Boral Cement Limited
Berrima Works

Non-Standard Fuels Pollutant Tracking
Second Half Year Report FY22

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.

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 details finding from the non-standard fuels Pollutant Tracking Program for testing undertaken on 27-28 January 2022. This report incorporates the requirements of Condition 3.23.

This report incorporates the use of AKF5 tyre chips.

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 27-28 January 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 R012341 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	27_28/01/2022 R012341
Mercury	mg/m3	0.05	0.0093
Type 1 and type 2 substances	mg/m3	0.5	<0.047
Solid particles	mg/m3	50	18
Nitrogen oxides	mg/m3	1250	1100
Cadmium and Thallium	mg/m3	0.05	<0.00057
Chlorine	mg/m3	50	<0.01
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.00072
Hydrogen chloride (HCl)*	mg/m3	10	0.42
Hydrogen fluoride	mg/m3	1	0.063
Sulfur dioxide	mg/m3	50	<0.02
Sulfuric acid mist and sulfur trioxide	mg/m3	50	1.9
Volatiles organic compounds	mg/m3	40	1.2

*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 January 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 %	85.23%	1.17%	7.15%	0.00%	3.45%	3.00%	100.00%
Arsenic	As (mg/kg)	1.3	10.2	4.6		1.4	1	1.63
Beryllium	Be (mg/kg)	0.1	1.2	1		0.3	6.9	0.39
Cadmium	Cd (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chromium	Cr (mg/kg)	2.1	38	23.1		1920	16.3	70.62
Cobalt	Co (mg/kg)	1.2	21.2	16.9		1.5	0.2	2.54
Copper	Cu (mg/kg)	1.8	14.4	45.6		25.3	0.7	5.86
Mercury	Hg (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Manganese	Mn (mg/kg)	148	599	1110		26500	2220	1193.36
Nickel	Ni (mg/kg)	2.7	15.4	23.9		9	0.5	4.52
Lead	Pb (mg/kg)	2.2	14	17.7		1.9	0.1	3.37
Antimony	Sb (mg/kg)	0.2	0.6	0.2		0.1	0.1	0.20
Selenium	Se (mg/kg)	1	1	2		1	5	1.19
Tin	Sn (mg/kg)	0.5	2.4	0.5		1.5	0.1	0.54
Vanadium	V (mg/kg)	3	49	44		2050	46	78.38
Thallium	Th (mg/kg)	0.1	0.2	0.1		0.1	0.1	0.10
Chlorine	Cl (mg/kg)	10	110	20		10	90	14.285
kg mat/kg clinker								1.55

To interpret the table, 85.23% of the raw material is limestone. Within limestone there is 1.3 mg/kg of Arsenic (As), while yellow shale used at 1.17% contained 10.2 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 1.63 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. Stack test in January 22 was done during tyre chips trial.

Table 3 – Kiln Fuel Input Quantities and Chemical Properties

		Kiln Fuel - Input				
Chemical		Fuel Source 1	Fuel Source 2	Fuel Source 3	Fuel Source 4	Final
Properties		Coal	Wood Veolia	Tyre chips	Wood Brandown	Fuel - Kiln
	Set Point %	91.67%	0.00%	8.33%	0.00%	100.00%
Arsenic	As (mg/kg)	0.7		2		0.8
Beryllium	Be (mg/kg)	0.6		23		2.5
Cadmium	Cd (mg/kg)	0.1		1		0.2
Chromium	Cr (mg/kg)	1.2		13		2.2
Cobalt	Co (mg/kg)	0.5		60		5.5
Copper	Cu (mg/kg)	11.8		98		19.0
Mercury	Hg (mg/kg)	0.1		0.07		0.1
Manganese	Mn (mg/kg)	351		136		333.1
Nickel	Ni (mg/kg)	0.4		6		0.9
Lead	Pb (mg/kg)	10.2		19		10.9
Antimony	Sb (mg/kg)	0.1		8		0.8
Selenium	Se (mg/kg)	1		1		1.0
Tin	Sn (mg/kg)	0.2		17		1.6
Vanadium	V (mg/kg)	3		5		3.2
Thallium	Th (mg/kg)	0.1		1		0.2
Chlorine	Cl (mg/kg)	10		0.1		9.175
kg fuel/kg clinker		0.1310		0.0119		0.143

Table 3 details the inventory of fuel input and the percentage of each fuel used. As can be seen 91.67% of the fuel in use was coal, with tyre chips accounting for 8.33% total fuel.

Taking As as an example, coal contains 0.7 mg/kg and tyre chips 2 mg/kg. As makes up 0.8 mg/kg in the total fuel.

To produce 1kg of Clinker a total of 0.143 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	2.65	0.001	0.00257	0.00097
Beryllium	0.95	0.0004	0.00103	0.00108
Cadmium	0.18	0.00057	0.00147	0.00814
Chromium	109.77	0.001	0.00257	0.00002
Cobalt	4.71	0.0005	0.00129	0.00027
Copper	11.79	0.0015	0.00386	0.00033
Mercury	0.17	0.0093	0.02391	0.14156
Manganese	1897.30	0.013	0.03343	0.00002
Nickel	7.12	0.0012	0.00309	0.00043
Lead	6.79	0.012	0.03086	0.00454
Antimony	0.42	0.003	0.00771	0.01856
Selenium	1.99	0.004	0.01029	0.00517
Tin	1.07	0.001	0.00257	0.00240
Vanadium	121.94	0.001	0.00257	0.00002
Thallium	0.18	0.001	0.00257	0.01414
Chlorine	23.452	0.01	0.02571	0.00110

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).

(1.63*1.55) + (0.8*0.143) = 2.65 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.

0.00257/2.65 = 0.00097

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	0.12	0.001	0.002571429	0.02227
Beryllium	0.35	0.0004	0.001028571	0.00292
Cadmium	0.03	0.00057	0.001465714	0.05863
Chromium	0.31	0.001	0.002571429	0.00824
Cobalt	0.78	0.0005	0.001285714	0.00165
Copper	2.71	0.0015	0.003857143	0.00142
Mercury	0.01	0.0093	0.023914286	1.71692
Manganese	47.58	0.013	0.033428571	0.00070
Nickel	0.12	0.0012	0.003085714	0.02492
Lead	1.56	0.012	0.030857143	0.01976
Antimony	0.11	0.003	0.007714286	0.07121
Selenium	0.14	0.004	0.010285714	0.07200
Tin	0.23	0.001	0.002571429	0.01125
Vanadium	0.45	0.001	0.002571429	0.00568
Thallium	0.03	0.001	0.002571429	0.10286
Chlorine	1.311	0.01	0.025714286	0.01962

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. 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	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%