

## SECTION 7 ALTERNATIVES

The purpose of this section of the document is to give due consideration to possible feasible alternatives to the proposed development. The guideline for the identification and analysis of these alternatives are derived from the DEAT (2004) IEM Information Series <sup>51</sup>. The process alternatives for this proposal consider the following:

**Table 7-1: Process Alternatives investigated**

Possible process alternatives	Reasons for considering alternative	Decision re: alternative consideration
Different types of secondary materials	The composition of the secondary materials will affect the emissions generated by the kiln, as well the composition of the final cement	Many alternative waste streams were considered and are discussed in report, Section 8.1.
Storage locations for the secondary materials	A centralised blending platform may provide more specialised facilities for the storage and blending of waste streams at locations more central to the cement kiln.	This was not considered as it would require a separate EIA application. For the five waste streams applied for by PPC, on-site storage has been proposed.
Transportation alternative (road or rail)	Different routes and reliabilities of transporting hazardous waste and therefore different levels of risk	Not considered as the quantities of waste transported require only road transport, and as no centralised blending platform is considered, transport directly from the waster generator to PPC De Hoek needs to occur. Rail transport does not provide the flexibility of routes to allow this.
Different feeding equipment to the kiln	Not applicable	Standard equipment is available from international suppliers according to best international practice. Not considered further.
Disposal of waste to landfill, incinerator and/or recycling (no-go option)	These are considered as waste disposal and treatment alternatives in terms of the waste hierarchy as published by DWAF.	Considered in depth in Section 11.7.

Location alternatives may include other PPC plants, but these have applied separately for authorisation for secondary materials co-processing.

<sup>51</sup> DEAT (2004) *Criteria for determining Alternatives in EIA, Integrated Environmental Management, Information Series 11, Department of Environmental Affairs and Tourism (DEAT), Pretoria*

## 7.1 TYPES OF SECONDARY MATERIALS

The waste streams chosen for this application were selected on reasons both economic and environmental. They were chosen from all the possible waste streams which were researched by PPC as being:

1. Readily available in the market;
2. Problematic in that financially-feasible recycling or re-use alternatives do not exist in the market at present;
3. High in calorific or mineralogical value;
4. Available in large quantities on a regular basis from the same generators. This is an important consideration when considering the choice of a waste stream as PPC did not want to consider irregular or inconsistent waste streams. Once-off or irregular waste streams of small quantities would introduce too great a risk of variance in the quality of the waste stream, which would introduce the risk of exceedences on emissions and unacceptable variations to product quality.
5. Sufficient international experience exists in the processing of the waste streams, from impact of the waste streams on the operation of kiln to the design of feeding equipment.
6. Providing a low risk of process upset conditions;
7. Can be easily transported, handled, stored and fed into the kiln.

Furthermore, there are certain waste streams which have been deemed by the ACMP as being unacceptable for disposal to cement kiln. These include:

1. Anatomical Hospital Wastes;
2. Asbestos-containing Wastes;
3. Unsorted Electronic Scrap;
4. Bio-hazardous Wastes;
5. Entire Batteries;
6. Explosives;
7. Mineral Acids;
8. Radioactive Wastes, and
9. Unsorted Municipal Waste.

It is for these reasons that PPC considered the five streams for which this application is being made as being the most suitable for their purposes.

## 7.2 TRANSPORTATION ALTERNATIVES

### 7.2.1 Modes of transport - Road and Rail

It is not anticipated that PPC will be responsible for the transportation of the waste materials to PPC De Hoek manufacturing plant. The onus will be on the waste generator to transport the waste to the factory.

The preferred alternative for transportation of the waste is by rail as the risks of accidental spillage are minimised. However as PPC has no control over the transportation of the waste to their facility, this cannot be a recommendation of this study, or a condition of the approval of this application.

## 7.3 TECHNOLOGY ALTERNATIVES

### 7.3.1 Baghouses

Baghouses are fabric collectors which use filtration to separate dust particulates from gases. Baghouse are one of the most efficient and cost effective dust collectors used in cement manufacture and can achieve a dust removal efficiency of more than 99% for very fine particulates. The baghouse is designed to pass the kiln gases through fabric bags that act as filters.

The high efficiency of these filters is due to the formation of a dust cake which settles on the surfaces of the bags. The fabric primarily provides a surface on which dust particulates can be collected.

As stated in Section 3.2.3, when there is an insufficient supply of O<sub>2</sub> for combustion of fuels and raw materials, the O<sub>2</sub> level will drop and CO will be formed, as indicated by the following formula  
$$C + \frac{1}{2} O_2 \rightarrow CO.$$

CO is an explosive gas, even at low concentrations. The ESP is a filter used to reduce the particulate emissions from the stack. The gases from the kiln are sent through negatively charged pipes at the entrance to the ESP, giving the particles a negative charge. In the ESP, the particles are routed past positively charged plates which attract the negatively charged particle, causing them to stick to the plates, for later collection. Due to the highly charged electrical environment and the potential for sparks between the electrodes, there is a risk of explosion when flammable gases, such as CO, enter the ESP.

As a routine practise, the power to the ESP is cut when CO levels at the back end of the kiln reach 1%, which allows the CO levels to drop in the ESP, but results in the increase in particulates emitted from the stack. The ESP is usually tripped for 2 – 3 minutes at a time. At De Hoek, the ESP is tripped 800 – 1,000 times per year. In the event of such trips, the dust emissions can increase to 500mg/Nm<sup>3</sup>.

Baghouses have a higher dust removal efficiency than the ESP, and has no risk of explosion on contact with flammable gases, removing the necessity for frequent controlled trips, and therefore removing the risk of uncontrolled release of cement kiln dust. Further, there is a possibility that dust composition may change with the introduction of secondary materials to the process and the installation of baghouses will mitigate the volume of dust generated from clinker produced with secondary materials.

The installation of baghouses represents a significant expenditure for PPC. In light of this and current economic trends, the installation of baghouses is planned for the end of 2011, which is in line with the timeframes stipulated in the proposed emission limits in the National Policy for High Temperature Thermal Waste Treatment and Cement Kiln Alternative Fuel Use.

### 7.3.2 Methods to increase efficiency of scrubbing effect

The scrubbing effect is inherent to the process and cannot readily be improved without significant capital investment. In particular to De Hoek, the scrubbing effect is due to the intensive contact between process gas and solids in the 4 stage pre heaters. Under the current economic climate, it is not feasible for PPC to consider such process alterations prior to the timeframes stipulated in the National Policy for High Temperature Thermal Waste Treatment and Cement Kiln Alternative Fuel Use.

The addition of secondary materials will not significantly increase SO<sub>2</sub> emissions, and PPC are committed to comply with the self imposed emissions, as described in Section 8. This alternative is therefore regarded as mitigation for current operations that should be considered by PPC at a later stage in line with the proposed national policy.

## 7.4 NO-GO ALTERNATIVE

### 7.4.1 Incineration vs. Cement Kiln Co-processing

There are many different types of incineration technology in use today, but the Rotary Kiln, Multiple Hearth and Fluidized Bed Furnaces have been shown to be the most versatile for hazardous waste streams. Hazardous waste normally requires very high temperatures (up to 1,250°C) and long residence times (1 to 2 seconds) for complete combustion of thermally stable materials such as PCB's and dioxins. The high cost of incineration is exacerbated by the following:

- The need for considerable atmospheric pollution control equipment, which often costs more than the combustor itself;
- The sophistication of the equipment required for the safe handling and analysis of highly toxic materials; and
- The need for highly trained staff.

Hazardous waste incineration is an engineered process that employs thermal oxidation at high temperature (normally 900°C or higher) to destroy the organic fraction of waste. Minimum temperatures required for incineration range from 875°C for incineration of municipal garbage to 1,400°C for incineration of more stable organic compounds such as PCB's, dioxins, and residues from the manufacture halogenated polyvinyl products. Residence time at high temperature must be at least 2 seconds.

Production of cement clinker in cement kilns also involves high temperature burning. Liquid waste can be introduced into cement kilns using conventional oil burners; solid waste in the form of granulated material or powder can be fired like coal dust. In comparison with other types of hazardous waste incinerators, cement kilns possess several characteristics, which make them a more efficient technology for destroying highly toxic and stable organic wastes:<sup>52</sup>

- Combustion gas temperatures and residence times in cement kilns exceed those of commercial hazardous waste incinerators. These high combustion temperatures and long residence times, along with the strong turbulence encountered in cement kilns, assure the complete destruction of even the most stable organic compounds;
- Burning of cement clinker requires a material temperature of 1,400 – 1,500°C; consequently the flame temperature must be even higher in order to obtain the required heat transmission from flame to material. In the case of short kilns such as preheater kilns and calciner kilns the gas temperature in the burning zone is about 2,000°C, at mid-kiln it is about 1,700 °C, and at the kiln exit it is about 1,100°C;
- The gas retention time is about 5 seconds; and

<sup>52</sup> Bolwerk, R. *Genehmigungspraxis beim Einsatz von Abfällen in Zementwerken – Vorsorgeaspekte, Emissionsminderung, Qualitätssicherungskonzept, Umweltrechtliche Studien (27) 2001, Nomos Verlagsgesellschaft, Baden Baden.*

- The inherent process controls and self-governance imposed on the cement process due to the fact that the core business of the cement industry is to produce cement and not burn wastes.

Table 7-2 compares the general differences and similarities between dedicated incinerators and the co-processing of waste in a cement kiln. A comparison of the emission limits as prescribed by the European Community for dedicated incinerators and cement kiln is depicted in Table 7-3. The limits for incinerators are somewhat different but basically equally stringent.

**Table 7-2: Comparison of inputs and outputs to a cement kiln used for co-processing and dedicated incinerators<sup>53</sup>**

Inputs and Outputs	Dedicated Incinerators	Cement Kiln: Co-processing
<i>Input Materials</i>	Spent solvents Filter cake Paint residues Sewage sludge	Spent solvents Filter cake Paint residues Sewage sludge
<i>Input Utilities</i>	Electricity Lime Sodium hydroxide Ammonia	Electricity at the kiln Electricity for waste processing Transport to kiln
<i>Airborne Emissions</i>	Acid gases Metals CO <sub>2</sub> CO Dioxins Hydrocarbons	Acid gases Metals CO <sub>2</sub> CO Dioxins Hydrocarbons
<i>Waterborne Releases</i>	Metals in effluent	None (no liquid effluent)
<i>Solid Wastes</i>	Solid residue Fly ash and bottom ash	None (incorporated in clinker)
<i>Avoided Products</i>	Steam Electricity	Input coal Input crude oil Input raw material

**Table 7-3: Air emission limit values for incineration and co-incineration of waste under Directive 2000/76/EC<sup>54</sup>**

Pollutant	Incinerators	Cement Kilns
Total dust	10	30
HCl	10	10
HF	1	1
NO <sub>x</sub> for existing plants	400	800
NO <sub>x</sub> for new plants	200	500
SO <sub>2</sub>	50	50
TOC	10	10

<sup>53</sup> CEMBEREAU. *Environmental Benefits of using Alternative Fuels in Cement*

<sup>54</sup> WRC Ref: CO5087\_4 July 2003 pg 132

Pollutant	Incinerators	Cement Kilns
Cd +Ti	0.05	0.05
Hg	0.05	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni + V	0.5	0.5
Dioxins toxic equivalence	0.1	0.1

*Units are all in mg/Nm<sup>3</sup> except Dioxins, which are in ng/Nm<sup>3</sup>*

#### 7.4.2 Disposal to Landfill versus Cement Kiln Co-processing

The two main benefits from a secondary materials programme to the broader environment are:

1. The avoidance of landfilling of hazardous wastes, and
2. The replacement of non-renewable fossil fuels (i.e. coal).

Cement kilns, due to their size, are capable of making a significant difference to especially the former, whereas hazardous waste incinerators generally process small volumes of highly hazardous waste.

With the integration of cement kilns into regional or national waste management schemes, additional space for landfills can be saved. In line with international best practice, the South African authorities have declared their intention to reduce waste to landfill by 50% by 2012 and to have no waste to landfill by 2022. Cement kilns can make a significant contribution towards achieving these goals due to the fact that no solid or liquid wastes are generated during the co-processing of secondary materials.

Including mine tailings, South Africa produces over 400 million tons of waste every year. Of this, close to 2 million tons can be classed as hazardous which requires special attention for treatment and disposal. As discussed in Section 8.13, the volumes of waste which may be processed by kilns can significantly delay the construction of further hazardous landfill in South Africa.

A simple calculation using Gauteng as an example illustrates this point:

- A cement plant consumes 3,000 to 6,500 MJ of fuel per ton of clinker produced, depending on the raw materials and the process used;
- PPC, on average, uses 4,500 MJ per ton of clinker (average for all PPC kilns). For an average cement kiln in SA (i.e. 360 000 tons of clinker pa), 66,100 tpa of coal is required at a calorific value of 25 MJ/t;
- Using a waste pitch stream, for example, of 30 MJ, at a 30% heat replacement rate<sup>55</sup>, equates to 16 500 tpa or roughly 15,000 m<sup>3</sup> of waste which would have ordinarily reported to a hazardous landfill. This waste is normally pretreated with fly-ash to stabilise the waste prior to disposal at landfill, thereby increasing its volume by 200 – 300%;
- It may be assumed therefore, that for the five PPC kilns capable of servicing the Gauteng area, for example, (Jupiter, Hercules, Slurry and Dwaalboom (2 kilns)), PPC may have a maximum effect of preventing 225,000 m<sup>3</sup> of landfill airspace from being occupied per annum;

<sup>55</sup> In Europe, certain kilns have been mandated by government to have up to a 30% of their fuel substituted by waste.

- Currently Holfontein (the only H:H landfill in Gauteng) and Rietfontein (the only engineered general landfill capable of receiving delisted hazardous waste) are both filling up at a rate of 180,000 m<sup>3</sup> per annum<sup>56</sup>, or 360,000 m<sup>3</sup> pa when including the mixing of hazardous waste with fly-ash<sup>57</sup>; and
- By comparison, the other major hazardous waste incinerator company (not medical waste) in Gauteng processes 60 tons per day at its one site, which will soon be upgraded to 150 tpd (i.e. equivalent to approx. 8,000 m<sup>3</sup> per month of H:H landfill airspace).

PPC's proposal therefore offers the potential to significantly divert waste from landfills: equivalent in volume to:

- Approx. 60% of the waste disposal at Holfontein. Cement kiln disposal by PPC alone (by kilns servicing the Gauteng area) is, on a volumetric basis, roughly equivalent to constructing another H:H landfill site without the capital costs and long-term environmental risks of landfill disposal; and
- 28 times the capacity of the largest hazardous waste incinerator in Gauteng.

Figures for the Piketburg area were not available at the time but this illustrative example serves to reflect the impact that cement kiln disposal will have on waste disposal to landfill.

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<sup>56</sup> GDACE: *Gauteng State of the Environment Report, 2004.*

<sup>57</sup> *Personal communication: E Gombault, Technical Director, Enviroserv, Jan 2007*