NSW Department of Planning & Environment and the EPA

Modification to Berrima Cement Works - Use of Waste Derived Fuels

Review of Environmental Assessment

DA-401-11-2002-MOD 9

Final | 9 October 2015

Job number 245530-00

Arup
Arup Pty Ltd ABN 18 000 966 165

Arup
Level 4, 108 Wickham Street
Fortitude Valley
QLD 4006
GPO Box 685 Brisbane QLD 4001
Australia
www.arup.com

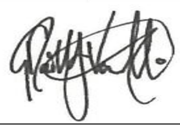
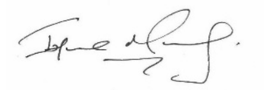
This report has been prepared by Arup on behalf of both the NSW Environment Protection Authority (EPA) and the Department of Planning and Environment, NSW in connection with the review of the Environmental Impact Assessment for Berrima Cement Works, Modification 9 – Use of Solid Waste Derived Fuels.

ARUP

Document Verification

ARUP

Job title	Modification to Berrima Cement Works - Use of Waste Derived Fuels			**Job number** 245530-00
Document title	Review of Environmental Assessment			**File reference**
Document ref	DA-401-11-2002-MOD 9			

Revision	**Date**	**Filename**	Berrima Summary Report Draft_Issue 1.docx		
Draft 1	01 Oct 2015	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Joyanne Manning/Guy Raithby-Veall	Guy Raithby-Veall	Joyanne Manning
		Signature			
Final	09 Oct 2015	**Filename**	245530_Berrima Summary Report Final_ 091015.docx		
		Description	Revision to draft to encompass review comments received from Department of Planning & Environment on 08 Oct 2015. Finalisation of report		
			Prepared by	Checked by	Approved by
		Name	Joyanne Manning/Guy Raithby-Veall	Guy Raithby-Veall	Joyanne Manning
		Signature	 		
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

This report has been prepared by Arup on behalf of both the NSW Department of Planning and Environment and the NSW Environment Protection Authority (EPA) in connection with the review of the Environmental Impact Assessment for Berrima Cement Works, Modification 9 – Use of Solid Waste Derived Fuels and takes into account their particular instructions and requirements. It is not intended for and should not be relied on by any third party and no responsibility is undertaken to any third party.

1 Scope of Work

Arup was appointed in August 2015 by the NSW Department of Planning & Environment and the EPA to undertake a review of the technical components of Berrima Cement Works Modification 9, Environmental Impact Assessment for the Use of Solid Waste Derived Fuels (DA 401-11-2002 MOD 9).

The scope of this commission included:

- A merit review of the proposed modification including the use of solid waste derived fuel as an energy source and the proposed changes to emission limits and emissions reporting;
- A critical review of the existing and proposed technology/infrastructure and its ability to meet the criteria of the NSW Energy from Waste Policy Statement (2014);
- An assessment of the eligibility of the proposed waste derived fuels and whether the facility meets the requirements to be an energy recovery facility;
- Recommendations for changes to the proposed modification and/or any necessary mitigation measures; and
- Recommended conditions of approval (should the modification be approved)

This report documents the findings of this assessment and provides advice for the development of conditions of approval should the development be approved.

2 Summary of findings

2.1 Introduction

Boral Cement Limited (Boral) operates a cement works at New Berrima, NSW and have made an application for a modification to their current approval at the Boral Cement Works, New Berrima. The Cement Works operate subject to two development consents issued by the Department of Planning and Environment (DPE) (DA 401-11-2002 (Kiln 6), May 2003 and DA 85-4-2005 (Mill 7), Aug 2005). The development consent for Kiln 6 has since been modified eight times. An Environment Protection Licence (EPL 1698) issued by the Environment Protection Authority (EPA) is also held by Boral for the operation of the facility.

This application, Modification 9, seeks approval for the following:

- use of Solid Waste Derived Fuel (SWDF) as an energy source;
- changes to the air emission limits of particulate matter (PM), nitrous oxides (NOx) and volatile organic compounds (VOC); and
- construction and operation of a fuel storage and kiln feeding system.

In addition, Boral wishes to surrender Modification No. 6 (June 2012) relating to the stockpiling of coal for sale and transport to Port Kembla.

An assessment of applicant documentation has been made against:

- The Secretary Environmental Assessment Requirements (SEARS) dated 28 October 2014 (Appendix A)
- The NSW Energy from Waste Policy Statement 2015 (Appendix B)
- EU Best Practice (Industrial Emissions Directive 2010/75/EU) and associated Best Available Techniques (BAT) Guidance (Appendix C)

This report provides a summary of the key findings of this assessment. Detailed assessments against each of the reference documents is provided in the Appendices.

2.2 Feedstocks and Reference Facilities.

The proposed modification to the existing approved feedstock is to use up to 100,000 tonnes per annum of SWDF and residual wood waste as input fuel for the facility.

It is proposed that the facility will be fuelled on a number of residual waste fuel types. These are:

- **Wood Waste –** consisting of material left over from industrial processes such as milling, furniture making, and from the building and construction; and
- **Refuse Derived Fuel (RDF) -** fuel made from the combustible materials recovered and processed from waste streams, such as papers, cardboards, packaging, and construction and demolition materials

The EIS provides an indicative breakdown of the waste streams for wood waste and RDF that is based on information they have sourced from potential suppliers.

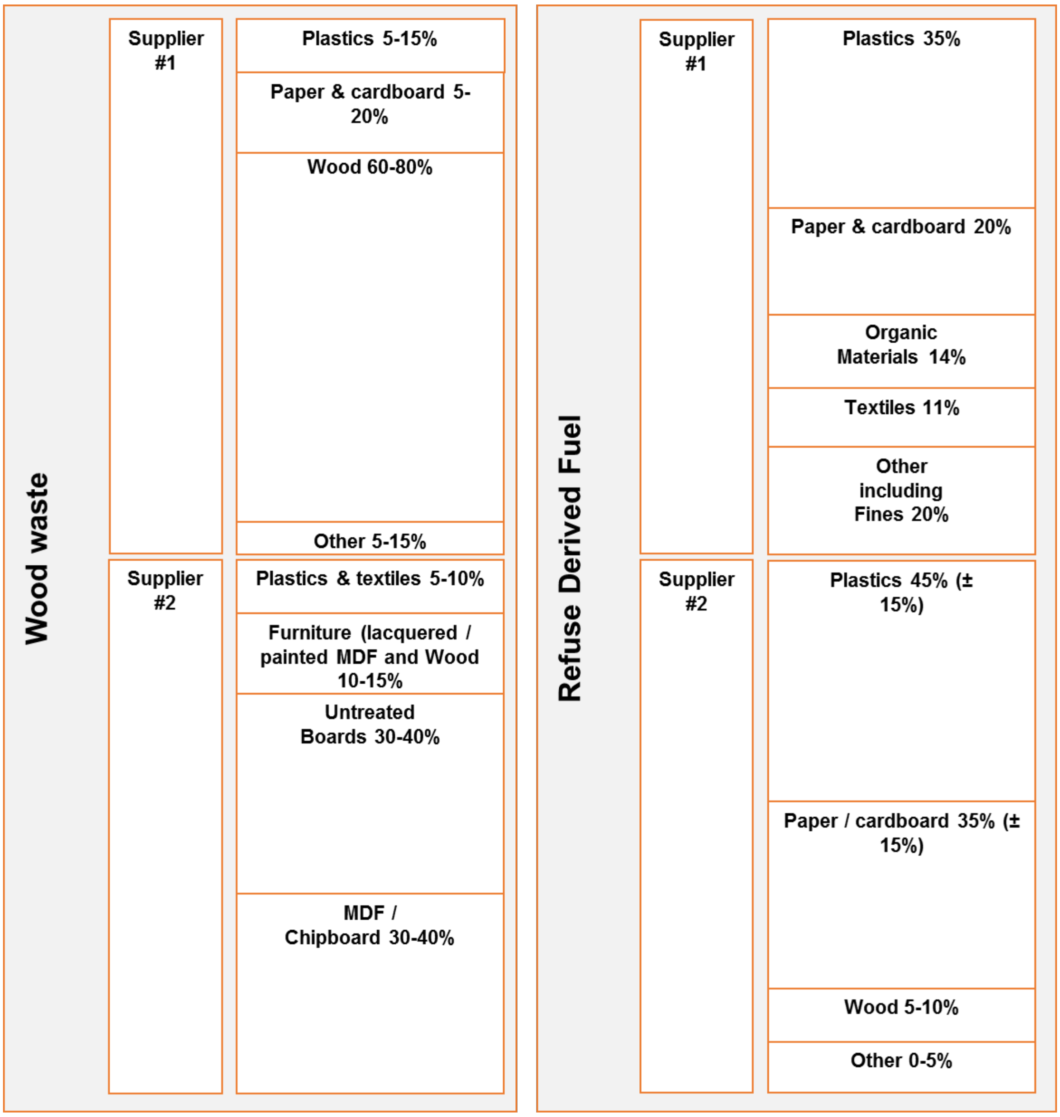


Figure 1 Indicative breakdown of Solid Waste Derived Fuels waste streams

The proponent has not provided in the EIS an initial breakdown of the volume range for each waste stream that makes up the proposed 100,000 tonnes.

The proponent has proposed a risk based approach to ensure that the SWDF suppliers 'agree to meet the EPA guidelines' and that this will be a prerequisite in supplier contracts.

The EIS outlines the proponents approach to the avoidance of any environmental impact associated with using feedstock as an 'eligible waste fuel'. Adequacy has been deemed 'Partial', pending the supply and assessment of the documents referenced in the assessment, namely:

1. Sampling and testing regime for waste fuels supplied from both the supplier, and the Cement Works
2. Boral and Industry data that demonstrates cement kilns have high capture efficiency for heavy metal contaminants.

It is recommended that the proponent provides an estimated volume range breakdown of the SWDF waste streams proposed.

The NSW EPA Energy from Waste Policy statement states that:

> *'Energy recovery facilities must use technologies that are proven, well understood and capable of handling the expected variability and type of waste feedstock.'*

and that:

> *'This must be demonstrated through reference to fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions.'*

The proponent has identified three existing cement facilities in operation in the UK that are currently using SWDF as a feedstock fuel. These are:

- **Lafarge Tarmac Tunstead and Lowe Plants, UK** - Similar kiln/precalciner design burning tyre chips, wood chips, RDF, carpet and meat and bone meal up to 50% heat replacement
- **Cemex Rugby Plant UK –** Precalciner plant burning RDF and other solid waste derived fuels
- **Heidelberg Padeswood Plant UK –** Precalciner plant burning RDF and other solid waste fuels.

Mass balance for any of the reference facilities have not been provided, nor are any of the listed reference facilities deemed to meet the NSW EfW policy criteria of *'treating like waste streams in other similar jurisdictions'*.

Before the acceptance of SWDF commences, it is recommended that the proponent provides information of reference facilities treating similar type waste streams, of a similar range, and within a similar jurisdiction to that that is proposed.

2.3 Air Quality Emission Limits

The NSW Policy statement states that:

> *The process and air emissions from the facility must satisfy at a minimum the requirements of the Group 6 emission standards within the Protection of the Environment Operations (Clean Air) Regulation 2010*

The proposed air emissions limits against the facilities current limits and the Group 6 emission limits from the *POEO (Clean Air) Regulation 2010* are detailed in Table 1.

Air impurity	**POEO (Clean Air) Regulation 2010 Group 6 Limits**	**EU Industrial Emissions Directive***	**Limit using standard fuel**	**Non-Standard Fuels**	
				Current limit	**Proposed limit**
Solid particles (Total)	**50 mg/m^3**	**20 mg/Nm^3**	95 mg/m^3	30 mg/m^3	50 mg/m^3**
Nitrogen Oxides (NOx)	**500 mg/m^3**	**500 mg/m^3**	1000 mg/m^3	800 mg/m^3	1000 mg/m^3***
Volatile Organic Compounds (VOCs)	**40 mg/m^3**	**10 mg/Nm^3**	N/A	20 ppm	40 ppm***

Table 1 Proposed emission limits

* Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

** NSW Group 6 emission criteria as per Energy from Waste Policy 2014

** Alternative emission standards applied for as per Clause 36 of POEO (Clean Air) Regulation 2010

Furthermore, a comparison has been made on the proposed emission limits to European limits of similar types of facilities that would require an Industrial Emissions licence under Article 10 and A1 Class 3 of the European Industrial Emissions Directive 2010/75/EU (IED).

It is noted that the proponent is proposing to increase the facilities current NOx limit from 800 mg/m^3 to 1000 mg/m^3. However this proposed limit is above the Group 6 limit of 500 mg/m^3 for cement kilns.

It is noted that the proponent is proposing to increase the facilities current particulates limit from 30 mg/Nm^3 to 50 mg/Nm^3. Whilst the Group 6 limit is 50 mg/Nm^3, the IED limit is 20 mg/Nm^3 for existing cement kilns.

It is noted that the proponent is proposing to increase the facilities current VOCs limit from 20 mg/Nm^3 to 40 mg/Nm^3. Whilst the Group 6 limit is 40 mg/Nm^3, the IED limit is 10 mg/Nm^3 for existing cement kilns. The IED however also states: “The competent authority may grant derogations for emission limit values set out in this point in cases where TOC and SO_2 do not result from the co-incineration of waste."

Boral pertain that the *"VOC emissions are not associated with the combustion of fuels. Rather, the VOCs are associated with the natural composition of onsite blue shale used as a raw material in Kiln 6"*. However, when waste comprising or containing organic materials is incinerated, incomplete combustion may result in emission of organic compounds. The EIS states in Table 3: Indicative breakdown of Solid Waste Derived fuel waste streams that the percentage of organic materials in the RDF will be 14%. Therefore it is possible that there could be VOC emissions associated with the combustion of fuels.

Given it is not possible to convert ppm to mg/Nm^3 without knowing the composition of waste, until such time as the actual waste is being processed through the facility, it will not be possible to understand the actual likely VOCs concentration in the feedstock.

However, given the very high temperatures and long residence times that are a feature of cement kilns, it would be expected that thermal destruction of organic material would be substantially complete.

It is recommended that the proponent investigates the feasibility for the installation of NOx reducing emission control equipment (SNCR or SCR) and if financially and technically viable propose a timeframe for its installation.

Justification should also be provided if emission control equipment is not considered feasible, and consideration should be given to other NOx abatement control measures.

There are a number of emission control measures for particulates defined by the EU. It is recommended that the proponent consider and determine what measures could be feasibly implemented in order to reduce particulate emissions in line with international best practice.

The emission limit value for VOCs (20 ppm) should remain unless the applicant demonstrates that it is physically impossible due to the nature of the raw materials, to achieve this limit, in which case the higher limit sought (40 ppm) could be granted.

The EIS addresses, at a limited level, pollution monitoring arrangements for the facility. However the EIS lacks to address any pollution control equipment. In particular, the mechanisms for fugitive / point source emissions are not differentiated.

2.4 Emission Reporting

Boral are seeking minor changes in the development consent to the way two emissions are reported.

The changes sought are:

The definitions of Volatile Organic Compounds to be changed to Non-Methane Volatile Organic Compounds; and

The averaging period for the reporting of Nitrogen Oxides changed from 1-hour averaging, to 24 hour averaging.

With respect to the change in the definition of VOCs, as outlined in Section 2.3 until such time as the composition of the SWDF is fully known and the concentration of organic compounds within the waste feed has been determined, it is recommended that the definition of VOCs remains the same. Consideration of a change in definition can be given once the composition and concentration of organic compounds within the waste feed has been provided.

With regard to changing the reporting of NOx from 1-hour averaging to 24 hour averaging. The EU BAT conclusions document gives NOx limits as daily average value which is the average value over a period of 24 hours measured by the continuous monitoring of emissions. Therefore, it is recommended that this change in reporting is granted for NOx emissions.

It is recommended that the definition of VOCs remains until such time as the composition and concentration of organic compounds within the waste feed has been provided.

It is recommended that the change of reporting of NOx from 1-hour averaging to 24 hour averaging is granted.

2.5 Emission Control Equipment

The NSW Policy statement states that

'Facilities proposing to recover energy from waste will need to meet current international best practice techniques, particularly with respect to:

- *process design and control*
- *emission control equipment design and control*
- *emission monitoring with real-time feedback to the controls of the process'*

The Industrial Emissions Directive (IED) 2010/75/EU defines Best Available Techniques (BAT), BAT Reference Document (BREF) and BAT Conclusions as follows:

The Industrial Emissions Directive defines Best Available Techniques (BAT) as follows:

'best available techniques' means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole:

(a) 'techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned; **(b) 'available techniques' means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator;** **(c) 'best' means most effective in achieving a high general level of protection of the environment as a whole;**
The Industrial Emissions Directive definition of BAT Reference Document is as follows: "(11) 'BAT reference document' means a document, resulting from the exchange of information organised pursuant to Article 13, drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques, giving special consideration to the criteria listed in Annex III;" SI 138 of 2013 has a similar definition.
The Industrial Emissions Directive and SI 138 of 2010 have the same definition of BAT conclusions, as follows: 'BAT conclusions' means a document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures;

The European IPPC Bureau (EIPPCB) organises and co-ordinates the exchange of information between Member States and the industries concerned on Best Available Techniques (BAT), as required by Article 13 of the IED. The EIPPCB produces BAT reference documents (BREF) and BAT conclusions.

Relevant to this application are the BAT Conclusions (Commission Implementing Decision), and BAT reference document(s) (BREFs):

> '*Commission Implementing Decision of 26th March 2013 establishing the Best Available Techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on Industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU) (known as CLM).'*

Appendix C provides a detailed review of the Berrima Cement Plant installation as proposed against the relevant documents. The IED sets out emission control equipment that could be used on their own or in combination to reduce emissions. Emission control measures are defined for a range of emissions and BAT-associated emission levels are provided.

The current consent provides the maximum allowable discharge concentration limits (Air) when Kiln 6 is used for both standard (table 3) and non-standard fuels (table 4). The limits defined in the EU BAT are more stringent than the limits set out in the current consent and that sought in the application for burning non-standard fuel (refer Section 2.3). In order to reduce emissions of NOx and particulates to come in line with the emissions limits defined in the EU BAT, additional emission control equipment will be required.

With regard to NOx the best practice abatement control techniques include primary techniques which include flame cooling, low NOx burners, mid kiln firing, addition of mineralisers and process optimisation. Other techniques defined that can result in lower NOx emissions include staged combustion, also in combination with a precalciner and the use of optimised fuel mix. For rotary cement kilns selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR) are appropriate.

Much lower NOx levels can be achieved by techniques such as SNCR. However this would entail a capital cost and ongoing operational costs for ammonia or urea.

Therefore, it is recommended that Boral investigate the installation of NOx reducing emission control equipment (SNCR or SCR) and if financially and technically viable propose a timeframe for its installation. Justification needs to be provided if not considered feasible and consideration to other NOx abatement control needs to be provided.

With regard to particulates the current consent limit is 30 mg/Nm^3. The IED limit is 20 mg/Nm^3 for existing cement kilns. Boral are seeking an increase from their current limit of 30mg/Nm^3 to 50 mg/Nm^3.

There are a number of emission control measures for particulates defined by the EU.

Boral needs to consider and determine what measures could be feasibly implemented in order to reduce particulate emissions in line with international best practice.

The SEARs required that details of any pollution control equipment and other impact mitigation measures for fugitive and point source emissions are required. Pollution monitoring is explained in Section 7.1.5 of the EIS, albeit in limited detail. However pollution control equipment is not discussed, and mechanisms for fugitive / point source are not differentiated. Although this information may be contained within the detailed Air Quality Impact Assessment Report (Appendix D) it is reasonable to expect that this information should have been included in the main EIS document.

2.6 Solid Waste Derived Fuels Acceptance

The solid waste derived fuel (SWDF) specification is provided in Appendix B of the EIS. The specification sets out the chemical composition that the SDWF must adhere to and the quality assurance measures that must be implemented by the suppliers of the SWDF.

The EU BAT Conclusion document sets out specific guidance with regard to the use of waste. With regard to waste quality control the best available techniques are:

a) Apply quality assurance systems to guarantee the characteristics of wastes and to analyse any waste that is to be used as raw material and/or fuel in a cement kiln for:

   i) constant quality

   ii) physical criteria, e.g. emissions formation, coarseness, reactivity, burnability, calorific value

   iii) chemical criteria, e.g. chlorine, sulphur, alkali and phosphate content and relevant metals content

b) Control the amount of relevant parameters for any waste that is to be used as raw material and/or fuel in a cement kiln, such as chlorine, relevant metals (e.g. cadmium, mercury, thallium), sulphur, total halogen content

c) Apply quality assurance systems for each waste load

In Ireland where the Irish EPA has licenced two facilities to use waste as alternative fuels, a conservative approach has been taken with regard to the need to demonstrate through trials that the introduction of waste as an alternative fuel so that it does not lead to emission to atmosphere exceeding licence limits. A secondary measure of limiting emissions is to ensure that the contaminants of concern are not contained in the waste stream at a concentration that could result in exceedances in atmospheric emissions.

The draft specification references two international standards for sampling refuse derived fuels and Solid Biofuels. Both sampling methodologies call for a sample size is 3 litres (approximately 144mm cube), whereas the maximum particle size as stated in the SWDF specification is 100mm. It may not be possible to obtain a representative sample from an alternative fuel with large particles.

Therefore Arup would recommend that the capacity of the sampling container and the maximum particle size should be reviewed and a means developed for obtaining a representative sample.

The obligation of standards and specifications for waste to be used as SWDF wastes may give rise to problems for the user (the cement kiln operator) and the supplier. Wastes are generally heterogeneous in terms of physical condition and source, which means that obtaining representative samples may be challenging. Furthermore, SWDF may only be sourced from facilities that meet the requirements of the NSW EPA Energy from Waste Policy Table 1 – Resource recovery criteria for energy recovery facilities. For the supplier the difficulty is to source or blend waste to achieve the specification. For the user the difficulty is to ensure that only reliable suppliers are used, that the Policy is being met, that sufficient samples are taken and that a means is established for returning out-of-specification material to the supplier.

Therefore we would recommend that a robust methodology is developed by Boral for pre-qualifying suppliers of SWDF to ensure that contracts for the supply of alternative fuels are placed only with suppliers that have appropriate technical expertise, are operating in accordance with the NSW EPA Energy from Waste Policy and have appropriate quality assurance systems.

Boral should also provide prior to the receipt of any waste at the facility, a comprehensive suite of operational procedures for the weighing, checking and handling of incoming waste fuels. This should form part of their QA/QC system and standard operating procedures for site operation.

A quarantine area should be provided onsite for waste received onsite that does not meet visual inspection criteria and to allow for its storage while being chemically assessed.

By implementing strict acceptance and quality control testing on the feedstock the likelihood of non-compliant or ‘contaminated’ SWDF making its way into the kiln should be reduced. However, as will be discussed in Section 2.4, Boral should maintain and operate an automatic system to prevent waste feed entering the kiln under a number of different scenarios including whenever the continuous measurements show that any emission limit value is exceeded. Therefore, if any ‘contaminated’ SWDF enters the kiln and results in exceedances in the ELVs, the automated system will prevent any further waste feed of potentially contaminated material and thus should limit the exceedance impact.

The EIS states that RDF received onsite for outdoor storage will be plastic wrapped.

Boral should consider the impact the plastic wrapping will have on its fuel specification if it is intended to prepare the RDF inclusive of the plastic wrapping. If the RDF is prepared inclusive of the plastic wrapping any RDF sample should include a portion of plastic wrapping.

Conditions should be provided in any amended Consent that details the requirements for waste acceptance including sampling, testing, prequalification of suppliers and material handling of suspect or non-conforming waste.

2.7 Co-incineration of SWDF

The EU BAT Conclusion document sets out what is BAT in order to ensure appropriate treatment of the wastes used as fuel and/or raw materials in the kiln. This includes:

a) Use appropriate points to feed the waste into the kiln in terms of temperature and residence time depending on kiln design and kiln operation

b) To feed waste materials containing organic components that can be volatilised before the calcining zone into the adequately high temperature zones of the kiln system

c) To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion, even under the most unfavourable conditions, to a temperature of 850°C for 2 seconds

d) To raise the temperature to 1100°C, if hazardous waste with a content of more than 1% of halogenated organic substances, expressed as chlorine, are co-incinerated

e) To feed wastes continuously and constantly

f) Delay or stop co-incinerating waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence times cannot be reached, as noted in a) to d) above

It is important that SWDF and non-standard fuels will be used as fuel only. All materials in the SWDF must either end up in the clinker or in emissions to atmosphere. The inclusion of materials in the clinker is a matter of quality of the cement product. Hence the focus from a regulatory viewpoint is on emissions to atmosphere, which will be determined to some extent by the combustion efficiency in the kiln and by the partitioning of materials in the waste between clinker and air emissions. Incomplete combustion may lead to higher emissions of organic materials. Exceedance of product specification limits may lead to higher emissions of acid gases, etc. Therefore the Irish EPA imposes requirements regarding the amount or proportion of alternative fuel that may be introduced to a cement kiln.

It is standard practice in EU that a staged commissioning approval is provided in order to demonstrate the appropriateness of the SWDF and other fuels at different ratios and feed rates until the desired performance is achieved and then full scale operation can occur or the feed rate may be increased.

A test program for the staged commissioning of non-standard fuel use should be prepared by Boral for the co-incineration of each alternative fuel.

The program should be submitted to the regulatory authority prior to implementation.

The test programme shall as a minimum:

a) Verify the residence time, the minimum temperature and the oxygen content of the exhaust gas which will be achieved during normal operation and under the most unfavourable operating conditions anticipated.

b) Establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence.

c) Assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.

d) Establish criteria for the control of all alternative fue1 input including the maximum flow and maximum calorific value.

e) Confirm that all measurement equipment of devices (including thermocouples) used for the purpose of establishing compliance with this licence have been subjected, in situ, to normal operating temperatures to prove their operation under such conditions.

A report on each test programme shall be submitted within one month of completion.

Co-incineration of alternative fuels shall not be permitted (outside of the agreed test programme) until such time as the NSW EPA has indicated in writing that it is satisfied with the results of the test programme for an individual alternative fuel.

With regard to operational procedures Boral should provide details of their operational procedures when co-firing using SWDF.

The operational procedures shall ensure that the requirements of the NSW EPA Energy from Waste Policy are met with regard to raising of gas from the process to a minimum temperature of 850°C for a minimum of two seconds.

It is important that waste is only co-incinerated during normal operating conditions and that waste cannot be fed into the kiln when the required temperature is not achieved or when emission limit values are exceeded, or in any other abnormal condition.

It is therefore recommended that Boral should maintain and operate an automatic system to prevent waste feed:

- **a. at start-up, until the temperature of >850°C has been reached;**
- **b. whenever the temperature falls below 850°C;**
- **c. whenever the continuous measurements show that any emission limit value is exceeded;**
- **d. whenever stoppages, disturbances or failure of the purification devices or the measurement devices may result in the exceedance of the emission limit values; or**
- **e. in the case of a breakdown or incident.**

2.8 Thermal Efficiency

The NSW EPA Energy from Waste Policy requires a thermal efficiency of at least 25% of the energy generated from the thermal treatment of the material captured as electricity and that energy recovery facilities must also demonstrate that any heat generated by the thermal processing of waste is recovered as far as practicable including use of waste heat for steam or electricity generation or for process heating of combined heat and power schemes.

The use of SWDF in the cement works is as a fuel source to produce heat for the kiln. The SWDF will directly replace the use of standard fuels such as coal. Therefore effectively all SWDF being accepted and used is being captured as heat.

There is no electricity capture as there is no excess heat being generated that could be captured. The SWDF is being as a direct substitute for standard fuels needed to fire the kiln.

2.9 Chlorine

The EIS highlights the difference in the wording between the NSW policy and Industrial Emissions Directive (IED) and identifies that the NSW EPA policy applies to all waste not just Hazardous waste as in the IED.

Cement kilns are designed to fire at temperatures in excess of 1400°C, as this is the temperature required to produce the clinker. In addition the Berrima operation includes a precalciner which operates at temperatures in excess of 800°C which gives fuels a longer time to burn out at high temperatures.

The inclusion of high chlorine levels in the fuel feed stock is an issue for the cement manufacture as elevated levels of chlorine can impact the quality of the clinker. Therefore, cement manufacturers require that any SDWF used as a fuel source contain less than 1% chlorine. The SDWF specification provided in Appendix B of the EIS states that the maximum concentration of chlorine allowable is 1%.

2.10 Storage and stockpiling of SWDF

The EIS states that SWDF will be stored and handled in a new designated facility on site designed to store and handle SWDF such as the waste tyre chips, wood waste and refuse derived fuel. A designated ground outdoor storage area will also be provided for the SWDF received in the form of covered bales or within covered delivery vehicles.

The EIS indicates that it is the intention of Boral to stockpile each SWDF waste type and allow onsite enough waste for one year operation. This size of stockpiles appears excessive and consideration by Boral should be given to the actual operational stockpile needed to ensure normal operations.

The EIS does not provide a breakdown of the amount of RDF that will be stored internally and externally. The EIS dos not consider the visual impact of external stockpiles of RDF onsite. Given that the EIS states that stockpiles of RDF could be up to 50,000 tonnes/annum, this could equate to considerable external stockpiles of RDF if stored externally**.**

In order to inform the local community of the possible magnitude of external stockpiles, Boral should consider what is the maximum operational stockpile of RDF required for normal operations and what proportion of RDF will be received in 1m^3 bales for external storage.

Boral should then consider the visual impact of external stockpiling on the local community.

3 Summary

Boral proposes to use up to 100,000 tonnes per year of SWDF in Kiln 6 operations. This would replace approximately 50,000 tonnes of coal currently used to fire the kiln. Boral are seeking approval for a modification to their existing consent to allow the following:

- Use of Solid Waste Derived Fuel (SWDF) as an energy source;
- Changes to the air emission limits of particulate matter (PM), nitrous [sic] oxides (NOx) and volatile organic compounds (VOC); and
- Construction of a fuel storage and kiln feeding system.

The fuels that are the subject of this modification are the following SWDF:

- Wood Waste - material left over from industrial processes like milling, furniture making, and building and construction; and
- Refuse Derived Fuel (RDF) - fuel made from the combustible materials recovered and processed from waste

A detailed assessment of the application has been made against:

- The Secretary Environmental Assessment Requirements (SEARS) dated 28 October 2014 (Appendix A)
- The NSW Energy from Waste Policy Statement 2015 (Appendix B)
- EU Best Practice (Industrial Emissions Directive 2010/75/EU) and associated Best Available Techniques (BAT) Guidance (Appendix C).

The NSW EPA Energy from Waste Policy Statement requires that facilities must demonstrate that they will be using current international best practice techniques and the European Union provides the most appropriate international best practice guidance with regard to the regulation of pollutant emissions from industrial installations including cement kilns through the European Industrial Emissions Directive 2010/75/EU. The IED provides through the Commission Implementing Decision of 26 March 2013 best available techniques (BAT) conclusions on industrial emissions for the production of cement, lime and magnesium oxide. This document provides BAT-emission levels that are required under the IED.

The NSW EPA Energy from Waste policy statement also requires that best practice must be demonstrated through reference to fully operational plants using the same technology and treating like waste streams in other similar jurisdictions. Whilst the EIS provides references to facilities in the UK specific details of the technologies and abatement equipment employed at the reference facilities and mass balances for the types of SWDF used as alternative fuels have not been provided.

Before the acceptance of SWDF commences, it is recommended that the proponent provides information of reference facilities treating similar type waste streams, of a similar range, using similar technology, and within a similar jurisdiction to that that is proposed.

The NSW EPA Energy from Waste policy statement requires that process and air emissions from the facility must satisfy at a minimum the requirements of the Group 6 emission standards within the Protection of the Environment Operations (Clean Air) Regulation 2010.

With respect to NOx the IED BAT-emission limit value of 500mg/Nm³. The Group 6 emission standard for NOx is 500mg/Nm³ for cement kilns. Boral are seeking an increased limit of 1000 mg/Nm³ when using non-standard fuels. It is recommended that Boral investigate the installation of NOx reducing emission control equipment and if financially and technically viable propose a timeframe for its installation.

With respect to particulate matter the IED BAT-emission limit value of 20mg/Nm³. Boral are seeking an increase in particulate matter to 50mg/Nm³ from their current limit of 30mg/Nm³. There are a number of emission control measures defined by the EU which Boral need to consider and determine what measures could be feasibly implemented in order to reduce particulate emissions in lined with international best practice.

With respect to VOCs the IED BAT-emission limit value of 10mg/Nm³. Boral are seeking an increase in VOCs to 40mg/Nm³ from their current limit of 20mg/Nm³. The emission limit value for VOCs (20 ppm) should remain unless the applicant demonstrates that it is physically impossible due to the nature of the raw materials, to achieve this limit, in which case the higher limit sought (40 ppm) could be granted.

It is recommended that the definition of VOCs remains until such time as the composition and concentration of organic compounds within the waste feed has been provided.

It is recommended that the change of reporting of NOx from 1-hour averaging to 24 hour averaging is granted.

Operational procedures with respect to the sampling of SWDF should be reviewed and consideration needs to be given to the most appropriate sample size required to obtain a representative sample based on the specification provided in the EIS.

A methodology should be developed for the pre-qualifying suppliers of SWDF to ensure that contracts for supply of alternative fuels are placed only with suppliers that have appropriate technical expertise, are operating in accordance with the NSW EPA Energy from Waste policy and have appropriate quality assurance systems.

Boral should also provide prior to the receipt of any waste at the facility, a comprehensive suite of operational procedures for the weighing, checking and handling of incoming waste fuels. This should form part of their QA/QC system and standard operating procedures for site operation.

A quarantine area should be provided onsite for waste received onsite that does not meet visual inspection criteria and to allow for its storage while being chemically assessed.

A test program for the staged commissioning of non-standard fuel use should be prepared by Boral for the co-incineration of each alternative fuel.

SWDF should only be used during normal operations. An automatic feed system should be operated to ensure that waste feed is prevented during non-normal operations.

Storage of RDF outside needs to be clarified by Boral and the visual impact that potentially up to 50,000 tonnes may have on the local community needs to be considered, including any potential health and safety issues.

Storage procedures and limits should be prepared for bailed RDF that is stored on the outside storage area.

Appendix A

NSW EPA Energy from Waste Policy Statement Review

ARUP

Document:	NSW Energy from Waste Policy Statement	Project:	Modification to Berrima Cement Works - Use of Waste Derived Fuels
Owner:	NSW EPA	Project ID:	245530-00
Version/Date:	Friday, 9 October 2015	Prepared by	Guy Raithby-Veall and Joyanne Manning
Link:	https://majorprojects.affinitylive.com/public/9f0b4d7c9976ef926f54292a34a73687/Boral%20Kiln%206%20SEARs.p	Reviewed by:	Joyanne Manning

Section	Page Ref	NSW EfW Policy Criteria	Arup Comments on EIS	Suggested conditions
1. Introduction	1	The EPA has applied the following overarching principles to waste avoidance and recovery:	The report defines the proposed development.	The Proponent should submit for approval a concept design that comprehensively and accurately defines the facility. This should then flow down accurately through all documents and drawings.
		• higher value resource recovery outcomes are maximised	Proposal is to use Solid Waste Derived Fuel (SWDF) and residual wood waste as input fuel for the facility.	
		• air quality and human health are protected		
		• 'mass burn' disposal outcomes are avoided		
		• scope is provided for industry innovation		
		Facilities proposing to recover energy from waste will need to **meet current international best practice techniques**, particularly with respect to:	Refer to BAT Review	
		• **process design and control**		
		• **emission control equipment** design and control		
		• **emission monitoring with real-time feedback** to the controls of the process	Existing monitoring equipment installed in 2004 for Kiln-6. Proponent proposes to continue monitoring for specified air emissions - NOx, TSP & VOCs.	
2. Energy recovery framework and scope	4	As proposals progress from the concept to detailed development assessment stage, proponents should engage in a genuine dialogue with the community and ensure that planning consent and other approval authorities are provided with accurate and reliable information.	Proponent has conducted consultation with stakeholder groups regarding their proposal, including: · NSW Environment Protection Authority · NSW Roads & Maritime Services · Wingecarribee Shire Council · Berrima Cement Works Community Liaison Group. Evidence of consultation with NSW EPA provided in Appendix J.	The Proponent should submit for approval the ongoing community engagement programme through the design, construction and commissioning stage. The Proponent should submit for approval details of it Emission Data Monitoring access to stakeholders or access through live online portals.
		The operators of an energy from waste facility will need to be 'good neighbours' – particularly if near a residential setting but also where there are workers in other facilities. This would apply to waste deliveries and operating hours, but most importantly with respect to readily available information about emissions and resource recovery outcomes.	Facility located in Berrima since 1927 (operational since 1929). New Berrima built to support the Cement Works. Local residents but have long standing relationship with the Works. Relatively minor increase in traffic volumes (c6.5% on weekdays and c10% on weekends). No change to operational hours or hours of traffic	The Proponent should submit for approval a detailed community engagement plan for the life of the facility The Proponent is to pay levy relating to paying road maintenance levy as agreed with the Local Council
3. Eligible waste fuels	5	The following wastes are categorised by the EPA as *eligible waste fuels* :		Permission should be obtained from the NSW EPA before processing Eligible Waste Fuels in the facility
		1. biomass from agriculture	n/a	
		2. forestry and sawmilling residues	Potentially could be considered as the wood waste	
		3. uncontaminated wood waste	Potentially could be considered as the wood waste	
		4. recovered waste oil	n/a	
		5. organic residues from virgin paper pulp activities	n/a	
		6. landfill gas and biogas	n/a	
		7. source-separated green waste (used only in processes to produce char)	n/a	
		8. tyres (used only in approved cement kilns).	Retain waste tyres and included in overall tonnage of 100,000 tpa.	Condition tonnage of tyres that can be accepted.

ARUP

Document:	NSW Energy from Waste Policy Statement	**Project:**	Modification to Berrima Cement Works - Use of Waste Derived Fuels
Owner:	NSW EPA	**Project ID:**	245530-00
Version/Date:	Friday, 9 October 2015	**Prepared by**	Guy Raithby-Veall and Joyanne Manning
Link:	https://majorprojects.affinitylive.com/public/9f0b4d7c9976ef926f54292a34a73687/Boral%20Kiln%206%20SEARs.pd	**Reviewed by:**	Joyanne Manning

Section	Page Ref	NSW EfW Policy Criteria	Arup Comments on EIS	Suggested conditions
		Any facility proposing to thermally treat a waste or waste-derived material that is **not a listed eligible waste fuel** (Section 3) must **meet the requirements to be an energy recovery facility**. Energy recovery facilities refer to facilities that **thermally treat waste-derived materials that fall outside of the low-risk *'eligible waste fuels'***	Facility is proposing to use feedstock that is not currently listed as non-eligible waste fuels, being wood waste and RDF.	
		These facilities must therefore **demonstrate** that they will be **using current international best practice techniques**, particularly with respect to:	Proponent addresses Part 4 requirements of the EfW Policy Statement in Table 12 of the EIS. Refer to BAT Review	The Proponent should provide a comparison of the design to the EU Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide
		• **process design** and control	Gas from the process will be raised to a min temperature of 850C for at least 2 seconds. Process includes a precaliner which has a greater than 6 seconds gas residence time above 800C. Typical kiln temperatures are c1500C.	
		• **emission control equipment** design and control	Section 3.5 details the existing emission control equipment. Does not include SNCR or SCR for reduction of NOx	The Proponent is to investigate the installation of Nox reducing emission control equipment (SNCR or SCR) and if financially and technically viable propose a timeframe for its installation? Justification needs to be provided if not considered feasible and consideration to other NOx abatement control needs to be provided.
4. Energy recovery facilities	6	• **emission monitoring with real-time feedback** to the controls of the process	Monitoring data will be made publically available. Section 7.1.5/Ch. 8 of the EIS sets out the Environmental Management with respect to emissions monitoring. Continuous monitoring required of TSP on Kiln 6 stack since 30 March 2012. Additional continuous measurement and monitoring of Kiln 6 stack for NO, NO2, VOCs and other chemical species relevant to the burning of non standard fuels will be carried out. Continuous monitoring of specified operational parameters incl temperature in the combustion chamber and stack, oxygen concentration and water content. Boral will operate an ambient monitoring station beyond the site boundary which will record meteorological data continuously and TSP, PM10s and other compounds on a one day in six basis.	Condition to address requirements of continuous monitoring.
		• **arrangements for the receipt of waste**	Section 4.5.3 and Appendix A provides details on the location and size of the storage and handling facility. Feedstock will be received and stored in a storage building located on the southern side of Kiln 6 pre heater tower. RDF will be received on site in bales and will be transferred. Bales will be debaled and shredded before being conveyed into the pre-caliner. SWDF will be plastic wrapped and stored in a designated ground outdoor area or within covered delivery vehicles.	Before receipt of any waste at the facility the proponent should submit for approval a comprehensive suite of operational procedures for the weighing, checking and handling of incoming waste fuels. A quarantine area should be provided for onsite for waste received onsite that does not meet visual inspection criteria and to allow for its storage while being chemically assessed.
		• **management of residues** from the energy recovery process.	According to proponent there is no residual waste from the process. Suggest that the plastic film waste is confirmed as a viable feedstock into the facility - plastic film wrap not considered as RDF, but non-putrescible general solid waste?	Note that plastic wrapping may not considered as part of the composition of the SWDF or RDF and if to be fed into the kiln as fuel needs consideration.

ARUP

Document:	NSW Energy from Waste Policy Statement	Project:	Modification to Berrima Cement Works - Use of Waste Derived Fuels
Owner:	NSW EPA	Project ID:	245530-00
Version/Date:	Friday, 9 October 2015	Prepared by	Guy Raithby-Veall and Joyanne Manning
Link:	https://majorprojects.affinitylive.com/public/9f0b4d7c9976ef926f54292a34a73687/Boral%20Kiln%206%20SEARs.p	Reviewed by:	Joyanne Manning

Section	Page Ref	NSW EfW Policy Criteria	Arup Comments on EIS	Suggested conditions
		Energy recovery facilities must **use technologies that are proven**, **well understood** and **capable of handling the expected variability and type of waste feedstock**.	Proponent identifies three (3) existing cement facilities in the UK that use SWDF: · Lafarge Tarmac Tunstead and Lowe Plants, UK · Cemex Rugby Plant UK · Heidelberg Padeswood Plant UK Mass balance of these facilities have not been provided and if they are using similar mix of feedstock. Detailed feedstock specification has been provided. Limitation on some components is due to impact on the product (e.g. PVC).	SWDF and non standard fuels will be used as fuel only. It is standard practice in EU that a staged commissioning approval is provided in order to demonstrate the appropriateness of the SWDF and other fuels at different ratios until the desired performance is achieved and then full scale operation can occur. This will allow for the demonstration of the process to handle the expected variability and type of feedstock proposed.
		This must be **demonstrated through reference to fully operational plants** using the **same technologies** and **treating like waste streams** in other **similar jurisdictions**.	Proponent identifies three (3) existing cement facilities in the UK that use SWDF: · Lafarge Tarmac Tunstead and Lowe Plants, UK · Cemex Rugby Plant UK · Heidelberg Padeswood Plant UK Mass balance of these facilities have not been provided and if they are using similar mix of feedstock. No similar facilities have been identified for Australia. Proponent to identify other reference facilities for Australia (or similar jurisdiction).	Before the acceptance of SWDF commences the Proponent should submit for approval information that demonstrates this clause of the policy has been met including referencing fully operational plants using the same technologies and treating like waste streams in other similar jurisdictions.
		The **gas resulting from the process should be raised**, after the last injection of combustion air, in a **controlled and homogenous fashion** and even under the most unfavourable conditions to a **minimum temperature of 850°C for at least 2 seconds** (as measured near the inner wall or at another representative point of the combustion chamber).	Gas from the process will be raised to a min temperature of 850C for at least 2 seconds. Process includes a precaliner which has a greater than 6 seconds gas residence time above 800C. Typical kiln temperatures are c1500C.	
	6	If a waste has a **content of more than 1% of halogenated organic substances**, expressed as chlorine, the **temperature should be raised to 1100°C for at least 2 seconds** after the last injection of air.	Proponent would limit the Chlorine content of SWDF to <1.0% through fuel procurement specifications. The control of inputs is proposed to be managed through a risk based approach detailed in Section 4.5.1. But no details have been provided of contingency measures to be employed for identifying inappropriate materials. Chlorine content greater than 1% actually impacts quality of clinker so needs to be controlled for this purpose too. Strict controls and requirements of SWDF manufacturers to limit PVC content in product.	Refer to Boral Solid Waste Derived Fuel Technical Specification (Appendix B)
		The process and air emissions from the facility must satisfy at a minimum the requirements of the Group 6 emission standards within the Protection of the Environment Operations (Clean Air) Regulation 2010	NOx limit is 500mg/m3. for cement kilns	The Proponent is to investigate the installation of NOx reducing emission control equipment (SNCR or SCR) and if financially and technically viable propose a timeframe for its installation. Justification needs to be provided if not considered feasible and consideration to other NOx abatement control needs to be provided.
		There must be continuous measurements of NOx, CO, particles (total), total organic compounds, HCl, HF and SO2. This data must be made available to the EPA in real-time graphical publication and a weekly summary of continuous monitoring data and compliance with emissions limits published on the internet. The continuous measurement of HF may be omitted if treatment stages for HCl are used which ensure that the emission limit value for HCl is not being exceeded.	Will be provided.	Before development commences the Proponent should submit for approval information that demonstrates this clause of the policy has been met.
Technical criteria		There must be **continuous measurements** of the following **operational parameters: temperature** at a representative point in the combustion chamber; **concentration of oxygen**; **pressure and temperature in the stack**; and **water vapour content** of the exhaust gas.	Will be provided.	Before development commences the Proponent should submit for approval information that demonstrates this clause of the policy has been met.

ARUP

Document:	NSW Energy from Waste Policy Statement	Project:	Modification to Berrima Cement Works - Use of Waste Derived Fuels
Owner:	NSW EPA	Project ID:	245530-00
Version/Date:	Friday, 9 October 2015	Prepared by	Guy Raithby-Veall and Joyanne Manning
Link:	https://majorprojects.affinitylive.com/public/9f0b4d7c9976ef926f54292a34a73687/Boral%20Kiln%206%20SEARs.p	Reviewed by:	Joyanne Manning

Section	Page Ref	NSW EfW Policy Criteria	Arup Comments on EIS	Suggested conditions
	7	As part of the environment protection licence conditions of any energy recovery facilities, the EPA will require operators to undertake proof of performance (POP) trials to demonstrate compliance with air emissions standards. Following successful POP trials, there must be at least two measurements per year of heavy metals, polycyclic aromatic hydrocarbons, and chlorinated dioxins and furans. One measurement at least every three months shall be carried out for the first 12 months of operation. If and when appropriate measurement techniques are available, continuous monitoring of these pollutants will be required.		Before development commences the Proponent should submit for approval information that demonstrates this clause of the policy has been met.
		The **total organic carbon** (TOC) or **loss on ignition** (LOI) content of the **slag and bottom ashes must not be greater than 3% or 5%,** respectively, of the dry weight of the material.	Not applicable, no ash generated.	
		Waste feed interlocks are required to prevent waste from being fed to the facility when the required temperature has not been reached either at start-up or during operation.	Kiln operates at c1500C.	Condition that SWDF and other non standard fuels can only be used once facility is operating at normal conditions. Waste should not be used as a input fuel a. at start-up, until the temperature of >850°C has been reached; b. whenever the temperature falls below 850°C; c. whenever the continuous measurements show that any emission limit value is exceeded; d. whenever stoppages, disturbances or failure of the purification devices or the measurement devices may result in the exceedence of the emission limit values; or e. in the case of a breakdown or incident.
Thermal efficiency criteria	7	The **net energy produced** from thermally treating that waste, **including the energy used in applying best practice techniques, must therefore be positive.**	Waste being used as substitute for coal. Therefore energy produced is positive.	
		To meet the **thermal efficiency criteria**, facilities must **demonstrate that at least 25%** of the energy generated from the thermal treatment of the material **will be captured as electricity** (or an equivalent level of recovery for facilities generating heat alone).	No electricity capture. SWDF being used as fuel source to produce heat for the kiln. Therefore effectively all SWDF being used is being captured as heat. Ratio of SWDF required to coal is 2:1.	SDWF to be used as fuel source for kiln only.
		Energy recovery facilities must also **demonstrate that any heat generated** by the thermal processing of waste is **recovered as far as practicable,** including **use of waste heat for steam or electricity generation** or for **process heating of combined heat and power schemes**.	All heat generated by SWDF will be utilised in the cement process for heating of the kiln.	SDWF to be used as fuel source for kiln only.
Resource recovery criteria	7	The policy statement's objectives in setting resource recovery criteria are to: • **promote the source separation of waste** where **technically and economically achievable** • drive the use of **best practice material recovery processes** • ensure **only the residual from bona-fide resource recovery operations are eligible** for use as a feedstock for an energy recovery facility	Proposal is to use Solid Waste Derived Fuel (SWDF) and residual wood waste as input fuel for the facility. Suppliers of SWDF and residual wood waste will be required to meet the criteria of Table 1 in the NSW EfW Policy. Specification for SWDF is provided in Appendix B.	The proponent needs to provide evidence that any residual waste material accepted at the facility is eligible for use as a feedstock. Copies of the Environmental Management Procedures should be provided to demonstrate how best practice is being benchmarked and is being achieved. Approval must be sought in advance for the acceptance of feedstocks not listed in Schedule XX of the Approval or in quantities exceeding those listed in Schedule XX.
	8	Energy recovery facilities **may only receive feedstock from "authorised" waste facilities or collection systems** that meet the criteria outlined in **Table 1**.	Proponent outlines in Section 4.5.1 a risk based approach of only sourcing feedstock from suppliers that 'agree to meet the EPA guidelines' and is proposed as a prerequisite in supplier contracts. As yet no waste facilities to supply feedstock have been identified.	The proponent should provide details of source facilities of feedstock prior to receiving them at the facility and approval should be sought for their acceptance.

ARUP

Document:	NSW Energy from Waste Policy Statement	Project:	Modification to Berrima Cement Works - Use of Waste Derived Fuels
Owner:	NSW EPA	Project ID:	245530-00
Version/Date:	Monday, 28 September 2015	Prepared by	Guy Raithby-Veall and Joyanne Manning
Link:	www.epa.nsw.gov.au/resources/epa/150011enfromwasteps.pdf	Reviewed by:	Joyanne Manning

Table 1 - Resource recovery criteria for energy recovery facilities (adapted from NSW EfW Policy Statement)

Waste stream	Authorised facility	% of residual waste allowed for energy recovery	Arup Comments on EIS	Suggested conditions
Mixed municipal waste (MSW)	Facility processing **mixed MSW** waste where a **council has separate collection systems** for dry recyclables and food and garden waste	**No limit** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual MSW as part of SWDF that the supplier of SWDF input MSW feedstock meets the % requirements of the MSW waste stream that can be recovered.
	Facility processing **mixed MSW** waste where a council has **separate collection systems for dry recyclables and garden waste**	**Up to 40%** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual MSW as part of SWDF that the supplier of SWDF input MSW feedstock meets the % requirements of the MSW waste stream that can be recovered.
	Facility processing **mixed MSW** waste where a council has a **separate collection system for dry recyclables**	**Up to 25%** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual MSW as part of SWDF that the supplier of SWDF input MSW feedstock meets the % requirements of the MSW waste stream that can be recovered.
Mixed commercial and industrial waste (C&I)	Facility processing **mixed C&I** waste where that waste is **sourced solely from an entity that has separate collection systems** for all relevant waste streams	**No limit** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual C&I waste as part of SWDF that the supplier of SWDF input C&I waste feedstock meets the % requirements of the C&I waste stream that can be recovered.
	Facility processing **mixed C&I waste**	**Up to 50%** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual C&I waste as part of SWDF that the supplier of SWDF input C&I waste feedstock meets the % requirements of the C&I waste stream that can be recovered.
Mixed construction and demolition waste (C&D)	Facility processing **mixed C&D waste**	**Up to 25%** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual C&D waste as part of SWDF that the supplier of SWDF input C&D waste feedstock meets the % requirements of the C&D waste stream that can be recovered.
Source-separated recyclables	Facility processing **source-separated recyclables**	**Up to 10%** by weight of the waste stream received at an authorised facility	N/A. The sources of Solid Waste Derived Fuel have not been provided.	The proponent to demonstrate prior to accepting any residual source separated recyclables waste as part of SWDF that the supplier of SWDF feedstock meets the 10% requirement of residual source separated recyclables that can be recovered.
Source-separated garden waste	Facility processing **garden waste**	**Up to 5%** by weight of the waste stream received at an authorised facility	N/A. Mixed Garden Waste is not a proposed design fuel for the facility.	Provide a condition that Mixed Garden waste is not an acceptable waste input stream.
Source-separated food waste (or food and garden waste)	Facility processing **source-separated food or source-separated food and garden waste**	**Up to 10%** by weight of the waste stream received at an authorised facility	N/A. Source separated FOGO waste not a proposed design fuel for the facility.	Provide a condition that source separated FOGO waste is not an acceptable waste input stream.
Notes	1. The EPA may give consideration to increases to the maximum allowable percentage of residuals from facilities receiving mixed municipal and commercial and industrial waste where a facility intends to use the biomass component from that process for energy recovery, rather than land application and the facility can demonstrate they are using best available technologies for material recovery of that stream.			
	2. Waste streams proposed for energy recovery should not contain contaminants such as batteries, light bulbs or other electrical or hazardous wastes.			
	3. Bio-char or char materials produced from facilities using mixed waste streams will not be able to be considered for land application as a soil amendment or improvement agent.			
	4. The C&I no limit category is likely to apply only to mixed waste collected from single generators of large volumes of waste (e.g. supermarkets) or precinct based businesses (e.g. shopping centers). Proponents will need to demonstrate that each entity generating waste has effective and operating collection systems for all waste streams they generate that have reuse or recycling opportunities (e.g. paper/cardboard collection; organic collection; and residual waste collection). Proponents wishing to use the C&I no limit category will need to contact the EPA to determine the eligibility of each entity.			

Appendix B

SEARS Review

ARUP

Document:	**Boral Kiln 6 SEARs**	**Project:**	**Modification to Berrima Cement Works - Use of Waste Derived Fuels**
Owner:		**Project ID:**	**245530-00**
Version/Date:	**Friday, 9 October 2015**	**Prepared by**	**Guy Raithby-Veall and Joyanne Manning**
Link:	https://majorprojects.affinitylive.com/public/9f0b4d7c9976ef926f54292a34a7	**Reviewed by:**	**Joyanne Manning**

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
	Arup's General Observations on EIS + Supporting Technical Studies				
General	ARUP1	Assumption has been made that there is no residual waste from the proposed facility.			**Question to EPA** - the plastic film waste that will wrap the bales has not been addressed. It is therefore assumed that this will be processed through the proposed facility. Is this not categorised as non-putrescible general solid waste and not RDF? Management measure should be outlined for the management of plastic film wrapping - proponent should investigate the use of alternative materials, e.g. bio plastic
	General Requirements		No Requirements		
	Strategic Planning		No Requirements		
	Waste Management		Requirements	Partial	
SEARs	WM1	A description of the classes and quantities of waste that would be thermally treated at the facility	Table 4	Yes	Table 4 adequately identifies the categories of waste that would be thermally treated at the facility. Table 4 provides a breakdown of the categories and proposed volumes of input material to be processed at the facility. Table 3 also provides further details on the indicative breakdown of SWDF streams.
SEARs	WM2	A demonstration that waste used as a feedstock in Kiln 6 would be the residual from a resource recovery process that maximises the recovery of material in accordance with the Environmental Protection Authority (EPA) Guidelines	Section 4.5.1	Partial	Proponent outlines in Section 4.5.1 a risk based approach of only sourcing feedstock from suppliers that 'agree to meet the EPA guidelines' and is proposed as a prerequisite in supplier contracts. The report outlines Boral's approach to the avoidance of any environmental impact associated with using feedstock as an 'eligible waste fuel'. Adequacy has been deemed 'Partial', pending the supply and assessment of the documents referenced in the assessment, namely: 1. Sampling and testing regime for waste fuels supplied from both the supplier, and the Cement Works 2. Boral and Industry data that demonstrates cement kilns have high capture efficiency for heavy metal contaminants.

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
SEARs	WM3	Procedures that would be implemented to control the inputs to Kiln 6, including contingency measures that would be implemented if inappropriate materials are identified	Section 4.5.1	Partial	Control of inputs is proposed to be managed through a risk based approach detailed in Section 4.5.1. Section 4.5.1 discusses procedures that will assist in controlling inputs to Kiln 6. Similar to the above, the applicant is requested to provide the documents that are referenced as evidence, namely: 1. Boral's fuel specifications for SWDF 2. Sampling and testing regime for waste fuels supplied from both the supplier, and the Cement Works No details are provided in Section 4.5.1 that address the contingency measures to be employed for identifying inappropriate materials. The applicant is to direct the reader to where this is discussed, or add details on such measures. Proponent to identify and outline the contingency measures to be implemented.
SEARs	WM4	Details on the location and size of stockpiles of unprocessed and processed recycled waste at the site	Section 4.5.1	Yes	Not in Section 4.5.1 Section 4.5.3 and Appendix A provides details on the location and size of the storage and handling facility. Details and drawings are provided for the receival and storage of input feedstock prior to transport (via conveyor) to processing unit.
SEARs	WM5	A demonstration that any waste material (e.g. biochar) produced from Kiln 6 for land application is fit for purpose and poses minimal risk of harm to the environment in order to meet the requirements for consideration of a resource recovery exemption by the EPA under Clause 51A of the *Protection of the Environment Operations (Waste) Regulation 2005*	Not applicable as it is not proposed to use waste material for land application		n/a

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
SEARs	WM6	Procedures for the management of other solid, liquid and gaseous waste streams	Only applicable to air quality emissions. Dealt with in Section 7.1		Section 7.1 does not describe any procedures for management of air quality emissions. Section 7.7 discusses this requirement by directing the reader to 'elsewhere in the document'. The applicant does not provide procedures for management of gaseous waste streams, but rather puts arguments forward regarding re-evaluation of the limits currently imposed between different authorities and states. These arguments are valid, and are seen as a part measure. ***Question to EPA*** *- the plastic film that will wrap the bales has not been addressed. It is therefore assumed that this will be processed through the proposed facility. Is this not categorised as non-putrescible general solid waste and not RDF?* Management measure should be outlined for the management of plastic film wrapping - proponent should investigate the use of alternative materials, e.g. bio plastic
SEARs	WM7	The measures that would be implemented to ensure that the development is consistent with the aims, objectives and guidance in the *NSW Waste Avoidance and Resource Recovery Strategy 2007*	Section 5.4		NSW WARR Strategy 2007 superseded by NSW WARR 2014-21. Proponent addressed NSW WARR 2014-21 in Section 5.4. The proposed project is aligned to the WARR Strategy with energy recovery being part of Key Result Area 3 and also supporting the 2021 WARR target of 75% landfill diversion though energy recovery of SWDF.
	Air Quality and Odour		Requirements		
SEARs	AQ1	A quantitative assessment of the potential air quality and odour impacts of the development on surrounding landowners and sensitive receptors under the EPA guidelines	Section 7.1	Yes	
SEARs	AQ2	Details of any pollution control equipment and other impact mitigation measures for fugitive and point source emissions	Section 7.1	No	Pollution monitoring is explained in Section 7.1.5, albeit in limited detail. However pollution control equipment is not discussed, and mechanisms for fugitive / point source are not differentiated. Although this may be explained in Appendix D, this information is required in the chapter. The applicant is requested to add sufficient detail to the chapter on mitigation measures for fugitive emissions, noting that proposing an increase in the EPL is not considered an adequate environmental mitigation measure.
SEARs	AQ3	A demonstration of how the facility would be operated in accordance with best practice measures to manage toxic air emissions with consideration of the European Union's *Waste Incineration Directive 2000* and the Environment Protection Authority's draft policy statement NSW Energy from Waste	Section 4.1	Partial	Section 4.1 does not demonstrate how the facility will practice measures to align itself with EU and NSW waste and energy policies. Adherence to such policy is discussed in part in Section 4.5.1. However before assessing this point as adequate the documents referenced in this section as evidence for adhering to guidelines must be seen and assessed.

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
SEARs	AQ4	Details of the proposed technology and a demonstration that it is technically fit for purpose	Section 4.1	No	Section 4.1 does not provide adequate details on the technology, or mention any technical details. The fit-for-purpose discussion is partly had in Section 4.4, however this is limited and references only the outcomes of testing the proposed fuels sources and whether or not they meet EPA standards. Specifications and supporting data is required on the best practice examples that are discussed. A sufficient link has not been established between the technology the applicant is using, outcomes (environmental impact) and whether these outcomes and technology meet the needs of end users and expectations of regulatory authorities.
	Noise		Requirements	Yes	
SEARs	N1	A quantitative assessment of the potential construction, operational and transport impacts on surrounding receivers	Section 7.4	Yes	Quantitative noise assessment for construction, traffic and operational noise addressed in Section 7.4 and further detailed in Appendix G of EIS.
SEARs	N2	Details of the proposed management and monitoring measures	Section 7.4	Yes	Section 7.4.3 provides details of mitigation measures for construction noise management. Road and Operational noise is not deemed to have any increase impact on current levels.
	Soils and Water		Requirements	Partial	
SEARs	S&W1	Details of the proposed management and monitoring measures, including the proposed erosion and sediment controls and consideration of potential surface water, groundwater, contamination impacts that could result during construction	Section 8	Partial	Section 8 provides only identifies high level mitigation measures that will be adopted during the construction phase - namely the development of a ESC Plan. Details on calculation of truck movements against tonnage capacity has not been provided. Management and monitoring measures have not been identified for surface water, groundwater and contamination impacts.

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
	Traffic and Transport		Requirements	Partial	
SEARs	T1	An assessment of additional traffic movements and updated site access plans	Section 7.5	Partial	Assessment of additional traffic movements provided in Section 7.5, and Appendix H. Assessment has been conducted on the number of truck movements for the proposed operation. Assessment does not provide the tonnage assumptions per truck used to complete traffic assessment. Figure 4 in Appendix H outlines site access points.
SEARs	T2	The impact to the function and performance of key local roads and intersections associated with the proposed modification	Section 7.5	Yes	Traffic assessment has identified that there will be limited additional traffic during construction and minor additional operational trucks. Impacts have been identified for local roads (Taylor Avenue) and detailed in Section 7.5 and Appendix H.
	Hazards and Risk		Requirements	No	
SEARs	HAZ1	Preliminary Hazard Analysis in accordance with Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis and Multi Level Risk Assessment (if necessary) and details of fire/emergency measures and procedures	Section 7.3	No	Section 7.3 details preliminary risk screening of the hazards associated with the proposed facility in accordance with NSW State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33). Rationale has not been provided why SEPP 33 guidelines was used and not the stipulated NSW Hazardous Industry Planning Advisory Paper No. 6 – Guidelines for Hazard Analysis and Multi Level Risk Assessment. If Industry Planning Advisory Paper No. 6 is not necessary, proponent to provide explanation of why Industry Planning Advisory Paper No. 6 is not required. It is recommended that the applicant revise the study in accordance with HIPAP No.6, making special mention of: - New hazards associated with receiving, storing, handling and production of the modifications requested, and associated mitigation measures.
SEARs	HAZ2	Contingency plans for any potential incidents or equipment failure during the operation of the project	n/a screening assessment concluded proposed development is not potentially hazardous	No	SEPP 33 assessment used indicates that the facility is below the SEPP 33 screening thresholds and a PHA was not necessary (Appendix F). Proponent to readdress hazards and risks using SEPP 33 - stipulated assessment methodology.

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
SEARs	HAZ3	An assessment of the potential fire risks of the proposed development	n/a screening assessment concluded proposed development is not potentially hazardous	No	No assessment of potential fire risks in EIS or Appendix F. Proponent to readdress potential fire risks using SEPP 33 - stipulated assessment methodology.
	Flora and Fauna		No Requirements		
	Visual		Requirements	Partial	
SEARs	VIS1	Details of the proposed management and monitoring measures, particularly from private receptors and key vantage points	Section 7.6	Partial	An erosion and sediment control plan has been recommended, however only very high level erosion and sediment controls have been identified. No management or monitoring measures have been identified for water, ground water or construction contamination impacts other than a recommendation to develop an EMP (C) that would address each point. The applicant is requested to develop an EMP (C) that includes an erosion and sediment control plan as well as management and monitoring of water, ground water and possible contamination measures. Section 7.6 provides assessment of visual impacts and management measures. Further details are provided in Appendix I. No details provided for monitoring measures have been identified in either EIS or Appendix I. Proponent to readdress visual impact and identify monitoring measures.
	Greenhouse Gas		Requirements	Partial	
SEARs	GHG1	A full greenhouse gas assessment (including an assessment of the potential scope 1, 2 and 3 greenhouse gas emissions) of the proposed development, and an assessment of the potential impact of these emissions on the environment	Section 7.2	Partial	This has been deemed 'Partial', as there were no supporting figures to verify calculations were carried out correctly. Section 7.2 and Appendix E provides details on GHG assessment. Information and data on how proposed operations calculations for Scope 1 and 2 emissions has not been provided.

General Observation / Secretary's Environmental Assessment Requirement	Ref	Environmental Assessment Requirements / General Requirements	EIS Section/Appendix Cross-Reference	Adequacy against TOR (Y/N/Partial)	Review Comments
SEARs	GHG2	A detailed description of the measures that would be implemented on site to ensure that the project is energy efficient	Section 7.2	Partial	Table 12 has the best discussion on the matter, however there is little if any technical data on the matter of justifying direct substitute No detailed description of energy efficiency measures have been provided in Section 7.2. Section 6 of Appendix E provides high level GHG mitigation and management measures. Recommend that proponent includes mitigation and management measures in EIS and further details on to ensure that the project would be energy efficient.
	Aboriginal and non-Aboriginal Cultural Heritage		No Requirements		
	[*Other requirements*]		No Requirements		

Appendix C

EU Best Practice and BAT Review

NSW Department of Planning & Environment and the EPA

Berrima Cement Works Waste Derived Fuels

EU Best Practice and BAT Review

Rev A | 30 September 2015

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number

Ove Arup & Partners Ireland Ltd

Arup
50 Ringsend Road
Dublin 4
Ireland
www.arup.com

This report has been prepared by Arup on behalf of both the NSW Environment Protection Authority (EPA) and the Department of Planning and Environment, NSW in connection with the review of the Environmental Impact Assessment for Berrima Cement Works, Modification 9 – Use of Solid Waste Derived Fuels.

ARUP

Document Verification

ARUP

Job title	Berrima Cement Works Waste Derived Fuels	Job number
Document title	EU Best Practice and BAT Review	**File reference**
Document ref		

Revision	Date	Filename	EU_Review_Berrima_150910.docx		
Issue	10 Sep 2015	**Description**	First draft		
			Prepared by	Checked by	Approved by
		Name	Janet Lynch/ Don Menzies	Don Menzies	Joyanne Manning
		Signature			
Rev A	30 Sep 2015	**Filename**	BAT_Review_Berrima_Draft4_150927_JL.docx		
		Description	Incorporating Client Comments		
			Prepared by	Checked by	Approved by
		Name	Janet Lynch/ Don Menzies	Don Menzies	Joyanne Manning
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Executive Summary

This scope of this report is a review of a proposal to increase use of solid waste derived fuels at Berrima Cement Works, Australia. The review compares a modification application to the Department of Planning and Environment with the requirements of European Union (EU) Legislation and Best Practice.

This modification, Modification 9, seeks approval for the following:

Boral proposes to use up to 100,000 tonnes per year of SWDF in Kiln 6 operations. This would replace 20-30% of the coal used in the facility.

The European Industrial Emissions Directive 2010/75/EU (IED) regulates pollutant emissions from industrial installations, including cement kilns.

As the Berrima Cement Works is licenced to produce up to 1.56 million tonnes per annum (or approximately 30,000 tonnes per week) of cement products it falls within the type of facility which would require an Industrial Emissions licence under Article 10 and A1 Class 3 of the IED.

IED Article 14 Permit Conditions notes that “BAT conclusions” shall be the reference for setting permit conditions within the European Union. In addition Article 14(2) notes that emission limit values for polluting substances may be supplemented or replaced by equivalent parameters or technical measures ensuring an equivalent level of environmental protection.

EU Legislation reviewed is the Industrial Emissions Directive 2010/75/EU. EU Best Practice reviewed is the BREF on the Production of Cement, Lime and Magnesium Oxide 2013.

In summary, limits which would apply to Berrima Cement Works under the Industrial Emissions Directive 2010/75/EU are as follows:

Parameter	**Emission Limit Values (BAT)**	**Notes**
NO_X	500 mg/Nm³	BAT 19 BAT-associated emission levels for NO_X from the flue-gases of kiln firing and/or preheating/precalcining processes in the cement industry for pre-heater kilns is 200-400 mg/Nm³. The upper level of the BAT-AEL range is 500 mg/Nm³, if the initial NO_X level after primary techniques is > 1000 mg/Nm³. Existing kiln system design, fuel mix properties including waste and raw material burnability (e.g. special cement or white cement clinker) can influence the ability to be within the range. Levels below 350 mg/Nm³ are achieved at kilns with favourable conditions when using SNCR. In 2008, the lower value of 200 mg/Nm³ has been reported as a monthly average for three plants (easy burning mix used) using SNCR
SO_X expressed as SO_2	< 50 – 400 mg/Nm³	BAT 21 The range takes into account the sulphur content in the raw materials. For white cement and special cement clinker production, the ability of clinker to retain fuel sulphur might be significantly lower leading to higher SO_X emissions.
Dust (flue gas from Kiln 6)	20 mg/Nm³	BAT 17 BAT-associated emission levels The BAT-AEL for dust emissions from flue-gases of kiln firing processes is <10 – 20 mg/Nm³, as the daily average value. When applying fabric filters or new or upgraded ESPs, the lower level is achieved.

Parameter	Emission Limit Values (BAT)	Notes
Dust (flue gases of cooling and milling processes)	20 mg/Nm³	BAT-associated emission levels The BAT-AEL for dust emissions from the flue-gases of cooling and milling processes is <10 – 20 mg/Nm³, as the daily average value or average over the sampling period (spot measurements for at least half an hour). When applying fabric filters or new or upgraded ESPs, the lower level is achieved.
Channelled Dust Emissions	10 mg/Nm³	BAT 16 BAT-associated emission levels The BAT-AEL for channelled dust emissions from dusty operations (other than those from kiln firing, cooling and the main milling processes) is < 10 mg/Nm³, as the average over the sampling period (spot measurement, for at least half an hour).
CO	Max 30 minutes CO trips annually when using ESP's or fabric filters	BAT 23 IED: Competent authority may set limit value.
NH_3 Slip	Applies when SNCR in use	
VOC	See TOC below	
HCl	10 mg/Nm³	BAT 25 BAT-associated emission levels The BAT-AEL for the emissions of HCl is <10 mg/Nm³, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).

Parameter	**Emission Limit Values (BAT)**	**Notes**
HF	1 mg/Nm³	BAT 26 BAT-associated emission levels The BAT-AEL for the emissions of HF is <1 mg/Nm³, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).
TOC	10 mg/Nm³	Competent authority may set higher limit where TOC does not result from the co-incineration of waste, i.e. from raw materials.
∑ Cd + Tl	0.05 mg/Nm³	BAT 28 BAT-AEL (average over the sampling period (spot measurements, for at least half an hour)) Note: Low levels have been reported based on the quality of the raw materials and the fuels.
Hg	0.05 mg/Nm³	BAT 28 BAT-AEL (average over the sampling period (spot measurements, for at least half an hour)) Note: Low levels have been reported based on the quality of the raw materials and the fuels. Values higher than 0.03 mg/Nm³ have to be further investigated. Values close to 0.05 mg/Nm³ require consideration of additional techniques (e.g. lowering of the flue-gas temperature, activated carbon).
∑ Sb +As +Pb +Cr +Co +Cu+Mn+Ni+V	0.5 mg/Nm³	BAT 28 BAT-AEL (average over the sampling period (spot measurements, for at least half an hour)) Note: Low levels have been reported based on the quality of the raw materials and the fuels.

Parameter	Emission Limit Values (BAT)	Notes
Dioxins and Furans	0.05-0.1 ng/Nm³	BAT 27 BAT-associated emission levels The BAT-AEL for the emissions of PCDD/F from the flue-gases of the kiln firing processes is <0.05 – 0.1 ng PCDD/ F I-TEQ/Nm³, as the average over the sampling period (6 – 8 hours).

In addition to the above limits we would recommend the following measures:

- In relation to the SWDF Specification proposals for SWDF sampling the capacity of the sampling container and the maximum particle size should be reviewed and a means developed for obtaining a representative sample.
- A methodology should be developed for pre-qualifying suppliers of SWDF to ensure that contracts for supply of alternative fuels are placed only with suppliers that have the appropriate technical expertise, quality assurance systems, identifiable sources of waste, etc.
- The Environment Protection Licence should include the following requirement:

  "The licensee shall prepare to the satisfaction of the EPA a test programme for the co-incineration of each alternative fuel. This programme shall be submitted to the EPA prior to implementation.
  This test programme, following agreement with the EPA, shall be implemented and a report on its implementation shall be submitted to the Agency within one month of completion.
  The test programme shall as a minimum:
  a) Verify the residence time, the minimum temperature and the oxygen content of the exhaust gas which will be achieved during normal operation and under the most unfavourable operating conditions anticipated.
  b) Establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence.
  c) Assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.
  d) Establish criteria for the control of all alternative fie1 input including the maximum flow and maximum calorific value.
  e) Confirm that all measurement equipment of devices (including thermocouples) used for the purpose of establishing compliance with this licence have been subjected, in situ, to normal operating temperatures to prove their operation under such conditions.
  A report on each test programme shall be submitted to the EPA within one month of completion.
  Co-incineration of alternative fuels shall not be permitted (outside of the agreed test programme) until such time as the EPA has indicated in writing that it is satisfied with the results of the test programme for an individual alternative fuel."

- In relation to particulate matter a view should be taken on how long should be allowed for existing industry to achieve much more stringent emission limits and the approval should take this into account.
- In relation to nitrogen oxides a view should be taken on the time that should be allowed for existing industry to achieve much more stringent emission limits and the approval should take this into account.
- The emission limit value for VOCs (20 ppm) should remain unless the applicant demonstrates that it is physically impossible due to the nature of the

raw materials, to achieve this limit, in which case the higher limit sought (40 ppm) could be granted.

1 Introduction

1.1 Objectives

This purpose of this report is a review of a proposal to increase use of solid waste derived fuels at Berrima Cement Works, Australia.

The review compares a modification application to the Department of Planning and Environment with the requirements of EU Legislation and Best Practice.

EU Legislation reviewed is the Industrial Emissions Directive 2010/75/EU. EU Best Practice reviewed is the BREF on the Production of Cement, Lime and Magnesium Oxide 2013.

1.2 Industrial Emissions Directive 2010/75/EU

The European Industrial Emissions Directive 2010/75/EU (IED) regulates pollutant emissions from industrial installations, including cement kilns.

As the Berrima Cement Works is licenced to produce up to 1.56 million tonnes per annum (or approximately 30,000 tonnes per week) cement products it falls within the type of facility which would require an Industrial Emissions licence under Article 10 and A1 Class 3 of the IED.

IED *Article 14 Permit Conditions* notes that “BAT conclusions” shall be the reference for setting permit conditions within the European Union. In addition Article 14(2) notes that emission limit values for polluting substances may be supplemented or replaced by equivalent parameters or technical measures ensuring an equivalent level of environmental protection.

The Directive includes special provisions for Cement Kilns co-incinerating waste as follows:

Parameter	**Measurement Conditions**[1]	**Total emission limit values (mg/Nm^3)**
Total dust	Daily average values (for continuous measurements), standardised at 10% oxygen	30
HCl		10
HF		1
NOx		500
SO2		50
TOC		10
Cd + Tl	average values over the sampling period of a minimum of 30 minutes and a maximum of 8 hours for heavy metals, standardised at 10% oxygen	0.05
Hg		0.05
Sb +As +Pb +Cr +Co +Cu+Mn+Ni+V		0.5
Dioxins and Furans (ng/Nm^3)	average values over the sampling period of a minimum of 6 hours and a maximum of 8 hours for dioxins and furans, standardised at 10% oxygen	0.1 (ng/Nm^3)

[1] Half-hourly average values shall only be needed in view of calculating the daily average values

1.3 BAT and BREF

The Industrial Emissions Directive 2010/75/EU defines BAT, BAT Reference Document and BAT Conclusions as follows:

The Industrial Emissions Directive defines Best Available Techniques (BAT) as follows: ‘best available techniques’ means the most effective and advanced stage in the development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing the basis for emission limit values and other permit conditions designed to prevent and, where that is not practicable, to reduce emissions and the impact on the environment as a whole: (a) ‘techniques’ includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned; (b) ‘available techniques’ means those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the Member State in question, as long as they are reasonably accessible to the operator; (c) ‘best’ means most effective in achieving a high general level of protection of the environment as a whole;
The Industrial Emissions Directive definition of BAT Reference Document is as follows: “(11) ‘BAT reference document’ means a document, resulting from the exchange of information organised pursuant to Article 13, drawn up for defined activities and describing, in particular, applied techniques, present emissions and consumption levels, techniques considered for the determination of best available techniques as well as BAT conclusions and any emerging techniques, giving special consideration to the criteria listed in Annex III;”
The Industrial Emissions Directive defines BAT conclusions, as follows: ‘BAT conclusions’ means a document containing the parts of a BAT reference document laying down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures;

The Industrial Emissions Directive (IED) 2010/75/EU replaces seven existing directives including the IPPC Directive (2008/1/EC).

- Historically, the BREF process for the IPPC Directive produced guidance documents that member states had to have regard to when permitting (licensing) installations. The Industrial Emissions Directive (IED) 2010/75/EU replaces seven existing directives including the IPPC Directive (2008/1/EC).
- However, the IED has made BAT conclusions mandatory in the permitting process (Article 14(3) of the IED).

Where BAT conclusions are available for any new installations they must achieve the required standard before commencement of operations.

For existing installations, the IED requires that where a Commission Implementing Decision on BAT conclusions is published, within four years (relating to the main activity of the installation), the regulatory authority must ensure that ‘all permit/licence conditions for the installation concerned are reconsidered, where necessary updated’ and ‘ensure compliance with the BAT’.

An example of this which would apply to Berrima Cement Works is the applicability of the

> *Commission Implementing Decision of 26th March 2013 establishing the Best Available Techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on Industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU)* (known as CLM).

If the Berrima plant was located within the EU it would be required to comply with the CLM, through the use of permit/licence conditions by 26th March 2017.

The European IPPC Bureau (EIPPCB) organises and co-ordinates the exchange of information between Member States and the industries concerned on Best Available Techniques (BAT), as required by Article 13 of the IED. The EIPPCB produces BAT reference documents (BREF) and BAT conclusions. A list of the BREF and BAT conclusions published by the EIPPCB at the time of preparation of this report is included as **Appendix A.**

Of decisions on BAT Conclusions (Commission Implementing Decision (CID)), BAT reference document(s) (BREFs) the following are relevant to the Berrima Cement Works Site review**:**

> *Commission Implementing Decision of 26th March 2013 establishing the Best Available Techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on Industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU) (known as CLM).*

A copy of the CLM is included as Appendix B.

1.4 Definitions

For the purpose of BAT conclusions, the following definitions apply:

Term used	**Definition**
New plant	A plant introduced on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions
Existing plant	A plant which is not a new plant
Major upgrade	An upgrade of the plant/kiln involving a major change in the kiln requirements or technology, or replacement of the kiln
'Use of waste as fuel and/or raw material'	The term covers the use of: – waste fuels with significant calorific value; and – waste materials without significant calorific value but with mineral components used as raw materials that contribute to the intermediate product clinker; and – waste materials that have both a significant calorific value and mineral components

Definition for certain air pollutants

Term used	**Definition**
NO_X expressed as NO_2	The sum of nitrogen (nitric) oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2
SO_X expressed as SO_2	The sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) expressed as SO_2
Hydrogen chloride expressed as HCl	All gaseous chlorides expressed as HCl
Hydrogen fluoride expressed as HF	All gaseous fluorides expressed as HF

2 Description of the Installation

2.1 Existing Installation

Boral Cement Limited (Boral) operates a Cement Works at New Berrima in the Wingecarribee Local Government Area.

Berrima Cement Works has been operating since 1929 and produces cement products (cement and clinker) for sale in NSW, the ACT and for export. The Cement Works is approved to produce up to 1.56 million tonnes per annum of cement products which has historically represented 60% of cement sold for building and construction in NSW. Operating today with one kiln (No. 6), the Cement Works takes limestone delivered by rail from Marulan South and burns it at high temperature (after blending with other materials) to produce 'clinker'. Cement products are dispatched to domestic customers by train and truck and international customers through Port Kembla.

The facility operates one kiln and two cement mills (Cement Mill 6 and cement Mill 7), along with storage and stockpile facilities, and a substantial fleet of heavy vehicles for transportation. The clinker, which looks like small balls of pumice, is stored before being passed to the grinding mill where it is ground into cement. The cement is stored on site before being loaded for transport off-site.

Cement manufacture is an energy intensive process due to the high temperatures required for the production of clinker. Currently 220,000 tonnes per year of coal is used to heat the kiln to a temperature of up to 1500°C. Up until 2013 coal was sourced from the nearby Medway Colliery but since the colliery's closure, coal is currently sourced from the Illawarra area by road. This reliance on coal contributes to the total energy cost at the facility, which represents 40% of Boral's costs in the cement production process.

The main raw material inputs are limestone, sourced from the Marulan mine, and shale, sourced on site. Limestone is transported via rail and combined with the shale and other materials in the blending bed. The blended material is passed through a raw milling and gas cleaning system and into the rotary kiln where the material elements are combined at very high temperature to form clinker.

2.2 Existing Statutory Consents

The Cement Works operate subject to two development consents issued by the Department of Planning and Environment (DPE) (DA 401-11-2002 (Kiln 6), May 2003 and DA 85-4-2005 (Mill 7), Aug 2005). Boral Cement is permitted to produce up to 1.56 million tonnes of cement a year at the facility.

An Environment Protection Licence (EPL 1698) issued by the Environment Protection Authority (EPA) is also held by Boral for the operation of the facility.

The following fuels are permitted under the current licence:

- Natural Gas, Fuel Oil, Diesel (Standard Fuel)

- Coal (Standard Fuel)
- Coke Fires (Standard Fuel)
- Aluminium electrode carbon (known as Hi Cal 50) (Non- Standard Fuel)
- Liquid Oil Residues (known as AKF1) (Non- Standard Fuel)
- Waste Tyres (known as AKF5) (Non- Standard Fuel)

2.3 Proposed Activity

The current modification application Modification 9, seeks approval for the following:

- Use of Solid Waste Derived Fuel (SWDF) as an energy source;
- Changes to the air emission limits of particulate matter (PM), nitrous oxides (NOx) and volatile organic compounds (VOC); and
- Construction and operation of a fuel storage and kiln feeding system.

In addition, Boral wishes to surrender Modification No. 6 (June 2012) relating to the stockpiling of coal for sale and transport to Port Kembla.

The fuels that are the subject of this modification are the following SWDF:

- Wood Waste - material left over from industrial processes like milling, furniture making, and building and construction; and
- Refuse Derived Fuel (RDF) - fuel made from the combustible materials recovered and processed from waste streams, such as papers, cardboards, packaging, and construction and demolition materials.

Boral proposes to use up to 100,000 tonnes per year of SWDF in Kiln 6 operations. This would replace 20-30% of the coal used in the facility.

3 BAT Conclusions Review

The tables in this section set out BAT for the Berrima Cement Plant installation from the relevant BAT reference documents (BREF).

Table 4.1 BAT Conclusion on the Production of Cement Lime and Magnesium Oxide 2013

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
BAT Conclusion on the Production of Cement Lime and Magnesium Oxide 2013			
1.1.1 Environmental Management Systems (EMS)			
BAT 1	1. In order to improve the overall environmental performance of the plants/installations producing cement, lime and magnesium oxide, production BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features: i. commitment of the management, including senior management; ii. definition of an environmental policy that includes the continuous improvement of the installation by the management; iii. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment; iv. implementation of procedures paying particular attention to: (a) structure and responsibility (b) training, awareness and competence (c) communication (d) employee involvement (e) documentation	Applicable	Condition 4.6 of the current Environment Protection Licence requires that 12 months of receipt of the first load of non- standard fuels an audit should be undertaken that complies with ISO 19011:2002 - Guidelines for Quality and/ or Environmental Management Systems Auditing. Consolidated consent 2012 requires: *"Operation Environmental Management Plan (OEMP) 6.3 The Applicant shall prepare and implement an Operation Environmental Management Plan (OEMP) to detail an environmental management framework, practices and procedures to be followed during the operation of the cement works upgrade. The plan shall include, but not necessarily be limited to:* *a) identification of all statutory and other obligations that the Applicant is required* *to fulfil in relation to operation of the cement works upgrade, including all consents, licences, approvals and consultations;*

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	(f) efficient process control (g) maintenance programmes (h) emergency preparedness and response (i) safeguarding compliance with environmental legislation; v. checking performance and taking corrective action, paying particular attention to: (a) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring) (b) corrective and preventive action (c) maintenance of records (d) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained; vi. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management; vii. following the development of cleaner technologies; iii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life; ix. application of sectoral benchmarking on a regular basis. x.		*b) a description of the roles and responsibilities for all relevant employees involved in the operation of the cement works upgrade;* *c) overall environmental policies and principles to be applied to the operation of the cement works upgrade;* *d) standards and performance measures to be applied to the cement works upgrade, and a means by which environmental performance can be periodically reviewed and improved;* *e) management policies to ensure that environmental performance goals are met and to comply with the conditions of this consent;* *f) the Management Plans listed under condition 6.4 of this consent; and* *g) the environmental monitoring requirements outlined under conditions 0 to 4.3 of this consent, inclusive.* *The OEMP shall be submitted for the approval of the Director-General no later than one month prior to the commencement of operation of the cement works upgrade, or within such period otherwise agreed by the Director-General. Operation shall not commence until written approval has been received from the Director-General. Upon receipt of the Director-General's approval, the Applicant shall supply a copy of the OEMP to the EPA and Council as soon as practicable."*

BAT Ref. Number	**BAT Conclusion**	**Applicability Assessment**	**Notes relating to technique and whether it is in place at Berrima Cement Works**
1.1.2 Noise			
BAT 2	In order to reduce/minimise noise emissions during the manufacturing processes for cement, lime and magnesium oxide, BAT is to use a combination of the following techniques:	Applicable	Proposed new external conveyor to transfer material to the pre-heater tower will be enclosed on three sides (top and sides) Material will be deposited into the enclosed surge bin within the pre-heater tower. Consolidated consent 2012 requires: "6.4 As part of the OEMP for the cement works upgrade, required under condition 6.3 of this consent, the Applicant shall prepare and implement the following Management Plans: a) a Noise Management Plan to outline measures to minimise the impacts from the operation of the cement works upgrade on local noise levels. The Plan shall address the requirements of the EPA and shall include, but not necessarily be limited to: i) identification of all major sources of noise that may be emitted as a result of the operation of the cement works upgrade; ii) specification of the noise criteria as it applies to the particular activity; iii) procedures for the monitoring of noise emissions from the cement works upgrade, in accordance with any requirements of the EPA; iv) protocols for the minimisation of noise emissions;
	a Select an appropriate location for noisy operations		
	b Enclose noisy operations/units		
	c Use vibration insulation of operations/units		
	d Use internal and external lining made of impact-absorbent material		
	e Use soundproofed buildings to shelter any noisy operations involving material transformation equipment		
	f Use noise protection walls and/or natural noise barriers		
	g Use outlet silencers to exhaust stacks		
	h Lag ducts and final blowers which are situated in soundproofed buildings		
	i Close doors and windows of covered areas		
	j Use sound insulation of machine buildings		
	k Use sound insulation of wall breaks, e.g. by installation of a sluice at the entrance point of a belt conveyor		
	l Install sound absorbers at air outlets, e.g. the clean gas outlet of dedusting units		
	m Reduce flow rates in ducts		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	n Use sound insulation of ducts o Apply the decoupled arrangement of noise sources and potentially resonant components, e.g. of compressors and ducts p Use silencers for filter fans q Use soundproofed modules for technical devices (e.g. compressors) r Use rubber shields for mills (avoiding the contact of metal against metal) s Construct buildings or growing trees and bushes between the protected area and the noisy activity		v) measures to consider and manage the cumulative impact of operating both kilns simultaneously; and vi) description of procedures to be undertaken if any non-compliance is detected.
1.2.1 General Primary Techniques			
BAT 3	In order to reduce emissions from the kiln and use energy efficiently, BAT is to achieve a smooth and stable kiln process, operating close to the process parameter set points by using the following techniques: a Process control optimisation, including computer-based automatic control b Using modern, gravimetric solid fuel feed systems	Applicable	The kiln feeding system has been designed to incorporate measures to control the quantity of SWDF fed into the pre- calciner at the appropriate rate to replace 30% of the heat energy required for Kiln 6. The design features a weighing and programmable control system which will control the feed rate by pre-programmed loading volume rates and conveyor speed. The system will be calibrated during dry commissioning. An air lock on the precalciner screw conveyor will also form part of the design to control oxygen levels in the process, and interlocks linked to

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
			the plant control system to ensure SWDF is only fed when kiln temperatures are appropriate.
BAT 4	In order to prevent and/or reduce emissions, BAT is to carry out a careful selection and control of all substances entering the kiln. (Description: Careful selection and control of substances entering the kiln can reduce emissions. The chemical composition of the substances and the way they are fed in the kiln are factors that should be taken into account during the selection. Substances of concern may include the substances mentioned in BAT 11 and in BAT 24 to 28.)	Applicable	Solid Waste Derived Fuels waste streams would be sorted, tested and shredded off-site by authorised waste suppliers to maintain compliance with relevant specifications. Boral would only source feedstock from suppliers that have agreed to meet the requirements of the EPA guidelines, including the resource recovery criteria for energy recovery facilities set out in the NSW EPA Energy from Waste Policy (2014). This would be a prerequisite when establishing supply contracts for kiln feedstock. The policy specifies what is considered to be an 'eligible waste fuel' which would be reviewed over time. Boral proposes to adopt a risk based approach to minimise any potential environmental impact of using SWDF. Boral's approach includes risk protection as follows: **Detailed fuel specifications** Boral has developed detailed fuel specifications for the proposed SWDF based on established European and USA standards. The levels of contaminants, such as heavy metals, in these standards are low enough to ensure that when used as a fuel in the cement kiln, emissions are unlikely to exceed the limits defined in the Energy from Waste Policy and the sites EPL. The

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
			fuel specifications would be the basis of acceptance of deliveries of fuels from suppliers. **Supplier control systems** Suppliers of SWDF to Berrima would be required to establish rigorous Quality Assurance / Quality Control procedures to ensure the SWDF products produced from their operations meet Boral's specifications. The QA/QC of suppliers would be subject to regular audit by Boral or external parties. Regular statistical check sampling and testing of dispatched waste fuel products would be established based on the European standards. Using this methodology, samples of fuel would be taken at either the supplier’s site or at the Cement Works on a regular basis and analysed to determine compliance with the fuel specification. This will provide a regular check of the effectiveness of the supplier’s quality assurance processes. Analysis of test results would be undertaken by suitably accredited laboratories using standard test methods.

BAT Ref. Number	BAT Conclusion		Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
1.2.2 Monitoring				
BAT 5	BAT is to carry out the monitoring and measurements of process parameters and emissions on a regular basis and to monitor emissions in accordance with the relevant EN standards or, if EN standards are not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality, including the following:			
	a	Continuous measurements of process parameters demonstrating the process stability, such as temperature, O_2 content, pressure and flowrate	Generally applicable	Kiln 6 has continuous measurements for all the following operational parameters: temperature at a representative point in the combustion chamber; concentration of oxygen; pressure and temperature in the stack; and water vapour content of the exhaust gas. Condition 4.1A of the existing Environment Protection Licence requires continuous fuel feed monitoring.
	b	Monitoring and stabilising critical process parameters, i.e. homogenous raw material mix and fuel feed, regular dosage and excess oxygen	Generally applicable	The design features a weighing and programmable control system which will control the feed rate by pre-programmed loading volume rates and conveyor speed. The system will be calibrated during dry commissioning. An air lock on the precalciner screw conveyor will also form part of the design to control oxygen levels in the process, and interlocks linked to

BAT Ref. Number	BAT Conclusion		Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
				the plant control system to ensure SWDF is only fed when kiln temperatures are appropriate.
	c	Continuous measurements of NH_3 emissions when SNCR is applied	Generally applicable	SNCR not mentioned in application or Environment Protection Licence documents
	d	Continuous measurements of dust, NOx, SOx , and CO emissions	Applicable to kiln processes	Continuous emissions monitoring will be provided for NOx, particulates, and SO2 during use of non-standard fuels. While continuous emission monitoring of CO will be provided for non-standard fuels this will be for indication purposes only and emission limits for combustion will be based on VOC as per Group 6 requirements.
	e	Periodic measurements of PCDD/F and metal emissions	Applicable to kiln processes	Dioxins, furans and metals must be measured periodically at specified frequencies in accordance with the current Environment Protection Licence condition M2.4 during use of non- standard fuels.
	f	Continuous or periodic measurements of HCl, HF and TOC emissions. (Description The selection between continuous or periodic measurements mentioned in BAT 5(f) is based on the emission source and the type of pollutant expected.)	Applicable to kiln processes	During use of non- standard fuels Continuous emissions monitoring will be provided for VOC (as Non-methane), and HCl. Boral proposes to monitor. HF emissions routinely as part of periodic stack emission tests, on the basis that due to the nature of the cement manufacturing process HF emissions are typically very low and follow similar trends to HCl.

BAT Ref. Number	BAT Conclusion		Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	g	Continuous or periodic measurements of dust	Applicable to non-kiln activities. For small sources (< 10 000 Nm³ /h) from dusty operations other than cooling and the main milling processes, the frequency of measurements or performance checks should be based on a maintenance management system.	The current Environment Protection Licence requires continuous monitoring of solid particles during standard operation and operation with non- standard fuels. Solid particles must be measured yearly at points 4, 5, 7 and 10. Insoluble solids must be measured monthly at Points 11, 12, 13, 14, 15, 16 and 17. Boral operates an ambient air quality monitoring station (AQMS) beyond the site boundary. The AQMS records data for Total Suspended Particulates (TSP), PM10 and heavy metals.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
1.2.3 Energy Consumption and Process Selection			
1.2.3.1 Process Selection			
BAT 6	In order to reduce energy consumption, BAT is to use a dry process kiln with multistage preheating and precalcination. (Description: In this type of kiln system, exhaust gases and recovered waste heat from the cooler can be used to preheat and precalcine the raw material feed before entering the kiln, providing significant savings in energy consumption.) (Table 1 not included here as its non-applicable)	Not applicable: Applicable to new plants and major upgrades, subject to raw materials moisture content.	
1.2.3.2 Energy Consumption			
BAT 7	In order to reduce/minimise thermal energy consumption, BAT is to use a combination of the following techniques: **Description** Several factors affect the energy consumption of modern kiln systems such as raw materials properties (e.g. moisture content, burnability), the use of fuels, with different properties, as well as the use of a gas bypass system. Furthermore, the	Applicable	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	production capacity of the kiln has an influence on the energy demand.		
a	Applying improved and optimised kiln systems and a smooth and stable kiln process, operating close to the process parameter set points by applying: i. process control optimisation, including computer- based automatic control systems ii. modern, gravimetric solid fuel feed systems iii. preheating and precalcination to the extent possible, considering the existing kiln system configuration	Generally applicable. For existing kilns, the applicability of preheating and precalcination is subject to the kiln system configuration	For proposed SWDF The design features a weighing and programmable control system which will control the feed rate by pre-programmed loading volume rates and conveyor speed. A cement kiln preheater/pre-calciner is in use at Kiln 6
b	Recovering excess heat from kilns, especially from their cooling zone. In particular, the kiln excess heat from the cooling zone (hot air) or from the preheater can be used for drying raw materials.	Generally applicable in the cement industry. Recovery of excess heat from the cooling zone is applicable when grate coolers are used. Limited	The cement kiln at Berrima recovers most of the heat input as part of clinker manufacturing process. Combustion gases from the kiln are used to heat up raw materials from ambient temperature to 1450°C to make clinker. Clinker leaving the kiln is cooled down by air at ambient temperature. The heat from clinker is recovered as hot air at 1200°C and used for combustion of fuel into kiln and calciner.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		recovery efficiency can be achieved on rotary coolers.	
c	Applying the appropriate number of cyclone stages related to the characteristics and properties of raw material and fuels used Technique 7c: the appropriate number of cyclone stages for preheating is determined by the throughput and the moisture content of raw materials and fuels which have to be dried by the remaining flue-gas heat because local raw materials vary widely regarding their moisture content or burnability	Not applicable: Cyclone preheater stages are applicable to new plants and major upgrades.	
d	Using fuels with characteristics which have a positive influence on the thermal energy consumption. Technique 7d: conventional and waste fuels can be used in the cement industry. The characteristics of the fuels used, such as adequate calorific value and low moisture content, have a positive influence on the specific energy consumption of the kiln.	The technique is generally applicable to the cement kilns subject to fuel availability and for existing kilns subject to the technical possibilities of	A minimum calorific value and maximum moisture content are included in the fuel specification

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		injecting the fuel into the kiln.	
e	When replacing conventional fuels by waste fuels, using optimised and suitable cement kiln systems for burning wastes.	Generally applicable to all cement kiln types	In 2004, Boral upgraded Kiln 6 and installed additional equipment specifically suited to the burning of SWDF. The key features of this equipment are: • a large volume pre-calciner combustion vessel, which gives fuels longer time to burn out (>6 seconds) at high temperatures (>800 Deg C). This means that all of the solid fuel is given the chance to burn out and eliminates residues like smoke; • the raw mill dust collector, which filters kiln exhaust gas particulates and provides additional high efficiency cleaning capacity to minimise stack emissions; and • the installation of continuous monitoring equipment for key gaseous pollutants, which allows prompt response to any adverse trends in stack emissions.
f	Minimising bypass flows Technique 7f: the removal of hot raw material and hot gas leads to a higher specific energy consumption of about 6 – 12 MJ/tonne clinker per percentage point of removed kiln inlet gas.	Generally applicable to the cement industry	The cement kiln at Berrima recovers most of the heat input as part of clinker manufacturing process. Combustion gases from the kiln are used to heat up raw materials from ambient temperature to 1450°C to make clinker. Clinker leaving the kiln is cooled down by air at ambient temperature. The heat from clinker is

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	Hence, minimising the use of gas bypass has a positive effect on energy consumption.		recovered as hot air at 1200°C and used for combustion of fuel into kiln and calciner.
BAT 8	In order to reduce primary energy consumption, BAT is to consider the reduction of the clinker content of cement and cement products. **Description** The reduction of the clinker content of cement and cement products can be achieved by adding fillers and/or additions, such as blast furnace slag, limestone, fly ash and pozzolana in the grinding step in accordance with the relevant cement standards.	Generally applicable to the cement industry, subject to (local) availability of fillers and/or additions and local market specificities.	The following alternative raw materials are permitted in accordance with section O5.8 of the Environment Protection Licence: • BOS Secondary Fines • Mill Scale • Steel Slag • Spent Fluidised Cracking Catalyst • Cement Fibre Board • Coal Washery Reject • Blast Furnace Slag
BAT 9	In order to reduce primary energy consumption, BAT is to consider cogeneration/combined heat and power plants. **Description** The employment of cogeneration plants for the production of steam and electricity or combined heat and power plants can be applied in the cement industry by recovering waste heat from the clinker cooler or kiln flue-gases using the conventional steam cycle processes or other techniques. Furthermore, excess heat can be recovered from the clinker cooler or kiln flue-	**Applicability** The technique is applicable in all cement kilns if sufficient excess heat is available, if appropriate process parameters can be met, and if economic	As the heat energy from SWDF combustion will be a direct substitute for the heat energy currently provided by coal combustion in the cement manufacturing process, the heat recovery rate for SWDF in the proposed process is effectively 100%. The cement kiln at Berrima recovers most of the heat input as part of clinker manufacturing process. Combustion gases from the kiln are used to heat up raw materials from ambient temperature to 1450°C to make clinker. Clinker leaving the kiln is cooled down by air at ambient temperature. The heat from clinker is recovered as hot air at 1200°C and used for combustion of fuel into kiln and calciner.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	gases for district heating or industrial applications.	viability is ensured.	
BAT 10	In order to reduce/minimise electrical energy consumption, BAT is to use one or a combination of the following techniques:		Insufficient information is available to comment on this BAT. This does not impact on recommended emission limit values set out in the BAT Conclusions or this report. However energy efficiency is an important aspect of BAT and NSW EPA may wish to include a licence condition for an energy audit to be undertaken at Berrima to include measures set out in this BAT.
a	Using power management systems		
b	Using grinding equipment and other electricity based equipment with high energy efficiency		
c	Using improved monitoring systems		
d	Reducing air leaks into the system		
e	Process control optimisation		
1.2.4 Use of Waste			
1.2.4.1 Waste Quality Control			
BAT 11	Waste Quality Control In order to guarantee the characteristics of the wastes to be used as fuels and/or raw materials in a cement kiln and reduce emissions, BAT is to apply the following techniques: **Description** Different types of waste materials can replace primary raw materials and/or fossil fuels in	Applicable	A “Specification for Solid Waste Derived Fuel (SWDF)” is included in Appendix B of the EIS. Supplier test methods are not however specified and most of them are noted to be TBA. The Supplier shall ensure that sampling is carried out in accordance with EN14778:2011 “Solid biofuels – Sampling” or EN15442:2011 “Solid Recovered Fuels

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	cement manufacturing and will contribute to saving natural resources.		- Methods for sampling" as relevant to the specific type of fuel supplied. This will typically mean that for solid biofuels one 3-Litre sample bucket will be taken as a sample from every 125 tonnes of solid biofuel fuel despatched and for solid recovered fuels one 3-Litre sample bucket will be taken as a sample from every 70 tonnes of solid recovered fuel despatched.
a	Apply quality assurance systems to guarantee the characteristics of wastes and to analyse any waste that is to be used as raw material and/or fuel in a cement kiln for: i. constant quality ii. physical criteria, e.g. emissions formation, coarseness, reactivity, burnability, calorific value iii. chemical criteria, e.g. chlorine, sulphur, alkali and phosphate content and relevant metals content		
b	Control the amount of relevant parameters for any waste that is to be used as raw material and/or fuel in a cement kiln, such as chlorine, relevant metals (e.g. cadmium, mercury, thallium), sulphur, total halogen content		
c	Apply quality assurance systems for each waste load		
1.2.4.2 Waste Feeding into the Kiln			

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
BAT 12	In order to ensure appropriate treatment of the wastes used as fuel and/or raw materials in the kiln, BAT is to use the following techniques:	Applicable	A large volume pre-calciner combustion vessel wil be used, which gives fuels longer time to burn out (>6 seconds) at high temperatures (>800 Deg C). This means that all of the solid fuel is given the chance to burn out and eliminates residues like smoke; An average gas temperature for the combustion section of the cement kiln preheater/pre-calciner will be measured to demonstrate compliance with this condition. Gas residence time in this section of the plant is well in excess of 2 seconds. In addition, as part of the 2004 Kiln upgrade, additional equipment was installed, including a large volume pre-calciner combustion vessel, which gives fuels longer time to burn out (>6 seconds) at high temperatures (>800 Deg C). This means that all of the solid fuel is given the chance to burn out and eliminates residues like smoke. The EIS states that *"gas from the process would be raised to a minimum temperature of 850°C for at least 2 seconds"* Condition 1.40 of the existing Environment Protection Licence states that *"Only Standard Fuels are permitted to be used at the development during start/up and shut/down."*
a	Use appropriate points to feed the waste into the kiln in terms of temperature and residence time depending on kiln design and kiln operation		
b	To feed waste materials containing organic components that can be volatilised before the calcining zone into the adequately high temperature zones of the kiln system		
c	To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion, even under the most unfavourable conditions, to a temperature of 850 °C for 2 seconds		
d	To raise the temperature to 1 100 °C, if hazardous waste with a content of more than 1 % of halogenated organic substances, expressed as chlorine, are co-incinerated		
e	To feed wastes continuously and constantly		
f	Delay or stop co-incinerating waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	times cannot be reached, as noted in a) to d) above		*In relation to halogenated organic substances the EIS states: Fuel specifications would limit the Chlorine content of SWDF to <1.0%*
1.2.4.3 Safety Management for the use of Hazardous Waste Materials			
BAT 13	BAT is to apply safety management for the storage, handling and feeding of hazardous waste materials, such as using a risk-based approach according to the source and type of waste, for the labelling, checking, sampling and testing of waste to be handled.	Applicable	A preliminary risk screening has been undertaken to provide an assessment of the hazards associated with the storage of dangerous goods on the site of the Cement Works in accordance with NSW State Environmental Planning Policy No. 33 – Hazardous and Offensive Development (SEPP 33). The purpose of the initial SEPP 33 risk screening is to exclude from more detailed studies those developments which do not pose significant risk. Due to the limited storage and transportation of dangerous goods the preliminary risk screening concludes that the proposed modification of the Cement Works is not “potentially hazardous” in accordance with SEPP 33 and therefore a Preliminary Hazardous Assessment is not required. No site specific environmental management measures are required outside of best practice in the management of dangerous goods.
1.2.5 Dust Emissions			

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
1.2.5.1 Diffuse Dust Emissions			
BAT 14	In order to minimise/prevent diffuse dust emissions from dusty operations, BAT is to use one or a combination of the following techniques:		PRP8 Fugitive Dust Action Plan is in place since September 2012 (Environment Protection Licence condition G2.1) Crushing of raw materials is carried out in an enclosed building with emissions control. Transfer points for materials are enclosed. Proposed new conveyors will be covered with the exception of the RDF baled feed conveyor Loading of clinker and cement onto trains and trucks is carried out in an enclosure with dust control The raw mill has a dust collector which filters kiln exhaust gas particulates Environment Protection Licence conditions note an electrostatic precipitator and fabric filter on Kiln 6 (Conditions 3.24 and 4.1C) Insufficient information is available to consider existing conveyors and elevators on site in relation to this BAT. This does not change recommended emission limit values set out in the BAT Conclusions or this report.
a	Use a simple and linear site layout of the installation	Not applicable, applicable to new plants only	
b	Enclose/encapsulate dusty operations, such as grinding, screening and mixing	Generally applicable	
c	Cover conveyors and elevators, which are constructed as closed systems, if diffuse dust emissions are likely to be released from dusty material		
d	Reduce air leakages and spillage points		
e	Use automatic devices and control systems		
f	Ensure trouble-free operations		
g	Ensure proper and complete maintenance of the installation using mobile and stationary vacuum cleaning. – During maintenance operations or in cases of trouble with conveying systems, spillage of materials can take place. To prevent the formation of diffuse dust during removal operations, vacuum systems should be used. New buildings can easily be equipped with		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	stationary vacuum cleaning piping, while existing buildings are normally better fitted with mobile systems and flexible connections – In specific cases, a circulation process could be favoured for pneumatic conveying systems		
h	Ventilate and collect dust in fabric filters: – As far as possible, all material handling should be conducted in closed systems maintained under negative pressure. The suction air for this purpose is then dedusted by a fabric filter before being emitted into the air		
i	Use closed storage with an automatic handling system: – Clinker silos and closed fully automated raw material storage areas are considered the most efficient solution to the problem of diffuse dust generated by high volume stocks. These types of storage are equipped with one or more fabric filters to prevent diffuse dust formation in loading and unloading operations – Use storage silos with adequate capacities, level indicators with cut out switches and with filters to deal with dust-bearing air displaced during filling operations		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
j	Use flexible filling pipes for dispatch and loading processes, equipped with a dust extraction system for loading cement, which are positioned towards the loading floor of the lorry		
BAT 15	In order to minimise/prevent diffuse dust emissions from bulk storage areas, BAT is to use one or a combination of the following techniques:		Dust mitigation activities such as road sweeping and water spraying are undertaken Dust from surfaces at the plant is sheltered due to stockpiles and trees Some material stockpiles are covered with tarpaulin
a	Cover bulk storage areas or stockpiles or enclose them with screening, walling or an enclosure consisting of vertical greenery (artificial or natural wind barriers for open pile wind protection)		
b	Use open pile wind protection: - Outdoor storage piles of dusty materials should be avoided, but when they do exist it is possible to reduce diffuse dust by using properly designed wind barriers		
c	Use water spray and chemical dust suppressors: - When the point source of diffuse dust is well localised, a water spray injection system can be installed. The humidification of dust particles aids agglomeration and so helps dust settle. A wide variety of agents is also available to improve the overall efficiency of the water spray.		
d	Ensure paving, road wetting and housekeeping:		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	- Areas used by lorries should be paved when possible and the surface should be kept as clean as possible. Wetting the roads can reduce diffuse dust emissions, especially during dry weather. They also can be cleaned with road sweepers. Good housekeeping practices should be used in order to keep diffuse dust emissions to a minimum		
e	Ensure humidification of stockpiles: - Diffuse dust emissions at stockpiles can be reduced by using sufficient humidification of the charging and discharging points, and by using conveyor belts with adjustable heights		
f	Match the discharge height to the varying height of the heap, automatically if possible or by reduction of the unloading velocity, when diffuse dust emissions at the charging or discharging points of storage sites cannot be avoided		
1.2.5.2 Channelled dust emissions from dusty operations This section concerns dust emissions arising from dusty operations other than those from kiln firing, cooling and the main milling processes. This covers processes such as the crushing of raw materials; raw material conveyors and elevators; the storage of raw materials, clinker and cement; the storage of fuels and the dispatch of cement.			
BAT 16	In order to reduce channelled dust emissions, BAT is to apply a maintenance management system which especially addresses the performance of filters applied to dusty operations, other than those from kiln firing,		The raw mill has a dust collector which filters kiln exhaust gas particulates

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	cooling and main milling processes. Taking this management system into account, BAT is to use dry flue-gas cleaning with a filter. **Description** For dusty operations, dry flue-gas cleaning with a filter usually consists of a fabric filter. **BAT-associated emission levels** The BAT-AEL for channelled dust emissions from dusty operations (other than those from kiln firing, cooling and the main milling processes) is < 10 mg/Nm^3, as the average over the sampling period (spot measurement, for at least half an hour). It should be noted that for small sources (< 10 000 Nm^3/h) a priority approach, based on the maintenance management system, regarding the frequency for checking the performance of the filter has to be taken into account (see also BAT 5).		
1.2.5.3 Dust Emissions from Kiln Firing Processes			
BAT 17	In order to reduce dust emissions from flue-gases of kiln firing processes, BAT is to use dry flue-gas cleaning with a filter.	Applicable to all kiln systems	Environment Protection Licence conditions notes an electrostatic precipitator and fabric filter on Kiln 6 (Conditions 3.24 and 4.1C)

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	BAT-associated emission levels The BAT-AEL for dust emissions from flue-gases of kiln firing processes is <10 – 20 mg/Nm³, as the daily average value. When applying fabric filters or new or upgraded ESPs, the lower level is achieved.		
Technique a	Electrostatic precipitators (ESPs)		
Technique b	Fabric filters		
Technique c	Hybrid filters		
1.2.5.4 Dust Emissions from Cooling and Milling Processes			
BAT 18	In order to reduce dust emissions from the flue-gases of cooling and milling processes, BAT is to use dry flue-gas cleaning with a filter **BAT-associated emission levels** The BAT-AEL for dust emissions from the flue-gases of cooling and milling processes is <10 – 20 mg/Nm³, as the daily average value or average over the sampling period (spot measurements for at least half an hour). When applying fabric	Generally applicable to clinker coolers and cement mills.	The raw mill has a dust collector which filters kiln exhaust gas particulates.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	filters or new or upgraded ESPs, the lower level is achieved.		
Technique a	Electrostatic precipitators (ESPs)		
Technique b	Fabric filters		
Technique c	Hybrid filters		
1.2.6 Gaseous Compounds			
1.2.6.1 NO_x emissions			
BAT 19	In order to reduce the emissions of NO_X from the flue-gases of kiln firing and/or reheating/ precalcining processes, BAT is to use one or a combination of the following techniques.		A rotary kiln is used. Insufficient information is available to comment on this BAT. Please refer to Section 5.2 and Section 5.3.2 of this report for our recommendations in relation to NOx.
a	Primary Techniques		
	I. Flame cooling	Applicable to all types of kilns used for cement manufacturing. The degree of applicability can be limited by product quality requirements	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		and potential impacts on process stability	
	II. Low NO_X burners	Applicable to all rotary kilns, in the main kiln as well as in the precalciner	
	III. Mid-kiln firing	Generally applicable to long rotary kilns	
	IV. Addition of mineralisers to improve the burnability of the raw meal (mineralised clinker)	Generally applicable to rotary kilns subject to final product quality requirements	
	V. Process optimisation	Generally applicable to all kilns	
b	Staged combustion (conventional or waste fuels), also in combination with a precalciner and the use of optimised fuel mix	In general, can only be applied in kilns equipped with a precalciner. Substantial	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		plant modifications are necessary in cyclone preheater systems without a precalciner. In kilns without precalciner, lump fuels firing might have a positive effect on NO_X reduction depending on the ability to produce a controlled reduction atmosphere and to control the related CO emissions	
c	Selective non-catalytic reduction (SNCR)	In principle, applicable to rotary cement kilns. The injection zones	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		vary with the type of kiln process. In long wet and long dry process kilns it may be difficult to obtain the right temperature and retention time needed. See also BAT 20	
d	Selective catalytic reduction (SCR)	Applicability is subject to appropriate catalyst and process development in the cement industry	
Table 2	BAT-associated emission levels for NO x from the flue-gases of kiln firing and/or preheating/precalcining processes in the cement industry		
	Kiln type	**Unit**	**BAT-AEL (daily average value)**
	Preheater kilns	mg/Nm 3	< 200 – 450 (1)(2)
	Lepol and long rotary kilns	mg/Nm 3	400 – 800 (3)
	(1) The upper level of the BAT-AEL range is 500 mg/Nm^3, if the initial NO_x level after primary techniques is > 1 000 mg/Nm^3.		

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	(2) Existing kiln system design, fuel mix properties including waste and raw material burnability (e.g. special cement or white cement clinker) can influence the ability to be within the range. Levels below 350 mg/Nm^3 are achieved at kilns with favourable conditions when using SNCR. In 2008, the lower value of 200 mg/Nm^3 has been reported as a monthly average for three plants (easy burning mix used) using SNCR. (3) Depending on initial levels and NH^3 slip.		
BAT 20	When SNCR is used, BAT is to achieve efficient NO_x reduction, while keeping the ammonia slip as low as possible, by using the following technique:	SNCR is generally applicable to rotary cement kilns. The injection zones vary with the type of kiln process. In long wet and long dry process kilns it may be difficult to obtain the right temperature and retention time needed. See also BAT 19.	SNCR is not applied
a	To apply an appropriate and sufficient NO_x reduction efficiency along with a stable operating process		
b	To apply a good stoichiometric distribution of ammonia in order to achieve the highest efficiency of NO_x reduction and to reduce the NH_3 slip		
c	To keep the emissions of NH_3 slip (due to unreacted ammonia) from the flue-gases as low as possible taking into account the correlation between the NO_x abatement efficiency and the NH_3 slip		
Table 3	**BAT-associated emission levels for NH3 slip in the flue-gases when SNCR is applied**		
	Parameter	Unit	BAT-AEL (daily average value)
	NH_3 slip	mg/Nm³	< 30 – 50 (1)

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	(1) The ammonia slip depends on the initial NO_X level and on the NO_X abatement efficiency. For Lepol and long rotary kilns, the level may be even higher.		
	1.2.6.2 SO_x Emissions		
BAT 21	In order to reduce/minimise the emissions of SO_X from the flue-gases of kiln firing and/or preheating/precalcining processes, BAT is to use one of the following techniques **Description** Depending on the raw materials and the fuel quality, levels of SO_x emissions can be kept low not requiring the use of an abatement technique. If necessary, primary techniques and/or abatement techniques such as absorbent addition or wet scrubber can be used to reduce SO_x emissions. Wet scrubbers have already been operated in plants with initial unabated SO_X levels higher than 800 – 1000 mg/Nm^3.		SO2 (sulphur dioxide) is absorbed onto alkaline reactants in Kiln 6 The assessment results for 1-hour, 24-hour and annual average cumulative concentrations are below the criteria concentrations specified by the NSW EPA.
a	Absorbent addition	Absorbent addition is, in principle, applicable to all kiln systems, although it is mostly used in	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		suspension preheaters. Lime addition to the kiln feed reduces the quality of the granules/ nodules and causes flow problems in Lepol kilns. For preheater kilns it has been found that direct injection of slaked lime into the flue-gas is less efficient than adding slaked lime to the kiln feed.	
b	Wet scrubber	Applicable to all cement kiln types with appropriate (sufficient)	

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
		SO_2 levels for manufacturing the gypsum.	
Table 4	BAT-associated emission levels for SO_x from the flue-gases of kiln firing and/or preheating/ precalcining processes in the cement industry		
	Parameter	Unit	BAT-AEL (1) (2) (daily average value)
	SO_x expressed as SO_2	mg/Nm^3	< 50 – 400
	(1) The range takes into account the sulphur content in the raw materials. (2) For white cement and special cement clinker production, the ability of clinker to retain fuel sulphur might be significantly lower leading to higher SO_X emissions.		
BAT 22	In order to reduce SO_2 emissions from the kiln, BAT is to optimise the raw milling processes. **Description** The technique consists of optimising the raw milling process so that the raw mill can be operated to act as SO_2 abatement for the kiln. This can be achieved by adjusting factors such as: – raw material moisture – mill temperature – retention time in the mill	Applicable if the dry milling process is used in compound mode.	Not clear if dry milling process is used in compound mode

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	– fineness of the ground material.		
	1.2.6.3 CO emissions and CO trips		
	1.2.6.3.1 Reduction of CO trips		
BAT 23	In order to minimise the frequency of CO trips and keep their total duration to below 30 minutes annually, when using electrostatic precipitators (ESPs) or hybrid filters, BAT is to use the following techniques in combination: **Description** For safety reasons, due to the risk of explosions, ESPs will have to shut down during elevated CO levels in the flue-gases. The following techniques prevent CO trips and, therefore, reduce ESP shutdown times: — control of the combustion process — control of the organic load of raw materials — control of the quality of the fuels and fuel feeding system. Disruptions predominantly happen during the start-up operation phase. For safe operation, the gas analysers for ESP protection have to be on-line during all operational phases and the ESP		While continuous emission monitoring of CO will be provided this will be for indication purposes only and emission limits for combustion will be based on VOC as per Group 6 requirements.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	downtime can be reduced by using a backup monitoring system maintained in operation. The continuous CO monitoring system needs to be optimised for reaction time and should be located close to the CO source, e.g. at a preheater tower outlet, or at a kiln inlet in the case of a wet kiln application. When hybrid filters are used, the grounding of the bag support cage with the cell plate is recommended.		
a	Manage CO trips in order to reduce the ESP downtime		
b	Continuous automatic CO measurements by means of monitoring equipment with a short response time and situated close to the CO source		
1.2.6.4 Total organic carbon emissions (TOC)			
BAT 24	In order to keep the emissions of TOC from the flue-gases of the kiln firing processes low, BAT is to avoid feeding raw materials with a high content of volatile organic compounds (VOC) into the kiln system via the raw material feeding route.		VOC content in emissions is from blue shale used as a raw material To date at the facility VOC emissions were up to two times higher with use of waste-derived fuels but still

BAT Ref. Number	**BAT Conclusion**	**Applicability Assessment**	**Notes relating to technique and whether it is in place at Berrima Cement Works**
			below the applicable emission limit when using non-standard fuels of 20mg/Nm3
1.2.6.5 Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions			
BAT 25	In order prevent/reduce the emissions of HCl from flue-gases of the kiln firing processes, BAT is to use one or a combination of the following primary techniques: **BAT-associated emission levels** The BAT-AEL for the emissions of HCl is <10 mg/Nm³, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).		In relation to halogenated organic substances the EIS states: Fuel specifications would limit the Chlorine content of SWDF to <1.0% The Environment Protection Licence limits HCl for non-standard fuels to 10 mg/Nm^3.
a	Using raw materials and fuels with a low chlorine content		
b	Limiting the amount of chlorine content for any waste that is to be used as raw material and/or fuel in a cement kiln		
BAT 26	In order to prevent/reduce the emissions of HF from the flue-gases of the kiln firing processes, BAT is to use one or a combination of the following primary techniques		Fluorine levels in the incoming raw materials are limited using the SWDF Specification. The Environment Protection Licence limits HF for non-standard fuels to 1 mg/Nm^3.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	BAT-associated emission levels The BAT-AEL for the emissions of HF is <1 mg/Nm³, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).		
a	Using raw materials and fuels with a low fluorine content		
b	Limiting the amount of fluorine content for any waste that is to be used as raw material and/or fuel in a cement kiln		
1.2.7 PCDD/F emissions			
BAT 27	In order to prevent emissions of PCDD/F or to keep the emissions of PCDD/F from the flue-gases of the kiln firing processes low, BAT is to use one or a combination of the following techniques: **BAT-associated emission levels** The BAT-AEL for the emissions of PCDD/F from the flue-gases of the kiln firing processes is <0.05 – 0.1 ng PCDD/ F I-TEQ/Nm³, as the average over the sampling period (6 – 8 hours).		The Environment Protection Licence limits dioxins and furans for non-standard fuels to 0.1 ng/m³. The specification for SWDF notes a limit for Chlorine and Copper VOC content in emissions is from blue shale used as a raw material. Emissions during testing of RDF are not greater than the allowable limit. Chlorine is a carefully controlled operational parameter in the feed as it impacts clinker quality and

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
a	Carefully selecting and controlling of kiln inputs (raw materials), i.e. chlorine, copper and volatile organic compounds	Generally applicable	marked increases in emission concentrations for this element are unlikely.
b	Carefully selecting and controlling kiln inputs (fuels), i.e. chlorine and copper	Generally applicable	
c	Limiting/avoiding the use of wastes which contain chlorinated organic materials	Generally applicable	
d	Avoid feeding fuels with a high content of halogens (e.g. chlorine) in secondary firing	Generally applicable	
e	Quick cooling of kiln flue-gases to lower than 200 °C and minimising residence time of flue-gases and oxygen content in zones where the temperatures range between 300 and 450 °C	Applicable to long wet kilns and long dry kilns without preheating. In modern preheater and precalciner kilns, this feature is already inherent	
f	Stop co-incinerating waste for operations such as start-ups and/or shutdowns	Generally applicable	
1.2.8 Metal Emissions			
BAT 28	In order to minimise the emissions of metals from the flue-gases of the kiln firing processes,		Mercury and Total Group II metals (mg/kg)

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	BAT is to use one or a combination of the following techniques:		Cadmium (Cd) + Thallium (Tl) are limited in the SWDF Specification. Current Environment Protection Licence limit for Hg when non-standard fuels are in use is 0.05 mg/m^3. Current Environment Protection Licence limit for Cadmium and Thallium when non-standard fuels are in use is 0.05 mg/m3
a	Selecting materials with a low content of relevant metals and limiting the content of relevant metals in materials, especially mercury		
b	Using a quality assurance system to guarantee the characteristics of the waste materials used		
c	Using effective dust removal techniques as set out in BAT 17		
Table 5	Metals	Unit	BAT-AEL (average over the sampling period (spot measurements, for at least half an hour))
	Hg	mg/Nm^3	< 0.05 (2)
	Σ (Cd, Tl)	mg/Nm^3	< 0.05 (1)
	Σ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	mg/Nm^3	< 0.5 (1)
	(1) Low levels have been reported based on the quality of the raw materials and the fuels. (2) Low levels have been reported based on the quality of the raw materials and the fuels. Values higher than 0.03 mg/Nm³ have to be further investigated. Values close to 0.05 mg/Nm³ require consideration of additional techniques (e.g. lowering of the flue-gas temperature, activated carbon).		
1.2.9 Process losses/ waste			
BAT 29	In order to reduce solid waste from the cement manufacturing process along with raw material savings, BAT is to: **Description** Collected dust can be recycled back into the production processes whenever practicable. This		Insufficient information is available to comment on this BAT. While waste minimisation is an important aspect of BAT, this does not change recommended emission limit values set out in the BAT Conclusions or this report.

BAT Ref. Number	BAT Conclusion	Applicability Assessment	Notes relating to technique and whether it is in place at Berrima Cement Works
	recycling may take place directly into the kiln or kiln feed (the alkali metal content being the limiting factor) or by blending with finished cement products. A quality assurance procedure might be required when the collected dusts are recycled back into the production processes. Alternative uses may be found for material that cannot be recycled (e.g. additive for flue-gas desulphurisation in combustion plants).		
a	Reuse collected dusts in the process, wherever practicable		
b	Utilise these dusts in other commercial products, when possible		
1.3 BAT Conclusions for the Lime Industry			
BAT 30-54		Not applicable	
1.4 BAT conclusions for the magnesium oxide industry			
BAT 55-69		Not applicable	

*how the technique applies or not to the installation

4 Eligibility of Proposed Waste Derived Fuels

4.1 Scope

An assessment of the eligibility of the proposed waste derived fuels and whether the facility meets the requirements to be an energy recovery facility, (based on the requirements of the IED)

4.2 Introduction

This modification, Modification 9, seeks approval for the following:

- use of Solid Waste Derived Fuel (SWDF) as an energy source;
- changes to the air emission limits of particulate matter (PM), nitrous *[sic]* oxides (NOx) and volatile organic compounds (VOC); and
- construction of a fuel storage and kiln feeding system.

The fuels that are the subject of this modification are the following SWDF:

- Wood Waste - material left over from industrial processes like milling, furniture making, and building and construction; and
- Refuse Derived Fuel (RDF) - fuel made from the combustible materials recovered and processed from waste

Boral proposes to use up to 100,000 tonnes per year of SWDF in Kiln 6 operations. This would replace 20-30% of the coal used in the facility.

The NSW Environment Protection Authority (EPA) considers eligible waste fuels to be those that pose a low risk of harm to human health and the environment due to their origin, composition and consistency.

The following wastes are categorised by the EPA as eligible waste fuels:

1. biomass from agriculture
2. forestry and sawmilling residues
3. uncontaminated wood waste
4. recovered waste oil
5. organic residues from virgin paper pulp activities
6. landfill gas and biogas
7. source-separated green waste (used only in processes to produce char)
8. tyres (used only in approved cement kilns).

4.3 Assessment

The wastes proposed come within the EPA categories.

The use of cement kilns for incinerating waste including hazardous waste has long been recognised. In the Irish EPA's National Hazardous Waste Management Plan 2008-2012 it is stated (p.ix):

> *Of the 48% of hazardous waste exported in 2006, a significant proportion could be dealt with in Ireland at existing authorised facilities and in cement kilns.*

And (p.55):

> *The promotion of some technologies (namely cement kilns and landfill) is actively encouraged …*

In the NHWMP 2014-20 continues with this theme (p.73):

> *The promotion of some technologies (namely combustion in cement kilns and landfill (of certain wastes where no other option is available)) should be facilitated in the interest of reducing exports by using existing infrastructure, provided they can be correctly operated to protect human health and the environment.*

Two cement manufacturing facilities in the Republic of Ireland have been licenced to use wastes as alternative fuels. Notwithstanding their generally supportive comments in the NHWMPs, the Irish EPA has adopted a very cautious approach to licensing such facilities. In all cases combustion trials are required to demonstrate that the introduction of waste as an alternative fuel does not lead to emissions to atmosphere exceeding licence limits, particularly with regard to acid gases, heavy metals and dioxins/furans.

While seeking to ensure that limits imposed on emissions are such as to protect ambient air quality and the environment in general, the EPA has also taken a keen interest in the specification of wastes for use as alternative fuels. By restricting the concentration in waste of components/chemical compounds that contain halogens and/or heavy metals, the EPA attempts to impose a second means of limiting emissions to the environment – if it's not in the waste it can't be emitted.

The draft proposed SWDF Specification is attached to the EIS as Appendix B. The draft specification references two international standards for sampling RDF and Solid Biofuels. The capacity of the sample size is 3 litres (approximately 144mm cube), whereas the maximum particle size is 100mm. It may not be possible to obtain a representative sample from an alternative fuel with large particles.

Recommendation:

The capacity of the sampling container and the maximum particle size should be reviewed and a means developed for obtaining a representative sample.

The imposition of standards for waste to be used as alternative wastes may give rise to problems for the user (the cement kiln operator) and the supplier. Wastes are generally heterogeneous in terms of physical condition and source, which means that obtaining representative samples may be challenging. For the supplier the difficulty is to source or blend waste to achieve the specification. For the user the difficulty is to ensure that only reliable suppliers are used, that sufficient samples are taken and that a means is established for returning out-of-specification material to the supplier.

Recommendation:

A methodology should be developed for pre-qualifying suppliers of SWDF to ensure that contracts for supply of alternative fuels are placed only with suppliers that have the appropriate technical expertise, quality assurance systems, identifiable sources of waste, etc.

All materials in SWDF must either end up in the clinker produced or in emissions to atmosphere. Emissions of materials to water or to waste from a cement plant are small or non-existent. The inclusion of materials in the clinker is a matter of quality of the cement product. Hence the focus is on emissions to atmosphere, which will be determined to some extent by the combustion efficiency in the kiln and by the partitioning of materials in the waste between clinker and air emissions. Incomplete combustion may lead to higher emissions of organic materials. Exceedance of product specification limits may lead to higher emissions of acid gases, etc. Therefore the Irish EPA imposes requirements regarding the amount or proportion of alternative fuel that may be introduced to a cement kiln. A step-wise approach is adopted in which the ability of the kiln to use a certain feed rate of alternative fuel is checked before the rate may be increased.

The Irish EPA has licenced a number of cement kilns for co-incineration of waste fuels in accordance with EU Directive 2010/75/EU of the European Parliament and the Council on industrial emissions. All licences include conditions that require the licence holder to prepare a test programme for the co-incineration of solid recovered fuel.

Typically the test programme must be submitted to and agreed with the Irish EPA prior to implementation. Following completion a report on its implementation must be submitted to the agency, typically within one month of completion. All criteria for operation control and management of abatement equipment to achieve licence emission limit values and fuel feed control.

In our experience test programmes are not a matter for licensing and details including the timescale etc are typically worked out by negotiation between the EPA and the licensee following grant of the Industrial Emissions Licence.

Recommendation:

The Environment Protection Licence should include the following requirement:

The licensee shall prepare to the satisfaction of the EPA a test programme for the co-incineration of each alternative fuel. This programme shall be submitted to the EPA prior to implementation.

This test programme, following agreement with the EPA, shall be implemented and a report on its implementation shall be submitted to the Agency within one month of completion.

The test programme shall as a minimum:

a) Verify the residence time, the minimum temperature and the oxygen content of the exhaust gas which will be achieved during normal operation and under the most unfavourable operating conditions anticipated.

b) Establish all criteria for operation, control and management of the abatement equipment to ensure compliance with the emission limit values specified in this licence.

c) Assess the performance of any monitors on the abatement system and establish a maintenance and calibration programme for each monitor.

d) Establish criteria for the control of all alternative fie1 input including the maximum flow and maximum calorific value.

e) Confirm that all measurement equipment of devices (including thermocouples) used for the purpose of establishing compliance with this licence have been subjected, in situ, to normal operating temperatures to prove their operation under such conditions.

A report on each test programme shall be submitted to the EPA within one month of completion.

Co-incineration of alternative fuels shall not be permitted (outside of the agreed test programme) until such time as the EPA has indicated in writing that it is satisfied with the results of the test programme for an individual alternative fuel.

5 Modifications and Mitigation

5.1 Scope

Recommendations for changes to the proposed modification and/or any necessary mitigation measures

5.2 Introduction

Previous modifications and the currently proposed modification to the original development are shown in the following table.

Modifications to the original development

	Reference	Date	Description
1	MOD 2_1_2004	Sept 2005	Use of non-standard fuels, including used tyres, liquid oil residues and spent aluminium electrode carbon
2	MOD 109_9_2006	Sep 2006	Removal of hazardous waste prohibition
3	MOD 12_2_2007	Feb 2007	Trial use of tyre chips
4	MOD 4	April 2008	Varying usage of coke fines
5	MOD 5	Aug 2009	Coal deliveries by rail
6	MOD 6	June 2012	Stockpiling of coal for sale and transport to Port Kembla
7	MOD 7	April 2012	Trial and use of blast furnace slag
8	MOD 8	July 2012	Administrative changes to align DA and EPL conditions
9	MOD 9	Current Application	• use of Solid Waste Derived Fuel (SWDF) as an energy source; • changes to the air emission limits of particulate matter (PM), nitrous [sic] oxides (NOx) and volatile organic compounds (VOC); • construction of a fuel storage and kiln feeding system.

The use of Solid Waste Derived Fuel (SWDF) as an energy source is considered elsewhere in this report.

The construction of a fuel storage and kiln feeding system is not considered to present ongoing environmental issues. However in the event of a fire, a smoke plume and contaminated firewater could arise. Therefore the applicant should be required to demonstrate that appropriate fire prevention, fire detection and fire suppression measures will be used and to carry out a firewater risk assessment with the provision of containment for potentially contaminated firewater.

Regarding emission limits, the following table shows the relevant values.

Proposed emission limits for burning Non-Standard Fuel

Emission types	Limit using standard fuel	Current limit using non-standard fuel	Proposed limit using non-standard fuel
Particulate matter (PM)	95 mg/m^3	30 mg/m^3	50 mg/m^3 *
Nitrogen Oxides (NO_X)	1000 mg/m^3	800 mg/m^3	1000 mg/m^3 **
Volatile Organic Compounds (VOCs)	N/A	20 ppm	40 ppm **

* NSW Group 6 emission criteria as per *Energy from Waste Policy 2014*

** Alternative emission standards applied for as per Clause 36 of *POEO (Clean Air) Regulation 2010*

5.3 Assessment

In the EIS it is argued that these "proposed emission limits are considered safe with regards to public health and environmental impacts" and are also "realistic for Boral to achieve at a commercially acceptable cost".

5.3.1 Particulate Matter

The current limit for particulate matter is 30 mg/Nm^3. Boral argues that the cost of achieving this limit is commercially prohibitive. However, the IED proposes a limit of 20 mg/Nm^3 for existing cement kilns. In the long term the proposed limit of 30 mg/Nm^3 and eventually 20 mg/Nm^3 should be imposed.

Recommendation:

A view should be taken on how long should be allowed for existing industry to achieve much more stringent emission limits and the approval should take this into account.

5.3.2 Nitrogen Oxides

The current limit for NO_X is 800 mg/Nm^3. Boral wants this increased to 1000 mg/Nm^3. Much lower NO_X levels can be achieved by techniques such as SNCR. However this entails a capital cost and ongoing costs for ammonia or urea.

Recommendation:

A view should be taken on how long should be allowed for existing industry to achieve much more stringent emission limits and the approval should take this into account when setting progressively lower limits.

5.3.3 VOCs

Boral also wants the emission limit value for VOCs to take into account the fact that “VOC emissions are not associated with the combustion of fuels. Rather, the VOCs are associated with the natural composition of onsite blue shale used as a raw material in Kiln 6.”

Further, when waste comprising or containing organic materials is incinerated, incomplete combustion may result in emission of organic compounds.

The IED sets an emission limit value of 10 mg/Nm³ for VOCs as TOC for waste incineration plants, including cement kilns. However it also states: “The competent authority may grant derogations for emission limit values set out in this point in cases where TOC and SO_2 do not result from the co-incineration of waste.”

It is not possible to convert ppm to mg/Nm³ without knowing the composition of waste.

However, given the very high temperatures and long residence times that are a feature of cement kilns, it would be expected that thermal destruction of organic material would be substantially complete.

Recommendation:

The emission limit value for VOCs (20 ppm) should remain unless the applicant demonstrates that it is physically impossible due to the nature of the raw materials, to achieve this limit, in which case the higher limit sought (40 ppm) could be granted.

Glossary and Acronyms

Term/Acronym	Definition
ACT	Australian Capital Territories
AEL	Associated Emission Levels
AKF1	Liquid Oil Residues (Non- Standard Fuel)
AKF5	Waste Tyres (Non- Standard Fuel)
AQMS	air quality monitoring station
As	Arsenic
BAT	Best Available Techniques
BAT-AEL	BAT Associated Emission Levels
BAT Conclusions	'BAT conclusions' as defined in Article 3(12) of Directive 2010/75/EU are the key element of BAT reference documents and lay down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.
BREF	Best Available Techniques (BAT) reference documents published by the European Commission
Cd	Cadmium
CLM	Commission Implementing Decision of 26th March 2013 establishing the Best Available Techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on Industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU)
CO	Carbon Monoxide
Co	Cobalt
Cr	Chromium
Cu	Copper
DPE	Department of Planning and Environment
EIPPCB	European IPPC Bureau
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPA	Environmental Protection Agency
EPL	Environment Protection Licence
ESP	Electrostatic Precipitator
EU	European Union
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
Hi Cal 50	Aluminium electrode carbon (Non- Standard Fuel)
Hydrogen chloride expressed as HCl	All gaseous chlorides expressed as HCl
Hydrogen fluoride expressed as HF	All gaseous fluorides expressed as HF
IED	Directive 2010/75/EU of the European Parliament and of the Councilof 24 November 2010 on industrial emissions (integrated pollution prevention and control)
IPPC	Industrial Pollution Prevention and Control
ISO	International Organization for Standardization
I-TEQ	International toxicity equivalent
mg/Nm3	milligrams per normalised cubic metre
Mn	Manganese
MJ	Megajoule
ng	nanogram

NH3	Ammonia
NHWMP 2014-20	National Hazardous Waste Management Plan (Irish) 2014-2020
Ni	Nickel
NOx	Nitrogen oxide
NO_X expressed as NO_2	The sum of nitrogen (nitric) oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2
NSW	New South Wales
NSW SEPP	New South Wales State Environmental Planning Policy
OEMP	Operation Environmental Management Plan
Pb	Lead
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PM	Particulate matter
PM10	Fine dust particles with a grain size less than 10 microns in diameter in solid form or in aerosols
POEO	*POEO (Clean Air) Regulation 2010*
ppm	Parts per million
PRP8	PRP8 Fugitive Dust Action Plan
RDF	Refuse Derived Fuel
QA/QC	Quality Assurance/ Quality Control
Sb	Antimony
SCR	Selective catalytic reduction
SNCR	Selective non-catalytic reduction
SOx	Sulphur Oxides
SO_X expressed as SO_2	The sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) expressed as SO_2
SWDF	Solid Waste Derived Fuel
Tl	Thallium
TOC	Total Organic Carbon
TSP	Total Suspended Particulates
V	Vanadium
VOC	Volatile Organic Compounds

Appendix A

Published BREFs

A1 BAT and BREF Documents

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
Reference Document on Best Available Techniques in the **Ceramic Manufacturing** Industry, August 2007.	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Not applicable
Best Available Techniques (BAT) Reference Document for **Common Waste water and Waste Gas Treatment/Management Systems in the Chemical Sector** Final draft July 2014	Formal Draft document sent to the IED Article 13 Forum for its opinion (Best Available Techniques (BAT) Reference Document for Common Waste water and Waste Gas Treatment/Management Systems in the Chemical Sector Final Draft July 2014 European Commission)	Not applicable: Cement manufacture is not one of the industries listed in the chemical sector in the BREF
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques **on Emissions from Storage** July 2006	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Applicable, guidance only
Reference Document on Best Available **Techniques for Energy Efficiency** February 2009	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Applicable, guidance only

[2] Draft of (B)REFs have no legal value. They only reflect work in progress and are available for information only to those interested in the exchange of information under Article 13(1) of the IED.

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the **Ferrous Metals Processing Industry** December 2001	work has started but a draft is not yet available. Review is on hold	Not applicable
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the **Food, Drink and Milk Industries** August 2006	work has started but a draft is not yet available.	Not applicable
Integrated Pollution Prevention and Control (IPPC) Reference Document on the application of Best Available Techniques to **Industrial Cooling Systems** December 2001	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Not applicable
Best Available Techniques (BAT) Reference Document for the **Intensive Rearing of Poultry or Pigs** Final Draft - August 2015	This is the latest formal draft which is available.	Not applicable
2012/135/EU Commission Implementing Decision of 28 February 2012 establishing the best available techniques	Bat Conclusions were published in March 2012	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
(BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for **iron and steel production**		
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for **Large Combustion Plants** July 2006 European Commission	Current adopted BREF	Not Applicable Installations where the combustion process is an integrated part of a specific production is not covered by this BREF. Therefore the cement kiln used for the production of cement is not covered.
Best Available Techniques (BAT) Reference Document for the **Large Combustion Plants** Draft 1 June 2013	This is the latest formal draft which is available.	Not Applicable Process furnaces or heaters are not covered by this BREF. The definition of *"process furnaces or heaters"* includes *"combustion plants whose flue-gases are used for the thermal treatment of objects or feed material through a direct contact heating mechanism (e.g. cement and lime kiln, glass furnace, asphalt kiln, drying process, chemical reactors)"*
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Manufacture of Large Volume Inorganic**	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
Chemicals - Ammonia, Acids and Fertilisers August 2007		
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Manufacture of Large Volume Inorganic Chemicals - Solids and Others industry** August 2007	formally adopted by the European Commission under the IPPC Directive (2008/1/EC)	Not applicable
Best Available Techniques (BAT) Reference Document in the **Large Volume Organic Chemical Industry** Draft 1 (April 2014)	This is the latest formal draft which is available	Not applicable
Reference Document on Best Available Techniques for **Management of Tailings and Waste-Rock in Mining Activities** January 2009	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
012/134/EU Commission Implementing Decision of 28 February 2012 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the BREF and the related BAT conclusions can be found.	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
industrial emissions for the **manufacture of glass**		
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Manufacture of Organic Fine Chemicals** August 2006	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
Best Available Techniques (BAT) Reference Document for the **Non-Ferrous Metals Industries** Final Draft (October 2014)	FD document has been sent to the IED Article 13 Forum for its opinion.	Not applicable
2013/163/EU Commission Implementing Decision of 26 March 2013 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the **production of cement, lime and magnesium oxide**	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the BREF and the related BAT conclusions can be found.	Applicable
(2013/732/EU) COMMISSION IMPLEMENTING DECISION of 9 December 2013 establishing the best	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the **production of chlor-alkali**	BREF and the related BAT conclusions can be found.	
Reference Document on Best Available Techniques in the **Production of Polymers** August 2007	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
(2014/687/EU) COMMISSION IMPLEMENTING DECISION of 26 September 2014 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for the **production of pulp, paper and board**	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the BREF and the related BAT conclusions can be found. The fully revised BREF including the adopted BAT conclusions published on the Official Journal is being prepared and will be made available shortly	Not applicable
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Production of Speciality Inorganic Chemicals** August 2007	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
(2014/738/EU) COMMISSION IMPLEMENTING DECISION of 9 October 2014 establishing best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the **refining of mineral oil and gas**	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the BREF and the related BAT conclusions can be found.	Not applicable
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the **Slaughterhouses and Animal By-products Industries** May 2005	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques in the **Smitheries and Foundries Industry** May 2005	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Surface Treatment of Metals and Plastics** August 2006	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
Reference Document on Best Available Techniques **on Surface Treatment using Organic Solvents** August 2007	work has started but a draft is not yet available.	Not applicable
(2013/84/EU) COMMISSION IMPLEMENTING DECISION of 11 February 2013 establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the **tanning of hides and skins**	document has been published by the European Commission under the IED (post 2010). Under Adopted Document, both the BREF and the related BAT conclusions can be found.	Not applicable
Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques for the **Textiles Industry** July 2003	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not applicable
Integrated Pollution Prevention and Control Reference Document on the Best Available Techniques for **Waste Incineration** August 2006	work has started but a draft is not yet available.	Applicable, guidance only

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
Integrated Pollution Prevention and Control Reference Document on Best Available Techniques for the **Waste Treatments Industries** August 2006	work has started but a draft is not yet available.	Applicable, guidance only
Best Available Techniques (BAT) Reference Document for the **Production of Wood–based Panels** Final Draft July 2014	FD document has been sent to the IED Article 13 Forum for its opinion.	Not applicable
Two reference documents or REFs[3] have also been published by the European IPPC Bureau. These are as follows:		
Integrated Pollution Prevention and Control Reference Document on **Economics and Cross-Media Effects**. July 2006	document has been formally adopted by the European Commission under the IPPC Directive (2008/1/EC).	Not Applicable: Choosing between alternative options might require a choice to be made between releasing different pollutants in the same environmental medium (e.g. different technology options might release different air pollutants). In other cases, the choice might be between releasing to different media (e.g. using water to scrub an air emission thereby producing waste water or filtering a water discharge to produce a solid waste). When determining BAT, most of the cross-media conflicts that are encountered should be relatively simple to

[3] On the European IPPC Bureau website, a REF is explained as follows:
"The REF or 'reference document' or 'reference report" means a document, which is not a BREF, used as the main reference for a specific horizontal task or topic in the Sevilla process."

Title of most recent European Commission Document	Status (as of 24 August 2015)[2]	Applicability of adopted BAT and BREF Documents
		understand and it will be easy to come to a decision. In other cases, the trade-offs will be more complex. The purpose of the cross-media methodology set out below is to provide guidance on how to choose which option is best for the environment in these more complex cases. When the methodology is applied it should help to clarify the decision making process and ensure that any conclusions are determined in a consistent and transparent way.
JRC Reference Report on **Monitoring of emissions from IED-installations** FINAL DRAFT October 2013	document has been sent to the IED Article 13 Forum for its opinion.	Applicable, guidance only

Appendix B

Commission Implementing Decision of 26th March 2013 establishing the Best Available Techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on Industrial emissions for the production of cement, lime and magnesium oxide (2013/163/EU) (known as CLM)

B1

See Appendix D

Appendix D

EU BAT 2013/163/EU

ISSN 1977-0677

Official Journal of the European Union

L 100

English edition

Legislation

Volume 56

9 April 2013

Contents

Price: EUR 3

[1] Text with EEA relevance

EN

Acts whose titles are printed in light type are those relating to day-to-day management of agricultural matters, and are generally valid for a limited period.

The titles of all other acts are printed in bold type and preceded by an asterisk.

II

(Non-legislative acts)

DECISIONS

COMMISSION IMPLEMENTING DECISION

of 26 March 2013

establishing the best available techniques (BAT) conclusions under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions for the production of cement, lime and magnesium oxide

(notified under document C(2013) 1728)

(Text with EEA relevance)

(2013/163/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) ([1]), and in particular Article 13(5) thereof,

Whereas:

(1) Article 13(1) of Directive 2010/75/EU requires the Commission to organise an exchange of information on industrial emissions between it and Member States, the industries concerned and non-governmental organisations promoting environmental protection in order to facilitate the drawing up of best available techniques (BAT) reference documents as defined in Article 3(11) of that Directive.

(2) In accordance with Article 13(2) of Directive 2010/75/EU, the exchange of information is to address the performance of installations and techniques in terms of emissions, expressed as short- and long-term averages, where appropriate, and the associated reference conditions, consumption and nature of raw materials, water consumption, use of energy and generation of waste and the techniques used, associated monitoring, cross-media effects, economic and technical viability and developments therein and best available techniques and emerging techniques identified after considering the issues mentioned in points (a) and (b) of Article 13(2) of that Directive.

(3) 'BAT conclusions' as defined in Article 3(12) of Directive 2010/75/EU are the key element of BAT reference documents and lay down the conclusions on best available techniques, their description, information to assess their applicability, the emission levels associated with the best available techniques, associated monitoring, associated consumption levels and, where appropriate, relevant site remediation measures.

(4) In accordance with Article 14(3) of Directive 2010/75/EU, BAT conclusions are to be the reference for setting permit conditions for installations covered by Chapter II of that Directive.

(5) Article 15(3) of Directive 2010/75/EU requires the competent authority to set emission limit values that ensure that, under normal operating conditions, emissions do not exceed the emission levels associated with the best available techniques as laid down in the decisions on BAT conclusions referred to in Article 13(5) of Directive 2010/75/EU.

(6) Article 15(4) of Directive 2010/75/EU provides for derogations from the requirement laid down in Article 15(3) only where the costs associated with the achievement of the emission levels associated with the BAT disproportionately outweigh the environmental benefits due to the geographical location, the local environmental conditions or the technical characteristics of the installation concerned.

(7) Article 16(1) of Directive 2010/75/EU provides that the monitoring requirements in the permit referred to in point (c) of Article 14(1) of the Directive are to be based on the conclusions on monitoring as described in the BAT conclusions.

(8) In accordance with Article 21(3) of Directive 2010/75/EU, within 4 years of publication of decisions on BAT conclusions, the competent authority is to reconsider and, if necessary, update all the permit conditions and ensure that the installation complies with those permit conditions.

([1]) OJ L 334, 17.12.2010, p. 17.

(9) Commission Decision of 16 May 2011 establishing a forum for the exchange of information pursuant to Article 13 of Directive 2010/75/EU on industrial emissions [1] established a forum composed of representatives of Member States, the industries concerned and non-governmental organisations promoting environmental protection.

(10) In accordance with Article 13(4) of Directive 2010/75/EU, the Commission obtained the opinion [2] of that forum on the proposed content of the BAT reference document for the production of cement, lime and magnesium oxide on 13 September 2012 and made it publicly available.

(11) The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 75(1) of Directive 2010/75/EU,

HAS ADOPTED THIS DECISION:

Article 1

The BAT conclusions for the production of cement, lime and magnesium oxide are set out in the Annex to this Decision.

Article 2

This Decision is addressed to the Member States.

Done at Brussels, 26 March 2013.

For the Commission

Janez POTOČNIK

Member of the Commission

---

(1) OJ C 146, 17.5.2011, p. 3.

(2) http://circa.europa.eu/Public/irc/env/ied/library?l=/ied_art_13_forum/opinions_article

ANNEX

BAT CONCLUSIONS FOR THE PRODUCTION OF CEMENT, LIME AND MAGNESIUM OXIDE

SCOPE

These BAT conclusions concern the following industrial activities specified in Section 3.1 of Annex I to Directive 2010/75/EU, namely:

'3.1. Production of cement, lime and magnesium oxide', which involve:

(a) production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or in other kilns with a production capacity exceeding 50 tonnes per day;

(b) production of lime in kilns with a production capacity exceeding 50 tonnes per day;

(c) production of magnesium oxide in kilns with a production capacity exceeding 50 tonnes per day.

Regarding point 3.1(c) above, these BAT conclusions only address the production of MgO using the dry process route based on mined natural magnesite (magnesium carbonate - $MgCO_3$).

In particular, concerning the above-mentioned activities, these BAT conclusions cover the following:

— production of cement, lime and magnesium oxide (dry process route)

— raw materials – storage and preparation

— fuels – storage and preparation

— use of waste as raw materials and/or fuels – quality requirements, control and preparation

— products – storage and preparation

— packaging and dispatch.

These BAT conclusions do not address the following activities:

— the production of magnesium oxide using the wet process route using magnesium chloride as the starting material, covered by the Reference Document on Best Available Techniques for Large Volume Inorganic Chemicals – Solids and Others Industry (LVIC-S)

— the production of ultra low-carbon dolime (i.e. a mixture of calcium and magnesium oxides produced by the nearly full decarbonation of dolomite ($CaCO_3.MgCO_3$). The residual CO_2 content of the product is below 0,25 % and the bulk density well below 3,05 g/cm^3)

— shaft kilns for cement clinker production

— activities which are not directly associated with the primary activity such as quarrying.

Other reference documents which are of relevance for the activities covered by these BAT conclusions are the following:

Reference documents	Activity
Emissions from Storage (EFS)	Storage and handling of raw materials and products
General Principles of Monitoring (MON)	Emissions monitoring
Waste Treatments Industries (WT)	Waste treatment
Energy Efficiency (ENE)	General energy efficiency
Economic and Cross-media Effects (ECM)	Economics and cross-media effects of techniques

The techniques listed and described in these BAT conclusions are neither prescriptive nor exhaustive. Other techniques may be used that ensure at least an equivalent level of environmental protection.

Where these BAT conclusions address waste co-incineration plants, this is without prejudice to the provisions of Chapter IV of and Annex VI to Directive 2010/75/EU.

Where these BAT conclusions address energy efficiency, this is without prejudice to the provisions of the new Directive 2012/27/EU of the European Parliament and of the Council (1) on Energy Efficiency.

NOTE ON THE EXCHANGE OF INFORMATION

The exchange of information on BAT for the Cement, Lime and Magnesium Oxide sectors ended in 2008. The information available then, complemented by additional information concerning the emissions from magnesium oxide production, was used for reaching these BAT conclusions.

DEFINITIONS

For the purposes of these BAT conclusions, the following definitions apply:

Term used	Definition
New plant	A plant introduced on the site of the installation following the publication of these BAT conclusions or a complete replacement of a plant on the existing foundations of the installation following the publication of these BAT conclusions
Existing plant	A plant which is not a new plant
Major upgrade	An upgrade of the plant/kiln involving a major change in the kiln requirements or technology, or replacement of the kiln
'Use of waste as fuel and/or raw material'	The term covers the use of: — waste fuels with significant calorific value; and — waste materials without significant calorific value but with mineral components used as raw materials that contribute to the intermediate product clinker; and — waste materials that have both a significant calorific value and mineral components

Definition for certain products

Term used	Definition
White cement	Cement falling under the following PRODCOM 2007 code: 26.51.12.10 – White Portland cement
Special cement	Special cements falling under the following PRODCOM 2007 codes: — 26.51.12.50 – Aluminous cement — 26.51.12.90 – Other hydraulic cements
Dolime or calcinated dolime	A mixture of calcium and magnesium oxides produced by the decarbonation of dolomite ($CaCO_3.MgCO_3$) with a residual CO_2 content of the product exceeding 0,25 % and the bulk density of the commercial product well below 3,05 g/cm^3. The free content as MgO is usually between 25 % and 40 %.
Sintered dolime	A mixture of calcium and magnesium oxides used solely for the production of refractory bricks and other refractory products, with a minimum bulk density of 3,05 g/cm^3

(1) OJ L 315, 14.11.2012, p. 1.

Definition for certain air pollutants

Term used	Definition
NO_x expressed as NO_2	The sum of nitrogen oxide (NO) and nitrogen dioxide (NO_2) expressed as NO_2
SO_x expressed as SO_2	The sum of sulphur dioxide (SO_2) and sulphur trioxide (SO_3) expressed as SO_2
Hydrogen chloride expressed as HCl	All gaseous chlorides expressed as HCl
Hydrogen fluoride expressed as HF	All gaseous fluorides expressed as HF

Abbreviations

ASK	Annular shaft kiln
DBM	Dead burned magnesia
I-TEQ	International toxicity equivalent
LRK	Long rotary kiln
MFSK	Mixed feed shaft kiln
OK	Other kilns For the lime industry this covers: — double-inclined shaft kilns — multi-chamber shaft kilns — central burner shaft kilns — external chamber shaft kilns — beam burner shaft kilns — internal arch shaft kilns — travelling grate kilns — 'top-shaped' kilns — flash calciner kilns — rotating hearth kilns
OSK	Other shaft kiln (shaft kilns other than ASK and MFSK)
PCDD	Polychlorinated dibenzo-p-dioxin
PCDF	Polychlorinated dibenzofuran
PFRK	Parallel flow regenerative kiln
PRK	Rotary kiln with preheater

GENERAL CONSIDERATIONS

Averaging periods and reference conditions for air emissions

Emission levels associated with the best available techniques (BAT-AELs) given in these BAT conclusions refer to standard conditions: dry gas at a temperature of 273 K, and a pressure of 1 013 hPa.

Values given in concentrations apply under the following reference conditions:

Activities		Reference conditions
Kiln activities	Cement industry	10 % oxygen by volume
	Lime industry (1)	11 % oxygen by volume
	Magnesium oxide industry (dry process route) (2)	10 % oxygen by volume
Non-kiln activities	All processes	No correction for oxygen
	Lime hydrating plants	As emitted (no correction for oxygen and for dry gas)

(1) For sintered dolime produced by the 'double-pass process', the correction for oxygen does not apply.
(2) For dead burned magnesia (DBM) produced by the 'double-pass process', the correction for oxygen does not apply.

For averaging periods the following definitions apply:

Daily average value	Average value over a period of 24 hours measured by the continuous monitoring of emissions
Average over the sampling period	Average value of spot measurements (periodic) of at least 30 minutes each, unless otherwise stated

Conversion to reference oxygen concentration

The formula for calculating the emissions concentration at a reference oxygen level is shown below:

$$E_R = \frac{21 - O_R}{21 - O_M} * E_M$$

Where:

E_R (mg/Nm^3): emissions concentration related to the reference oxygen level O_R

O_R (vol %): reference oxygen level

E_M (mg/Nm^3): emissions concentration related to the measured oxygen level O_M

O_M (vol %): measured oxygen level

BAT CONCLUSIONS

1.1 **General BAT conclusions**

The BAT mentioned in this section apply to all installations covered by these BAT conclusions (cement, lime and magnesium oxide industry).

The process-specific BAT included in Sections 1.2 - 1.4 apply in addition to the general BAT mentioned in this section.

1.1.1 *Environmental management systems (EMS)*

1. In order to improve the overall environmental performance of the plants/installations producing cement, lime and magnesium oxide, production BAT is to implement and adhere to an environmental management system (EMS) that incorporates all of the following features:

i. commitment of the management, including senior management;

ii. definition of an environmental policy that includes the continuous improvement of the installation by the management;

iii. planning and establishing the necessary procedures, objectives and targets, in conjunction with financial planning and investment;

iv. implementation of procedures paying particular attention to:

(a) structure and responsibility

(b) training, awareness and competence

(c) communication

(d) employee involvement

(e) documentation

(f) efficient process control

(g) maintenance programmes

(h) emergency preparedness and response

(i) safeguarding compliance with environmental legislation;

v. checking performance and taking corrective action, paying particular attention to:

(a) monitoring and measurement (see also the Reference Document on the General Principles of Monitoring)

(b) corrective and preventive action

(c) maintenance of records

(d) independent (where practicable) internal and external auditing in order to determine whether or not the EMS conforms to planned arrangements and has been properly implemented and maintained;

vi. review of the EMS and its continuing suitability, adequacy and effectiveness by senior management;

vii. following the development of cleaner technologies;

viii. consideration for the environmental impacts from the eventual decommissioning of the installation at the stage of designing a new plant, and throughout its operating life;

ix. application of sectoral benchmarking on a regular basis.

Applicability

The scope (e.g. level of details) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

1.1.2 *Noise*

2. In order to reduce/minimise noise emissions during the manufacturing processes for cement, lime and magnesium oxide, BAT is to use a combination of the following techniques:

	Technique
a	Select an appropriate location for noisy operations
b	Enclose noisy operations/units

	Technique
c	Use vibration insulation of operations/units
d	Use internal and external lining made of impact-absorbent material
e	Use soundproofed buildings to shelter any noisy operations involving material transformation equipment
f	Use noise protection walls and/or natural noise barriers
g	Use outlet silencers to exhaust stacks
h	Lag ducts and final blowers which are situated in soundproofed buildings
i	Close doors and windows of covered areas
j	Use sound insulation of machine buildings
k	Use sound insulation of wall breaks, e.g. by installation of a sluice at the entrance point of a belt conveyor
l	Install sound absorbers at air outlets, e.g. the clean gas outlet of dedusting units
m	Reduce flow rates in ducts
n	Use sound insulation of ducts
o	Apply the decoupled arrangement of noise sources and potentially resonant components, e.g. of compressors and ducts
p	Use silencers for filter fans
q	Use soundproofed modules for technical devices (e.g. compressors)
r	Use rubber shields for mills (avoiding the contact of metal against metal)
s	Construct buildings or growing trees and bushes between the protected area and the noisy activity

1.2 **BAT conclusions for the cement industry**

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all installations in the cement industry.

1.2.1 *General primary techniques*

3. In order to reduce emissions from the kiln and use energy efficiently, BAT is to achieve a smooth and stable kiln process, operating close to the process parameter set points by using the following techniques:

	Technique
a	Process control optimisation, including computer-based automatic control
b	Using modern, gravimetric solid fuel feed systems

4. In order to prevent and/or reduce emissions, BAT is to carry out a careful selection and control of all substances entering the kiln.

Description

Careful selection and control of substances entering the kiln can reduce emissions. The chemical composition of the substances and the way they are fed in the kiln are factors that should be taken into account during the selection. Substances of concern may include the substances mentioned in BAT 11 and in BAT 24 to 28.

1.2.2 *Monitoring*

5. BAT is to carry out the monitoring and measurements of process parameters and emissions on a regular basis and to monitor emissions in accordance with the relevant EN standards or, if EN standards are not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality, including the following:

<table>
<tr><th></th><th>Technique</th><th>Applicability</th></tr>
<tr><td>a</td><td>Continuous measurements of process parameters demonstrating the process stability, such as temperature, O_2 content, pressure and flowrate</td><td>Generally applicable</td></tr>
<tr><td>b</td><td>Monitoring and stabilising critical process parameters, i.e. homogenous raw material mix and fuel feed, regular dosage and excess oxygen</td><td>Generally applicable</td></tr>
<tr><td>c</td><td>Continuous measurements of NH_3 emissions when SNCR is applied</td><td>Generally applicable</td></tr>
<tr><td>d</td><td>Continuous measurements of dust, NO_x, SO_x, and CO emissions</td><td rowspan="3">Applicable to kiln processes</td></tr>
<tr><td>e</td><td>Periodic measurements of PCDD/F and metal emissions</td></tr>
<tr><td>f</td><td>Continuous or periodic measurements of HCl, HF and TOC emissions.</td></tr>
<tr><td>g</td><td>Continuous or periodic measurements of dust</td><td>Applicable to non-kiln activities.
For small sources (< 10 000 Nm^3/h) from dusty operations other than cooling and the main milling processes, the frequency of measurements or performance checks should be based on a maintenance management system.</td></tr>
</table>

Description

The selection between continuous or periodic measurements mentioned in BAT 5(f) is based on the emission source and the type of pollutant expected.

1.2.3 *Energy consumption and process selection*

1.2.3.1 Process selection

6. In order to reduce energy consumption, BAT is to use a dry process kiln with multistage preheating and precalcination.

Description

In this type of kiln system, exhaust gases and recovered waste heat from the cooler can be used to preheat and precalcine the raw material feed before entering the kiln, providing significant savings in energy consumption.

Applicability

Applicable to new plants and major upgrades, subject to raw materials moisture content.

BAT-associated energy consumption levels

See Table 1.

Table 1

BAT-associated energy consumption levels for new plants and major upgrades using dry process kiln with multistage preheating and precalcination

Process	Unit	BAT-associated energy consumption levels (1)
Dry process with multistage preheating and precalcination	MJ/tonne clinker	2 900 – 3 300 (2) (3)

(1) Levels do not apply to plants producing special cement or white cement clinker that require significantly higher process temperatures due to product specifications.
(2) Under normal (excluding, e.g. start-ups and shutdowns) and optimised operational conditions.
(3) The production capacity has an influence on the energy demand, with higher capacities providing energy savings and smaller capacities requiring more energy. Energy consumption also depends on the number of cyclone preheater stages, with more cyclone preheater stages leading to lower energy consumption of the kiln process. The appropriate number of cyclone preheater stages is mainly determined by the moisture content of raw materials.

1.2.3.2 Energy consumption

7. In order to reduce/minimise thermal energy consumption, BAT is to use a combination of the following techniques:

	Technique	Applicability
a	Applying improved and optimised kiln systems and a smooth and stable kiln process, operating close to the process parameter set points by applying: I. process control optimisation, including computer-based automatic control systems II. modern, gravimetric solid fuel feed systems III. preheating and precalcination to the extent possible, considering the existing kiln system configuration	Generally applicable. For existing kilns, the applicability of preheating and precalcination is subject to the kiln system configuration
b	Recovering excess heat from kilns, especially from their cooling zone. In particular, the kiln excess heat from the cooling zone (hot air) or from the preheater can be used for drying raw materials	Generally applicable in the cement industry. Recovery of excess heat from the cooling zone is applicable when grate coolers are used. Limited recovery efficiency can be achieved on rotary coolers
c	Applying the appropriate number of cyclone stages related to the characteristics and properties of raw material and fuels used	Cyclone preheater stages are applicable to new plants and major upgrades.
d	Using fuels with characteristics which have a positive influence on the thermal energy consumption	The technique is generally applicable to the cement kilns subject to fuel availability and for existing kilns subject to the technical possibilities of injecting the fuel into the kiln
e	When replacing conventional fuels by waste fuels, using optimised and suitable cement kiln systems for burning wastes	Generally applicable to all cement kiln types
f	Minimising bypass flows	Generally applicable to the cement industry

Description

Several factors affect the energy consumption of modern kiln systems such as raw materials properties (e.g. moisture content, burnability), the use of fuels, with different properties, as well as the use of a gas bypass system. Furthermore, the production capacity of the kiln has an influence on the energy demand.

Technique 7c: the appropriate number of cyclone stages for preheating is determined by the throughput and the moisture content of raw materials and fuels which have to be dried by the remaining flue-gas heat because local raw materials vary widely regarding their moisture content or burnability

Technique 7d: conventional and waste fuels can be used in the cement industry. The characteristics of the fuels used, such as adequate calorific value and low moisture content, have a positive influence on the specific energy consumption of the kiln.

Technique 7f: the removal of hot raw material and hot gas leads to a higher specific energy consumption of about 6 – 12 MJ/tonne clinker per percentage point of removed kiln inlet gas. Hence, minimising the use of gas bypass has a positive effect on energy consumption.

8. In order to reduce primary energy consumption, BAT is to consider the reduction of the clinker content of cement and cement products.

Description

The reduction of the clinker content of cement and cement products can be achieved by adding fillers and/or additions, such as blast furnace slag, limestone, fly ash and pozzolana in the grinding step in accordance with the relevant cement standards.

Applicability

Generally applicable to the cement industry, subject to (local) availability of fillers and/or additions and local market specificities.

9. In order to reduce primary energy consumption, BAT is to consider cogeneration/combined heat and power plants.

Description

The employment of cogeneration plants for the production of steam and electricity or combined heat and power plants can be applied in the cement industry by recovering waste heat from the clinker cooler or kiln flue-gases using the conventional steam cycle processes or other techniques. Furthermore, excess heat can be recovered from the clinker cooler or kiln flue-gases for district heating or industrial applications.

Applicability

The technique is applicable in all cement kilns if sufficient excess heat is available, if appropriate process parameters can be met, and if economic viability is ensured.

10. In order to reduce/minimise electrical energy consumption, BAT is to use one or a combination of the following techniques:

	Technique
a	Using power management systems
b	Using grinding equipment and other electricity based equipment with high energy efficiency
c	Using improved monitoring systems
d	Reducing air leaks into the system
e	Process control optimisation

1.2.4 *Use of waste*

1.2.4.1 Waste quality control

11. In order to guarantee the characteristics of the wastes to be used as fuels and/or raw materials in a cement kiln and reduce emissions, BAT is to apply the following techniques:

	Technique
a	Apply quality assurance systems to guarantee the characteristics of wastes and to analyse any waste that is to be used as raw material and/or fuel in a cement kiln for: I. constant quality II. physical criteria, e.g. emissions formation, coarseness, reactivity, burnability, calorific value III. chemical criteria, e.g. chlorine, sulphur, alkali and phosphate content and relevant metals content
b	Control the amount of relevant parameters for any waste that is to be used as raw material and/or fuel in a cement kiln, such as chlorine, relevant metals (e.g. cadmium, mercury, thallium), sulphur, total halogen content
c	Apply quality assurance systems for each waste load

Description

Different types of waste materials can replace primary raw materials and/or fossil fuels in cement manufacturing and will contribute to saving natural resources.

1.2.4.2 Waste feeding into the kiln

12. In order to ensure appropriate treatment of the wastes used as fuel and/or raw materials in the kiln, BAT is to use the following techniques:

	Technique
a	Use appropriate points to feed the waste into the kiln in terms of temperature and residence time depending on kiln design and kiln operation
b	To feed waste materials containing organic components that can be volatilised before the calcining zone into the adequately high temperature zones of the kiln system
c	To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion, even under the most unfavourable conditions, to a temperature of 850 °C for 2 seconds
d	To raise the temperature to 1 100 °C, if hazardous waste with a content of more than 1 % of halogenated organic substances, expressed as chlorine, are co-incinerated
e	To feed wastes continuously and constantly
f	Delay or stop co-incinerating waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence times cannot be reached, as noted in a) to d) above

1.2.4.3 Safety management for the use of hazardous waste materials

13. BAT is to apply safety management for the storage, handling and feeding of hazardous waste materials, such as using a risk-based approach according to the source and type of waste, for the labelling, checking, sampling and testing of waste to be handled.

1.2.5 *Dust emissions*

1.2.5.1 Diffuse dust emissions

14. In order to minimise/prevent diffuse dust emissions from dusty operations, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Use a simple and linear site layout of the installation	Applicable to new plants only

	Technique	Applicability
b	Enclose/encapsulate dusty operations, such as grinding, screening and mixing	Generally applicable
c	Cover conveyors and elevators, which are constructed as closed systems, if diffuse dust emissions are likely to be released from dusty material	
d	Reduce air leakages and spillage points	
e	Use automatic devices and control systems	
f	Ensure trouble-free operations	
g	Ensure proper and complete maintenance of the installation using mobile and stationary vacuum cleaning. — During maintenance operations or in cases of trouble with conveying systems, spillage of materials can take place. To prevent the formation of diffuse dust during removal operations, vacuum systems should be used. New buildings can easily be equipped with stationary vacuum cleaning piping, while existing buildings are normally better fitted with mobile systems and flexible connections — In specific cases, a circulation process could be favoured for pneumatic conveying systems	
h	Ventilate and collect dust in fabric filters: — As far as possible, all material handling should be conducted in closed systems maintained under negative pressure. The suction air for this purpose is then dedusted by a fabric filter before being emitted into the air	
i	Use closed storage with an automatic handling system: — Clinker silos and closed fully automated raw material storage areas are considered the most efficient solution to the problem of diffuse dust generated by high volume stocks. These types of storage are equipped with one or more fabric filters to prevent diffuse dust formation in loading and unloading operations — Use storage silos with adequate capacities, level indicators with cut out switches and with filters to deal with dust-bearing air displaced during filling operations	
j	Use flexible filling pipes for dispatch and loading processes, equipped with a dust extraction system for loading cement, which are positioned towards the loading floor of the lorry	

15. In order to minimise/prevent diffuse dust emissions from bulk storage areas, BAT is to use one or a combination of the following techniques:

	Technique
a	Cover bulk storage areas or stockpiles or enclose them with screening, walling or an enclosure consisting of vertical greenery (artificial or natural wind barriers for open pile wind protection)
b	Use open pile wind protection: — Outdoor storage piles of dusty materials should be avoided, but when they do exist it is possible to reduce diffuse dust by using properly designed wind barriers
c	Use water spray and chemical dust suppressors: — When the point source of diffuse dust is well localised, a water spray injection system can be installed. The humidification of dust particles aids agglomeration and so helps dust settle. A wide variety of agents is also available to improve the overall efficiency of the water spray

	Technique
d	Ensure paving, road wetting and housekeeping: — Areas used by lorries should be paved when possible and the surface should be kept as clean as possible. Wetting the roads can reduce diffuse dust emissions, especially during dry weather. They also can be cleaned with road sweepers. Good housekeeping practices should be used in order to keep diffuse dust emissions to a minimum
e	Ensure humidification of stockpiles: — Diffuse dust emissions at stockpiles can be reduced by using sufficient humidification of the charging and discharging points, and by using conveyor belts with adjustable heights
f	Match the discharge height to the varying height of the heap, automatically if possible or by reduction of the unloading velocity, when diffuse dust emissions at the charging or discharging points of storage sites cannot be avoided

1.2.5.2 Channelled dust emissions from dusty operations

This section concerns dust emissions arising from dusty operations other than those from kiln firing, cooling and the main milling processes. This covers processes such as the crushing of raw materials; raw material conveyors and elevators; the storage of raw materials, clinker and cement; the storage of fuels and the dispatch of cement.

16. In order to reduce channelled dust emissions, BAT is to apply a maintenance management system which especially addresses the performance of filters applied to dusty operations, other than those from kiln firing, cooling and main milling processes. Taking this management system into account, BAT is to use dry flue-gas cleaning with a filter.

Description

For dusty operations, dry flue-gas cleaning with a filter usually consists of a fabric filter. A description of fabric filters is provided in Section 1.5.1.

BAT-associated emission levels

The BAT-AEL for channelled dust emissions from dusty operations (other than those from kiln firing, cooling and the main milling processes) is < 10 mg/Nm^3, as the average over the sampling period (spot measurement, for at least half an hour).

It should be noted that for small sources (< 10 000 Nm^3/h) a priority approach, based on the maintenance management system, regarding the frequency for checking the performance of the filter has to be taken into account (see also BAT 5).

1.2.5.3 Dust emissions from kiln firing processes

17. In order to reduce dust emissions from flue-gases of kiln firing processes, BAT is to use dry flue-gas cleaning with a filter.

	Technique [1]	Applicability
a	Electrostatic precipitators (ESPs)	Applicable to all kiln systems
b	Fabric filters	
c	Hybrid filters	

(1) A description of the techniques is given in Section 1.5.1.

BAT-associated emission levels

The BAT-AEL for dust emissions from flue-gases of kiln firing processes is <10 – 20 mg/Nm^3, as the daily average value. When applying fabric filters or new or upgraded ESPs, the lower level is achieved.

1.2.5.4 Dust emissions from cooling and milling processes

18. In order to reduce dust emissions from the flue-gases of cooling and milling processes, BAT is to use dry flue-gas cleaning with a filter.

	Technique [1]	Applicability
a	Electrostatic precipitators (ESPs)	Generally applicable to clinker coolers and cement mills.
b	Fabric filters	Generally applicable to clinker coolers and mills
c	Hybrid filters	Applicable to clinker coolers and cement mills.

([1]) A description of the techniques is given in Section 1.5.1

BAT-associated emission levels

The BAT-AEL for dust emissions from the flue-gases of cooling and milling processes is <10 – 20 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements for at least half an hour). When applying fabric filters or new or upgraded ESPs, the lower level is achieved.

1.2.6 *Gaseous compounds*

1.2.6.1 NO_x emissions

19. In order to reduce the emissions of NO_x from the flue-gases of kiln firing and/or preheating/precalcining processes, BAT is to use one or a combination of the following techniques:

	Technique [1]	Applicability
a	Primary techniques	
	I. Flame cooling	Applicable to all types of kilns used for cement manufacturing. The degree of applicability can be limited by product quality requirements and potential impacts on process stability
	II. Low NO_x burners	Applicable to all rotary kilns, in the main kiln as well as in the precalciner
	III. Mid-kiln firing	Generally applicable to long rotary kilns
	IV. Addition of mineralisers to improve the burnability of the raw meal (mineralised clinker)	Generally applicable to rotary kilns subject to final product quality requirements
	V. Process optimisation	Generally applicable to all kilns
b	Staged combustion (conventional or waste fuels), also in combination with a precalciner and the use of optimised fuel mix	In general, can only be applied in kilns equipped with a precalciner. Substantial plant modifications are necessary in cyclone preheater systems without a precalciner. In kilns without precalciner, lump fuels firing might have a positive effect on NO_x reduction depending on the ability to produce a controlled reduction atmosphere and to control the related CO emissions
c	Selective non-catalytic reduction (SNCR)	In principle, applicable to rotary cement kilns. The injection zones vary with the type of kiln process. In long wet and long dry process kilns it may be difficult to obtain the right temperature and retention time needed. See also BAT 20
d	Selective catalytic reduction (SCR)	Applicability is subject to appropriate catalyst and process development in the cement industry

([1]) A description of the techniques is provided in Section 1.5.2.

BAT-associated emission levels

See Table 2.

Table 2

BAT-associated emission levels for NO_x from the flue-gases of kiln firing and/or preheating/precalcining processes in the cement industry

Kiln type	Unit	BAT-AEL (daily average value)
Preheater kilns	mg/Nm^3	< 200 – 450 (1) (2)
Lepol and long rotary kilns	mg/Nm^3	400 – 800 (3)

(1) The upper level of the BAT-AEL range is 500 mg/Nm^3, if the initial NO_x level after primary techniques is > 1 000 mg/Nm^3.
(2) Existing kiln system design, fuel mix properties including waste and raw material burnability (e.g. special cement or white cement clinker) can influence the ability to be within the range. Levels below 350 mg/Nm^3 are achieved at kilns with favourable conditions when using SNCR. In 2008, the lower value of 200 mg/Nm^3 has been reported as a monthly average for three plants (easy burning mix used) using SNCR.
(3) Depending on initial levels and NH_3 slip.

20. When SNCR is used, BAT is to achieve efficient NO_x reduction, while keeping the ammonia slip as low as possible, by using the following technique:

	Technique
a	To apply an appropriate and sufficient NO_x reduction efficiency along with a stable operating process
b	To apply a good stoichiometric distribution of ammonia in order to achieve the highest efficiency of NO_x reduction and to reduce the NH_3 slip
c	To keep the emissions of NH_3 slip (due to unreacted ammonia) from the flue-gases as low as possible taking into account the correlation between the NO_x abatement efficiency and the NH_3 slip

Applicability

SNCR is generally applicable to rotary cement kilns. The injection zones vary with the type of kiln process. In long wet and long dry process kilns it may be difficult to obtain the right temperature and retention time needed. See also BAT 19.

BAT-associated emission levels

See Table 3.

Table 3

BAT-associated emission levels for NH_3 slip in the flue-gases when SNCR is applied

Parameter	Unit	BAT-AEL (daily average value)
NH_3 slip	mg/Nm^3	< 30 – 50 (1)

(1) The ammonia slip depends on the initial NO_x level and on the NO_x abatement efficiency. For Lepol and long rotary kilns, the level may be even higher.

1.2.6.2 SO_x emissions

21. In order to reduce/minimise the emissions of SO_x from the flue-gases of kiln firing and/or preheating/precalcining processes, BAT is to use one of the following techniques:

	Technique [1]	Applicability
a	Absorbent addition	Absorbent addition is, in principle, applicable to all kiln systems, although it is mostly used in suspension preheaters. Lime addition to the kiln feed reduces the quality of the granules/nodules and causes flow problems in Lepol kilns. For preheater kilns it has been found that direct injection of slaked lime into the flue-gas is less efficient than adding slaked lime to the kiln feed
b	Wet scrubber	Applicable to all cement kiln types with appropriate (sufficient) SO_2 levels for manufacturing the gypsum

[1] A description of the techniques is provided in Section 1.5.3

Description

Depending on the raw materials and the fuel quality, levels of SO_x emissions can be kept low not requiring the use of an abatement technique.

If necessary, primary techniques and/or abatement techniques such as absorbent addition or wet scrubber can be used to reduce SO_x emissions.

Wet scrubbers have already been operated in plants with initial unabated SO_x levels higher than 800 – 1 000 mg/Nm^3.

BAT-associated emission levels

See Table 4.

Table 4

BAT-associated emission levels for SO_x from the flue-gases of kiln firing and/or preheating/precalcining processes in the cement industry

Parameter	Unit	BAT-AEL [1] [2] (daily average value)
SO_x expressed as SO_2	mg/Nm^3	< 50 – 400

[1] The range takes into account the sulphur content in the raw materials.
[2] For white cement and special cement clinker production, the ability of clinker to retain fuel sulphur might be significantly lower leading to higher SO_X emissions.

22. In order to reduce SO_2 emissions from the kiln, BAT is to optimise the raw milling processes.

Description

The technique consists of optimising the raw milling process so that the raw mill can be operated to act as SO_2 abatement for the kiln. This can be achieved by adjusting factors such as:

— raw material moisture

— mill temperature

— retention time in the mill

— fineness of the ground material.

Applicability

Applicable if the dry milling process is used in compound mode.

1.2.6.3 CO emissions and CO trips

1.2.6.3.1 Reduction of CO trips

23. In order to minimise the frequency of CO trips and keep their total duration to below 30 minutes annually, when using electrostatic precipitators (ESPs) or hybrid filters, BAT is to use the following techniques in combination:

	Technique
a	Manage CO trips in order to reduce the ESP downtime
b	Continuous automatic CO measurements by means of monitoring equipment with a short response time and situated close to the CO source

Description

For safety reasons, due to the risk of explosions, ESPs will have to shut down during elevated CO levels in the flue-gases. The following techniques prevent CO trips and, therefore, reduce ESP shutdown times:

— control of the combustion process

— control of the organic load of raw materials

— control of the quality of the fuels and fuel feeding system.

Disruptions predominantly happen during the start-up operation phase. For safe operation, the gas analysers for ESP protection have to be on-line during all operational phases and the ESP downtime can be reduced by using a backup monitoring system maintained in operation.

The continuous CO monitoring system needs to be optimised for reaction time and should be located close to the CO source, e.g. at a preheater tower outlet, or at a kiln inlet in the case of a wet kiln application.

When hybrid filters are used, the grounding of the bag support cage with the cell plate is recommended.

1.2.6.4 Total organic carbon emissions (TOC)

24. In order to keep the emissions of TOC from the flue-gases of the kiln firing processes low, BAT is to avoid feeding raw materials with a high content of volatile organic compounds (VOC) into the kiln system via the raw material feeding route.

1.2.6.5 Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions

25. In order prevent/reduce the emissions of HCl from flue-gases of the kiln firing processes, BAT is to use one or a combination of the following primary techniques:

	Technique
a	Using raw materials and fuels with a low chlorine content
b	Limiting the amount of chlorine content for any waste that is to be used as raw material and/or fuel in a cement kiln

BAT-associated emission levels

The BAT-AEL for the emissions of HCl is <10 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).

26. In order to prevent/reduce the emissions of HF from the flue-gases of the kiln firing processes, BAT is to use one or a combination of the following primary techniques:

	Technique
a	Using raw materials and fuels with a low fluorine content
b	Limiting the amount of fluorine content for any waste that is to be used as raw material and/or fuel in a cement kiln

BAT-associated emission levels

The BAT-AEL for the emissions of HF is <1 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements, for at least half an hour).

1.2.7 *PCDD/F emissions*

27. In order to prevent emissions of PCDD/F or to keep the emissions of PCDD/F from the flue-gases of the kiln firing processes low, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Carefully selecting and controlling of kiln inputs (raw materials), i.e. chlorine, copper and volatile organic compounds	Generally applicable
b	Carefully selecting and controlling kiln inputs (fuels), i.e. chlorine and copper	Generally applicable
c	Limiting/avoiding the use of wastes which contain chlorinated organic materials	Generally applicable
d	Avoid feeding fuels with a high content of halogens (e.g. chlorine) in secondary firing	Generally applicable
e	Quick cooling of kiln flue-gases to lower than 200 °C and minimising residence time of flue-gases and oxygen content in zones where the temperatures range between 300 and 450 °C	Applicable to long wet kilns and long dry kilns without preheating. In modern preheater and precalciner kilns, this feature is already inherent
f	Stop co-incinerating waste for operations such as start-ups and/or shutdowns	Generally applicable

BAT-associated emission levels

The BAT-AEL for the emissions of PCDD/F from the flue-gases of the kiln firing processes is <0,05 – 0,1 ng PCDD/F I-TEQ/Nm^3, as the average over the sampling period (6 – 8 hours).

1.2.8 *Metal emissions*

28. In order to minimise the emissions of metals from the flue-gases of the kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique
a	Selecting materials with a low content of relevant metals and limiting the content of relevant metals in materials, especially mercury
b	Using a quality assurance system to guarantee the characteristics of the waste materials used
c	Using effective dust removal techniques as set out in BAT 17

BAT-associated emission levels

See Table 5.

Table 5

BAT-associated emission levels for metals from the flue-gases of kiln firing processes

Metals	Unit	BAT-AEL (average over the sampling period (spot measurements, for at least half an hour))
Hg	mg/Nm^3	< 0,05 ([2])
Σ (Cd, Tl)	mg/Nm^3	< 0,05 ([1])
Σ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	mg/Nm^3	< 0,5 ([1])

([1]) Low levels have been reported based on the quality of the raw materials and the fuels.
([2]) Low levels have been reported based on the quality of the raw materials and the fuels. Values higher than 0,03 mg/Nm^3 have to be further investigated. Values close to 0,05 mg/Nm^3 require consideration of additional techniques (e.g. lowering of the flue-gas temperature, activated carbon).

1.2.9 *Process losses/waste*

29. In order to reduce solid waste from the cement manufacturing process along with raw material savings, BAT is to:

	Technique	Applicability
a	Reuse collected dusts in the process, wherever practicable	Generally applicable but subject to dust chemical composition
b	Utilise these dusts in other commercial products, when possible	The utilisation of the dusts in other commercial products may not be within the control of the operator

Description

Collected dust can be recycled back into the production processes whenever practicable. This recycling may take place directly into the kiln or kiln feed (the alkali metal content being the limiting factor) or by blending with finished cement products. A quality assurance procedure might be required when the collected dusts are recycled back into the production processes. Alternative uses may be found for material that cannot be recycled (e.g. additive for flue-gas desulphurisation in combustion plants).

1.3 **BAT conclusions for the lime industry**

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all installations in the lime industry.

1.3.1 *General primary techniques*

30. In order to reduce all kiln emissions and use energy efficiently, BAT is to achieve a smooth and stable kiln process, operating close to the process parameter set points by using the following techniques:

	Technique
a	Process control optimisation, including computer-based automatic control
b	Using modern, gravimetric solid fuel feed systems and/or gas flow meters

Applicability

Process control optimisation is applicable to all lime plants to varying degrees. Complete process automation is generally not achievable due to the uncontrollable variables, i.e. quality of the limestone.

31. In order to prevent and/or reduce emissions, BAT is to carry out a careful selection and control of the raw materials entering the kiln.

Description

Raw materials entering the kiln have a significant effect on air emissions due to their impurities content; hence, a careful selection of raw materials may reduce these emissions at source. For example, the variations of sulphur and chlorine contents in the limestone/dolomite have an effect on the range of the SO_2 and HCl emissions in the flue-gas, while the presence of organic matter has an influence on TOC and CO emissions.

Applicability

The applicability depends on the (local) availability of raw materials with low impurities content. The type of final product and the type of kiln used may represent an additional constraint.

1.3.2 *Monitoring*

32. BAT is to carry out monitoring and measurements of process parameters and emissions on a regular basis and to monitor emissions in accordance with the relevant EN standards or, if EN standards are not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality, including the following:

	Technique	Applicability
a	Continuous measurements of process parameters demonstrating the process stability, such as temperature, O_2 content, pressure, flow rate and CO emissions	Applicable to kiln processes
b	Monitoring and stabilising of critical process parameters, e.g. fuel feed, regular dosage and excess oxygen	
c	Continuous or periodic measurements of dust, NO_x, SO_x, CO emissions and NH_3 emissions when SNCR is applied	Applicable to kiln processes
d	Continuous or periodic measurements of HCl and HF emissions in case wastes are co-incinerated	Applicable to kiln processes
e	Continuous or periodic measurements of TOC emissions or continuous measurements in case wastes are co-incinerated	Applicable to kiln processes
f	Periodic measurements of PCDD/F and metal emissions	Applicable to kiln processes
g	Continuous or periodic measurements of dust emissions	Applicable to non-kiln processes For small sources (<10 000 Nm^3/h) the frequency of the measurements should be based on a maintenance management system

Description

The selection between continuous or periodic measurements mentioned in BAT 32(c) to 32(f) is based on the emission source and the type of pollutant expected.

For periodic measurements of dust, NO_x, SO_x and CO emissions, a frequency of once a month and up to once a year at the time of normal operating conditions is given as an indication.

For periodic measurements of PCDD/F, TOC, HCl, HF, metal emissions, a frequency appropriate to the raw materials and fuels that are used in the process should be applied.

1.3.3 *Energy consumption*

33. In order to reduce/minimise thermal energy consumption, BAT is to use a combination of the following techniques:

	Technique	Description	Applicability
a	Applying improved and optimised kiln systems and a smooth and stable kiln process, operating close to the process parameter set points, through: I. process control optimisation II. heat recovery from flue-gases (e.g. use of surplus heat from rotary kilns to dry limestone for other processes such as limestone milling) III. modern, gravimetric solid fuel feed systems IV. maintenance of the equipment (e.g. air tightness, erosion of refractory) V. the use of optimised grain size of stone	Maintaining kiln control parameters close to their optimum values has the effect of reducing all consumption parameters due to, among other things, reduced numbers of shutdowns and upset conditions. The use of optimised grain size of stone is subject to raw material availability	Technique (a) II is applicable only to long rotary kilns (LRK)
b	Using fuels with characteristics which have a positive influence on thermal energy consumption	The characteristics of fuels, e.g. high calorific value and low moisture content can have a positive effect on the thermal energy consumption	The applicability depends on the technical possibility to feed the selected fuel into the kiln and on the availability of suitable fuels (e.g. high calorific value and low humidity) which may be impacted by the energy policy of the Member State
c	Limiting excess air	A decrease of excess air used for combustion has a direct effect on fuel consumption since high percentages of air require more thermal energy to heat up the excess volume. Only in LRK and PRK the limitation of excess air has an impact on thermal energy consumption. The technique has a potential of increasing TOC and CO emission	Applicable to LRK and PRK within the limits of a potential overheating of some areas in the kiln with consequent deterioration of the refractory lifetime

BAT-associated consumption levels

See Table 6.

Table 6

BAT-associated levels for thermal energy consumption in the lime and dolime industry

Kiln type	Thermal energy consumption [1] GJ/tonne of product
Long rotary kilns (LRK)	6,0 – 9,2
Rotary kilns with preheater (PRK)	5,1 – 7,8
Parallel flow regenerative kilns (PFRK)	3,2 – 4,2
Annular shaft kilns (ASK)	3,3 – 4,9

Kiln type	Thermal energy consumption [1] GJ/tonne of product
Mixed feed shaft kilns (MFSK)	3,4 – 4,7
Other kilns (OK)	3,5 – 7,0

[1] Energy consumption depends on the type of product, the product quality, the process conditions and the raw materials

34. In order to minimise electrical energy consumption, BAT is to use one or a combination of the following techniques:

	Technique
a	Using power management systems
b	Using optimised grain size of limestone
c	Using grinding equipment and other electricity based equipment with high energy efficiency

Description – Technique (b)

Vertical kilns can usually burn only coarse limestone pebbles. However, rotary kilns with higher energy consumption can also valorise small fractions and new vertical kilns can burn small granules from 10 mm. The larger granules of kiln feed stone are used more in vertical kilns than in rotary kilns.

1.3.4 *Consumption of limestone*

35. In order to minimise limestone consumption, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Specific quarrying, crushing and well directed use of limestone (quality, grain size)	Generally applicable in the lime industry; however, stone processing is dependent on the limestone quality
b	Selecting kilns applying optimised techniques which allow for operating with a wider range of limestone grain sizes to make optimum use of quarried limestone	Applicable to new plants and major upgrades of kiln. Vertical kilns can in principle only burn coarse limestone pebbles. Fine lime PFRK and/or rotary kilns can operate with smaller limestone grain sizes

1.3.5 *Selection of fuels*

36. In order to prevent/reduce emissions, BAT is to carry out a careful selection and control of fuels entering the kiln.

Description

Fuels entering the kiln may have a significant effect on air emissions due to their impurities content. The content of sulphur (for long rotary kilns in particular), nitrogen and chlorine have an effect on the range of the SO_x, NO_x and HCl emissions in the flue-gas. Depending on the chemical composition of the fuel and the type of kiln used, the choice of appropriate fuels or a fuel mix can lead to emissions reductions.

Applicability

Except for mixed feed shaft kilns, all types of kilns can operate with all types of fuels and fuel mixtures subject to fuels availability which may be impacted by the energy policy of the Member State. The selection of fuel also depends on the desired quality of the final product, the technical possibility to feed the fuel into the selected kiln, and economic considerations.

1.3.5.1 Use of waste fuels

1.3.5.1.1 Waste quality control

37. In order to guarantee the characteristics of waste to be used as fuel in a lime kiln, BAT is to apply the following techniques:

	Technique
a	Apply a quality assurance system to guarantee and control the characteristics of wastes and to analyse any waste that is to be used as fuel in the kiln for: I. constant quality II. physical criteria, e.g. emissions formation, coarseness, reactivity, burnability, calorific value III. chemical criteria, e.g. total chlorine content, sulphur, alkali, and phosphate content and relevant metals content (e.g. total chromium, lead, cadmium, mercury, thallium)
b	Control the amount of relevant components for any waste that is to be used as fuel, such as total halogen content, metals (e.g. total chromium, lead, cadmium, mercury, thallium) and sulphur

1.3.5.1.2 Waste feeding into the kiln

38. In order to prevent/reduce emissions occurring from the use of waste fuels into the kiln, BAT is to use the following techniques:

	Technique
a	To use appropriate burners for feeding suitable wastes depending on kiln design and kiln operation
b	To operate in such a way that the gas resulting from the co-incineration of waste is raised in a controlled and homogeneous fashion and even under the most unfavourable conditions, to a temperature of 850 °C for 2 seconds
c	To raise the temperature to 1 100 °C if hazardous wastes with a content of more than 1 % of halogenated organic substances, expressed as chlorine, are co-incinerated
d	To feed wastes continuously and constantly
e	To stop feeding waste for operations such as start-ups and/or shutdowns when appropriate temperatures and residence times cannot be reached, as mentioned in (b) and (c) above

1.3.5.1.3 Safety management for the use of hazardous waste materials

39. In order to prevent accidental emissions, BAT is to use safety management for the storage, handling and feeding into the kiln of hazardous waste materials.

Description

The use of a safety management for the storage, handling and feeding of hazardous waste materials consists of a risk-based approach according to the source and type of waste, for the labelling, checking, sampling and testing of waste to be handled.

1.3.6 *Dust emissions*

1.3.6.1 Diffuse dust emissions

40. In order to minimise/prevent diffuse dust emissions from dusty operations, BAT is to use one or a combination of the following techniques:

	Technique
a	Enclosure/encapsulation of dusty operations, such as grinding, screening and mixing
b	Use of covered conveyors and elevators, which are constructed as closed systems, if dust emissions are likely to be released from dusty material
c	Use of storage silos with adequate capacity, level indicators with cut out switches and with filters to deal with dust-bearing air displaced during filling operations
d	Use of a circulation process which is favoured for pneumatic conveying systems

	Technique
e	Material handling in closed systems maintained under negative pressure and dedusting of the suction air by a fabric filter before being emitted into the air
f	Reduction of air leakage and spillage points, completion of installation
g	Proper and complete maintenance of the installation
h	Use of automatic devices and control systems
i	Use of continuous trouble-free operations
j	Use of flexible filling pipes equipped with a dust extraction system for loading lime which are positioned at the loading floor of the lorry

Applicability

In raw material preparation operations, like crushing and sieving, dust separation is not normally needed, because of the moisture content of the raw material.

41. In order to minimise/prevent diffuse dust emissions from bulk storage areas, BAT is to use one or a combination of the following techniques:

	Technique
a	Enclose storage locations using screening, walling or vertical greenery (artificial or natural wind barriers for open pile wind protection)
b	Use product silos and closed, fully-automated raw material storages. These types of storage are equipped with one or more fabric filters to prevent diffuse dust formation in loading and unloading operations
c	Reduce diffuse dust emissions at stockpiles by using sufficient humidification of stockpile charging and discharging points and the use of conveyor belts with adjustable height. When using humidification or spraying measures/techniques, the ground can be sealed and the surplus water can be gathered, and if necessary this can be treated and used in closed cycles
d	Reduce diffuse dust emissions at charging or discharging points of storage sites if they cannot be avoided, by matching the discharge height to the varying height of the heap, if possible automatically, or by reduction of the unloading velocity
e	Keep the locations wet, especially dry areas, using spraying devices and clean them by cleaning lorries
f	Use vacuum systems during removal operations. New buildings can easily be equipped with stationary vacuum cleaning systems, while existing buildings are normally better fitted with mobile systems and flexible connections
g	Reduce diffuse dust emissions arising in areas used by lorries, by paving these areas when possible and keeping the surface as clean as possible. Wetting the roads can reduce diffuse dust emissions, especially during dry weather. Good housekeeping practices can be used in order to keep diffuse dust emissions to a minimum

1.3.6.2 Channelled dust emissions from dusty operations other than those from kiln firing processes

42. In order to reduce channelled dust emissions from dusty operations other than those from kiln firing processes, BAT is to use one of the following techniques and to use a maintenance management system which specifically addresses the performance of filters:

	Technique [1] [2]	Applicability
a	Fabric filter	Generally applicable to milling and grinding plants and subsidiary processes in the lime industry; material transport; and storage and loading facilities. The applicability of fabric filters in hydrating lime plants may be limited by the high moisture and low temperature of the flue-gases
b	Wet scrubbers	Mainly applicable to hydrating lime plants

[1] A description of the techniques is provided in Section 1.6.1.
[2] If necessary, centrifugal separators/cyclones can be used as pretreatment of the flue-gases.

BAT-associated emission levels

See Table 7.

Table 7

BAT-associated emission levels for channelled dust emissions from dusty operations other than those from kiln firing processes

Technique	Unit	BAT-AEL (daily average or average over the sampling period (spot measurements for at least half an hour))
Fabric filter	mg/Nm^3	< 10
Wet scrubber	mg/Nm^3	< 10 – 20

It should be noted that for small sources (< 10 000 Nm^3/h) a priority approach regarding the frequency for checking the performance of the filter has to be taken into account (see BAT 32).

1.3.6.3 Dust emissions from kiln firing processes

43. In order to reduce dust emissions from the flue-gases of kiln firing processes, BAT is to use flue-gas cleaning with a filter. One or a combination of the following techniques can be used:

	Technique [1]	Applicability
a	ESP	Applicable to all kiln systems
b	Fabric filter	Applicable to all kiln systems
c	Wet dust separator	Applicable to all kiln systems
d	Centrifugal separator/cyclone	Centrifugal separators are only suitable as pre-separators and can be used to pre-clean the flue-gases from all kiln systems

[1] A description of the techniques is provided in Section 1.6.1.

BAT-associated emission levels

See Table 8.

Table 8

BAT-associated emission levels for dust emissions from the flue-gases of kiln firing processes

Technique	Unit	BAT-AEL (daily average value or average over the sampling period (spot measurements for at least half an hour))
Fabric filter	mg/Nm^3	< 10
ESP or other filters	mg/Nm^3	< 20 (*)

(*) In exceptional cases where the resistivity of dust is high, the BAT-AEL could be higher, up to 30 mg/Nm^3, as the daily average value.

1.3.7 *Gaseous compounds*

1.3.7.1 Primary techniques for reducing emissions of gaseous compounds

44. In order to reduce the emissions of gaseous compounds (i.e. NO_x, SO_x, HCl, CO, TOC/VOC, volatile metals) from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Careful selection and control of substances entering the kiln	Generally applicable
b	Reducing the pollutant precursors in fuels and, if possible, in raw materials, i.e. I. selecting fuels, where available, with low contents of sulphur (for long rotary kilns in particular), nitrogen and chlorine II. selecting raw materials, if possible, with low contents of organic matter III. selecting suitable waste fuels for the process and the burner	Generally applicable in the lime industry subject to local availability of raw materials and fuels, the type of kiln used, the desired product qualities and the technical possibility of feeding the fuels into the selected kiln
c	Using process optimisation techniques to ensure an efficient absorption of sulphur dioxide (e.g. efficient contact between the kiln gases and the quicklime)	Applicable to all lime plants. In general, complete process automation is not achievable due to uncontrollable variables, i.e. quality of the limestone

1.3.7.2 NO_x emissions

45. In order to reduce the emissions of NO_X from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Primary techniques	
	I. Appropriate fuel selection along with limitation of nitrogen content in the fuel	Generally applicable in the lime industry subject to fuel availability which may be impacted by the energy policy of the Member State and to the technical possibility to feed a certain type of fuel into the selected kiln
	II. Process optimisation including flame shaping and temperature profile	Optimisation of process and process control can be applied in lime manufacturing but is subject to the final product quality
	III. Burner design (low NO_X burner) ([1])	Low NO_X burners are applicable to rotary kilns and to annular shaft kilns presenting conditions of high primary air. PFRKs and other shaft kilns have flameless combustion, thus rendering low NO_X burners not applicable to this kiln type
	IV. Air staging ([1])	Not applicable to shaft kilns. Applicable only to PRK but not when hard burned lime is produced. The applicability may be limited by constraints imposed by the type of final product, due to possible overheating in some areas of the kiln and consequent deterioration of the refractory lining
b	SNCR ([1])	Applicable to Lepol rotary kilns. See also BAT 46

([1]) A description of the techniques is provided in Section 1.6.2

BAT-associated emission levels

See Table 9.

Table 9

BAT-associated emission levels for NO_x from flue-gases of kiln firing processes in the lime industry

Kiln type	Unit	BAT-AEL (daily average value or average over the sampling period (spot measurements for at least half an hour), stated as NO_2)
PFRK, ASK, MFSK, OSK	mg/Nm^3	100 – 350 (1) (3)
LRK, PRK	mg/Nm^3	< 200 – 500 (1) (2)

(1) The higher ends of the ranges are related to the production of dolime and hard burned lime. Higher levels than the upper end of the range may be associated with the production of sintered dolime.
(2) For LRK and PRK with shaft producing hard burned lime, the upper level is up to 800 mg/Nm^3
(3) Where primary techniques as indicated in BAT 45 (a)I are not sufficient to reach this level and where secondary techniques are not applicable to reduce the NO_x emissions to 350 mg/Nm^3, the upper level is 500 mg/Nm^3, especially for hard burned lime and for the use of biomass as fuel.

46. When SNCR is used, BAT is to achieve efficient NO_x reduction, while keeping the ammonia slip as low as possible, by using the following technique:

	Technique
a	To apply an appropriate and sufficient reduction efficiency along with a stable operating process
b	To apply a good stoichiometric ratio and distribution of ammonia in order to achieve the highest efficiency of NO_x reduction and to reduce the ammonia slip
c	To keep the emissions of NH_3 slip (due to unreacted ammonia) from the flue-gases as low as possible, taking into account the correlation between the NO_x abatement efficiency and the NH_3 slip.

Applicability

Applicable only to Lepol rotary kilns, where the ideal temperature range of 850 to 1 020 °C is accessible. See also BAT 45, technique (b).

BAT-associated emission levels

The BAT-AEL for the emissions of NH_3 slip from the flue-gases is <30 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements for at least half an hour).

1.3.7.3 SO_x emissions

47. In order to reduce the emissions of SO_x from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Process optimisation to ensure an efficient absorption of sulphur dioxide (e.g. efficient contact between the kiln gases and the quicklime)	Process control optimisation is applicable to all lime plants
b	Selecting fuels with a low sulphur content	Generally applicable, subject to fuel availability in particular for use in long rotary kilns (LRK), due to high SO_x emissions
c	Using absorbent addition techniques (e.g. absorbent addition, dry flue-gas cleaning with a filter, wet scrubber, or activated carbon injection) (1)	Absorbent addition techniques are, in principle, applicable in the lime industry; however, this technique had not yet been applied in the lime sector in 2007. Particularly for rotary lime kilns further investigation is required in order to assess its applicability

(1) A description of the techniques is provided in Section 1.6.3

BAT-associated emission levels

See Table 10.

Table 10

BAT-associated emission levels for SO_x from flue-gases of kiln firing processes in the lime industry

Kiln type	Unit	BAT-AEL (1) (2) (daily average value or average over the sampling period (spot measurements for at least half an hour), SO_x expressed as SO_2)
PFRK, ASK, MFSK, OSK, PRK	mg/Nm^3	< 50 – 200
LRK	mg/Nm^3	< 50 – 400

(1) The level depends on the initial SO_x level in the flue-gas and on the reduction technique used.
(2) For the production of sintered dolime using the 'double- pass process', SO_x emissions might be higher than the upper end of the range.

1.3.7.4 CO emissions and CO trips

1.3.7.4.1 CO emissions

48. In order to reduce the emissions of CO from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique	Applicability
a	Selecting, raw materials with a low content of organic matter	Generally applicable to the lime industry within the constraints of the local availability and composition of raw materials, the type of kiln used and the quality of the final product
b	Using process optimisation techniques to achieve a stable and complete combustion	Applicable to all lime plants. In general, complete process automation is not achievable due to uncontrollable variables, i.e. quality of the limestone

In this context, see also BAT 30 and 31 in Section 1.3.1 and BAT 32 in Section 1.3.2.

BAT-associated emission levels

See Table 11.

Table 11

BAT-associated emission levels for CO from the flue-gas of kiln firing processes

Kiln type	Unit	BAT-AEL (1) (2) (daily average value or average over the sampling period (spot measurements for at least half an hour))
PFRK, OSK, LRK, PRK	mg/Nm^3	< 500

(1) Emissions can be higher depending on raw materials used and/or type of lime produced, e.g. hydraulic lime.
(2) BAT-AEL does not apply to MFSK and ASK.

1.3.7.4.2 Reduction of CO trips

49. In order to minimise the frequency of CO trips when using electrostatic precipitators, BAT is to use the following techniques:

	Technique
a	Manage CO trips in order to reduce the ESP downtime
b	Continuous automatic CO measurements by means of monitoring equipment with a short response time and situated close to the CO source

Description

For safety reasons, due to the risk of explosions, ESPs will have to shut down during elevated CO levels in the flue-gases. The following techniques prevent CO trips and, therefore, reduce ESP shutdown times:

— control of the combustion process

— control of the organic load of raw materials

— control of the quality of the fuels and fuel feeding system.

Disruptions predominantly happen during the start-up operation phase. For safe operation, the gas analysers for ESP protection have to be online during all operational phases and the ESP downtime can be reduced by using a backup monitoring system maintained in operation.

The continuous CO monitoring system needs to be optimised for reaction time and should be located close to the CO source, e.g. at a preheater tower outlet, or at a kiln inlet in the case of a wet kiln application.

Applicability

Generally applicable to rotary kilns fitted with electrostatic precipitators (ESPs).

1.3.7.5 Total organic carbon emissions (TOC)

50. In order to reduce the emissions of TOC from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique
a	Applying general primary techniques and monitoring (see also BAT 30 and 31 in Section 1.3.1, and BAT 32 in Section 1.3.2)
b	Avoid feeding raw materials with a high content of volatile organic compounds into the kiln system (except for hydraulic lime production)

Applicability

For applicability of general primary techniques and monitoring see BAT 30 and 31 in Section 1.3.1, and BAT 32 in Section 1.3.2.

Technique (b) is generally applicable to the lime industry, subject to local raw materials availability and/or the type of lime produced.

BAT-associated emission levels

See Table 12.

Table 12

BAT-associated emission levels for TOC from the flue-gas of kiln firing processes

Kiln type	Unit	BAT-AEL (1) (daily average value or average over the sampling period (spot measurements for at least half an hour))
LRK, PRK	mg/Nm^3	< 10
ASK, MFSK (2), PFRK (2)	mg/Nm^3	< 30

(1) Level can be higher depending on the content of organic matter of raw materials used and/or the type of lime produced, in particular for the production of natural hydraulic lime.
(2) In exceptional cases, the level can be higher.

1.3.7.6 Hydrogen chloride (HCl) and hydrogen fluoride (HF) emissions

51. In order to reduce the emissions of HCl and the emissions of HF from the flue-gas of kiln firing processes, when using waste, BAT is to use the following primary techniques:

	Technique
a	Using conventional fuels with a low chlorine and fluorine content
b	Limiting the amount of chlorine and fluorine content for any waste that is to be used as fuel in a lime kiln

Applicability

The techniques are generally applicable in the lime industry but subject to local availability of suitable fuel.

BAT-associated emission levels

See Table 13.

Table 13

BAT-associated emission levels for HCl and HF emissions from the flue-gas of kiln firing processes, when using wastes

Emission	Unit	BAT-AEL (daily average value or the average value over the sampling period (spot measurements, for at least half an hour))
HCl	mg/Nm^3	< 10
HF	mg/Nm^3	< 1

1.3.8 *PCDD/F emissions*

52. In order to prevent or reduce the emissions of PCDD/F from the flue-gas of kiln firing processes, BAT is to use one or a combination of the following primary techniques:

	Technique
a	Selecting fuels with a low chlorine content
b	Limiting the copper input through the fuel
c	Minimising the residence time of the flue-gases and the oxygen content in zones where the temperatures range between 300 and 450 °C

BAT-associated emission levels

The BAT-AELs are < 0,05 – 0,1 ng PCDD/F I-TEQ/Nm^3, as the average over the sampling period (6 – 8 hours).

1.3.9 *Metal emissions*

53. In order to minimise the emissions of metals from the flue-gases of kiln firing processes, BAT is to use one or a combination of the following techniques:

	Technique
a	Selecting fuels with a low content of metals
b	Using a quality assurance system to guarantee the characteristics of the waste fuels used
c	Limiting the content of relevant metals in materials, especially mercury
d	Using one or a combination of dust removal techniques as set out in BAT 43

BAT-associated emission levels

See Table 14.

Table 14

BAT associated emission levels for metals from the flue-gases of kiln firing processes, when using wastes

Metals	Unit	BAT-AEL (average over the sampling period (spot measurements for at least half an hour))
Hg	mg/Nm^3	< 0,05
Σ (Cd, Tl)	mg/Nm^3	< 0,05
Σ (As, Sb, Pb, Cr, Co, Cu, Mn, Ni, V)	mg/Nm^3	< 0,5
NB: Low levels were reported when applying techniques as mentioned in BAT 53 (a) – (d).		

Furthermore in this context, see also BAT 37 (Section 1.3.5.1.1) and BAT 38 (Section 1.3.5.1.2).

1.3.10 *Process losses/waste*

54. In order to reduce the solid wastes from the lime manufacturing processes and to save raw materials, BAT is to use the following techniques:

	Technique	Applicability
a	Reuse the collected dust or other particulate matter (e.g. sand, gravel) in the process	Generally applicable whenever practicable
b	Utilise dust, off-specification quicklime and off-specification hydrated lime in selected commercial products	Generally utilised in different kinds of selected commercial products, whenever practicable

1.4 **BAT conclusions for the magnesium oxide industry**

Unless otherwise stated, the BAT conclusions presented in this section can be applied to all installations in the magnesium oxide industry (dry process route).

1.4.1 *Monitoring*

55. BAT is to carry out monitoring and measurements of process parameters and emissions on a regular basis and to monitor emissions in accordance with the relevant EN standards or, if EN standards are not available, ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality, including the following:

	Technique	Applicability
a	Continuous measurements of process parameters demonstrating the process stability, such as temperature, O_2 content, pressure, flow rate	Generally applicable to kiln processes
b	Monitoring and stabilising critical process parameters, i.e. raw material and fuel feed, regular dosage and excess oxygen	
c	Continuous or periodic measurements of dust, NO_x, SO_x and CO emissions	Generally applicable to kiln processes
d	Continuous or periodic measurements of dust emissions	Applicable to non-kiln processes. For small source (< 10 000 Nm^3/h) the frequency of the measurements or performance check should be based on a maintenance management system

Description

The selection between continuous or periodic measurements mentioned in BAT 55 (c) is based on the emission source and the type of pollutant expected.

For periodic measurements for dust, NO_x, SO_x and CO emissions from kiln processes, a frequency of once a month and up to once a year and at the time of normal operating conditions is given as an indication.

1.4.2 *Energy consumption*

56. In order to reduce thermal energy consumption, BAT is to use a combination of the following techniques:

	Technique	Description	Applicability
a	Applying improved and optimised kiln systems and a smooth and stable kiln process by applying: I. process control optimisation II. heat recovery from flue-gases from kiln and coolers	Heat recovery from flue-gases by the preliminary heating of the magnesite can be used in order to reduce fuel energy use. Heat recovered from the kiln can be used for drying fuels, raw materials and some packaging materials	Process control optimisation is applicable to all kiln types used in the magnesia industry.
b	Using fuels with characteristics which have a positive influence on thermal energy consumption	The characteristics of fuels, e.g. high calorific value and low moisture content have a positive effect on the thermal energy consumption	Generally applicable subject to availability of the fuels, the type of kilns used, the desired product qualities and the technical possibilities of injecting the fuels into the kiln.
c	Limiting excess air	The excess oxygen level to obtain the required quality of the products and for optimal combustion is usually in practice about 1 – 3 %	Generally applicable

BAT-associated consumption levels

The BAT-associated thermal energy consumption is 6 – 12 GJ/t, depending on the process and the products ([1]).

57. In order to minimise electrical energy consumption, BAT is to use one or a combination of the following techniques:

	Technique
a	Using power management systems
b	Using grinding equipment and other electricity based equipment with high energy efficiency

1.4.3 *Dust emissions*

1.4.3.1 Diffuse dust emissions

58. In order to minimise/prevent diffuse dust emissions from dusty operations, BAT is to use one or a combination of the following techniques:

	Technique
a	Simple and linear site layout
b	Good housekeeping of buildings and roads, along with proper and complete maintenance of the installation
c	Watering of raw material piles
d	Enclosure/encapsulation of dusty operations, such as grinding and screening
e	Use of covered conveyors and elevators, which are constructed as closed systems, if dust emissions are likely to be released from dusty material

([1]) This range only reflects information provided for the magnesium oxide chapter of the BREF. More specific information about best performing techniques along with the products produced was not provided.

	Technique
f	Use of storage silos with adequate capacities and equipping them with filters to deal with dust-bearing air displaced during filling operations
g	A circulation process is favoured for pneumatic conveying systems
h	Reduction of air leakage and spillage points
i	Use of automatic devices and control systems
k	Use of continuous trouble-free operations

1.4.3.2 Channelled dust emissions from dusty operations other than kiln firing processes

59. In order to reduce channelled dust emissions from dusty operations other than those from kiln firing processes, BAT is to use flue-gas cleaning with a filter by applying one or a combination of the following techniques, and to use a maintenance management system which specifically addresses the performance of techniques:

	Technique [1]	Applicability
a	Fabric filters	Generally applicable to all units in the magnesium oxide manufacturing process, especially for dusty operations, screening, grinding and milling
b	Centrifugal separators/ cyclones	Because of the system-dependent limited degree of separation, cyclones are mainly applicable as preliminary separators for coarse dust and flue-gases
c	Wet dust separators	Generally applicable

[1] A description of the techniques is provided in Section 1.7.1

BAT-associated emission levels

The BAT-AEL for channelled dust emissions from dusty operations other than those from kiln firing processes is < 10 mg/Nm^3, as daily average or average over the sampling period (spot measurements, for at least half an hour).

It should be noted that for small sources (< 10 000 Nm^3/h) a priority approach, based on a maintenance management system regarding the frequency for checking the performance of the filter has to be taken into account (see BAT 55).

1.4.3.3 Dust emissions from the kiln firing process

60. In order to reduce dust emissions from the flue-gases of kiln firing processes, BAT is to use flue-gas cleaning with a filter by applying one or a combination of the following techniques:

	Technique [1]	Applicability
a	Electrostatic precipitators (ESPs)	ESPs are mainly applicable in rotary kilns. They are applicable for flue-gas temperatures above the dew point and up to 370 – 400 °C
b	Fabric filters	Fabric filters for dust removal from flue-gases can, in principle, be applied for all units in the magnesium oxide manufacturing process. They can be used for flue-gas temperatures above the dew point and up to 280 °C. For the production of caustic calcined magnesia (CCM) and sintered/dead burned magnesia (DBM), due to the high temperatures, the corrosive nature and the high volume of the flue-gases occurring from the kiln firing process, special fabric filters with high temperature-resistant filter material have to be used. However, experience from the magnesia industry producing DBM shows that no suitable equipment is available for flue-gas temperatures of approximately 400 °C for magnesia production

	Technique [1]	Applicability
c	Centrifugal separators/ cyclones	Because of the system-dependent limited degree of separation, cyclones are mainly applicable as preliminary separators for coarse dust and flue-gases
d	Wet dust separators	Generally applicable

([1]) A description of the techniques is provided in Section 1.7.1.

BAT-associated emission levels

The BAT-AEL for dust emissions from the flue-gases of kiln firing processes is < 20 – 35 mg/Nm^3 as the daily average value or average over the sampling period (spot measurements, for at least half an hour).

1.4.4 *Gaseous compounds*

1.4.4.1 General primary techniques for reducing emissions of gaseous compounds

61. In order to reduce the emissions of gaseous compounds (i.e. NO_x, HCl, SO_x, CO) from flue-gases of kiln firing processes, BAT is to use one or a combination of the following primary techniques:

	Technique	Applicability
a	Careful selection and control of the substances entering the kiln in order to reduce the pollutant precursors, i.e.: I. selecting fuels with low contents of sulphur, if available, chlorine and nitrogen II. selecting raw materials with low contents of organic matter III. selecting suitable waste fuels for the process and the burner	Generally applicable subject to availability of raw materials and fuels, the type of kiln used, the desired product qualities and the technical possibility of injecting the fuels into the selected kiln. Waste materials can be considered as fuels in the magnesia industry but had not yet been applied in the magnesia industry in 2007
b	Using process optimisation measures/techniques to ensure a smooth and stable kiln process, operating close to the stoichiometric required air	Process control optimisation is applicable to all kiln types used in the magnesia industry. However, a highly sophisticated process control system may be necessary

1.4.4.2 NO_x emissions

62. In order to reduce the emissions of NO_x from the flue-gases of kiln firing processes, BAT is to use a combination of the following techniques:

	Technique	Applicability
a	Appropriate fuel selection along with a limited nitrogen content in the fuel	Generally applicable subject to fuels availability
b	Process optimisation and improved firing technique	Generally applicable in the magnesia industry

BAT-associated emission levels

The BAT-AEL for the emissions of NO_X from the flue-gases of kiln firing processes is < 500 – 1 500 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements for at least half an hour) stated as NO_2. The higher values are related to the high temperature DBM process.

1.4.4.3 CO emissions and CO trips

1.4.4.3.1 CO emissions

63. In order to reduce the emissions of CO from the flue-gases of kiln firing processes, BAT is to use a combination of the following techniques:

	Technique	Description
a	Selecting raw materials with a low content of organic matter	A part of CO emissions results from the organic matter of raw materials thus selection of raw materials with low organic content can reduce CO emissions
b	Process control optimisation	A complete and correct combustion is essential to reduce CO emissions. Air supply from cooler and primary air as well as the draught of the stack fan can be controlled in order to keep an oxygen level of between 1 (sinter) and 1,5 % (caustic) during the combustion. A change of air and fuel charge can reduce CO emissions. Furthermore, CO emissions can be decreased by changing the depth of the burner
c	Feeding fuels controlled, constantly and continuously	Controlled fuel addition includes, e.g.: — using weight feeders and precision rotary valves for petcoke feeding and/or — using flow meters and precision valves for heavy oil or gas feeding regulation to the kiln burner

Applicability

The techniques for the reduction of CO emissions are generally applicable to the magnesia industry. The selection of raw materials with a low content of organic matter is subject to raw materials availability.

BAT-associated emission levels

The BAT-AEL for the emissions of CO from the flue-gases of kiln firing processes is < 50 – 1 000 mg/Nm^3, as the daily average value or average over the sampling period (spot measurements for at least half an hour).

1.4.4.3.2 Reduction of CO trips

64. In order to minimise the number of CO trips when applying ESPs, BAT is to use the following techniques:

	Technique
a	Manage CO trips in order to reduce the ESP downtime
b	Continuous automatic CO measurements by means of monitoring equipment with a short response time and situated close to the CO source

Description

For safety reasons, due to the risk of explosions, ESPs will have to shut down during elevated CO levels in the flue-gases. The following techniques prevent CO trips and, therefore, reduce ESP shutdown times:

— control of the combustion process

— control of the organic load of raw materials

— control of the quality of the fuels and fuel feeding system.

Disruptions predominantly happen during the start-up operation phase. For safe operation, the gas analysers for ESP protection have to be online during all operational phases and the ESP downtime can be reduced by using a backup monitoring system maintained in operation.

The continuous CO monitoring system needs to be optimised for reaction time and should be located close to the CO source, e.g. at a preheater tower outlet, or at a kiln inlet in the case of a wet kiln application.

Applicability

Generally applicable to kilns fitted with electrostatic precipitators (ESPs).

1.4.4.4 SO_x emissions

65. In order to reduce the emissions of SO_x from the flue-gases of kiln firing processes, BAT is to use a combination of the following primary and secondary techniques:

	Technique	Applicability
a	Process optimisation techniques	Generally applicable
b	Selecting fuels with a low sulphur content	Generally applicable subject to availability of low sulphur fuels which may be impacted by the energy policy of the Member State. The selection of fuel also depends on the quality of the final product, technical possibilities and economic considerations
c	A dry absorbent addition technique (sorbent addition into the flue gas stream such as reactive MgO grades, hydrated lime, activated carbon, etc.), in combination with a filter (1)	Generally applicable
d	Wet scrubber (1)	The applicability may be limited in arid areas by the large volume of water necessary and the need for waste water treatment and the related cross-media effects

(1) A description of the measure/technique is provided in Section 1.7.2

BAT-associated emission levels

See Table 15.

Table 15

BAT-associated emission levels for SO_x from flue-gases of kiln firing processes in the magnesia industry

Parameter	Unit	BAT-AEL (1) (2) (daily average value or average over the sampling period (spot measurements for at least half an hour))
SO_X expressed as SO_2	mg/Nm^3	< 50 – 400 (3)

(1) The BAT-AELs depend on the content of sulphur in the raw materials and fuels. The lower end of the range is associated with the use of raw materials with low sulphur content and the use of natural gas; the upper end of the range is associated with the use of raw materials with higher sulphur content and/or the use of sulphur-containing fuels.
(2) Cross-media effects should be taken into account to assess the best combination of BAT to reduce SO_x emissions.
(3) When a wet scrubber is not applicable, BAT-AELs depend on the sulphur content of raw materials and fuels. In this case, the BAT-AEL is < 1 500 mg/Nm^3 while ensuring a SO_X emissions removal efficiency of at least 60 %.

1.4.5 *Process losses/waste*

66. In order to reduce/minimise process losses/waste, BAT is to reuse various types of collected magnesium carbonate dusts in the process.

Applicability

Generally applicable, subject to dust chemical composition.

67. In order to reduce/minimise process losses/waste, BAT is to utilise the various types of collected magnesium carbonate dusts in other marketable products when these are not recyclable.

Applicability

The utilisation of magnesium carbonate dusts in other marketable products may not be within the control of the operator.

68. In order to reduce/minimise process losses/waste, BAT is to reuse sludge resulting from the wet process of the flue-gas desulphurisation in the process or in other sectors.

Applicability

The utilisation of sludge resulting from the wet process of the flue-gas desulphurisation in other sectors may not be within the control of the operator.

1.4.6 *Use of wastes as fuels and/or raw materials*

69. In order to guarantee the characteristics of waste to be used as fuels and/or raw materials in magnesium oxide kilns, BAT is to use the following techniques:

	Technique
a	To select suitable wastes for the process and the burner
b	To apply quality assurance systems to guarantee and control the characteristics of wastes and to analyse any waste that is to be used for: I. availability II. constant quality III. physical criteria, e.g. emissions formation, coarseness, reactivity, burnability, calorific value IV. chemical criteria, e.g. chlorine, sulphur, alkali and phosphate content and relevant metals (e.g. total chromium, lead, cadmium, mercury, thallium) content
c	To control the amount of relevant parameters for any waste that is to be used, such as total halogen content, metals (e.g. total chromium, lead, cadmium, mercury, thallium) and sulphur

Applicability

Wastes may be used as fuels and/or raw materials in the magnesia industry (although they had not yet been applied in the magnesia industry in 2007) subject to availability, the type of kiln used, the desired product qualities and the technical possibility of feeding the fuels into the kiln.

DESCRIPTION OF TECHNIQUES

1.5 **Description of techniques for the cement industry**

1.5.1 *Dust emissions*

	Technique	Description
a	Electrostatic precipitators	Electrostatic precipitators (ESPs) generate an electrostatic field across the path of particulate matter in the air stream. The particles become negatively charged and migrate towards positively charged collection plates. The collection plates are rapped or vibrated periodically, dislodging the material so that it falls into collection hoppers below. It is important that ESP rapping cycles be optimised to minimise particulate re-entrainment and thereby minimise the potential to affect plume visibility. ESPs are characterised by their ability to operate under conditions of high temperatures (up to approximately 400 °C) and high humidity. The major disadvantages of this technique are their decreased efficiency with an insulating layer and a build-up of material that may be generated with high chlorine and sulphur inputs. For the overall performance of ESPs, it is important to avoid CO trips Even though there are no technical restrictions on the applicability of ESPs in the various processes in the cement industry, they are not often chosen for cement mill dedusting because of the investment costs and the efficiency (relatively high emissions) during start-ups and shutdowns
b	Fabric filters	Fabric filters are efficient dust collectors. The basic principle of fabric filtration is to use a fabric membrane which is permeable to gas but which will retain the dust. Basically, the filter medium is arranged geometrically. Initially, dust is deposited both on the surface fibres and within the depth of the fabric, but as the surface layer builds up, the dust itself becomes the dominating filter medium. Off-gas can flow either from the inside of the bag outwards or vice versa. As the dust cake thickens, the resistance to gas flow increases. Periodic cleaning of the filter medium is therefore necessary to control the gas pressure drop across the filter. The fabric

	Technique	Description
		filter should have multiple compartments which can be individually isolated in case of bag failure and there should be sufficient of these to allow adequate performance to be maintained if a compartment is taken off line. There should be 'burst bag detectors' in each compartment to indicate the need for maintenance when this happens. Filter bags are available in a range of woven and non-woven fabrics. Modern synthetic fabrics can operate at quite high temperatures of up to 280 °C. The performance of fabric filters is mainly influenced by different parameters, such as compatibility of the filter medium with the characteristics of the flue-gas and the dust, suitable properties for thermal, physical and chemical resistance, such as hydrolysis, acid, alkali, and oxidation and process temperature. Moisture and temperature of the flue-gases have to be taken into consideration during the selection of the technique.
c	Hybrid filters	Hybrid filters are the combination of ESPs and fabric filters in the same device. They generally result from the conversion of existing ESPs. They allow the partial reuse of the old equipment

1.5.2 *NO_x emissions*

	Technique	Description
a	Primary measures/techniques	
	I Flame cooling	The addition of water to the fuel or directly to the flame by using different injection methods, such as injection of one fluid (liquid) or two fluids (liquid and compressed air or solids) or the use of liquid/solid wastes with a high water content reduces the temperature and increases the concentration of hydroxyl radicals. This can have a positive effect on NO_x reduction in the burning zone
	II Low NO_x burners	Designs of low NO_x burners (indirect firing) vary in detail but essentially the fuel and air are injected into the kiln through concentric tubes. The primary air proportion is reduced to some 6 – 10 % of that required for stoichiometric combustion (typically 10 – 15 % in traditional burners). Axial air is injected at high momentum in the outer channel. The coal may be blown through the centre pipe or the middle channel. A third channel is used for swirl air, its swirl being induced by vanes at, or behind, the outlet of the firing pipe. The net effect of this burner design is to produce very early ignition, especially of the volatile compounds in the fuel, in an oxygen-deficient atmosphere, and this will tend to reduce the formation of NO_x. The application of low NO_x burners is not always followed by a reduction of NO_x emissions. The set-up of the burner has to be optimised
	III Mid kiln firing	In long wet and long dry kilns, the creation of a reducing zone by firing lump fuel can reduce NO_x emissions. As long kilns usually have no access to a temperature zone of about 900 – 1 000 °C, mid-kiln firing systems can be installed in order to be able to use waste fuels that cannot pass the main burner (for example tyres). The rate of the burning of fuels can be critical. If it is too slow, reducing conditions can occur in the burning zone, which may severely affect product quality. If it is too high, the kiln chain section can be overheated – resulting in the chains being burned out. A temperature range of less than 1 100 °C excludes the use of hazardous waste with a chlorine content of greater than 1 %
	IV Addition of mineralisers to improve the burnability of the raw meal (mineralised clinker)	The addition of mineralisers, such as fluorine, to the raw material is a technique to adjust the clinker quality and allow the sintering zone temperature to be reduced. By reducing/lowering the burning temperature, NO_x formation is also reduced

	Technique	Description
	V Process optimisation	Optimisation of the process, such as smoothing and optimising the kiln operation and firing conditions, optimising the kiln operation control and/or homogenisation of the fuel feedings, can be applied for reducing NO_x emissions. General primary optimisation measures/techniques, such as process control measures/techniques, an improved indirect firing technique, optimised cooler connections and fuel selection, and optimised oxygen levels have been applied
b	Staged combustion (conventional or waste fuels), also in combination with a precalciner and the use of optimised fuel mix	Staged combustion is applied at cement kilns with an especially designed precalciner. The first combustion stage takes place in the rotary kiln under optimum conditions for the clinker burning process. The second combustion stage is a burner at the kiln inlet, which produces a reducing atmosphere that decomposes a portion of the nitrogen oxides generated in the sintering zone. The high temperature in this zone is particularly favourable for the reaction which reconverts the NO_x to elementary nitrogen. In the third combustion stage, the calcining fuel is fed into the calciner with an amount of tertiary air, producing a reducing atmosphere there, too. This system reduces the generation of NO_x from the fuel, and also decreases the NO_x coming out of the kiln. In the fourth and final combustion stage, the remaining tertiary air is fed into the system as 'top air' for residual combustion
c	SNCR	Selective non-catalytic reduction (SNCR) involves injecting ammonia water (up to 25 % NH_3), ammonia precursor compounds or urea solution into the combustion gas to reduce NO to N_2. The reaction has an optimum effect in a temperature window of about 830 to 1 050 °C, and sufficient retention time must be provided for the injected agents to react with NO
d	SCR	SCR reduces NO and NO_2 to N_2 with the help of NH_3 and a catalyst at a temperature range of about 300 – 400 °C. This technique is widely used for NO_x abatement in other industries (coal fired power stations, waste incinerators). In the cement industry, basically two systems are considered: low dust configuration between a dedusting unit and stack, and a high dust configuration between a preheater and a dedusting unit. Low dust flue-gas systems require the reheating of the flue-gases after dedusting, which may cause additional energy costs and pressure losses. High dust systems are considered preferable for technical and economical reasons. These systems do not require reheating, because the waste gas temperature at the outlet of the preheater system is usually in the right temperature range for SCR operation

1.5.3 *SO_x emissions*

	Technique	Description
a	Absorbent addition	Absorbent is either added to the raw materials (e.g. hydrated lime addition) or injected into the gas stream (e.g. hydrated or slaked lime ($Ca(OH)_2$), quicklime (CaO), activated fly ash with a high CaO content or sodium bicarbonate ($NaHCO_3$)). Hydrated lime can be charged into the raw mill together with the raw material constituents or directly added to the kiln feed. The addition of hydrated lime offers the advantage that the calcium-bearing additive forms reaction products that can be directly incorporated into the clinker-burning process. Absorbent injection into the gas stream can be applied in a dry or wet form (semi-dry scrubbing). The absorbent is injected into the flue-gas path at temperatures close to the water dew point, which results in more favourable conditions for SO_2 capture. In cement kiln systems, this temperature range is usually reached in the area between the raw mill and the dust collector

	Technique	Description
b	Wet scrubber	The wet scrubber is the most commonly used technique for flue-gas desulphurisation in coal-fired power plants. For cement manufacturing processes, the wet process for reducing SO_2 emissions is an established technique. Wet scrubbing is based on the following chemical reaction: $SO_2 + ½\ O_2 + 2\ H_2O + CaCO_3 \leftrightarrow CaSO_4 \cdot 2\ H_2O + CO_2$ SO_x are absorbed by a liquid/slurry which is sprayed in a spray tower. The absorbent is generally calcium carbonate. Wet scrubbing systems provide the highest removal efficiencies for soluble acid gases of all flue-gas desulphurisation (FGD) methods with the lowest excess stoichiometric factors and the lowest solid waste production rate. The technique requires certain amounts of water with a consequent need for waste water treatment

1.6 **Description of techniques for lime industry**

1.6.1 *Dust emissions*

	Technique	Description
a	ESP	A general description of ESPs is provided in Section 1.5.1. ESPs are suitable for use at temperatures above the dew point and up to 400 °C. Furthermore, it is also possible to use ESPs close to, or below, the dew point. Because of high volume flows and relatively high dust loads, mainly rotary kilns without preheaters but also rotary kilns with preheaters are equipped with ESPs. In the case of combination with a quenching tower, excellent performance can be achieved
b	Fabric filter	A general description of fabric filters is provided in Section 1.5.1. Fabric filters are well suited for kilns, milling and grinding plants for quicklime as well as for limestone; lime hydrating plants; material transport; and storage and loading facilities. Often a combination with cyclone prefilters is useful. The operation of fabric filters is limited by the flue-gas conditions such as temperature, moisture, dust load and chemical composition. There are various fabric materials available to resist mechanical, thermal and chemical wear to meet those conditions
c	Wet dust separator	With wet dust separators, dust is eliminated from off-gas streams by bringing the gas flow into close contact with a scrubbing liquid (usually water), so that the dust particles are retained in the liquid and can be rinsed away. There are a number of different types of wet scrubbers available for dust removal. The main types that have been used in lime kilns are multi-cascade/multistage wet scrubbers, dynamic wet scrubbers and venturi wet scrubbers. The majority of wet scrubbers used on lime kilns are multi-cascade/multistage wet scrubbers. Wet scrubbers are chosen when the flue-gas temperatures are close to, or below the dew point. They may also be chosen when space is limited. Wet scrubbers are sometimes used with higher temperature gases, in which case, the water cools the gases and reduces their volume
d	Centrifugal Separator/ cyclone	In a centrifugal separator/cyclone, the dust particles to be eliminated from an off-gas stream are forced out against the outer wall of the unit by centrifugal action and then eliminated through an aperture at the bottom of the unit. Centrifugal forces can be developed by directing the gas flow in a downward spiral motion through a cylindrical vessel (cyclonic separators) or by a rotating impeller fitted in the unit (mechanical centrifugal separators). However, they are only suitable as pre-separators because of their limited particle removal efficiency and they relieve ESPs and fabric filters from high dust loading, and reduce abrasion problems

1.6.2 *NO_x emissions*

	Technique	Description
a	Burner design (low NO_x burner)	The low NO_x burners are useful for reducing the flame temperature and thus reducing thermal and (to some extent) fuel derived NO_x. The NO_x reduction is achieved by supplying rinsing air for lowering the flame temperature or pulsed operation of the burners. Low NO_x burners are designed to reduce the primary air portion which leads to lower NO_x formation whereas common multi-channel burners are operated with a primary air portion of 10 to 18 % of the total combustion air. The higher portion of the primary air leads to a short and intensive flame by the early mixing of hot secondary air and fuel. This results in high flame temperatures along with a creation of a high amount of NO_x formation which can be avoided by using low NO_x burners
b	Air staging	A reducing zone is created by reducing the oxygen supply in the primary reaction zones. High temperatures in this zone are particularly favourable for the reaction which reconverts the NO_x to elementary nitrogen. At later combustion zones, the air and oxygen supply is increased to oxidise the gases formed. Effective air/gas mixing in the firing zone is required to ensure that CO and NO_x are both maintained at low levels. In 2007, air staging had never been applied in the lime sector
c	SNCR	Nitrogen oxides (NO and NO_2) from the flue-gases are removed by selective non-catalytic reduction and converted into nitrogen and water by injecting a reducing agent into the kiln which reacts with the nitrogen oxides. Ammonia or urea is typically used as the reducing agent. The reactions occur at temperatures of between 850 and 1 020 °C, with the optimal range typically between 900 to 920 °C

1.6.3 *SO_x emissions*

	Technique	Description
a	Absorbent addition techniques	The technique involves the addition of an absorbent in dry form directly into the kiln (fed or injected) or in dry or wet form (e.g. hydrated lime or sodium bicarbonate) into the flue-gases in order to remove SO_x emissions. When absorbent is injected into the flue-gases, a sufficient residence time between the injection point and the dust collector (fabric filter or ESP) must be provided in order to obtain an efficient absorption. For rotary kilns, absorption techniques may include: — Use of fine limestone: At a straight rotary kiln fed with dolomite, significant reductions in SO_2 emissions can occur with feedstones which either contain high levels of finely divided limestone or are prone to break up on heating. The finely divided limestone calcines are entrained in the kiln gases and remove SO_2 en route to, and in, the dust collector. — Lime injection into the combustion air: A patented technique (EP 0 734 755 A1) which removes SO_2 emissions from rotary kilns by injecting finely divided quick or hydrated lime into the air fed into the firing hood of the kiln

1.7 **Description of techniques for the magnesia industry (dry process route)**

1.7.1 *Dust emissions*

	Measure/Technique	Description
a	Electrostatic precipitators (ESPs)	A general description of ESPs is provided in Section 1.5.1

	Measure/Technique	Description
b	Fabric filters	A general description of fabric filters is provided in Section 1.5.1 Fabric filters receive high particle retention, typically over 98 % and up to 99 % depending on the particle size. This technique offers the best efficiency on particle collection in comparison to other dust abatement measures/techniques used in the magnesia industry. However, because of the high temperatures of the kiln flue-gases, special filter materials which can tolerate high temperatures have to be used. In DBM manufacturing, filter materials operating with temperatures of up to 250 °C are used, such as PTFE (Teflon) filter material. This filter material shows good resistance to acids or alkalis and a lot of corrosion problems have been solved
c	Cyclones (centrifugal separator)	A general description of cyclones is provided in Section 1.6.1. They are robust equipment and they have a wide operational temperature range with a low energy requirement. Because of the system-dependent limited degree of separation, cyclones are mainly used as preliminary separators for coarse dust and flue-gases
d	Wet dust separators	General description of wet dust separators (also called wet scrubbers) is provided in Section 1.6.1 Wet dust separators can be divided into various types according to their design and working principles, such as the venturi type. This type of wet dust separator has a number of applications in the magnesia industry, including when gas is directed through the narrowest section of the venturi tube, the 'venturi neck', and gas velocities of between 60 and 120 m/s can be achieved. The washing fluids which are fed into the venturi tube neck are diffused into a mist of very fine droplets and are intensively mixed with the gas. The particles separated onto the water droplets become heavier and can be readily drawn off using a drop separator installed in this venturi wet dust separator

1.7.2 *SO_x emissions*

	Technique	Description
a	Absorbent addition technique	The technique involves the injection of an absorbent in dry or wet form (semi-dry scrubbing) into the flue-gases in order to remove SO_x emissions. A sufficient gas residence time between the injection point and the dust collector is very important to obtain highly efficient absorption. Reactive MgO grades can be used as efficient absorbents for SO_2 in the magnesia industry. Despite the lower efficiency compared to other absorbents, the use or reactive MgO grades has a double advantage as it lowers the investment costs and also the filter dust is not contaminated by other substances and can be reused in place of raw materials for the production of magnesia or employed as a fertiliser (magnesium sulphate) minimising waste generation
b	Wet scrubber	In the wet scrubbing technique, SO_x are absorbed by a liquid/slurry which is sprayed countercurrently to the flue-gases in a spray tower. The technique requires an amount of water between 5 and 12 m^3/tonne product, with a consequent need for a waste water treatment

Appendix E

Best Available Techniques (BAT) Reference Document for the Production of Cement, Lime and Magnesium Oxide

E1