# Boral Cement Limited
# Berrima Works

## *Non-Standard Fuels Pollutant Tracking First Half Year Report*

*October 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.

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**Non-Standard Fuels Pollutant Tracking**

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 the 12 and 13th October 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 R015613-1 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 | 12 & 13 Oct 24 R015613-1 |
|---|---|---|---|
| Mercury | mg/m3 | 0.05 | 0.02 |
| Type 1 and type 2 substances | mg/m3 | 0.5 | <0.054 |
| Solid particles | mg/m3 | 50 | 42 |
| Nitrogen oxides | mg/m3 | 1250 | 110 |
| Cadmium and Thallium | mg/m3 | 0.05 | <0.003 |
| Chlorine | mg/m3 | 50 | 0.33 |
| Dioxine and Furans (I-TEQ middle bound) | ng/m3 | 0.1 | 0.0027 |
| Hydrogen chloride (HCl)* | mg/m3 | 10 | 0.19 |
| Hydrogen fluoride | mg/m3 | 1 | 0.083 |
| Sulfur dioxide | mg/m3 | 50 | 0.057 |
| Sulfuric acid mist and sulfur trioxide | mg/m3 | 50 | 0.06 |
| Volatiles organic compounds | mg/m3 | 40 | 2.6 |

*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 October 2023.

### 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 % | 81.50% | 3.70% | 9.00% | 0.00% | 2.00% | 5.00% | 101.20% |
| Arsenic | As (mg/kg) | 3 | 37.6 | 6.2 | | 2.1 | 0.7 | 4.47 |
| Beryllium | Be (mg/kg) | 0.2 | 1.2 | 1.4 | | 0.5 | 7 | 0.69 |
| Cadmium | Cd (mg/kg) | 0.2 | 0.2 | 0.2 | | 0.1 | 0.1 | 0.20 |
| Chromium | Cr (mg/kg) | 7.2 | 32.4 | 23 | | 1430 | 31.7 | 39.32 |
| Cobalt | Co (mg/kg) | 2.1 | 13.6 | 12.9 | | 2 | 0.1 | 3.42 |
| Copper | Cu (mg/kg) | 2.5 | 21.7 | 39.4 | | 27.3 | 0.9 | 6.98 |
| Mercury | Hg (mg/kg) | 0.1 | 0.1 | 0.1 | | 0.1 | 0.1 | 0.10 |
| Manganese | Mn (mg/kg) | 341 | 436 | 1080 | | 26200 | 2900 | 1060.25 |
| Nickel | Ni (mg/kg) | 4.6 | 13.6 | 22.5 | | 13.1 | 0.6 | 6.57 |
| Lead | Pb (mg/kg) | 3 | 39.5 | 21 | | 2.3 | 0.1 | 5.85 |
| Antimony | Sb (mg/kg) | 0.4 | 0.9 | 0.3 | | 0.2 | 0.1 | 0.40 |
| Selenium | Se (mg/kg) | 1 | 1 | 1 | | 1 | 3 | 1.11 |
| Tin | Sn (mg/kg) | 0.3 | 1.6 | 0.7 | | 1.9 | 0.1 | 0.41 |
| Vanadium | V (mg/kg) | 6 | 45 | 51 | | 3490 | 113 | 86.60 |
| Thallium | Th (mg/kg) | 0.1 | 0.3 | 0.1 | | 0.1 | 0.1 | 0.11 |
| Chlorine | Cl (mg/kg) | 20 | 30 | 50 | | 10 | 280 | 36.110 |
| g mat/kg clinker | | | | | | | | 1.55 |

To interpret the table, 81.50% of the raw material is limestone. Within limestone there is 3 mg/kg of Arsenic (As), while yellow shale used at 3.70% contained 37.6 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 4.47 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**

| Chemical Properties | | Fuel Source 1 Coal | Fuel Source 2 Wood Benedict | Fuel Source 3 RDF Bingo | Fuel Source 4 Wood Brandown | Final Fuel - Kiln |
|---|---|---|---|---|---|---|
| | Set Point % | 66.98% | 12.97% | 16.66% | 3.39% | 100.00% |
| Arsenic | As (mg/kg) | 0.4 | 124 | 37 | 16 | 23.1 |
| Beryllium | Be (mg/kg) | 0.6 | 1 | 1 | 1 | 0.7 |
| Cadmium | Cd (mg/kg) | 0.1 | 1 | 1 | 1 | 0.4 |
| Chromium | Cr (mg/kg) | 1.4 | 166 | 61 | 37 | 33.9 |
| Cobalt | Co (mg/kg) | 0.4 | 1 | 2 | 1 | 0.8 |
| Copper | Cu (mg/kg) | 7.5 | 95 | 43 | 22 | 25.3 |
| Mercury | Hg (mg/kg) | 0.1 | 0.05 | 0.05 | 0.05 | 0.1 |
| Manganese | Mn (mg/kg) | 209 | 36 | 42 | 61 | 153.7 |
| Nickel | Ni (mg/kg) | 0.5 | 1 | 2 | 2 | 0.9 |
| Lead | Pb (mg/kg) | 12.2 | 25 | 45 | 6 | 19.1 |
| Antimony | Sb (mg/kg) | 0.1 | 3 | 44 | 2 | 7.9 |
| Selenium | Se (mg/kg) | 1 | 1 | 1 | 1 | 1.0 |
| Tin | Sn (mg/kg) | 0.3 | 1 | 1 | 2 | 0.6 |
| Vanadium | V (mg/kg) | 4 | 1 | 2 | 3 | 3.2 |
| Thallium | Th (mg/kg) | 0.1 | 1 | 1 | 1 | 0.4 |
| Chlorine | Cl (mg/kg) | 10 | 0.04 | 0.1 | 0.29 | 6.730 |
| fuel/kg clinker | | 0.1126 | 0.0218 | 0.028 | 0.0057 | 0.168 |

Table 3 details the inventory of fuel input and the percentage of each fuel used. As can be seen 66.98% of the fuel in use was coal, with SWDF accounting for 33.02% total fuel, split between RDF and Wood.

Taking As as an example, coal contains 0.4 mg/kg and RDF 37 mg/kg. As makes up 23.1 mg/kg in the total fuel.

To produce 1kg of Clinker a total of 0.168 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 | 10.81 | 0.002 | 0.00523 | 0.00048 |
| Beryllium | 1.20 | 0.0006 | 0.00157 | 0.00131 |
| Cadmium | 0.37 | 0.00074 | 0.00193 | 0.00523 |
| Chromium | 66.64 | 0.0018 | 0.00471 | 0.00007 |
| Cobalt | 5.43 | 0.0008 | 0.00209 | 0.00039 |
| Copper | 15.06 | 0.0015 | 0.00392 | 0.00026 |
| Mercury | 0.17 | 0.02 | 0.05229 | 0.30598 |
| Manganese | 1669.22 | 0.0078 | 0.02039 | 0.00001 |
| Nickel | 10.33 | 0.0019 | 0.00497 | 0.00048 |
| Lead | 12.28 | 0.0019 | 0.00497 | 0.00040 |
| Antimony | 1.93 | 0.005 | 0.01307 | 0.00676 |
| Selenium | 1.89 | 0.0076 | 0.01987 | 0.01050 |
| Tin | 0.73 | 0.002 | 0.00523 | 0.00716 |
| Vanadium | 134.77 | 0.001 | 0.00261 | 0.00002 |
| Thallium | 0.24 | 0.002 | 0.00523 | 0.02224 |
| Chlorine | 57.102 | 0.33 | 0.86279 | 0.01511 |

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).

(4.47*1.55) + (23.1*0.168) = 10.81 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.

0.00523/10.81 = 0.000483

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 | 3.88 | 0.002 | 0.00523 | 0.00135 |
| Beryllium | 0.12 | 0.0006 | 0.00157 | 0.01275 |
| Cadmium | 0.07 | 0.00074 | 0.00193 | 0.02898 |
| Chromium | 5.70 | 0.0018 | 0.00471 | 0.00083 |
| Cobalt | 0.13 | 0.0008 | 0.00209 | 0.01627 |
| Copper | 4.24 | 0.0015 | 0.00392 | 0.00092 |
| Mercury | 0.01 | 0.02 | 0.05229 | 3.72572 |
| Manganese | 25.84 | 0.0078 | 0.02039 | 0.00079 |
| Nickel | 0.15 | 0.0019 | 0.00497 | 0.03414 |
| Lead | 3.21 | 0.0019 | 0.00497 | 0.00155 |
| Antimony | 1.32 | 0.005 | 0.01307 | 0.00990 |
| Selenium | 0.17 | 0.0076 | 0.01987 | 0.11821 |
| Tin | 0.09 | 0.002 | 0.00523 | 0.05505 |
| Vanadium | 0.55 | 0.001 | 0.00261 | 0.00479 |
| Thallium | 0.07 | 0.002 | 0.00523 | 0.07833 |
| Chlorine | 1.131 | 0.33 | 0.86279 | 0.76264 |

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<br>Raw material + Fuel | Alternative Fuels | |
| | mg/kg clk | mg/kg clk | % input from AF |
| Arsenic | 10.81 | 3.83 | 35.45% |
| Beryllium | 1.20 | 0.06 | 4.63% |
| Cadmium | 0.37 | 0.06 | 15.02% |
| Chromium | 66.64 | 5.54 | 8.31% |
| Cobalt | 5.43 | 0.08 | 1.54% |
| Copper | 15.06 | 3.40 | 22.58% |
| Mercury | 0.17 | 0.00 | 1.62% |
| Manganese | 1669.22 | 2.31 | 0.14% |
| Nickel | 10.33 | 0.09 | 0.86% |
| Lead | 12.28 | 1.84 | 14.98% |
| Antimony | 1.93 | 1.31 | 67.72% |
| Selenium | 1.89 | 0.06 | 2.93% |
| Tin | 0.73 | 0.06 | 8.38% |
| Vanadium | 134.77 | 0.09 | 0.07% |
| Thallium | 0.24 | 0.06 | 23.61% |
| Chlorine | 57.10 | 0.01 | 0.01% |

Taking As as an example, the total As concentration for inputs into the kiln per kg of clinker produced is 10.81 mg/kg clinker (see calculation for table 4)

The total As concentration for inputs from Alternate fuel is 3.83 mg/kg clinker. This represents 35.45% of the total As input in the process.

3.83/10.81 *100 = 35.45%