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Boral Cement Limited
Berrima Works

Non-Standard Fuels Pollutant Tracking
Half Year Report

April 2021

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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 details findings from the non-standard fuels Pollutant Tracking Program for the second 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 07 April 2021 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 R010398 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	11/05/2021 R010398
Mercury	mg/m3	0.05	0.008
Type 1 and type 2 substances	mg/m3	0.5	<0.3
Solid particles	mg/m3	50	20
Nitrogen oxides	mg/m3	1250	980
Cadmium and Thallium	mg/m3	0.05	0.007
Chlorine	mg/m3	50	0.023
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.0018
Hydrogen chloride (HCl)*	mg/m3	10	0.087
Hydrogen fluoride	mg/m3	1	<0.084
Sulfur dioxide	mg/m3	50	0.054
Sulfuric acid mist and sulfur trioxide	mg/m3	50	0.068
Volatiles organic compounds	mg/m3	40	1.3

*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 2021.

Table 2 – Raw Material Input Quantities and Chemical Properties

Raw Material - Input								
Chemical Properties		Feed Source1 Limestone	Feed Source2 Yellow Shale	Feed Source3 Blue Shale	Feed Source4 GYP	Feed Source5 Steel Slag	Feed Source3.1 GBFS	Final Feed
	Set Point %	85.97%	0.17%	7.51%	0.00%	3.45%	2.90%	100.00%
Arsenic	As (mg/kg)	1.7	8.9	4.1		0.9	0.6	1.83
Beryllium	Be (mg/kg)	0.1	1.2	1		0.3	7	0.38
Cadmium	Cd (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chromium	Cr (mg/kg)	4.1	43.3	13		1370	26	52.59
Cobalt	Co (mg/kg)	3	10.8	14.1		1	0.2	3.70
Copper	Cu (mg/kg)	4.7	15	37.5		18.8	1.4	7.57
Mercury	Hg (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Manganese	Mn (mg/kg)	150	415	1180		20900	2450	1010.38
Nickel	Ni (mg/kg)	4.9	19	20.1		6.4	0.8	6.00
Lead	Pb (mg/kg)	1.8	11.8	18.8		1.5	0.2	3.04
Antimony	Sb (mg/kg)	0.1	0.9	0.2		0.1	0.1	0.11
Selenium	Se (mg/kg)	1	1	1		1	3	1.06
Tin	Sn (mg/kg)	0.3	1.4	0.4		0.9	0.1	0.32
Vanadium	V (mg/kg)	8	44	37		2330	105	93.16
Thallium	Th (mg/kg)	0.1	0.2	0.1		0.1	0.1	0.10
Chlorine	Cl (mg/kg)	0.063	0.008	0.005		0.01	0.003	0.055
kg mat/kg clinker								1.54

To interpret the table, 85.97% of the raw material is limestone. Within limestone there is 1.7 mg/kg of Arsenic (As), while yellow shale used at 0.17% contained 8.9 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 1.83 mg/kg.

To produce 1 kg of clinker, 1.54 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

Chemical Properties		Fuel Source 1 Coal	Fuel Source 2 Wood Veolia	Fuel Source 3 RDF	Fuel Source 4 Wood Brandown	Final Fuel - Kiln
	Set Point %	78.55%	7.03%	7.13%	7.29%	100.00%
Arsenic	As (mg/kg)	0.4	33	15	71	8.9
Beryllium	Be (mg/kg)	0.5	1	1	1	0.6
Cadmium	Cd (mg/kg)	0.1	1	1	1	0.3
Chromium	Cr (mg/kg)	0.7	49	31	88	12.6
Cobalt	Co (mg/kg)	0.3	2	2	1	0.6
Copper	Cu (mg/kg)	7.8	45	19	54	14.6
Mercury	Hg (mg/kg)	0.1	0.08	0.05	0.06	0.1
Manganese	Mn (mg/kg)	224	45	56	38	185.9
Nickel	Ni (mg/kg)	0.5	2	2	1	0.7
Lead	Pb (mg/kg)	8.7	13	100	13	15.8
Antimony	Sb (mg/kg)	0.2	1	2	1	0.4
Selenium	Se (mg/kg)	1	1	1	2	1.1
Tin	Sn (mg/kg)	1	1	15	1	2.0
Vanadium	V (mg/kg)	1	2	3	1	1.2
Thallium	Th (mg/kg)	0.1	1	1	1	0.3
Chlorine	Cl (mg/kg)	0.0013	0.01	0.5	0.02	0.039
kg fuel/kg clinker		0.1299	0.0116	0.0118	0.0121	0.165

Table 3 details the inventory of fuel input and the percentage of each fuel used. As can be seen 78.55% of the fuel in use was coal, with Solid Waste Derived Fuels accounting for 21.45% (Wood Waste - Veolia 7.03%, RDF 7.13% and Wood Waste – Brandown 7.29%).

Taking As as an example, coal contains 0.4mg/kg, wood waste Veolia 33 mg/kg, RDF 15 mg/kg and wood waste Brandown 71 mg/kg. As makes up 8.9 mg/kg in the total fuel.

To produce 1kg of Clinker a total of 0.165 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	4.29	0.0043	0.009288	0.00216
Beryllium	0.68	0.0005	0.00108	0.00159
Cadmium	0.20	0.0006	0.001296	0.00640
Chromium	83.13	0.013	0.02808	0.00034
Cobalt	5.79	0.0034	0.007344	0.00127
Copper	14.08	0.012	0.02592	0.00184
Mercury	0.17	0.008	0.01728	0.10205
Manganese	1587.63	0.26	0.5616	0.00035
Nickel	9.37	0.0085	0.01836	0.00196
Lead	7.30	0.01	0.0216	0.00296
Antimony	0.24	0.004	0.00864	0.03585
Selenium	1.81	0.006	0.01296	0.00717
Tin	0.83	0.002	0.00432	0.00520
Vanadium	143.75	0.023	0.04968	0.00035
Thallium	0.20	0.0065	0.01404	0.06923
Chlorine	0.091	0.023	0.04968	0.54506

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).

(1.83*1.54) + (8.9*0.165) = 4.29 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.

0.009288/4.29 = 0.00216

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	1.47	0.0043	0.009288	0.00632
Beryllium	0.10	0.0005	0.00108	0.01075
Cadmium	0.05	0.0006	0.001296	0.02674
Chromium	2.09	0.013	0.02808	0.01345
Cobalt	0.10	0.0034	0.007344	0.07505
Copper	2.41	0.012	0.02592	0.01075
Mercury	0.02	0.008	0.01728	1.13445
Manganese	30.74	0.26	0.5616	0.01827
Nickel	0.12	0.0085	0.01836	0.14826
Lead	2.62	0.01	0.0216	0.00825
Antimony	0.07	0.004	0.00864	0.11795
Selenium	0.18	0.006	0.01296	0.07304
Tin	0.33	0.002	0.00432	0.01307
Vanadium	0.20	0.023	0.04968	0.24769
Thallium	0.05	0.0065	0.01404	0.28970
Chlorine	0.006	0.023	0.04968	7.73351

Any variance to the the Emissions Factors in Table 4 & Table 5 can be used to determine the contribution from either raw materials, standard and non-standard fuels. This will be undertaken during future reviews of tracking data.

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	4.29	1.42	33.00%
Beryllium	0.68	0.04	5.21%
Cadmium	0.20	0.04	17.51%
Chromium	83.13	2.00	2.40%
Cobalt	5.79	0.06	1.02%
Copper	14.08	1.40	9.93%
Mercury	0.17	0.00	1.32%
Manganese	1587.63	1.64	0.10%
Nickel	9.37	0.06	0.63%
Lead	7.30	1.49	20.38%
Antimony	0.24	0.05	19.61%
Selenium	1.81	0.05	2.63%
Tin	0.83	0.20	24.16%
Vanadium	143.75	0.07	0.05%
Thallium	0.20	0.04	17.49%
Chlorine	0.09	0.01	6.86%

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is 4.29 mg/kg clinker (see calculation for table 4)

The total As concentration for inputs from Alternate fuel is 1.42 mg/kg clinker. This represents 33% of the total As input in the process.

1.42/4.29 *100 = 33%