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Boral Cement Limited
Berrima Works

Non-Standard Fuels Pollutant Tracking First Half Year Report

April 2023

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1. Introduction

In July 2015, Boral sought approval to modify the consent for the Berrima Cement Works to enable the use of Solid Waste Derived Fuel (SWDF) as an energy source. Modification 9 to the consent DA 401-11-2002 was subsequently approved which included a number of additional monitoring and management conditions covering the use of these alternative fuels. The consent also separated the use of standard fuels, being traditional coal and coal derivatives along with diesel for start-up and non-standard fuels being derived from waste. Non-Standard Fuels (NSF) is the broad term now used to cover the various waste derived fuels approved to be used in the cement plant.

Boral commenced using two types of NSF in August 2018, including Wood Waste (WW) and Refuse Derived Fuels (RDF) known as Solid Waste Derived Fuels (SWDF). Both materials have undergone separation and screening processes to remove contaminants such as, glass and metals. Product specifications have been established and Quality Assurance/Quality Control (QA/QC) procedures implemented.

As per condition 3.22 of the DA, Boral are required to implement a tracking program to undertake:

a) Batch analysis of non-standard fuels received at the development as provided by suppliers and the results of any check analysis carried out by the applicant as part of the quality control management procedures
b) A mass inventory of each pollutant entering the process in raw materials, conventional fuels and non-standard fuels, with particular attention to, but not limited to chlorine, mercury cadmium and chromium.
c) Calculate emission factors for each pollutant based on inputs, outputs and measured air emissions and a variance in the emission factors from period to period.
d) Any adjustments that may be necessary to non-standard fuel specifications from the tracking analysis.

The initial period of use of SWDF was part of a Proof of Performance Trial which included the submission of monthly reports and a Proof of Performance Trial Consolidated Six Month Report for Solid Waste Derived Fuels on 28 February 2019. On the 23 April 2019 the Department of Planning and Environment approved the ongoing use of SWDF following consultation with the EPA subject to:

a) Limiting the amount of SWDF to be fired in Kiln 6 to 40%, as a percentage of total fuel
b) Periodic stack testing being undertaken every three months for the first 12 months of use of SWDF. The monitored pollutants must be consistent with the requirements of the Environment Protection Licence (EPL 1698)
c) Provision of a monitoring report that outlines the results of quarterly stack testing required in (a) and provides an assessment of compliance against the air emissions limits for the facility, to the satisfaction of the Secretary
d) Periodic measurements of hydrogen chloride (HCL) taken every 3 months until such time the Secretary agrees the accuracy of the HCL CEMS is confirmed through successful calibration audits undertaken in accordance with USEPA Performance Specification 18.

Condition 3.23 of the DA required Boral Cement to submit a report that assesses the results of the tracking program every 3 months in the first year of operating non-standard fuels under this consent to be synchronised with stack testing and every six months thereafter.

The following report is covering detailed findings from the non-standard fuels Pollutant Tracking Program for the biannual testing following the approval for continual use of SWDF. This report incorporates the requirements of Condition 3.23.

As part of the tracking program we consolidate all raw material and fuel specification testing against quantities used and compare this to actual stack testing to determine an emission factor by unit of input by chemical.

1.1 Stack Testing Result

On 18th April 2023 stack testing undertaken at Berrima Cement was compliant with the licence limits as summaries in Table 1 below. A copy of the full report numbered R014636 is attached. Metals and Chlorine are outlined in the pollutant tracking discussion. Emissions were in compliance with the Environment Protection Licence 1698.

Parameter	Unit	Limits	18/04/2023 R014636
Mercury	mg/m3	0.05	0.0047
Type 1 and type 2 substances	mg/m3	0.5	<0.034
Solid particles	mg/m3	50	19
Nitrogen oxides	mg/m3	1250	790
Cadmium and Thallium	mg/m3	0.05	<0.0024
Chlorine	mg/m3	50	<0.06
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.0074
Hydrogen chloride (HCl)*	mg/m3	10	0.15
Hydrogen fluoride	mg/m3	1	0.074
Sulfur dioxide	mg/m3	50	6.1
Sulfuric acid mist and sulfur trioxide	mg/m3	50	5.3
Volatiles organic compounds	mg/m3	40	2.5

*Note that HCl is well below the limit of 10mg/m3.

1.2 Raw Material Inputs

The raw materials used within Kiln 6 include Limestone, Yellow Shale, Blue Shale, Steel Slag and Granulated Blast Furnace Slag. Table 2 summaries the percentage of each raw material input used, the chemical properties of each of the raw material inputs, and the total chemical properties of the raw feed combined in use during the stack testing in April 2023.

Table 2 – Raw Material Input Quantities and Chemical Properties

Raw Material - Input								
Chemical		Feed Source1	Feed Source2	Feed Source3	Feed Source4	Feed Source5	Feed Source3.1	Final Feed
Properties		Limestone	Yellow Shale	Blue Shale	GYP	Steel Slag	GBFS	
	Set Point %	81.77%	3.17%	7.51%	0.00%	4.55%	3.00%	100.00%
Arsenic	As (mg/kg)	1.3	6.1	4.4		0.6	0.7	1.64
Beryllium	Be (mg/kg)	0.1	0.7	1.1		0.4	7.3	0.42
Cadmium	Cd (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chromium	Cr (mg/kg)	3.3	34	25.3		1840	19.5	89.98
Cobalt	Co (mg/kg)	1	7.4	15.1		0.5	0.1	2.21
Copper	Cu (mg/kg)	1.3	9.8	43		16.9	0.7	5.39
Mercury	Hg (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Manganese	Mn (mg/kg)	118	149	946		22600	2240	1267.76
Nickel	Ni (mg/kg)	2.5	10.1	21.3		2.7	0.4	4.10
Lead	Pb (mg/kg)	2.1	6.8	20.5		0.7	0.2	3.51
Antimony	Sb (mg/kg)	0.2	0.8	0.3		0.1	0.1	0.22
Selenium	Se (mg/kg)	1	1	2		1	4	1.17
Tin	Sn (mg/kg)	0.2	1.7	0.6		1.5	0.1	0.33
Vanadium	V (mg/kg)	3	34	51		1470	57	75.96
Thallium	Th (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chlorine	Cl (mg/kg)	20	10	20		10	340	28.828
kg mat/kg clinker								1.58

To interpret the table, 81.77% of the raw material is limestone. Within limestone there is 1.3 mg/kg of Arsenic (As), while yellow shale used at 3.17% contained 6.1 mg/kg of As. Combined with the other raw materials of blue shale, steel slag and granulated blast furnace slag, the total As of raw feed is 1.64 mg/kg.

To produce 1 kg of clinker, 1.58 kg of raw materials are required.

1.3 Kiln Fuel Inputs

The fuel in use at Berrima during normal operating conditions i.e. excluding start-up conditions includes Coal and Solid Waste Derived fuels Wood Waste and Refuse Derived Fuel.

Table 3 – Kiln Fuel Input Quantities and Chemical Properties

		Kiln Fuel - Input				
Chemical Properties		Fuel Source 1 Coal	Fuel Source 2 Wood Benedict	Fuel Source 3 RDF	Fuel Source 4 Wood Brandown	Final Fuel - Kiln
	Set Point %	62.15%	15.90%	6.44%	15.52%	100.00%
Arsenic	As (mg/kg)	1.7	50	31	21	14.3
Beryllium	Be (mg/kg)	1.3	1	1	1	1.2
Cadmium	Cd (mg/kg)	0.1	1	1	1	0.4
Chromium	Cr (mg/kg)	3.5	74	50	79	29.4
Cobalt	Co (mg/kg)	0.4	1	2	3	1.0
Copper	Cu (mg/kg)	3.6	51	31	31	17.2
Mercury	Hg (mg/kg)	0.1	0.05	0.05	0.05	0.1
Manganese	Mn (mg/kg)	102	51	39	274	116.5
Nickel	Ni (mg/kg)	11.5	4	1	4	8.5
Lead	Pb (mg/kg)	3.7	52	13	84	24.4
Antimony	Sb (mg/kg)	0.2	1	1	4	1.0
Selenium	Se (mg/kg)	1	1	1	1	1.0
Tin	Sn (mg/kg)	0.2	2	23	7	3.0
Vanadium	V (mg/kg)	11	3	45	7	11.3
Thallium	Th (mg/kg)	0.1	1	1	1	0.4
Chlorine	Cl (mg/kg)	10	0.08	0.1	0.21	6.266
kg fuel/kg clinker		0.1004	0.0257	0.0104	0.0251	0.162

Table 3 details the inventory of fuel input and the percentage of each fuel used. As can be seen 62.15% of the fuel in use was coal, with SWDF accounting for 37.85% total fuel, split between RDF and Wood.

Taking As as an example, coal contains 1.7 mg/kg and RDF 31 mg/kg. As makes up 14.3 mg/kg in the total fuel.

To produce 1kg of Clinker a total of 0.162 kg of fuel is consumed.

1.4 Total Fuel Inputs and Associated Emission Factors

Table 4 collates the raw material and fuel inputs comparing to stack emissions to calculate an emission factor per unit of chemical input.

Table 4 – Emissions Factors per unit of input for raw materials and fuel

	Total Input	Stack Emissions		Emission factor
	Raw material + Fuel			
	mg/kg clk	mg/Nm3	mg/kg clk	from input
Arsenic	4.88	0.002	0.00514	0.00105
Beryllium	0.86	0.0004	0.00103	0.00120
Cadmium	0.23	0.0004	0.00103	0.00450
Chromium	146.47	0.0017	0.00437	0.00003
Cobalt	3.65	0.0004	0.00103	0.00028
Copper	11.27	0.00092	0.00237	0.00021
Mercury	0.17	0.0047	0.01209	0.07084
Manganese	2015.54	0.011	0.02829	0.00001
Nickel	7.82	0.001	0.00257	0.00033
Lead	9.48	0.0028	0.00720	0.00076
Antimony	0.50	0.004	0.01029	0.02052
Selenium	2.00	0.004	0.01029	0.00515
Tin	1.01	0.002	0.00514	0.00508
Vanadium	121.46	0.0009	0.00231	0.00002
Thallium	0.23	0.002	0.00514	0.02249
Chlorine	46.417	0.06	0.15429	0.00332

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is calculated by (raw material chemical/kg X kg materials/kg clinker) + (Kiln fuel chemical/kg X kiln fuel kg/kg clinker).

(1.64*1.58) + (14.3*0.162) = 4.88 mg/kg clinker

The emission factor per unit of input for As is calculated by dividing the calculated emissions per kg of clinker by the total As input.

0.00514/4.88 = 0.00105

Table 5 is similar to Table 4 but calculates an emission factor based on the fuel only.

Table 5 – Emissions Factor fuel only

	Total Input	Stack Emissions		Emission factor
	Fuel only			
	mg/kg clk	mg/Nm3	mg/kg clk	from input
Arsenic	2.30	0.002	0.00514	0.00223
Beryllium	0.19	0.0004	0.00103	0.00537
Cadmium	0.07	0.0004	0.00103	0.01445
Chromium	4.75	0.0017	0.00437	0.00092
Cobalt	0.16	0.0004	0.00103	0.00635
Copper	2.77	0.00092	0.00237	0.00085
Mercury	0.01	0.0047	0.01209	0.92266
Manganese	18.83	0.011	0.02829	0.00150
Nickel	1.37	0.001	0.00257	0.00188
Lead	3.95	0.0028	0.00720	0.00182
Antimony	0.16	0.004	0.01029	0.06574
Selenium	0.16	0.004	0.01029	0.06366
Tin	0.49	0.002	0.00514	0.01058
Vanadium	1.82	0.0009	0.00231	0.00127
Thallium	0.07	0.002	0.00514	0.07223
Chlorine	1.012	0.06	0.15429	0.15239

Any variance to the Emissions Factors in Table 4 & Table 5 can be used to determine the contribution from either raw materials, standard and non-standard fuels.

1.5 Alternate Fuel Inputs and Total Inputs Raw Material and Fuel

Table 6 show the Alternate Fuel inputs against the total raw material and fuel inputs per unit of clinker produced.

Table 6 – Alternate Fuels inputs compared to total inputs from Raw materials and Fuels

	Input		
	Total Input		
	Raw material + Fuel	Alternative Fuels	
	mg/kg clk	mg/kg clk	% input from AF
Arsenic	4.88	2.13	43.72%
Beryllium	0.86	0.06	7.12%
Cadmium	0.23	0.06	26.74%
Chromium	146.47	4.40	3.01%
Cobalt	3.65	0.12	3.34%
Copper	11.27	2.41	21.39%
Mercury	0.17	0.00	1.79%
Manganese	2015.54	8.59	0.43%
Nickel	7.82	0.21	2.73%
Lead	9.48	3.58	37.75%
Antimony	0.50	0.14	27.20%
Selenium	2.00	0.06	3.06%
Tin	1.01	0.47	46.06%
Vanadium	121.46	0.72	0.59%
Thallium	0.23	0.06	26.74%
Chlorine	46.42	0.01	0.02%

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is 4.88 mg/kg clinker (see calculation for table 4)

The total As concentration for inputs from Alternate fuel is 2.13 mg/kg clinker. This represents 43.72% of the total As input in the process.

2.13/4.88 *100 = 43.72%