ABN 96 007 870 199

Adelaide Brighton Cement Ltd.

Alternative Fuel Post Trial Report

Increased Refuse Derived Fuel Addition up to 25 t/h

Birkenhead Works EPA (Licence 1126)

Report to the SA Environment Protection Authority

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Glossary

Term	**Definition**
g/h	grams per hour
m^3	cubic metres
ng	nanogram. (10^{-9} gram)
Nm^3	gas volume in dry cubic metres at STP dry basis
ppm	parts per million
t/h	tonnes per hour
Abbreviations	**Definition**
Air EPP	Environment Protection (Air Quality) Policy 2016
CKD	Cement Kiln Dust
GLC	Ground Level Concentration
ITEQ	International Toxic Equivalent for PCDD's & PCDF's, (NATO 1989 basis)
NATA	National Association Of Testing Authorities, Australia
NEPM	National Environmental Protection Measure
PCDD's	Polychlorinated Dibenzo-p-Dioxins
PCDF's	Polychlorinated dibenzofurans
RDF	Refuse derived fuel – processed fuel produced from waste materials generated by construction, demolition, commercial and industrial sources
RPP	Recovered Products Plan
SA EPA	South Australian Environment Protection Authority
SCADA	Supervisory Control and Data Acquisition (a control system that uses computers, networked data communications and graphical user interfaces for high-level process supervisory management)

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1. Introduction

The current EPA licence No. 1126 for the Birkenhead site licence allows for the burning of RDF with a maximum content of 20% plastics at a rate of 15 t/h.

This document forms part of the submission by Adelaide Brighton Cement Limited (ABC) requesting approval from the SA EPA to increase the maximum input of Refuse Derived Fuel (RDF) in the kiln process from the current maximum addition rate, approved by the SA EPA on 17 November 2006, of 15 t/h to an increased maximum addition rate of 25 t/h.

Refuse Derived Fuel is a generic name used to describe a processed fuel produced from various waste materials generated by construction, demolition, commercial and industrial sources. The major combustible components of the RDF are wood, paper, cardboard, textiles, plastic and rubber. Additionally, it contains approximately 15% ash, which is predominantly sand and clay. To be suitable for use as a fuel the materials are blended and shredded to an appropriate particle size. ABC has been able to use the material as a partial substitute for natural gas in its clinker-making process, since addition commenced in 2004.

The RDF is produced and supplied in compliance with an EPA approved Recovered Product Plan (RPP), for Adelaide Brighton Cement's Birkenhead Works, as required by the SA EPA "Standard for the production and use of refuse derived fuel", dated February 2010 (Standard).

Additionally, the supplier of the RDF operates under an SA EPA approved Environmental Management Plan for the supply of RDF to Adelaide Brighton Cement's Birkenhead Works, as required by the Standard.

The RDF Recovered Product Plan details the components and acceptance criteria for the RDF, quality control and quality assurance requirements and the management of the transport, storage and use of the RDF in the Birkenhead clinker kiln.

This submission has been prepared in accordance with the requirements of schedule W-1 of Birkenhead EPA licence 1126. In particular it presents information to meet requirements of section W-1.4 "Post-Trial Report – Summary of AFRM Trial". Increasing the addition rate of alternative fuels and raw materials forms part of an ongoing ABC strategy to trial and implement alternative fuels and raw materials.

The purpose of the trial was to demonstrate the capacity of the kiln process to sustainably burn increased volumes of RDF up to 25 t/h, test stack emissions and confirm product quality.

2. Demonstration of Beneficial Purposes

Historically the input materials have been landfilled, but when processed appropriately, ABC has been able to use the resultant RDF as a partial substitute for natural gas in its clinker-making process. Original trials were conducted in 2003, with ongoing burning commencing in 2004. To date ABC has consumed over 1,000,000 tonnes of RDF, which is a major contribution to the Government's zero waste philosophy and demonstrates support for the waste hierarchy.

Currently the RDF is burnt at the licence limit of 15 t/h; this represents in excess of 25% displacement of the kiln's natural gas requirement.

Increasing RDF usage will give environmental and raw material conservation benefits as follows:

- Beneficial re-use of a material with no other current viable use. The current maximum addition of RDF does not displace South Australia's total generation of construction, demolition, commercial and industrial waste, which means that there is still a significant surplus sent to landfill.
- The proposed additional 10 t/h use of RDF in the Birkenhead kiln will consume approximately a further 70,000 tonnes of waste produced from construction, demolition, commercial and industrial sources. SA landfill will correspondingly reduce by this amount.
- The RDF contains up to 15% ash, which is primarily sand and clay. These are useful raw materials in cement manufacture, so the ash will substitute for a further 12,000 tonnes per annum of mined clay.
- The additional RDF will displace up to a further [redacted]% of the kiln's natural gas use.
- The site's carbon footprint will reduce, as the fuel component of the RDF comes primarily from renewable sources.

3. Demonstrated Support for the Waste Hierarchy

The increase in RDF proposed is an extension of the existing approval for use in the Birkenhead kiln. The RDF has a useful calorific value, and so displaces a portion of the natural gas fuel currently used for cement clinker production.

Therefore, combustion of the RDF is primarily an energy recovery activity. According to the waste hierarchy, this is preferable to disposal. Currently the material is disposed in landfill and, if ABC were not to use the RDF, this disposal route would continue. In this way, waste is diverted from landfill to a more sustainable option.

ABC believes that extending the use of RDF in this manner demonstrates support for the waste hierarchy.

4. Trial Timing and Fuel Consumption

The final 25 t/h RDF burning trial under stabilised plant operating conditions commenced on the 22 October 2019 for 5 days with stack emissions tests undertaken during 22nd – 25th October 2019.

During the 5-day testing period a total of 2635t of RDF was burned. As expected there were standard process fluctuations during this extended testing period, both as a result of the kiln process and the inherent variability in the RDF. However, a sustainable maximum RDF addition rate of 25t/h was achieved. No carbon firing was undertaken during the trial.

5. Storage, Feed Method and Feed Rate

The RDF was delivered to the site in enclosed walking floor trucks and was fed into the kiln process through the existing feed system. The RDF was fired into the calciner with the point of entry into the vessel located above the natural gas burners. In summary, no changes were made to the normal delivery, storage and feed methods.

6. Trial Conditions

6.1 RDF trial summary

The RDF trial was undertaken in accordance with the RDF Rate Increase Pre- Trial Report, approved 11 January 2019. A number of short term trials were conducted to assess the maximum sustainable burn rate of RDF and to stabilise the process. The maximum sustainable burn rate was determined to be 25 t/h. Subsequently a 5-day trial with an RDF burn rate target of 25 t/h was then conducted, during which stack emissions testing was undertaken.

A summary of the RDF trials is contained in table 1.

Table 1: Summary of RDF Trials

Trial No.	Trial Date	Purpose	Achieved RDF burn rate t/h	Comments
Trial 1	13/5/19 to 18/5/19	RDF feed equipment, kiln process, clinker quality proving trial	20	RDF consumption rate varied due to fluctuations in process & chemistry conditions. However, 20t/h was achieved at times during the trial.
Trial 2	27/5/19 To 31/5/19	RDF feed equipment, kiln process, clinker quality proving trial	22	RDF Burn rate more consistent than last trial. Clinker chemistry was within normal variation
Trial 3	17/6/19 To 22/6/19	RDF feed equipment, kiln process, clinker quality proving trial	22	Further trials to verify process conditions, as established in trial 2.
Trial 4	8/7/19 to 15/7/19	RDF feed equipment, kiln process, clinker quality proving trial	25	RDF burn rate successfully increased to 25t/h. Supply chain capacity proven with new logistics provider. Clinker chemistry was stable at varying RDF burn rate.
Trial 5	22/10/19 to 27/10/19	Stack emissions test 22/10/19 to 25/10/19	25	Trial process conditions optimised for stack testing. A RDF burn rate of 25 t/h achieved. Process and clinker chemistry was within normal operating conditions.

Note all plant operating data is automatically retained in the Citect SCADA historian system for five years.

6.2 RDF feed rate

A maximum sustainable RDF burn rate of 25t/h was achieved during the trial. RDF Plastics content averaged 14% by weight. Laboratory records show that historically the plastic content of RDF has been highly variable, with a standard deviation of 3% by weight. As a result, ABC estimates that some deliveries could contain up to 20% plastic content by weight.

6.3 Fuel Value

The RDF has a calorific value that at an addition rate of 25 t/h will displace up to 45% of the total process fuel input. Inherent variability in the moisture and ash content affect the calorific value of the RDF.

6.4 Kiln Operation and Burning Conditions

During the trial the kiln feed rate and the RDF addition rates were held as constant as possible, with small variations in natural gas. There was no change anticipated or observed in the kiln burning or operating conditions as the combustion of RDF occurs in the calciner. Normal operating set points for temperature, oxygen and pressures were maintained during the trial. The automatic kiln control system was able to control to all set points during the trial. Variations in the feed rate of the RDF were able to be automatically compensated for by adjusting the flow of natural gas to maintain temperature set points.

In general, the stability of the kiln process during the trial was excellent.

7. Stack Emission Tests and Results for Specific Analytes

7.1 Summary

Stack emission sampling was conducted on both stacks during the trial by Airlabs Environmental Pty Ltd., between October 22nd – 25th October 2019, the results of which are documented in Airlabs Test Report No. OCT 19137.1 dated 19th December 2019, included with this submission as attachment 1.

The maximum sustainable RDF burn rate during the trial was 25 t/h

No carbon firing was undertaken during the trial.

Analyte concentration levels during the trial have been compared to previous stack testing results to observe and comment on any changes that resulted from the increased burn rate of RDF.

In the following section of tabled stack testing results, Nominal - refers to the average of the previous 3 years of stack emissions results for the purpose of this report.

7.2 Dust Emissions

Particulate levels did not increase during the trial. This provides confirmation that complete burnout of the RDF is occurring.

Table 2: Comparative Stack Emissions Test Results for Particulate Matter

Analyte	Nominal 4A stack emissions	Nominal 4B stack emissions	4A Stack Emissions 25 t/h RDF Trial	4B Stack Emissions 25 t/h RDF Trial
Total Particulate Matter (mg/Nm^3)	10	6	6	6

7.3 NOx Emissions

Emissions of oxides of nitrogen were similar during the trial. This is to be expected as NOx emissions are a function of temperature and use of ambient air for the combustion of natural gas. The kiln produces more NOx due to the much higher kiln operating temperatures compared with the calciner where the RDF is burnt. The variation observed between the trial and nominal results reflects the typical variation in kiln operating conditions.

Table 3: Comparative Stack Emissions Test Results for NOx Emissions

Analytes	Nominal 4A stack emissions	Nominal 4B stack emissions	4A Stack Emissions 25 t/h RDF Trial	4B Stack Emissions 25 t/h RDF Trial
Total Oxides of Nitrogen (expressed as mg/Nm^3 of NO_2 @ STP)	747	550	800	570

7.4 Carbon Monoxide

As RDF is burned in the calciner vessel on the 4B side, no changes were expected on the 4A stack. This was the observed result during the trial. There was also no significant change in carbon monoxide levels on the 4B stack during the testing period compared to the previous stack testing results. Higher than normal carbon monoxide levels on 4B stack could have indicated changes in burning conditions in the calciner, but it was pleasing to see that this was not the case. This provides confirmation that complete burnout of RDF is occurring.

Table 7 later in this report shows that the total predicted maximum Ground Level Concentrations (GLC) for carbon monoxide emitted for the whole process during the trial was very low at only 2.3% of the Environment Protection (Air Quality) Policy 2016, GLC criteria for carbon monoxide.

Actual results were as follows:

Table 4: Comparative Stack Emissions Test Results for Carbon Monoxide

Analytes	Nominal 4A stack emissions	Nominal 4B stack emissions	4A Stack Emissions 25 t/h RDF Trial	4B Stack Emissions 25 t/h RDF Trial
Carbon Monoxide mg/Nm^3	56	441	36	455

7.5 Hydrocarbons and Organic Emissions

Polyaromatic hydrocarbons (PAH) levels showed no significant change on either stack compared to previous results. Overall, the PAH levels are well within EPA licence limits, with a maximum of 0.04% of the predicted GLC limit. Benzene and VOC levels show a very small increase, however these remain at very low levels with a maximum of 1.4% of the predicted GLC limit for benzene. The results measured are within the normal range of variation previously observed. These results are further evidence that products of incomplete combustion are not being generated.

Table 5: Comparative Stack Emissions Test Results for Hydrocarbons and Organic Emissions

Analytes	Nominal 4A stack emissions	Nominal 4B stack emissions	4A Stack Emissions 25 t/h RDF Trial	4B Stack Emissions 25 t/h RDF Trial
Benzene (mg/Nm^3)	0.08	0.18	0.05	0.26
PAH (mg/Nm^3)	0.000018	0.000041	0.000021	0.0000093
VOC (mg/Nm^3)	0.26	0.74	1.21	1.6

7.6 Dioxins and Furans

The dioxins and furans test results are shown below and compared to previous stack test results at different RDF and plastics content levels. The results show that increased use of RDF does not increase dioxins and furans concentrations levels in stack emissions. This confirms that increasing RDF use does not increase emissions of dioxins and furans.

Table 6: Comparison of Dioxins and Furans to Previous Trials

Case	Date of tests	4A STACK	4B STACK	SA EPA Guideline
		ng/Nm^3	ng/Nm^3	ng/Nm^3
		ITEQ	ITEQ	ITEQ
Stack tests last 3 years (average)	2017-2019	0.003	0.004	0.1
RDF trial – 25 tonnes/hr + 20% plastics (average)	22/10/2019 -25/10/2019	0.003	0.002	0.1

The results above infer that increased RDF burning rate does not increase dioxin and furan concentration levels in stack emissions. The measured values from this stack test are considered to be very low.

7.7 Heavy Metal Emissions

Stack testing and air quality impact assessment showed that heavy metals concentrations continued to remain at extremely low levels of the predicted maximum ground level concentrations. This excellent result can be seen in Table 7 below in section 7.9 where the highest level was observed with Beryllium which was 23.5% of the maximum predicted GLC.

7.8 Other Analytes

Viewing Table 7 in section 7.9 it can be seen that levels of other analytes of concern such as sulphur dioxide, hydrogen chloride and fluorine remain at low levels of the maximum predicted GLC.

7.9 Ground Level Concentrations - Schedule Y-1

Airlabs Environmental completed dispersion modelling, of all pollutants of concern in accordance with EPA requirements. The modelling predicts the maximum ground level concentrations for each pollutant, which has been compared against the relevant Environment Protection (Air Quality) Policy 2016 criteria. The Airlabs modelling report, is included with this submission as attachment 2.

Table 7 summarises the predicted maximum GLC's which has been expressed as a percentage (%) of the GLC criteria with and without background GLC's.

Table 7: Predicted Maximum Ground Level Concentrations from Stacks 4A and 4B

Pollutant	Averaging period	Criteria (µg/m³)	Maximum off-site (µg/m³)	Percentage of Criteria Excluding Background (%)	Percentage of Criteria Including Background (%)
Particulate matter (PM_{10})	24-hour	50	0.85	1.7%	37.7%
Particulate matter ($PM_{2.5}$)	24-hour	25	0.43	1.7%	30.9%
	Annual	8	0.03	0.4%	91.7%
Benzene	3-minutes	58	0.8	1.4%	1.4%
Hydrogen chloride	3-minutes	270	53.1	19.7%	19.7%
Chlorine	3-minutes	110	15.9	14.5%	14.5%
Fluoride	24-hour	3	0.04	1.3%	1.3%
	7 days	2	0.011	0.5%	0.5%
	90 days	1	0.006	0.6%	0.6%
Sulphur dioxide	1-hour	570	5.9	1.0%	1.2%
Carbon monoxide	1-hour	31240	477	1.5%	2.3%
Nitrogen dioxide	1-hour	250	157.1	62.8%	67.2%
	Annual	60	1.0	1.7%	19.7%
Antimony & compounds	3-minutes	19	0.002	0.01%	0.01%
Barium - soluble compounds	3-minutes	19	0.073	0.38%	0.38%
Chromium III	3-minutes	19	0.05	0.3%	0.3%
Copper oxide fume	3-minutes	7.3	0.01	0.2%	0.2%
Iron oxide fume	3-minutes	190	2.8	1.5%	1.5%
Magnesium oxide fume	3-minutes	360	46.2	12.8%	12.8%
Manganese & compounds	3-minutes	36	0.09	0.26%	0.26%
Mercury – organic	3-minutes	0.36	0.0001	0.02%	0.02%
Mercury – inorganic	3-minutes	4	0.021	0.5%	0.54%
Lead (as particles)	Annual	0.5	0.000011	0.002%	0.002%
Zinc oxide	3-minutes	190	0.103	0.05%	0.05%
Arsenic & compounds	3-minutes	0.19	0.002	0.8%	0.8%
Beryllium & compounds	3-minutes	0.008	0.0019	23.5%	23.5%
Cadmium & compounds	3-minutes	0.036	0.0003	0.8%	0.8%
Chromium VI compounds	3-minutes	0.19	0.0014	0.7%	0.7%
Nickel & compounds	3-minutes	0.36	0.038	10.5%	10.5%
PAH (as benzo(a) pyrene) (Bap-TEQPAH)	3-minutes	0.8	0.00005	0.01%	0.01%
	Annual	3E-04	1.2E-07	0.04%	0.04%
Polychlorinated Dioxins & Furans (NATO-ITEQ)	3-minutes	3.7E-06	8.4E-09	0.2%	0.2%

7.10 Ground Level Concentrations - Schedule Y-1 Conclusion

The emission data from the stacks has been modelled by Airlabs Environmental Pty Ltd, so that they can be evaluated against Schedule Y-1 of the licence and the relevant ground level concentration criteria in the Environment Protection (Air Quality) Policy 2016.

Table 7, shows that all ground level concentrations are predicted to be well below the EPA guidelines. NO_2 was the closest to the SA EPA guideline at 67%. All other pollutants were predicted

to be orders of magnitude lower than the guidelines, which ABC believes supports the request to allow the burning of RDF at 25 t/h with up to 20 % plastic content by weight.

8. Changes to Plant Pollution Control Equipment, Kiln or Stack Conditions during the Trial

No significant changes in the values or variability of operating conditions were observed during the stack testing and trial period of 22nd – 27th of October 2019.

8.1 Overall Effectiveness of the Trial

From an operational viewpoint, the trial was effective in providing an understanding of the effect of increased burning rate of RDF in the calciner. The impacts on process operation, the burner management systems, product quality and the overall pyro processing circuit were assessed and no impediments to continuing at this rate were found.

8.2 Complaints and/or Enquiries Received About the Trial

No complaints were logged into the community complaints database that were related to any aspect of the RDF pre and final 25 t/h trials.

A community consultation program is in place at Birkenhead. The program consists of regular meetings with interested residents, local government and the EPA. Community meetings scheduled will enable feedback on the trial to be provided to residents and the local community.

9. Suitability for Continued Use in the Kiln Burner System

The modelling of emissions from ABC's Birkenhead facility during the 25 t/h burning rate of RDF has shown ground level concentrations of all schedule Y-1 pollutants to be well below the relevant criteria in the Environment Protection (Air Quality) Policy 2016.

The findings from this report show that burning of RDF at 25 t/h with a maximum content of 20% plastic by weight is a viable option to reduce the total natural gas requirement and raw material requirements for making clinker.

ABC therefore seeks approval for the maximum permitted burn rate of RDF to be increased to 25 t/h.

10. Attachments

10.1 RDF Trial Stack Emissions Report

Airlabs "Air Emissions Monitoring Of Release Points 4A and 4B at Adelaide Brighton Cement Ltd in Birkenhead 25 Tonne/Hr RDF Trial", Test Report No. OCT 19137.1, dated 19th December 2019

10.2 RDF Trial Stack Emissions Dispersion Modelling Report

Airlabs "Air Quality Impact Assessment of The ABC Birkenhead Cement Facility – RDF Trials October 2019 Emissions", Report No. OCT19137_A.1, dated 20th December 2019.