Boral Cement Limited
Berrima Works

Non-Standard Fuels Pollutant Tracking
Half Year Report

22 June 2020 Stack Test
(Report date: 25 November 2020)

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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 final quarterly report was submitted on 4 June 2020.

Quarterly stack tests were undertaken during the first year of operating non-standard fuels with the last quarterly stack test completed in April 2020 with the final quarterly report submitted on 4 June 2020. Commencing in June 2020 Boral will undertake stack testing every 6 months.

While Boral is aiming to undertake stack testing every 6 months, this exact frequency can be impacted by unscheduled stoppages, scheduled maintenance, clinker demand and the availability of technicians to undertake the stack testing at Berrima.

Berrima kiln was stopped in June 2020 for a period of 3 weeks due to low clinker demand and the first half year stack test was undertaken on the 22nd of June 2020 with the emissions report finalised on 7th October 2020.

The following report is covering details findings from the non-standard fuels Pollutant Tracking Program for the first biannual testing following the approval for continual use of SWDF. This report incorporates the requirements of Condition 3.23. While a summary of alternative fuels analysis is provided, no alternative fuels were in use at the time of the stack test.

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 22 June 2020 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 R008994 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	22/06/2020 R008994
Mercury	mg/m3	0.05	0.0037
Type 1 and type 2 substances	mg/m3	0.5	<0.046
Solid particles	mg/m3	50	27
Nitrogen oxides	mg/m3	1250	930
Cadmium and Thallium	mg/m3	0.05	0.0028
Chlorine	mg/m3	50	<0.01
Dioxine and Furans (I-TEQ middle bound)	ng/m3	0.1	0.0018
Hydrogen chloride (HCl)*	mg/m3	10	0.22
Hydrogen fluoride	mg/m3	1	<0.03
Sulfur dioxide	mg/m3	50	0.037
Sulfuric acid mist and sulfur trioxide	mg/m3	50	<0.033

Volatiles organic compounds	mg/m3	40	2.1

*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 June 2020.

Table 2 – Raw Material Input Quantities and Chemical Properties

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 %	82.84%	4.55%	6.53%	0.00%	3.65%	2.43%	100.00%
Arsenic	As (mg/kg)	1.8	4.9	4.7		0.5	1	2.06
Beryllium	Be (mg/kg)	0.1	0.9	1.1		0.2	6.9	0.37
Cadmium	Cd (mg/kg)	0.2	0.1	0.1		0.1	0.1	0.18
Chromium	Cr (mg/kg)	6.1	33	43.9		864	22.2	41.50
Cobalt	Co (mg/kg)	2.5	3.4	14.4		0.4	1.6	3.22
Copper	Cu (mg/kg)	4.2	15	46.7		13.8	2.8	7.78
Mercury	Hg (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Manganese	Mn (mg/kg)	171	134	1890		14600	2690	869.48
Nickel	Ni (mg/kg)	4.7	8.8	19.9		2.9	2	5.75
Lead	Pb (mg/kg)	2.7	47.5	21.5		0.8	1.6	5.87
Antimony	Sb (mg/kg)	0.1	0.3	0.2		0.1	0.1	0.12
Selenium	Se (mg/kg)	1	1	2		1	4	1.14
Tin	Sn (mg/kg)	0.3	1.1	0.5		0.5	0.1	0.35
Vanadium	V (mg/kg)	8	35	106		2000	134	91.40
Thallium	Th (mg/kg)	0.1	0.1	0.1		0.1	0.1	0.10
Chlorine	Cl (mg/kg)	0	0	0		100	10	3.893
kg mat/kg clinker								1.56

To interpret the table, 82.84% of the raw material is limestone. Within limestone there is 1.8 mg/kg of Arsenic (As), while yellow shale used at 4.55% contained 4.9 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 2.06 mg/kg.

To produce 1 kg of clinker, 1.56 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		Fuel Source 1	Fuel Source 2	Fuel Source 3	Fuel Source 4	Final
Properties		Coal	Wood Veolia	RDF	Wood Brandown	Fuel - Kiln
	Set Point %	100.00%	0.00%	0.00%	0.00%	100.00%
Arsenic	As (mg/kg)	0.3	49		19	0.3
Beryllium	Be (mg/kg)	0.3	1		1	0.3
Cadmium	Cd (mg/kg)	0.1	1		1	0.1
Chromium	Cr (mg/kg)	0.5	71		38	0.5
Cobalt	Co (mg/kg)	0.2	3		3	0.2
Copper	Cu (mg/kg)	5.8	49		22	5.8
Mercury	Hg (mg/kg)	0.1	0.05		0.05	0.1
Manganese	Mn (mg/kg)	200	37		48	200.0
Nickel	Ni (mg/kg)	0.2	2		2	0.2
Lead	Pb (mg/kg)	5.3	12		5	5.3
Antimony	Sb (mg/kg)	0.1	2		3	0.1
Selenium	Se (mg/kg)	1	1		1	1.0
Tin	Sn (mg/kg)	0.2	21		2	0.2
Vanadium	V (mg/kg)	2	1		2	2.0
Thallium	Th (mg/kg)	0.1	1		1	0.1
Chlorine	Cl (mg/kg)	99.9	0.28		0.18	99.900
kg fuel/kg clinker		0.1418	0.0000	0.0000	0.0000	0.142

Table 3 details the inventory of fuel input analysis results for the reporting period and the percentage of each fuel used. As can be seen 100% of the fuel in use was coal at the time of testing. Results for Solid Waste Derived Fuels are shown in the table but there is 0% usage of SWDF.

Taking As as an example, coal contains 0.3mg/kg, wood waste 49 mg/kg and 19 mg/kg. As makes up 0.3 mg/kg in the total fuel as coal was used 100%.

To produce 1kg of Clinker a total of 0.142 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	3.26	0.003	0.007854545	0.00241
Beryllium	0.62	0.0004	0.001047273	0.00169
Cadmium	0.30	0.0003	0.000785455	0.00262
Chromium	64.81	0.0052	0.013614545	0.00021
Cobalt	5.05	0.0005	0.001309091	0.00026
Copper	12.96	0.0022	0.00576	0.00044
Mercury	0.17	0.0037	0.009687273	0.05692
Manganese	1384.76	0.021	0.054981818	0.00004
Nickel	9.00	0.0021	0.005498182	0.00061
Lead	9.91	0.0014	0.003665455	0.00037
Antimony	0.19	0.003	0.007854545	0.04037
Selenium	1.92	0.003	0.007854545	0.00410
Tin	0.58	0.001	0.002618182	0.00454
Vanadium	142.87	0.0025	0.006545455	0.00005
Thallium	0.17	0.0028	0.007330909	0.04308
Chlorine	20.242	0.01	0.026181818	0.00129

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).

(2.06*1.56) + (0.3*0.142) = 3.26 mg/kg

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.

0.007854/3.26 = 0.00241

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	0.04	0.003	0.007854545	0.18461
Beryllium	0.04	0.0004	0.001047273	0.02461
Cadmium	0.01	0.0003	0.000785455	0.05538
Chromium	0.07	0.0052	0.013614545	0.19199
Cobalt	0.03	0.0005	0.001309091	0.04615
Copper	0.82	0.0022	0.00576	0.00700
Mercury	0.01	0.0037	0.009687273	0.68304
Manganese	28.37	0.021	0.054981818	0.00194
Nickel	0.03	0.0021	0.005498182	0.19384
Lead	0.75	0.0014	0.003665455	0.00488
Antimony	0.01	0.003	0.007854545	0.55382
Selenium	0.14	0.003	0.007854545	0.05538
Tin	0.03	0.001	0.002618182	0.09230
Vanadium	0.28	0.0025	0.006545455	0.02308
Thallium	0.01	0.0028	0.007330909	0.51690
Chlorine	14.168	0.01	0.026181818	0.00185

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	3.26	0.00	0.00%
Beryllium	0.62	0.00	0.00%
Cadmium	0.30	0.00	0.00%
Chromium	64.81	0.00	0.00%
Cobalt	5.05	0.00	0.00%
Copper	12.96	0.00	0.00%
Mercury	0.17	0.00	0.00%
Manganese	1384.76	0.00	0.00%
Nickel	9.00	0.00	0.00%
Lead	9.91	0.00	0.00%
Antimony	0.19	0.00	0.00%
Selenium	1.92	0.00	0.00%
Tin	0.58	0.00	0.00%
Vanadium	142.87	0.00	0.00%
Thallium	0.17	0.00	0.00%
Chlorine	20.24	0.00	0.00%

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is 3.65 mg/kg clinker (see calculation for table 4)

The total As concentration for inputs from Alternate fuel is 0.00 mg/kg clinker as no AF was used at the time of stack testing.