REPORT NUMBER R009302-1

Annual Emission Testing Compliance Report
Boral Cement Ltd, Berrima

Document Information

Template Version; 030620

Client Name:	Boral Cement Ltd (Berrima)
Report Number:	R009302-1
Date of Issue:	7 October 2020
Attention:	Gabriel Paicu
Address:	Taylor Avenue NEW BERRIMA NSW 2577
Testing Laboratory:	Ektimo Pty Ltd, ABN 86 600 381 413

Report Authorisation

Aaron Davis
Client Manager

NATA Accredited Laboratory
No. 14601

Accredited for compliance with ISO/IEC 17025 - Testing. NATA is a signatory to the ILAC mutual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Please note that only numerical results pertaining to measurements conducted directly by Ektimo are covered by Ektimo's terms of NATA accreditation. This does not include comments, conclusions or recommendations based upon the results. Refer to 'Test Methods' for full details of testing covered by NATA accreditation.

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1 EXECUTIVE SUMMARY

1.1 *Background*

Ektimo was engaged by Boral Cement Ltd (Berrima) to perform emission monitoring as requested.

1.2 *Project Objectives*

The objectives of the project were to conduct a monitoring programme to quantify emissions from 5 discharge points to determine compliance with Boral Cement Ltd (Berrima)'s Environmental Licence.

Monitoring was performed as follows:

Location	Test Date	Test Parameters*
EPA 2 – No.6 Kiln Stack	22 June 2020	Sulfur dioxide, sulfur acid mist and sulfur trioxide (as SO_3) Metals type 1 & 2 substances in aggregate (Sb, As, Cd, Pb, Hg, Be, Cr, Co, Mn, Ni, Se, Sn, V) thallium Total fluoride, hydrogen chloride, chlorine
	23 June 2020	Speciated volatile organic compounds (VOCs) Dioxins and furans (PCDD & PCDF) Nitrogen oxides, carbon monoxide, carbon dioxide, oxygen Hexavalent chromium
	25 September 2020	Solid particles Carbon dioxide, oxygen
EPA 4 – No.6 Cement Mill Duct 1	16 July 2020	Solid particles
EPA 4 – No.6 Cement Mill Duct 2		
EPA 5 – No.6 Kiln Cooler Stack	25 June 2020	
EPA 10 – No.7 Cement Mill Stack		

* Flow rate, velocity, temperature and moisture were also determined.

All results are reported on a dry basis at STP.

Plant operating conditions have been noted in the report.

1.3 *Licence Comparison*

The following licence comparison table shows that all analytes highlighted in green are within the licence limit and all analytes highlighted in red are outside the licence limit set by the NSW EPA as per licence 1698 (last amended on 18 December 2019).

EPA	Parameter	Units	Licence limit	Detected values	Detected values (corrected to 10% O_2)
EPA 2 - Kiln Stack No. 6	Mercury	mg/m^3	0.05	0.0029	0.0037
	Type 1 and Type 2 substances in aggregate	mg/m^3	0.5	≤0.037	≤0.046
	Solid particles	mg/m^3	50	32	27
	Nitrogen oxides	mg/m^3	1250	970	930
	Cadmium + Thallium	mg/m^3	0.05	0.0022	0.0028
	Chlorine	mg/m^3	50	<0.01	<0.01
	Dioxins & furans (I-TEQ middle bound)	ng/m^3	0.1	0.0019	0.0018
	Hydrogen chloride	mg/m^3	10	0.15	0.22
	Hydrogen fluoride	mg/m^3	1	≤0.02	≤0.03
	Sulfur dioxide	mg/m^3	50	0.0028	0.037
	Sulfuric acid mist and sulfur trioxide (as SO_3)	mg/m^3	50	≤0.025	≤0.033
	Volatile organic compounds	mg/m^3	40	2.2	2.1
EPA 4 - No.6 Cement Mill Stack Duct 1	Solid particles	mg/m^3	100	35	NA
EPA 4 - No.6 Cement Mill Stack Duct 2	Solid particles	mg/m^3	100	7.9	NA
EPA 5 - No. 6 Kiln Cooler Stack	Solid particles	mg/m^3	100	1.9	NA
EPA 10 - No.7 Cement Mill Stack	Solid particles	mg/m^3	20	6.9	NA

*Please note that the measurement uncertainty associated with the test results **was not** considered when determining whether the results were compliant or non-compliant.*

Refer to the Test Methods table for the measurement uncertainties.

2 RESULTS

2.1 *EPA 2 – No.6 Kiln Stack*

Date	22/06/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 2: No.6 Kiln Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Steven Cooper, Zoe Parker, Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		*200602*

Sampling Plane Details	
Sampling plane dimensions	3000 mm
Sampling plane area	7.07 m²
Sampling port size, number	3" BSP & 4" Flange
Access & height of ports	Elevator 30 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Junction 8 D
No. traverses & points sampled	2 24
Sample plane compliance to AS4323.1	Ideal

Stack Parameters		
Moisture content, %v/v	8.2	
Gas molecular weight, g/g mole	29.9 (wet)	30.9 (dry)
Gas density at STP, kg/m³	1.33 (wet)	1.38 (dry)
% Oxygen correction & Factor	10 %	1.33
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	0905 & 1125	
Temperature, °C	106	
Temperature, K	379	
Velocity at sampling plane, m/s	28	
Volumetric flow rate, actual, m³/s	200	
Volumetric flow rate (wet STP), m³/s	130	
Volumetric flow rate (dry STP), m³/s	120	
Mass flow rate (wet basis), kg/hour	620000	

Isokinetic Results	Average			Test 1			Test 2		
Sampling time				0917-1120			0917-1120		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Sulfur dioxide	0.028	0.037	0.2	0.029	0.038	0.2	0.027	0.036	0.19
Sulfur trioxide and/or Sulfuric acid (as SO3)	≤0.025	≤0.033	≤0.17	0.034	0.045	0.24	<0.01	<0.02	<0.1
Isokinetic Sampling Parameters									
Sampling time, min				120			120		
Isokinetic rate, %				97			96		
Velocity difference, %				<1			<1		

Date	22/06/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 2: No.6 Kiln Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Steven Cooper, Zoe Parker, Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		200602

Sampling Plane Details		
Sampling plane dimensions	3000 mm	
Sampling plane area	7.07 m²	
Sampling port size, number	3" BSP & 4" Flange	
Access & height of ports	Elevator 30 m	
Duct orientation & shape	Vertical Circular	
Downstream disturbance	Exit 8 D	
Upstream disturbance	Junction 8 D	
No. traverses & points sampled	2 24	
Sample plane compliance to AS4323.1	Ideal	

Stack Parameters		
Moisture content, %v/v	8.2	
Gas molecular weight, g/g mole	29.9 (wet)	31.0 (dry)
Gas density at STP, kg/m³	1.34 (wet)	1.38 (dry)
% Oxygen correction & Factor	10 %	1.26
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1125 & 1345	
Temperature, °C	103	
Temperature, K	376	
Velocity at sampling plane, m/s	27	
Volumetric flow rate, actual, m³/s	190	
Volumetric flow rate (wet STP), m³/s	130	
Volumetric flow rate (dry STP), m³/s	120	
Mass flow rate (wet basis), kg/hour	610000	

Isokinetic Results	Average			Test 1			Test 2		
Sampling time				1130-1335			1130-1335		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Antimony	<0.002	<0.003	<0.02	<0.002	<0.003	<0.02	<0.002	<0.003	<0.02
Arsenic	<0.001	<0.001	<0.007	<0.001	<0.001	<0.007	<0.001	<0.001	<0.008
Beryllium	<0.0003	<0.0004	<0.002	<0.0003	<0.0004	<0.002	<0.0003	<0.0004	<0.002
Cadmium	<0.0003	<0.0003	<0.002	<0.0003	<0.0003	<0.002	<0.0002	<0.0003	<0.002
Chromium	0.0042	0.0052	0.029	0.0011	0.0013	0.0074	0.0072	0.0091	0.051
Cobalt	<0.0004	<0.0005	<0.003	<0.0004	<0.0005	<0.003	<0.0004	<0.0005	<0.003
Lead	≤0.0011	≤0.0014	≤0.008	<0.0009	<0.001	<0.006	0.0014	0.0018	0.0098
Manganese	0.017	0.021	0.12	0.011	0.014	0.076	0.023	0.029	0.16
Mercury	0.0029	0.0037	0.02	0.0027	0.0033	0.019	0.0032	0.004	0.022
Nickel	0.0017	0.0021	0.012	0.00058	0.00073	0.0041	0.0028	0.0036	0.02
Selenium	<0.003	<0.003	<0.02	<0.003	<0.003	<0.02	<0.003	<0.003	<0.02
Thallium	0.0022	0.0028	0.015	0.0012	0.0015	0.0082	0.0032	0.004	0.023
Tin	<0.001	<0.001	<0.007	<0.001	<0.001	<0.007	<0.001	<0.001	<0.008
Vanadium	0.002	0.0025	0.014	0.0012	0.0015	0.0083	0.0028	0.0035	0.019
Type 1 & 2 Substances									
Upper Bound									
Total Type 1 Substances	≤0.0078	≤0.0098	≤0.055	≤0.0073	≤0.0092	≤0.051	≤0.0083	≤0.01	≤0.058
Total Type 2 Substances	≤0.029	≤0.037	≤0.2	≤0.018	≤0.023	≤0.13	≤0.04	≤0.051	≤0.28
Total Type 1 & 2 Substances	≤0.037	≤0.046	≤0.26	≤0.025	≤0.032	≤0.18	≤0.048	≤0.061	≤0.34
Isokinetic Sampling Parameters									
Sampling time, min				120			120		
Isokinetic rate, %				94			94		
Velocity difference, %				-4			-4		

Date	22/06/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 2: No.6 Kiln Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Steven Cooper, Zoe Parker, Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		

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Sampling Plane Details	
Sampling plane dimensions	3000 mm
Sampling plane area	7.07 m²
Sampling port size, number	3" BSP & 4" Flange
Access & height of ports	Elevator 30 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Junction 8 D
No. traverses & points sampled	2 24
Sample plane compliance to AS4323.1	Ideal

Stack Parameters		
Moisture content, %v/v	8.2	
Gas molecular weight, g/g mole	29.6 (wet)	30.7 (dry)
Gas density at STP, kg/m³	1.32 (wet)	1.37 (dry)
% Oxygen correction & Factor	10 %	1.49
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1345 & 1605	
Temperature, °C	104	
Temperature, K	377	
Velocity at sampling plane, m/s	28	
Volumetric flow rate, actual, m³/s	200	
Volumetric flow rate (wet STP), m³/s	130	
Volumetric flow rate (dry STP), m³/s	120	
Mass flow rate (wet basis), kg/hour	620000	

Isokinetic Results	Average			Test 1			Test 2		
Sampling time				1358-1602			1358-1602		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Chloride (as HCl)	0.15	0.22	1.1	0.17	0.26	1.2	0.12	0.18	0.89
Chlorine	<0.01	<0.01	<0.07	<0.01	<0.01	<0.07	<0.01	<0.01	<0.07
Total fluoride (as HF)	≤0.02	≤0.03	≤0.15	0.021	0.031	0.15	<0.02	<0.03	<0.1
Isokinetic Sampling Parameters									
Sampling time, min				120			120		
Isokinetic rate, %				99			96		
Velocity difference, %				9			9		

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Ektimo Staff	Steven Cooper & Zoe Parker	**State**	NSW
Process Conditions	Please refer to client records.		200602

Sampling Plane Details		
Sampling plane dimensions	3000 mm	
Sampling plane area	7.07 m²	
Sampling port size, number	3" BSP & 4" Flange	
Access & height of ports	Elevator 30 m	
Duct orientation & shape	Vertical Circular	
Downstream disturbance	Exit 8 D	
Upstream disturbance	Junction 8 D	
No. traverses & points sampled	2 24	
Sample plane compliance to AS4323.1	Ideal	

Stack Parameters		
Moisture content, %v/v	13	
Gas molecular weight, g/g mole	30.0 (wet)	31.7 (dry)
Gas density at STP, kg/m³	1.34 (wet)	1.41 (dry)
% Oxygen correction & Factor	10 %	0.95
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1108 & 1720	
Temperature, °C	110	
Temperature, K	383	
Velocity at sampling plane, m/s	27	
Volumetric flow rate, actual, m³/s	190	
Volumetric flow rate (wet STP), m³/s	130	
Volumetric flow rate (dry STP), m³/s	110	
Mass flow rate (wet basis), kg/hour	610000	

Gas Analyser Results	Average			Minimum			Maximum		
Sampling time	1115 - 1523			1115 - 1523			1115 - 1523		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Combustion Gases									
Nitrogen oxides (as NO_2)	970	930	6400	920	870	6000	1000	990	6900
Carbon monoxide	300	290	2000	250	240	1700	420	400	2800
	Concentration %v/v			Concentration %v/v			Concentration %v/v		
Carbon dioxide	20			18.6			22.1		
Oxygen	9.4			8.2			10.2		

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Dioxins & Furans (PCDDs & PCDFs)	Average			Test 1			Test 2		
Sampling time				1115 - 1627			1115 - 1627		
	Concentration ng/m³	Corrected to 10% O2 ng/m³	Mass Rate ng/min	Concentration ng/m³	Corrected to 10% O2 ng/m³	Mass Rate ng/min	Concentration ng/m³	Corrected to 10% O2 ng/m³	Mass Rate ng/min
2,3,7,8-TCDF	0.00033	0.00031	2.1	0.00022	0.00021	1.5	0.00043	0.00041	2.8
2,3,7,8-TCDD	<0.0002	<0.0002	<1	<0.0002	<0.0002	<1	<0.0002	<0.0002	<1
1,2,3,7,8-PeCDF	0.000079	0.000075	0.52	0.000087	0.000083	0.58	0.00007	0.000067	0.46
2,3,4,7,8-PeCDF	0.00087	0.00083	5.7	0.00095	0.00091	6.3	0.00079	0.00075	5.2
1,2,3,7,8-PeCDD	0.00014	0.00013	0.93	0.00014	0.00014	0.94	0.00014	0.00013	0.92
1,2,3,4,7,8-HxCDF	0.00012	0.00012	0.81	0.00015	0.00015	1	0.000093	0.000088	0.61
1,2,3,6,7,8-HxCDF	0.000092	0.000087	0.6	0.00012	0.00011	0.78	0.000064	0.000061	0.42
2,3,4,6,7,8-HxCDF	0.00006	0.000057	0.39	0.000065	0.000062	0.43	0.000055	0.000052	0.36
1,2,3,7,8,9-HxCDF	<0.00003	<0.00003	<0.2	<0.00003	<0.00003	<0.2	<0.00003	<0.00003	<0.2
1,2,3,4,7,8-HxCDD	<0.00001	<0.00001	<0.1	<0.00001	<0.00001	<0.09	<0.00001	<0.00001	<0.1
1,2,3,6,7,8-HxCDD	0.000025	0.000024	0.17	0.000024	0.000023	0.16	0.000026	0.000025	0.17
1,2,3,7,8,9-HxCDD	≤0.00002	≤0.000019	≤0.13	0.000025	0.000024	0.17	<0.00001	<0.00001	<0.1
1,2,3,4,6,7,8-HpCDF	0.000011	0.000011	0.073	0.000014	0.000013	0.089	0.0000088	0.0000083	0.058
1,2,3,4,7,8,9-HpCDF	0.0000022	0.0000021	0.014	0.0000024	0.0000023	0.016	0.000002	0.0000019	0.013
1,2,3,4,6,7,8-HpCDD	0.000012	0.000012	0.082	0.000013	0.000012	0.085	0.000012	0.000011	0.078
OCDF	0.00000033	0.00000032	0.0022	0.00000037	0.00000035	0.0024	0.0000003	0.00000028	0.002
OCDD	0.000013	0.000012	0.086	0.000017	0.000017	0.12	0.0000088	0.0000083	0.058
Total TCDF isomers	0.052	0.049	340	0.046	0.044	300	0.058	0.055	380
Total TCDD isomers	0.0033	0.0032	22	0.0024	0.0023	16	0.0043	0.0041	28
Total PeCDF isomers	0.0061	0.0058	40	0.0037	0.0035	24	0.0086	0.0082	57
Total PeCDD isomers	0.0051	0.0049	34	0.0043	0.0041	28	0.0059	0.0057	39
Total HxCDF isomers	0.0068	0.0064	45	0.0083	0.0079	54	0.0053	0.005	35
Total HxCDD isomers	0.0034	0.0032	22	0.003	0.0029	20	0.0038	0.0036	25
Total HpCDF isomers	0.0019	0.0018	12	0.0024	0.0023	16	0.0014	0.0013	8.9
Total HpCDD isomers	0.0025	0.0024	17	0.0025	0.0024	17	0.0025	0.0024	16
Total PCDDs + PCDFs	0.095	0.09	620	0.09	0.086	600	0.099	0.094	650
I-TEQ									
Lower Bound	0.0018	0.0017	12	0.0018	0.0017	12	0.0017	0.0016	11
Middle Bound	0.0019	0.0018	12	0.0019	0.0018	13	0.0018	0.0017	12
Upper Bound	0.002	0.0019	13	0.002	0.0019	13	0.0019	0.0018	13

Abbreviations and definitions

I-TEQ	International toxic equivalents for dioxins and furans
Lower Bound	Defines values reported below detection as equal to zero.
Middle Bound	Defines values reported below detection are equal to half the detection limit.
Upper Bound	Defines values reported below detection are equal to the detection limit.

TEQs are calculated by multiplying the quantified result for each toxic compound by its corresponding toxic equivalency factor.

Isokinetic Sampling Parameters		Test 1	Test 2
Dioxins & Furans			
Sampling time, min		360	360
Isokinetic rate, %		99	96
Velocity difference, %		4	4

Date	23/06/2020	**Client**	Boral Cement Ltd
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Ektimo Staff	Steven Cooper & Zoe Parker	**State**	NSW
Process Conditions	Please refer to client records.		200602

Sampling Plane Details	
Sampling plane dimensions	3000 mm
Sampling plane area	7.07 m²
Sampling port size, number	3" BSP & 4" Flange
Access & height of ports	Elevator 30 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Junction 8 D
No. traverses & points sampled	2 24
Sample plane compliance to AS4323.1	Ideal

Stack Parameters		
Moisture content, %v/v	13	
Gas molecular weight, g/g mole	29.9 (wet)	31.6 (dry)
Gas density at STP, kg/m³	1.33 (wet)	1.41 (dry)
% Oxygen correction & Factor	10 %	0.99
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	0845 & 1108	
Temperature, °C	108	
Temperature, K	381	
Velocity at sampling plane, m/s	27	
Volumetric flow rate, actual, m³/s	190	
Volumetric flow rate (wet STP), m³/s	120	
Volumetric flow rate (dry STP), m³/s	110	
Mass flow rate (wet basis), kg/hour	600000	

Isokinetic Results	Average			Test 1			Test 2		
Sampling time				0855-1059			0855-1059		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Hexavalent chromium	<0.001	<0.001	<0.01	<0.001	<0.001	<0.009	<0.002	<0.002	<0.01
Isokinetic Sampling Parameters									
Sampling time, min				120			120		
Isokinetic rate, %				105			98		
Velocity difference, %				<1			<1		

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Process Conditions	Please refer to client records.		200602

Total VOCs (as n-Propane)	Average			Test 1			Test 2		
Sampling time									
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Total	2.2	2.1	14	2.2	2.2	14	2.1	2.1	14

VOC (speciated)	Average			Test 1			Test 2		
Sampling time				0918-1018			1019-1119		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Detection limit[1]	<0.05	<0.05	<0.3	<0.05	<0.05	<0.3	<0.05	<0.05	<0.3
Benzene	2.8	2.8	18	2.9	2.8	19	2.7	2.7	18
Toluene	0.28	0.28	1.8	0.3	0.29	1.9	0.26	0.26	1.7
m + p-Xylene	0.055	0.054	0.36	0.058	0.057	0.38	0.053	0.052	0.34
Heptane	0.21	0.21	1.4	0.21	0.21	1.4	0.22	0.22	1.4
Methylcyclohexane	0.087	0.086	0.57	0.087	0.086	0.57	0.088	0.086	0.57
Octane	0.25	0.25	1.6	0.24	0.24	1.6	0.26	0.26	1.7
Nonane	0.24	0.23	1.6	0.23	0.22	1.5	0.25	0.25	1.6
Decane	0.19	0.19	1.3	0.18	0.18	1.2	0.21	0.21	1.4
Undecane	0.24	0.24	1.6	0.25	0.24	1.6	0.23	0.23	1.5

(1) Unless otherwise reported, the following target compounds were found to be below detection:
Ethanol, Isopropanol, 1,1-Dichloroethene, Dichloromethane, trans-1,2-Dichloroethene, cis-1,2-Dichloroethene, Chloroform, 1,1,1-Trichloroethane, 1,2-Dichloroethane, Carbon tetrachloride, Butanol, 1-Methoxy-2-propanol, Trichloroethylene, 1,1,2-Trichloroethane, Tetrachloroethene, Chlorobenzene, Ethylbenzene, Styrene, o-Xylene, 2-Butoxyethanol, 1,1,2,2-Tetrachloroethane, Isopropylbenzene, Propylbenzene, 1,3,5-Trimethylbenzene, tert-Butylbenzene, 1,2,4-Trimethylbenzene, 1,2,3-Trimethylbenzene, Acetone, Pentane, Acrylonitrile, Methyl ethyl ketone, n-Hexane, Ethyl acetate, Cyclohexane, 2-Methylhexane, Isopropyl acetate, 2,3-Dimethylpentane, 3-Methylhexane, Ethyl acrylate, Methyl methacrylate, Propyl acetate, Methyl Isobutyl Ketone, 2-Hexanone, Butyl acetate, 1-Methoxy-2-propyl acetate, Butyl acrylate, Cellosolve acetate, α-Pinene, β-Pinene, 3-Carene, D-Limonene, Dodecane, Tridecane, Tetradecane

Date	25/09/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 2: No.6 Kiln Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Aaron Davis / Joel Micale	**State**	NSW
Process Conditions	Please refer to client records.		200916

Sampling Plane Details	
Sampling plane dimensions	3000 mm
Sampling plane area	7.07 m²
Sampling port size, number	3" BSP and 4" Flange
Access & height of ports	Elevator 30 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 8 D
Upstream disturbance	Junction 8 D
No. traverses & points sampled	2 24
Sample plane compliance to AS4323.1	Ideal

Stack Parameters		
Moisture content, %v/v	10	
Gas molecular weight, g/g mole	30.8 (wet)	32.2 (dry)
Gas density at STP, kg/m³	1.37 (wet)	1.44 (dry)
% Oxygen correction & Factor	10 %	0.85
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1245 & 1500	
Temperature, °C	110	
Temperature, K	383	
Velocity at sampling plane, m/s	33	
Volumetric flow rate, actual, m³/s	240	
Volumetric flow rate (wet STP), m³/s	150	
Volumetric flow rate (dry STP), m³/s	140	
Mass flow rate (wet basis), kg/hour	750000	

Gas Analyser Results	Average	Minimum	Maximum
Sampling time	1305 - 1404	1305 - 1404	1305 - 1404
	Concentration %v/v	Concentration %v/v	Concentration %v/v
Carbon dioxide	23.6	22.9	24.2
Oxygen	8.1	7.9	8.5

Isokinetic Results	Average			Test 1			Test 2		
Sampling time				1250-1455			1250-1455		
	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min	Concentration mg/m³	Corrected to 10% O2 mg/m³	Mass Rate g/min
Solid Particles	32	27	260	31	27	260	33	28	270
Isokinetic Sampling Parameters									
Sampling time, min				120			120		
Isokinetic rate, %				91			107		
Velocity difference, %				9			9		

2.2 *EPA 4 – No.6 Cement Mill Stack (Duct 1)*

Date	16/07/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 4: No.6 Cement Mill Stack Duct 1
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Hamish Proust / Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		*200602*

Sampling Plane Details	
Sampling plane dimensions	1160 x 1160 mm
Sampling plane area	1.35 m²
Sampling port size, number	3" BSP (x3)
Access & height of ports	Stairs 20 m
Duct orientation & shape	Horizontal Rectangular
Downstream disturbance	Bend 0.5 D
Upstream disturbance	Bend 0.5 D
No. traverses & points sampled	3 15
Sample plane compliance to AS4323.1	Non-compliant

Comments
The discharge is assumed to be composed of dry air and moisture

The sampling plane is deemed to be non-compliant due to the following reasons:
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane

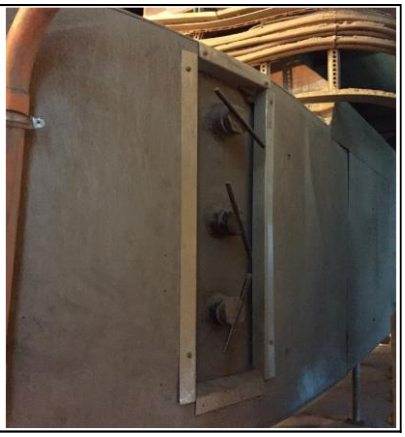
Stack Parameters		
Moisture content, %v/v	1.9	
Gas molecular weight, g/g mole	28.8 (wet)	29.0 (dry)
Gas density at STP, kg/m³	1.28 (wet)	1.29 (dry)
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	0945 & 1123	
Temperature, °C	77	
Temperature, K	350	
Velocity at sampling plane, m/s	15	
Volumetric flow rate, actual, m³/s	20	
Volumetric flow rate (wet STP), m³/s	15	
Volumetric flow rate (dry STP), m³/s	15	
Mass flow rate (wet basis), kg/hour	69000	

Isokinetic Results	Average		Test 1		Test 2	
Sampling time			0954-1115		1005-1125	
	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min
Solid Particles	35	31	66	59	4.4	3.9
Isokinetic Sampling Parameters						
Sampling time, min			75		75	
Isokinetic rate, %			94		98	
Velocity difference, %			5		5	

2.3 *EPA 4 – No.6 Cement Mill Stack (Duct 2)*

Date	16/07/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 4: No.6 Cement Mill Stack Duct 2
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Hamish Proust / Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		*200602*

Sampling Plane Details	
Sampling plane dimensions	700 x 1160 mm
Sampling plane area	0.812 m²
Sampling port size, number	3" BSP (x3)
Access & height of ports	Stairs 20 m
Duct orientation & shape	Horizontal Rectangular
Downstream disturbance	Bend 0.5 D
Upstream disturbance	Bend 0.5 D
No. traverses & points sampled	3 9
Sample plane compliance to AS4323.1	Non-compliant



Comments
The discharge is assumed to be composed of dry air and moisture
The downstream disturbance is <1D from the sampling plane
The upstream disturbance is <2D from the sampling plane

Stack Parameters		
Moisture content, %v/v	2.2	
Gas molecular weight, g/g mole	28.7 (wet)	29.0 (dry)
Gas density at STP, kg/m³	1.28 (wet)	1.29 (dry)
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1138 & 1252	
Temperature, °C	81	
Temperature, K	354	
Velocity at sampling plane, m/s	16	
Volumetric flow rate, actual, m³/s	13	
Volumetric flow rate (wet STP), m³/s	9.3	
Volumetric flow rate (dry STP), m³/s	9.1	
Mass flow rate (wet basis), kg/hour	43000	

Isokinetic Results	Average		Test 1		Test 2	
Sampling time			1143-1250		1143-1250	
	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min
Solid Particles	7.9	4.3	6.8	3.7	8.9	4.9
Isokinetic Sampling Parameters						
Sampling time, min			63		63	
Isokinetic rate, %			96		107	
Velocity difference, %			-3		-3	

2.4 *EPA 5 – No.6 Kiln Cooler Stack*

Date	25/06/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 5: No.6 Kiln Cooler Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Steven Cooper & Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		200602

Sampling Plane Details	
Sampling plane dimensions	2400 mm
Sampling plane area	4.52 m²
Sampling port size, number	3"BSP & 4" flange
Access & height of ports	Stairs 25 m
Duct orientation & shape	Vertical Circular
Downstream disturbance	Exit 5 D
Upstream disturbance	Junction 6 D
No. traverses & points sampled	2 16
Sample plane compliance to AS4323.1	Ideal

Comments
The discharge is assumed to be composed of dry air and moisture

Stack Parameters		
Moisture content, %v/v	<0.4	
Gas molecular weight, g/g mole	28.9 (wet)	29.0 (dry)
Gas density at STP, kg/m³	1.29 (wet)	1.29 (dry)
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	0928 & 1125	
Temperature, °C	87	
Temperature, K	360	
Velocity at sampling plane, m/s	11	
Volumetric flow rate, actual, m³/s	50	
Volumetric flow rate (wet STP), m³/s	35	
Volumetric flow rate (dry STP), m³/s	35	
Mass flow rate (wet basis), kg/hour	160000	

Isokinetic Results	Average		Test 1		Test 2	
Sampling time			0953-1116		0953-1116	
	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min
Solid Particles	1.9	4	1.8	3.7	2	4.3
Isokinetic Sampling Parameters						
Sampling time, min			80		80	
Isokinetic rate, %			96		101	
Velocity difference, %			6		6	

2.5 *EPA 10 – No.7 Cement Mill Stack*

Date	25/06/2020	**Client**	Boral Cement Ltd
Report	R009302	**Stack ID**	EPA 10: No.7 Cement Mill Stack
Licence No.	1698	**Location**	New Berrima
Ektimo Staff	Steven Cooper & Joel Micale-David	**State**	NSW
Process Conditions	Please refer to client records.		*200602*

Sampling Plane Details	
Sampling plane dimensions	1520 x 1800 mm
Sampling plane area	2.74 m²
Sampling port size, number	4" BSP (x5)
Access & height of ports	Stairs 10 m
Duct orientation & shape	Inclined Rectangular
Downstream disturbance	Bend 0.5 D
Upstream disturbance	Bend 2 D
No. traverses & points sampled	5 20
Sample plane compliance to AS4323.1	Non-compliant

Comments
The discharge is assumed to be composed of dry air and moisture

The sampling plane is deemed to be non-compliant due to the following reasons:
The gas velocity at some or all sampling points is less than 3 m/s
The highest to lowest differential pressure ratio exceeds 9:1
The downstream disturbance is <1D from the sampling plane
The sampling plane is too near to the upstream disturbance but is greater than or equal to 2D

Stack Parameters		
Moisture content, %v/v	14	
Gas molecular weight, g/g mole	27.4 (wet)	29.0 (dry)
Gas density at STP, kg/m³	1.22 (wet)	1.29 (dry)
Gas Flow Parameters		
Flow measurement time(s) (hhmm)	1226 & 1510	
Temperature, °C	97	
Temperature, K	370	
Velocity at sampling plane, m/s	5.3	
Volumetric flow rate, actual, m³/s	14	
Volumetric flow rate (wet STP), m³/s	9.9	
Volumetric flow rate (dry STP), m³/s	8.5	
Mass flow rate (wet basis), kg/hour	44000	

Isokinetic Results	Average		Test 1		Test 2	
Sampling time			1323-1507		1323-1507	
	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min	Concentration mg/m³	Mass Rate g/min
Solid Particles	6.9	3.5	7.3	3.7	6.5	3.3
Isokinetic Sampling Parameters						
Sampling time, min			100		100	
Isokinetic rate, %			107		108	
Velocity difference, %			-9		-9	

3 PLANT OPERATING CONDITIONS

See Boral Cement Ltd (Berrima) records for complete process conditions.

4 TEST METHODS

All sampling and analysis performed by Ektimo unless otherwise specified. Specific details of the methods are available upon request.

Parameter	Sampling Method	Analysis Method	Uncertainty*	NATA Accredited	
				Sampling	Analysis
Sample plane criteria	NSW TM-1	NA	NA	✓	NA
Flow rate, temperature and velocity	NA	NSW TM-2	8%, 2%, 7%	NA	✓
Moisture content	NSW TM-22	NSW TM-22	8%	✓	✓
Carbon dioxide	NSW TM-24	NSW TM-24	13%	✓	✓
Carbon monoxide	NSW TM-32	NSW TM-32	12%	✓	✓
Nitrogen oxides	NSW TM-11	NSW TM-11	12%	✓	✓
Oxygen	NSW TM-25	NSW TM-25	13%	✓	✓
Speciated volatile organic compounds (VOC's)	NSW TM-34[d]	Ektimo 344	19%	✓	✓[†]
Chlorine	NSW TM-7	Ektimo 235	14%	✓	✓[†]
Total and hexavalent chromium	NSW OM-4	Envirolab inhouse Metals-006, Inorg-024	16%	✓	✓[‡]
Dioxins and furans (PCDD's and PCDF's)	NSW TM-18	NMI AUTL_02	16%	✓	✓[¶]
Fluorine	NSW TM-9	ALS Method QWI-EN/EA144C & Ektimo 240	25%	✓	✓[#,†]
Hydrogen chloride	NSW TM-8	Ektimo 235	14%	✓	✓[†]
Solid particles (total)	NSW TM-15	NSW TM-15[††]	5%	✓	✓
Sulfuric acid mist and/or sulfur trioxide	NSW TM-3	Ektimo 235	16%	✓	✓[†]
Total (gaseous and particulate) metals and metallic compounds	NSW TM-12, NSW TM-13, NSW TM-14	Envirolab inhouse Metals-006, Metals-022, Metals-021	15%	✓	✓[‡]
Type 1 substances (Sb, As, Cd, Pb, Hg)	NSW TM-12	Envirolab inhouse Metals-006, Metals-022, Metals-021	15%	✓	✓[‡]
Type 2 substances (Be, Cr, Co, Mn, Ni, Se, Sn, V)	NSW TM-13	Envirolab inhouse Metals-006, Metals-022	15%	✓	✓[‡]

* Uncertainty values cited in this table are calculated at the 95% confidence level (coverage factor = 2)

† Analysis conducted at the Ektimo Mitcham, VIC laboratory, NATA accreditation number 14601. Results were reported on
2 July 2020 in report number R009302_Halides_Halogens.
7 July 2020 in report number R009302-SOx.
8 July 2020 in report number R009302-ISE-F.
13 July 2020 in report number R009302_SVOCs.

†† Gravimetric analysis conducted at the Ektimo Unanderra, NSW laboratory, NATA accreditation number 14601.

‡ Analysis performed by Envirolab, NATA accreditation number 2901. Results were reported to Ektimo on 24 July 2020 in report number 245721.

¶ Analysis performed by Australian Government National Measurement Institute, NATA accreditation number 198. Results were reported to Ektimo on 23 July 2020 in report number DAU20_183.

Analysis (solid fluoride only) performed by Australian Laboratory Services Pty Ltd, NATA accreditation number 825. Results were reported to Ektimo on 10 July 2020 in report number EN2004602.

d Excludes recovery study as specified in section 8.4.3 of USEPA Test Method 18.

5 QUALITY ASSURANCE/QUALITY CONTROL INFORMATION

Ektimo is accredited by the National Association of Testing Authorities (NATA) for the sampling and analysis of air pollutants from industrial sources. Unless otherwise stated test methods used are accredited with the National Association of Testing Authorities. For full details, search for Ektimo at NATA's website www.nata.com.au.

Ektimo is accredited by NATA (National Association of Testing Authorities) to ISO/IEC 17025 - Testing. ISO/IEC 17025 - Testing requires that a laboratory have adequate equipment to perform the testing, as well as laboratory personnel with the competence to perform the testing. This quality assurance system is administered and maintained by the Quality Director.

NATA is a member of APLAC (Asia Pacific Laboratory Accreditation Co-operation) and of ILAC (International Laboratory Accreditation Co-operation). Through the mutual recognition arrangements with both of these organisations, NATA accreditation is recognised worldwide.

6 DEFINITIONS

The following symbols and abbreviations may be used in this test report:

% v/v	Volume to volume ratio, dry or wet basis
~	Approximately
<	Less than
>	Greater than
≥	Greater than or equal to
APHA	American public health association, Standard Methods for the Examination of Water and Waste Water
AS	Australian Standard
BSP	British standard pipe
CARB	Californian Air Resources Board
CEM	Continuous Emission Monitoring
CEMS	Continuous Emission Monitoring System
CTM	Conditional test method
D	Duct diameter or equivalent duct diameter for rectangular ducts
D_{50}	'Cut size' of a cyclone defined as the particle diameter at which the cyclone achieves a 50% collection efficiency ie. half of the particles are retained by the cyclone and half are not and pass through it to the next stage. The D_{50} method simplifies the capture efficiency distribution by assuming that a given cyclone stage captures all of the particles with a diameter equal to or greater than the D_{50} of that cyclone and less than the D_{50} of the preceding cyclone.
DECC	Department of Environment & Climate Change (NSW)
Disturbance	A flow obstruction or instability in the direction of the flow which may impede accurate flow determination. This includes centrifugal fans, axial fans, partially closed or closed dampers, louvres, bends, connections, junctions, direction changes or changes in pipe diameter.
DWER	Department of Water and Environmental Regulation (WA)
DEHP	Department of Environment and Heritage Protection (QLD)
EPA	Environment Protection Authority
FTIR	Fourier Transform Infra-red
ISC	Intersociety committee, Methods of Air Sampling and Analysis
ISO	International Organisation for Standardisation
Lower Bound	Defines values reported below detection as equal to zero.
Medium Bound	Defines values reported below detection are equal to half the detection limit.
NA	Not applicable
NATA	National Association of Testing Authorities
NIOSH	National Institute of Occupational Safety and Health
NT	Not tested or results not required
OM	Other approved method
OU	The number of odour units per unit of volume. The numerical value of the odour concentration is equal to the number of dilutions to arrive at the odour threshold (50% panel response).
PM_{10}	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 10 microns (µm).
$PM_{2.5}$	Atmospheric suspended particulate matter having an equivalent aerodynamic diameter of less than approximately 2.5 microns (µm).
PSA	Particle size analysis
RATA	Relative Accuracy Test Audit
Semi-quantified VOCs	Unknown VOCs (those not matching a standard compound), are identified by matching the mass spectrum of the chromatographic peak to the NIST Standard Reference Database (version 14.0), with a match quality exceeding 70%. An estimated concentration will be determined by matching the integrated area of the peak with the nearest suitable compound in the analytical calibration standard mixture.
STP	Standard temperature and pressure. Gas volumes and concentrations are expressed on a dry basis at 0°C, at discharge oxygen concentration and an absolute pressure of 101.325 kPa, unless otherwise specified.
TM	Test Method
TOC	The sum of all compounds of carbon which contain at least one carbon to carbon bond, plus methane and its derivatives.
USEPA	United States Environmental Protection Agency
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
Velocity Difference	The percentage difference between the average of initial flows and afterflows.
Vic EPA	Victorian Environment Protection Authority
VOC	Any chemical compound based on carbon with a vapour pressure of at least 0.010 kPa at 25°C or having a corresponding volatility under the particular conditions of use. These compounds may contain oxygen, nitrogen and other elements, but specifically excluded are carbon monoxide, carbon dioxide, carbonic acid, metallic carbides and carbonate salts.
XRD	X-ray Diffractometry
Upper Bound	Defines values reported below detection are equal to the detection limit.
95% confidence interval	Range of values that contains the true result with 95% certainty. This means there is a 5% risk that the true result is outside this range.

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