Boral Cement Limited
Berrima Works

Non-Standard Fuels Pollutant Tracking
Six Monthly Report

September 2022

Table of Contents

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.

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 details findings from the non-standard fuels Pollutant Tracking Program for testing undertaken on 15 September 2022. 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 15th September 2022 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

R013511-1 dated 22 November 2022 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	15/09/2022 R013511
Mercury	mg/m3	0.05	0.0091
Type 1 and type 2 substances	mg/m3	0.5	<0.036
Solid particles	mg/m3	50	30
Nitrogen oxides	mg/m3	1250	1000
Cadmium and Thallium	mg/m3	0.05	<0.0045
Chlorine	mg/m3	50	<0.07
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.005
Hydrogen chloride (HCl)*	mg/m3	10	0.14
Hydrogen fluoride	mg/m3	1	<0.026
Sulfur dioxide	mg/m3	50	<0.017
Sulfuric acid mist and sulfur trioxide	mg/m3	50	0.061
Volatiles organic compounds	mg/m3	40	1.1

*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 September 2022.

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 %	77.85%	0.39%	9.78%	0.00%	4.98%	7.00%	100.00%
Arsenic	As (mg/kg)	1.2	11.1	4.9		1.2	0.8	1.57
Beryllium	Be (mg/kg)	0.1	1.3	1.4		0.3	7.2	0.74
Cadmium	Cd (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chromium	Cr (mg/kg)	1.8	13.6	15.8		1.2	0.1	3.07
Cobalt	Co (mg/kg)	2.9	35.4	19		1750	13.8	92.37
Copper	Cu (mg/kg)	1.5	19.5	42.4		21.9	0.6	6.52
Mercury	Hg (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Manganese	Mn (mg/kg)	177	407	1260		28700	2480	1865.47
Nickel	Ni (mg/kg)	3.1	16	25.4		9.4	0.4	5.46
Lead	Pb (mg/kg)	1.8	65.4	20.5		1.9	0.4	3.78
Antimony	Sb (mg/kg)	0.1	1	0.3		0.1	0.1	0.12
Selenium	Se (mg/kg)	1	2	3		1	5	1.48
Tin	Sn (mg/kg)	0.1	2.5	0.7		1.6	0.2	0.25
Vanadium	V (mg/kg)	5	46	48		2340	54	129.08
Thallium	Th (mg/kg)	0.1	0.2	0.1		0.1	0.1	0.10
Chlorine	Cl (mg/kg)	20	10	10		10	130	26.185
kg mat/kg clinker								1.55

To interpret the table, 77.85% of the raw material is limestone. Within limestone there is 1.2 mg/kg of Arsenic (As), while yellow shale used at 0.39% contained 11.1 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 1.57 mg/kg.

To produce 1 kg of clinker, 1.55 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 %	67.64%	8.09%	16.18%	8.09%	100.00%
Arsenic	As (mg/kg)	1	135	20	37	17.8
Beryllium	Be (mg/kg)	0.9	1	1	1	0.9
Cadmium	Cd (mg/kg)	0.1	1	1	1	0.4
Chromium	Cr (mg/kg)	1.1	194	47	54	28.4
Cobalt	Co (mg/kg)	1.9	1	3	1	1.9
Copper	Cu (mg/kg)	12.3	125	32	34	26.4
Mercury	Hg (mg/kg)	0.1	0.05	0.05	0.05	0.1
Manganese	Mn (mg/kg)	333	45	58	62	243.3
Nickel	Ni (mg/kg)	2.2	1	5	5	2.8
Lead	Pb (mg/kg)	9.4	16	28	9	12.9
Antimony	Sb (mg/kg)	0.4	2	14	4	3.0
Selenium	Se (mg/kg)	1	1	1	1	1.0
Tin	Sn (mg/kg)	0.3	1	2	2	0.8
Vanadium	V (mg/kg)	5	1	3	2	4.1
Thallium	Th (mg/kg)	0.1	1	1	1	0.4
Chlorine	Cl (mg/kg)	10	0.05	0.15	0.04	6.795
kg fuel/kg clinker		0.1130	0.0135	0.0270	0.0135	0.167

Table 3 details the inventory of fuel input and the percentage of each fuel used. As can be seen 67.64% of the fuel in use was coal, with SWDF accounting for 32.36% total fuel, split between RDF and Wood.

Taking As as an example, coal contains 1 mg/kg and RDF 20 mg/kg. As makes up 17.8 mg/kg in the total fuel.

To produce 1kg of Clinker a total of 0.167 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	5.42	0.002	0.00467	0.00086
Beryllium	1.30	0.0003	0.00070	0.00054
Cadmium	0.22	0.0003	0.00070	0.00318
Chromium	9.50	0.00062	0.00145	0.00015
Cobalt	143.50	0.0004	0.00093	0.00001
Copper	14.51	0.0022	0.00514	0.00035
Mercury	0.17	0.0091	0.02125	0.12574
Manganese	2932.11	0.012	0.02802	0.00001
Nickel	8.92	0.0013	0.00304	0.00034
Lead	8.02	0.012	0.02802	0.00349
Antimony	0.70	0.002	0.00467	0.00672
Selenium	2.46	0.003	0.00701	0.00285
Tin	0.52	0.001	0.00234	0.00453
Vanadium	200.76	0.0012	0.00280	0.00001
Thallium	0.22	0.0042	0.00981	0.04439
Chlorine	41.722	0.07	0.16346	0.00392

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).

(1.57*1.55) + (17.8*0.167) = 5.42 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.

0.00467/5.42 = 0.00086

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	2.98	0.002	0.00467	0.00157
Beryllium	0.16	0.0003	0.00070	0.00450
Cadmium	0.07	0.0003	0.00070	0.01072
Chromium	4.75	0.00062	0.00145	0.00031
Cobalt	0.32	0.0004	0.00093	0.00289
Copper	4.40	0.0022	0.00514	0.00117
Mercury	0.01	0.0091	0.02125	1.51784
Manganese	40.63	0.012	0.02802	0.00069
Nickel	0.46	0.0013	0.00304	0.00653
Lead	2.16	0.012	0.02802	0.01299
Antimony	0.50	0.002	0.00467	0.00925
Selenium	0.17	0.003	0.00701	0.04194
Tin	0.13	0.001	0.00234	0.01817
Vanadium	0.69	0.0012	0.00280	0.00408
Thallium	0.07	0.0042	0.00981	0.15007
Chlorine	1.135	0.07	0.16346	0.14402

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	2.65	0.02	0.90%
Beryllium	0.95	0.27	28.70%
Cadmium	0.18	0.01	6.61%
Chromium	109.77	0.15	0.14%
Cobalt	4.71	0.71	15.16%
Copper	11.79	1.17	9.90%
Mercury	0.17	0.00	0.49%
Manganese	1897.30	1.62	0.09%
Nickel	7.12	0.07	1.00%
Lead	6.79	0.23	3.33%
Antimony	0.42	0.10	22.92%
Selenium	1.99	0.01	0.60%
Tin	1.07	0.20	18.86%
Vanadium	121.94	0.06	0.05%
Thallium	0.18	0.01	6.55%
Chlorine	23.45	0.00	0.01%

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is 2.65 mg/kg clinker (see calculation for table 4)

The total As concentration for inputs from Alternate fuel is 0.02 mg/kg clinker. This represents 0.9% of the total As input in the process.

0.02/2.65 *100 = 0.9%