SECTION 4 PPC'S SECONDARY MATERIALS CO-PROCESSING PROGRAMME

This section describes in detail the proposed design and activities of PPC with respect to co-processing of secondary materials. Many of the activities listed below may be regarded as mitigation measures required to address the issues raised in the following sections of this scoping report. Since PPC's programme has, however, been designed with the mitigation measures in mind and cannot be separated from the co-processing programme, it is appropriate to present in this chapter PPC's entire proposed programme. Where necessary, mitigation measures have been repeated or summarised in Section 11.

4.1 SAMPLING AND ACCEPTANCE OF SECONDARY MATERIALS PRIOR TO PROCESSING

4.1.1 Introduction

In order to address the risks posed by inappropriate secondary materials on emissions, as well as to avoid compromising the quality of clinker produced and kiln stability, a rigorous programme of sampling and analysis of waste streams prior to being fed to the kiln has been developed by PPC. This is in line with international best practice, an example of which is provided below as adopted by international cement companies:

The use of a decision model, as illustrated in Figure 4-1, is essential to ensure that consistent and correct procedures are followed in line with company policies (see PPC policy in Section 9.1) and to prevent negative impacts on safety and health of workers and the environment in general.

PPC's Standard Operation Procedure (SOP), which will form part of its ISO 14001 Environmental Management System, is summarised in this chapter. It is important to note that this document, as required by the ISO 14001 system, will be updated and reviewed as it is implemented and process situations require.

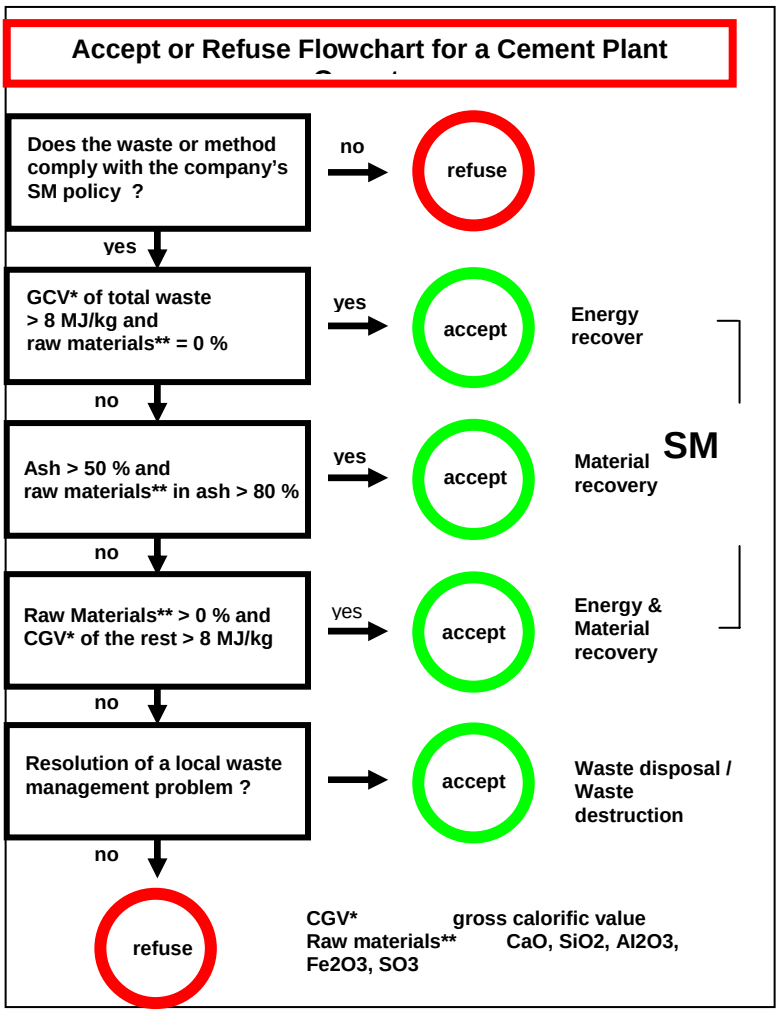

***Figure 4-1: Example of an Accept-Refuse Chart for SM use*[41]**

The procedures outlined in this SOP have been developed to ensure that the potential secondary materials undergo a systematic sampling, analysis and quality control process to ensure that those materials selected are suitable for co-processing, and are handled and transported in a responsible, legal and effective manner for both PPC and the generator of waste. This procedure therefore describes the manner in which secondary materials are sampled, analysed, transported, quality checked and describes all associated documentation and notifications that may be required.

Adherence to this procedure should therefore prevent the processing of unsuitable materials which may result in emissions transgressing the authorised limits, impact on plant operations, or the production of sub-standard cement. Furthermore, PPC must avoid materials arriving on site which are deemed unsuitable, and which must then be disposed of or returned to the waste generator (which may be costly and jeopardise business relations).

The seven principles of the Secondary Materials Policy (see Section 1.7) have been incorporated into the procedure.

[41] *Benefits & Limitation when using Secondary Materials: P. Liebl*

4.1.2 Initial Screening

Materials must be screened to establish whether it is a *potential secondary materials source* and suitable for co-processing, according to the following criteria:

1. Waste type (is it an authorised[42] material);
2. Physical properties (particle size, physical state);
3. Moisture content;
4. Chemical composition and calorific value (if known);
5. Potential volumes and supply;
6. Homogeneity of the waste (composition variance);
7. Transportation; and
8. Hazardous properties.

The Screening Checklist must be completed for the waste. Information for the material may be obtained from the following sources:

1. Information from the Secondary Materials Source Database;
2. Information from the waste generator;
3. Photographs; and
4. Visual assessment.

Should the waste be considered a potential secondary materials source, arrangements are made to obtain samples for a detailed Waste Identification Analysis to determine whether the material will be accepted or refused for co-processing.

4.1.3 Waste Identification Analysis

A comprehensive Waste Identification Analysis is required for wastes streams that have passed the initial screening phase. This is a detailed analysis, covering organic, inorganic and energy parameters, to establish the nature and composition of the waste to determine whether it is suitable for co-processing.

A Waste Identity Analysis sheet is completed for each waste stream, using information from:

a) The Generator of the waste;
b) Laboratory analysis;
c) MSDS of hazardous substances contained within the waste;
d) Visual observation; and
e) Secondary Materials Source Database.

The Secondary Materials Source Database is updated accordingly with the Waste Identification Analysis.

The approval of the waste material for co-processing is based on the acceptance criteria flowchart contained in Figure 4-1. If the waste material is approved, a suitability study for the cement kiln is required.

[42] *Authorised material – in terms of an EIA RoD ECA Waste Permit and APPA Registration Certificate. Materials refused include the listed "banned wastes" as per the ACMP Waste Charter dated 5 November 2004.*

4.1.4 Sampling Protocols

It is crucial that correct sampling protocols are followed to ensure that a representative sample is obtained for materials requiring a Waste Identification Analysis, Fingerprint Confirmation Analysis or Detailed Analysis, especially if there is a variance in the composition of the waste stream.

Detailed Work Instructions will be developed by PPC describing the sampling process in more detail for the following:

a) Sampling of liquids;

b) Sampling of bulk solids; and

c) Sampling costs.

These Work Instructions will describe the requirements for both fresh arisings and legacy material. Sampling principles will include the following:

a) Contamination - sampling equipment must be free from previous materials which can influence (contaminate) the physical or chemical composition of the waste. All equipment and containers should be cleaned thoroughly and decontaminated prior to use as well as after each sampling event;

b) Used containers that have not been decontaminated must be avoided to reduce the potential of cross-contamination;

c) Representative Sampling – as waste stream composition may change from time to time, a number of samples must be obtained to ensure a representative sample is analysed. Changes may occur as a result of:

- process changes;
- origin of waste;
- time stored on site;
- storage conditions (contamination with other wastes) , and
- if exposed to the elements, weather conditions (for example, rain may increase moisture content, effectively diluting hazardous components).

d) Representative sampling may include the following:

- Sampling at different areas of the waste (across the waste);
- Sampling at different depths within the waste container ;
- Sampling from different containers (skips/drums), and
- Sampling at different time periods.

e) Sampling may require obtaining a number of ‘grab’ samples to be tested individually (to establish the variance of the waste stream), or combining a number of samples into a composite sample (when average or normalised estimates are required);

f) Sample Size – a sufficient volume of material is required for accurate laboratory analysis; and

g) Sample Preservation and Storage - If applicable, sample preservation techniques (to be described in a Work Instruction entitled: “Sample Preservation and Storage” which will be compiled by PPC) must be employed to ensure that the integrity of the waste remains intact while the samples are in transport to the laboratory and/or while temporarily stored at the laboratory prior to analysis.

Analyses are to be conducted by ISO 17025 and SANAS-accredited methods.

4.1.5 Suitability for the Cement Kiln (Desktop Study)

Waste streams that are deemed suitable based on the Initial Screening and Waste Identification Analysis must be assessed for kiln suitability from a process and operation perspective. Waste streams that are unsuitable in terms of physical or other properties, pre-treatment (mechanical, chemical) by either PPC or the waste generator must be considered to establish the feasibility of transforming the material into a form or state that is suitable.

The following will be assessed:

a) Thermal substitution potential;

b) Capital expenditure requirements; and

c) Economic feasibility study.

If the waste is deemed suitable, plant trials may commence.

4.1.6 Plant Trial

Cost estimates for a plant trial are established and approved by PPC Management before they are initiated.

The trials will be executed and emission testing conducted, following which a Trial Report is compiled and published. The report is submitted to the following government agencies for approval of the co-processing of the respective waste stream:

a) DEAT (amendments to waste permit);

b) Provincial Authority (issues RoD changes); and

c) Local Municipality (governs stack emissions in accordance with the permits).

4.1.7 Implementation

a) Contracts with the Waste generator

Once the waste stream has been deemed ‘acceptable’ for co-processing, and approved by the authorities, a contract is drawn up between PPC and the waste generator, outlining, *inter alia*, the following:

- Responsibilities of both parties;
- Co-processing prices;
- Reliability of supply volume and frequency;
- Costs regarding regular laboratory analysis;
- Transportation logistics;
- Documentation;
- Reporting requirements for process changes (which may affect the waste composition); and
- Consequences and costs in the event of waste loads being ‘contaminated’ or not meeting the determined specifications (as determine from the fingerprint analysis).

Contracts are signed before any waste load is accepted.

b) Fingerprint developing

A “fingerprint” of the waste stream is developed, which is based on the Waste Identification Analysis. This fingerprint is used to confirm key properties of the waste stream, including

physical, chemical and energy, which will be used for calculating co-processing operation requirements.

The fingerprint of the waste will also be used to determine which parameters are required for a Fingerprint Confirmation Analysis for each load that is received for co-processing.

A Secondary Materials Profile is completed for each waste stream fingerprint developed, and added to the Secondary Materials Source Database.

c) Transportation of Secondary Materials to Site

Once the contract has been signed, and if the plant is able to receive and store the respective waste stream for co-processing, the necessary arrangements are made for the waste to be delivered to the plant (as specified in the contract).

Where transportation is arranged by PPC, PPC accepts a responsibility to ensure that the waste is transported from the waste generator to the plant in a safe and responsible manner. The requirements of the National Road Traffic Act, 1996 (Act No. 93 of 1996) and regulated SANS Codes for the Transportation of Dangerous Goods (which includes hazardous waste) will therefore apply. The SANS standards prescribe requirements for placarding, documentation and operational requirements for the following:

- Consignee (PPC);
- Operator (Transportation Company); and
- Consignor (waste generator).

The relevant codes include the following:

- SANS 10231 Transportation of dangerous goods - Operational requirements for road vehicles;
- SANS 10232-1 Transport of dangerous goods - Emergency information systems Part 1: Emergency information system for road transport;
- SANS 10232-3 Transportation of dangerous goods - Emergency information systems Part 3: Emergency response guides; and
- SANS 10232-4 Transport of dangerous goods - Emergency information systems Part 4 transport emergency card.

Although documentation such as the Transport Emergency Cards, Dangerous Goods Declaration and Waste Classification Certificate are the responsibility of the Consignor and Operator, PPC will assist, where required (to facilitate expediency in collecting and disposing of the waste stream), to develop the required documentation on behalf of the waste generator. Information will be largely based on the Waste Identification Analysis and Fingerprinting / Secondary Materials Profile). The contract between PPC and the waste generator must clearly state the responsibilities of the waste generator to provide the required documentation in accordance with the SANS standards.

It is the responsibility of the operator to ensure that the emergency system documentation is available and carried at all times by the vehicle when transporting any hazardous waste on public roads. This legal requirement is included in all contracts between the transporter (operator) and PPC (consignee).

Furthermore, to account for the waste leaving the waste generator, a number of documents must be completed and issued to the waste generator. These documents will be used as proof of waste collection, delivery to the processing site, and provide records of safe disposal, and include the following:

a. Waste Manifest Documents (WMD) – required to confirm that each waste load collected from the waste generator has arrived at the plant for co-processing;

b. Certificates of Safe Disposal (CoSD) – issued to waste generators to confirm the waste load (as per the Waste Manifest Document) has been safely disposed of; and

c. Weigh Bills – to determine the tonnage of waste received on site, referenced to the WMD.

Detailed steps for the transportation and waste accounting documentation are outlined in the flow chart of Figure 4-1, and further described in the Work Instruction "Transportation of Hazardous Waste" (which will be developed by PPC).

Hazardous waste is unloaded in accordance with the Work Instruction: "Receiving of Hazardous Waste" (which will be developed by PPC). The Unloading Checklist is used as a guide by the qualified person to ensure the materials are unloaded in the correct manner.

Waste is stored on site in a responsible manner that will not expose staff and pose harm to the environment, and in accordance with the Work instruction: "Storage of Hazardous Waste" (also to be developed by PPC).

Two copies of the WMD are issued to the waste generator – one at the collection of the load, and the final copy once signed by the relevant PPC Plant.

Each month CoSDs are issued to all waste generators for each load received on site for the relevant month and which has been disposed of in the required manner. The CoSD states the quantities, WMD reference numbers, disposal method for all loads disposed in that month (or up to a specified date).

d) Fingerprint Confirmation Analysis

To ensure and verify that the composition of the waste stream remains suitable for co-processing, a sample of each container (e.g. drum or skip) of each load received on site is submitted for a *Fingerprint Confirmation Analysis*. This test will not include a 'full' analysis required for the *Waste Identification Analysis*, but will include those key parameters that may affect plant operations, quality of emissions or quality of cement. The parameters selected for testing will depend on the waste stream, its composition, and likelihood of variance.

If the load is confirmed to be acceptable, in accordance with the acceptance criteria (which will be published by PPC prior to commencement of the project – see recommendations in Section 11), the material is sent for co-processing.

If there has been a change in the nature or composition of the load, investigations are made to determine the cause. This may include a more *Detailed Analysis* to establish the cause, and decisions must be made regarding the following:

- Rejecting the entire waste stream;
- Rejecting an individual container within a load; or
- Changing the blending ratio to ensure the co-processing operation will meet all applicable criteria.

4.1.8 Regular Cross Check

A regular cross check sample of each waste stream accepted for co-processing is submitted for a detailed analysis (same as the *Waste Identification Analysis)* at least once a year to establish changes in the waste stream and confirm whether the waste remains suitable for co-processing.

The waste stream may be analysed more frequently than once a year for the following reasons:

1. Minor variations in production process of the generator. For example, it is acknowledged that the concentration of metals in sewage varies from day to day, since the sewage plant cannot control the inputs from the public into the sewage system. Minor variations in the metals content of the sludge are therefore expected and normal, and PPC will accommodate such by monitoring the sludge pellets on a monthly basis.
2. Fundamental changes to the generators process, which includes process modifications. An example maybe the addition of a digester to the sewage plant, which will fundamentally change the nature of the waste stream on a permanent basis.

The relevant sampling work instructions are to be followed, which will also specify the number of samples required for the detailed analysis. A *Waste Identification Analysis* is also required where it is known that there have been process changes (where a *Fingerprint Confirmation Analysis* has not yet been conducted). The Secondary Materials Source Database is updated with the results of the cross check.

4.1.9 External verification, auditing and reporting

This SOP is audited once a year by an external and competent auditor to ensure that all plants are conforming to the requirements and objective of this procedure.

Furthermore, the acceptance of a new waste stream (i.e. from a new waste source, or a new waste category or type within the 5 listed in terms of this application) shall be reported to the authorities (Provincial Environmental Department) with full details regarding its source, quantity and composition.

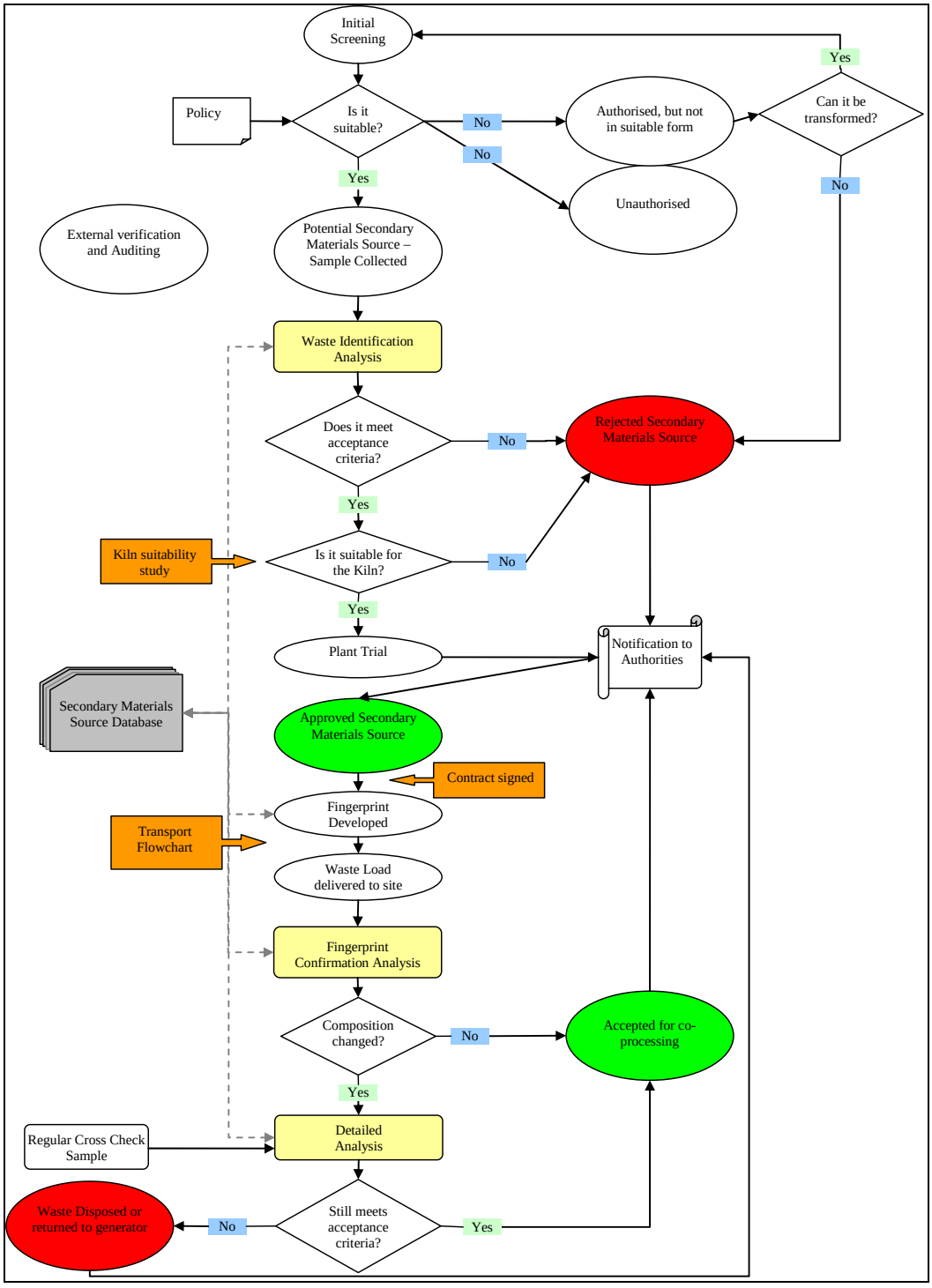

Figure 4-2: Secondary Materials Sampling and Handling

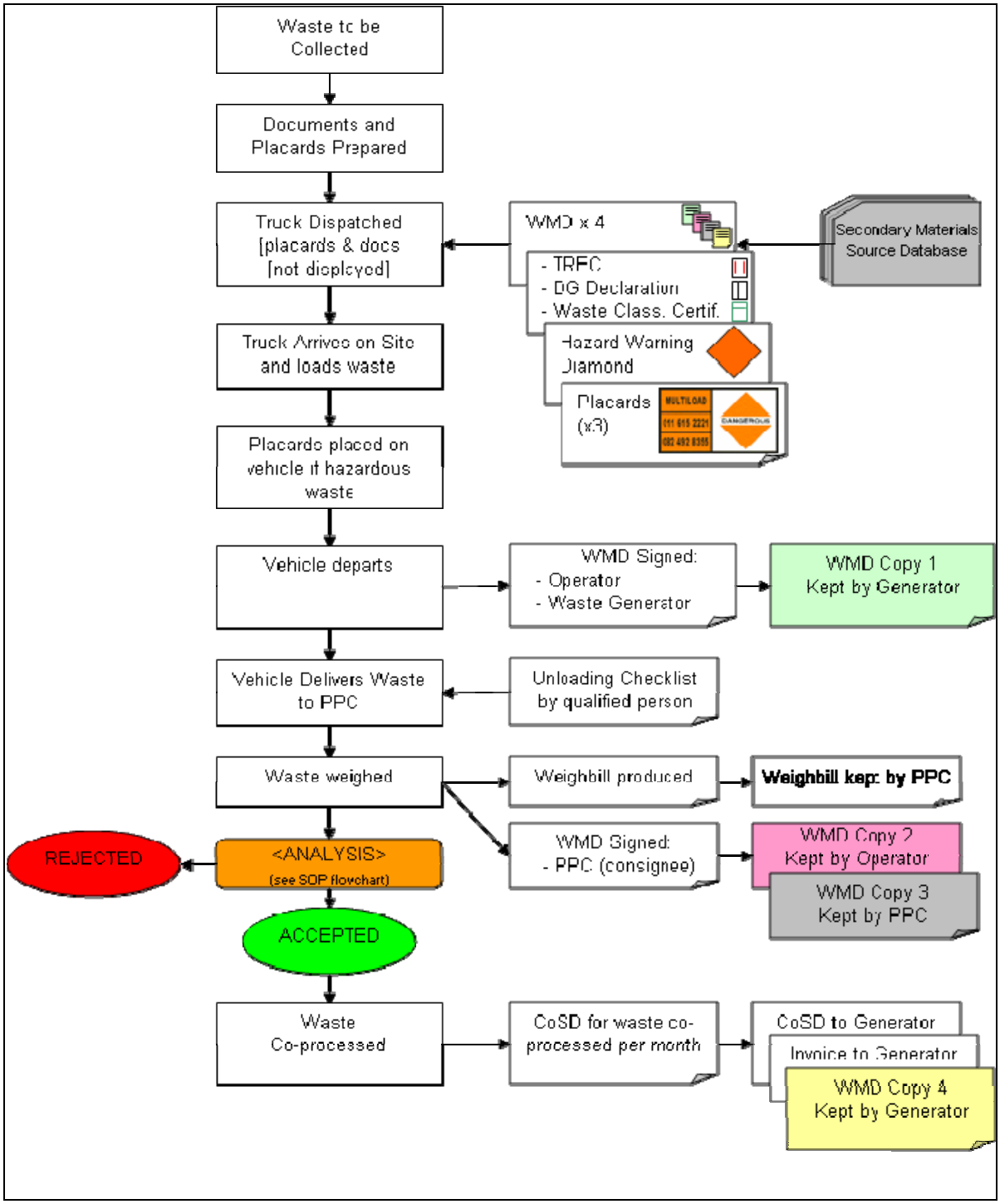

Figure 4-3: Secondary Materials Transport Flowchart

4.2 PHYSICAL OPERATION OF SECONDARY MATERIALS PROCESSING

4.2.1 Collection from Generator and Transport to site

Once the sampling protocols detailed in Section 4.1 have been completed and the waste stream is determined as being authorized and acceptable, PPC shall employ the services of a recognized waste transport contractor to deliver the waste to site as follows:

Table 4-1: Storage arrangements for Secondary Materials

Waste Stream	State of waste stream	Transport Containment
Waste Tyres		
	Whole tyres or chipped to a size required by the kiln system (20 - 50 mm chips) (including steel radials)	Open trucks
Sewage Sludge Pellets		
	Dried sewage pellets averaging < 20 mm in diameter. Moisture content < 15 %.	Covered skips or bulk bags. Material must be kept dry to ensure the area is not odorous and no CH_4 is generated
Pulp and Paper Waste:		
Dry	Shredded paper waste.	To avoid dust generation and moisture ingress during transport, covered skips or covered truck loads (not flat bed trucks).
Wet	Sludge or pulp slurries, with solid particle size < 25 mm. Note: these solutions may be corrosive due to their high pH.	Contained tankers, max. 30,000 l per load
Plastic waste:		
Dry	Shredded plastic waste (if sampling indicates no PVC contents)	To avoid dust generation during transport, covered skips or covered truck loads (not flat bed trucks).
Wet	Washed shredded plastic waste to remove all PVC through flotation separation	Covered skips or covered truck loads.
Hydrocarbon sludges and liquids:		
Received in drums (max. volume per drum = 210 l)	Liquid solutions with suspended solid fractions < 25 mm, and viscosity < 10,000 cP. Temperature = ambient.	Flatbed trucks are permissible as long as the drums are suitable strapped down.
Received in tankers		Contained tankers, max. 30,000 l per load

It will be an explicit requirement of any Supply Contracts entered into between PPC and the Generator of a waste stream, that the waste stream is prepared to a condition which is acceptable by PPC by the Generator. PPC will not establish a blending platform on site. PPC may, however, perform preparation of the waste streams in order to facilitate the safe feeding and metering of such to the kiln. Such preparation will be limited to physical preparation in such a manner as to

avoid the generation of noxious or offensive gases and any chemical alteration of the waste streams.

The appointment of the waste transport contractor shall be subject to the contractor complying with the following:

1. Compliance with all requirements of the National Road Traffic Act and associated SANS codes for Transportation of Dangerous Goods.
2. All Emergency Response equipment as stipulated in the Transport Emergency Card (as prescribed by SANS 10232-4) shall be carried on the vehicle.
3. All drivers carry a Professional Driver's Permit and are trained in HAZMAT response.
4. All documentation relevant to the load is accurate and complete.
5. The contractor has contracted adequate emergency response facilities along the route from the Generator to the PPC plant.
6. All placarding and emergency information relevant to the load is displayed by the transport contractor.

4.2.2 On-site storage

The general principles of storage and handling are as follows:

1. Establish suitable and safe transfer systems from transportation to the storage area to avoid SHEQ risks from spillage such as fugitive emissions or vapour displacement. Suitable vapour filtration and capture equipment should be in place to minimize impact to the reception point and surrounding areas from unloading activities.
2. Assure that storage facilities fit their purpose. Appropriate storage for liquids should meet relevant safety and design codes for storage pressures and temperatures.
3. Solid materials handling systems should have adequate dust control systems.
4. Storage design should be appropriate to maintain the quality of the materials: for solids, prevent build-up of old materials; for liquids, mix or agitate to prevent settlement, etc.
5. Design transfer and storage areas to manage and contain accidental spills into rainwater or firewater, which may be contaminated by the materials. This requires appropriate design for isolation, containment and treatment.
6. Appropriate storage for liquids should have adequate secondary containment.
7. There should be written procedures and instructions in place for the unloading, handling, and storage of the solid and liquid fuels and raw materials used on site.
8. Relevant employees should be trained in the company's operating procedures, and compliance with such procedures should be audited regularly.
9. Storage facilities should be operated in such a way as to control emissions to air, water, and soil.
10. Designated routes for vehicles carrying specified fuels and raw materials should be clearly identified within the site.
11. Appropriate signs indicating the nature of materials should be in place at storage, stockpiling, and tank locations. Storage halls should be fitted with water sprinkler systems and be vented to control accumulation of solvent vapours (which could be sent to the kiln).
12. Tanks should be fitted with an explosion safety device. Additional devices may be considered such as atmosphere control (e.g. N_2 inertisation) and temperature control (e.g. shell cooling), etc.
13. Storage areas should be kept clear of uncontrolled combustible materials. Clear safety warnings, no smoking, fire, evacuation route, and any procedures signs should be posted.

14. An emergency shower and eye washing station should be clearly marked and located near the storage of liquid alternative fuels.
15. A fire protection system must be available at all times and should meet all standards and specifications from local authorities (e.g. local fire department).
16. Adequate alarms should be provided to alert all personnel about emergency situations. Communications equipment (e.g. telephone) should be maintained at the site so that the site control room and the local fire department can be contacted immediately in case of a fire.
17. Equipment should be grounded and appropriate anti-static devices and adequate electrical devices selected (e.g. motors, instruments, etc.).
18. Adequate systems and procedures should be in place to minimize the risk of unauthorized access to hazardous materials used on-site.

Table 4-2 below details the storage facilities to be provided for each of the waste streams:

Table 4-2: On-site Storage Facilities for each waste stream

Waste Stream	Storage Facility	Environmental Risk
Waste tyres		
	Whole Tyres Stock pile on a walled concrete slab with storm water control Tyre chips Stockpile in walled open bunkers on a concrete bed. Ensure proper storm water runoff	Fire risk, and for whole tyres, rodents and mosquitoes.
Sewage Sludge Pellets		
	Store in a dry ventilated place under roof on concrete floor. Ensure fugitive dust control. Keep away from water	Fire risk, soil and surface water contamination Self heating when in contact with water
Pulp and Paper Waste:		
Dry	Store in a dry ventilated place under roof on concrete floor. Ensure fugitive dust control. Keep away from water.	Dust (occupational), Litter, Surface Water
Wet	Will not use due to high moisture content.	Surface Water and Soil contamination
Plastic waste:		
Dry	Stockpile in open bunkers on a concrete bed. Ensure proper storm water runoff.	Dust (occupational), Litter, Surface Water
Wet	Will not use due to high moisture content.	Surface Water and Soil contamination
Hydrocarbon sludges and liquids:		
Received in drums	Store in a dry ventilated place under roof on concrete	Fire, explosions, air emissions (VOC's), contaminated soil and

Waste Stream	Storage Facility	Environmental Risk
	floor.	surface water
Received in tankers	Well designed tank installation with bunds, fire protection and water management system.	

SANS 10232-1 Annexure F details compatibility of loads for transport and this shall be complied with by PPC in the absence of any other legal requirements in SA governing compatibility of storage of dangerous goods. In relation to the waste streams to be accepted by PPC, this requires that:

- Liquid streams shall be stored separately to solid wastes;
- Flammable liquids (i.e. hydrocarbon sludges) shall be stored separately to substances with a high oxidizing potential.
- Waste streams with toxic components (such as metals, PCB's) shall be stored separately from other toxic waste streams.

4.2.3 Feed to the kiln

Figure 4.4 illustrates the correct feed points (red arrows) for a typical multi-stage preheater dry kiln such as Dwaalboom Kilns 1 and 2 to optimize the benefits of temperature, time and turbulence as discussed in Section 3.1.

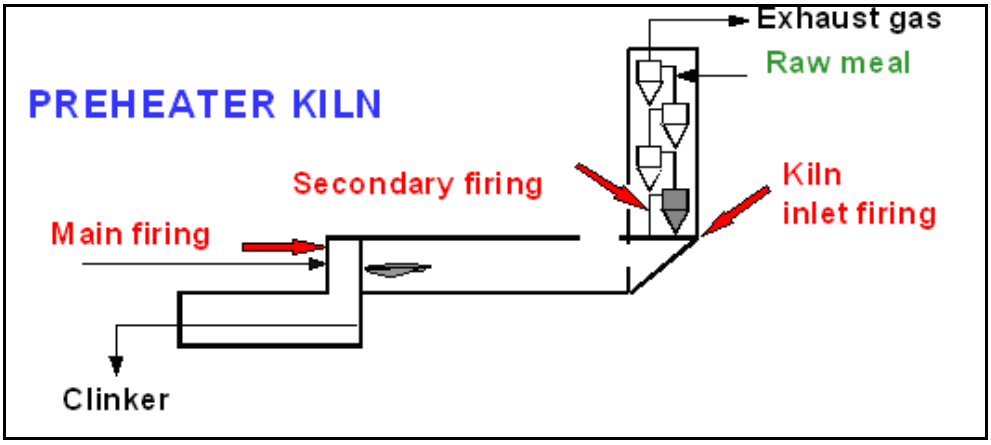

Figure 4-4: Possible Feed Points for Secondary Material

PPC shall employ the following approaches to feeding the various waste streams into the kiln:

Table 4-3: Feed systems for Secondary Materials

Waste Stream	Method of Feed to Kiln
Waste tyres	
	Back end of preheater of calciner kiln. Mid kiln injection of tyres to long dry kin.
Sewage Sludge Pellets	
	Feed through main burner. In calciner of preheater kilns, the sewage sludge can be fed to secondary firing point.
Pulp and Paper Waste:	
Dry	Feed to the calciner or back end.
Plastic waste:	
Dry	Small granules fired through the main burner. Larger pellets to the back end or the calciner.
Hydrocarbon sludges and liquids:	
Received in drums	Drums are decanted into a feed system that can feed the material to the back end, calciner or the main burner depending on the characteristics of the liquid or sludge.
Received in tankers	Unloaded into a liquid feeding system for use at the main burner or back end of the kiln.

In general, the following guidelines should be complied with:

1. Assess operations for health and safety risks or concerns to ensure that equipment is safe and to minimize risks of endangering people or installations, or damaging the environment.
2. Use appropriate procedures to assess risks or hazards for each stage of the design process. Only competent and qualified personnel should undertake or oversee such hazard and operability studies.
3. Carefully consider plant layout to ensure access for day-to-day operations, emergency escape routes, and maintainability of the plant and equipment.
4. Apply recognized standards to the design of installations and equipment. Any modification to installations and equipment should meet requirements set in the standards. Thoroughly evaluate existing equipment refitted for a different service from a safety and performance standpoint before resuming commercial production.
5. Document modifications to installations and equipment.
6. Handling systems and feed systems should be appropriate to the fuel and raw material used. The feed systems should allow stable and controlled input of materials to the kiln.
7. The operator should assess risks from fugitive emissions; equipment failure modes and appropriate safeguards should be incorporated into the design to prevent environmental pollution, health, and safety problems.

The following represents the best available technology in terms of feed equipment, and shall be implemented by PPC:

Tyres

For long dry kilns the best technology to use is mid-kiln injection of whole tyres into the kiln through a valve arrangement. For preheater and calciner kilns, depending on the distance of

the cement kiln from the source of used tyres, the tyres can be fed to preheater/calciner kilns either as whole tyres or chipped tyres.

Chipped tyres are fed to the riser duct of a preheater kiln or to the calciner. The feeding and transport equipment is designed to minimize human intervention and handles the material right from the discharge of the truck onto a large walking floor hopper arrangement. From the walking floor hopper, the tyres, chipped or whole, are transported to the preheater or precalciner with a conveyor belt. The tyres are weighed shortly before injection into the kiln system and locations of injection into the kiln are selected carefully to optimise combustion efficiency.

Sewage Sludge Pellets

Sewage Sludge pellets arrive at the cement operation in bulk bags and have to be stored on a covered, but ventilated, storage area to ensure that the material remains dry. The bulk bags are emptied using an automatic bulk bag emptying system and transported to an intermediate storage bin from where the material is weighed and fed to the main burner, together with coal into the main burner.

Again it is important, during handling of the material, to ensure that human intervention in the materials handling process is minimized and that the process is automated as much as possible. Dust masks and gloves will be worn by all personnel involved with this operation.

Pulp and Paper waste

Pulp and paper waste has to be shredded to prepare for use in a cement kiln. This material is then taken to the cement operation and stored under cover in a well ventilated area. Pulp and Paper waste is fed to the riser or calciner of the preheater/calciner.

The material can also be fired to the main burner of the kiln, but due to the low CV value and effect on the main flame, the substitution in the main flame would be lower than in the calciner or riser duct. This means that the achievable substitution for a long dry kiln using paper waste is lower than for preheater/calciner kilns.

Plastic Waste

Plastic waste is chipped to a particle size of less than 10 mm for injection into the main burner. The injection process is similar to that of sewage sludge. For injection into the calciner or riser duct, the feed technology used is similar to that of tyre chips.

Hydrocarbon sludges and liquids

Low viscosity liquids would be injected into the main burner, using a separate firing lance and air-liquid atomization system to ensure proper combustion. From delivery with a tanker, the liquids would be pumped to a set of bunded blending and storage tanks. The blending system would be designed to prepare batches of blended liquid material for firing into the kiln. The system should be designed according to MHI regulations and proper plant zoning principles should be followed.

For high viscosity liquids (sludges), these will be injected into the kiln system at the preheater or calciner. Injection is facilitated through a piston pump arrangement, fed from a well contained sludge basin.

4.3 SELECTION OF INJECTION POINT

In terms of selection of feed points to the kiln, the WBCSD[43] recommends that the point at which alternative fuels and raw materials are fed into the kiln ("feed point") should be selected according to the nature (and, if relevant, hazardous characteristics) of the alternative fuels and raw materials used. Alternative fuels should be introduced in the high-temperature combustion zone of the kiln system, i.e. the main burner, the calciner burner, the secondary firing at the preheater, or the mid-kiln (for long dry and wet kilns). Alternative fuels with highly stable molecules, such as highly chlorinated compounds, should be introduced at the main burner to ensure complete combustion due to the high

[43] *World Business Council on Sustainable Development: Cement Sustainability Initiative: Guidelines for the Selection and Use of Fuels and Raw Materials in the Cement Manufacturing Process, Dec 2005.*

combustion temperature and the long retention time. Other feed points are appropriate only where test have shown high destruction and removal efficiency rates. Alternative raw materials with volatile organic components should not be introduced with other raw materials in the process, unless tests have shown that undesired emissions at the stack do not occur.

This is in agreement with the technical discussion in the previous chapters regarding the thermodynamics of the kiln and factors affecting emissions.

4.4 PROCESS MONITORING DURING OPERATION

The use of alternative fuels and raw materials should not detract from smooth and continuous kiln operation, product quality, or the site's environmental performance. Therefore a constant quality and feed rate of the alternative fuels and raw materials must be ensured. The general principle of good operational control of the kiln system using conventional fuels and raw materials should be applied. In particular, all relevant process parameters should be measured, recorded and evaluated continuously; this should cover free lime, excess oxygen, and carbon monoxide levels. The impact of alternative fuels and raw materials on the total input of circulating volatile elements such as chlorine, sulphur, or alkalis must be assessed carefully prior to acceptance as they may cause operational troubles in the kiln system. Input limits and operational set points for these components should be set individually by the site based on the process type and on the specific site conditions.

For start-up, shut-down, or upset conditions of the kiln, written instructions should be issued, describing conditions of use of alternative fuels and raw materials. Kiln operators should know and understand these instructions. In most cases, waste fuels should not be used during start-up and shut-down of kilns, except where kiln temperatures are achieved to produce clinker that meets quality standards. Waste fuels should not be used during failure of the air pollution control devices (i.e. the ESP serving the kiln stack). This does not apply to CO purging.

There should be written procedures and operating instructions in place for the use of conventional and alternative fuels and raw materials, and such operating instructions should cover the start-up and shut-down of the kiln and actions to comply with set quality requirements of the product and emissions. Operators should be trained in the company's operating procedures, and compliance with such procedures should be audited regularly. Adequate personal protective equipment should be made available to employees and contractors, and to individuals visiting the installation.

4.5 EMISSIONS CONTROL AT PPC'S OPERATIONS

Table 4-4 describes the emissions control equipment currently installed at PPC's operations. The controlled water injection system installed at Dwaalboom, acts as a water conditioner and quench where water is sprayed with the air flow at the top of the downcomer pipe (preheater outlet duct), thereby evaporating the water (a high moisture content is required for effective operation of the ESP) but also effecting a rapid cooling of the gas stream out of the temperature window for the *de novo* synthesis of dioxins and furans. .

Table 4-4: Emissions Control equipment at PPC's facilities

Gas treatment after kiln or preheater exit					Temperatures (°C)				
Plant	**Kiln**	**Process type**	**Gas treatment**	**Gas to raw mill**	**Kiln exit**	**Pre-heater exit**	**C/tower exit**	**Raw mill exit**	**ESP exit**
Hercules	4	Long kiln 1-stage preheater	Conditioning tower and ESP	Only if K5 not in operation	NA		150	NA	
	5	4-stage preheater	Conditioning tower and ESP	Yes (before C/tower)	NA	400	130	75	120
Slurry	7	Long kiln 1-stage preheater	ESP	No	NA	430	NA	NA	370 (estimate)
	8	4-stage preheater	Conditioning tower and ESP	Yes (before C/tower)	NA	450	150		120 to 145
Dwaalboom	1	5-stage preheater	Water spray in duct and ESP	Yes	NA	300	NA	100 (estimate)	
De Hoek	5	4-stage preheater	Conditioning tower and ESP	Yes (before C/tower)	NA	395			
	6	4-stage preheater	Conditioning tower and ESP	Yes (before C/tower)	NA	405	120		
Port Elizabeth	4	Long kiln	Air bleed & ESP	No	420	NA	NA	NA	250

NOTE: NA – Not available, ESP = Electrostatic Precipitator

The gas exit from the kiln is at the preheater exit (where a preheater is installed)

Ducts are normally designed for a gas velocity of about 20m/sec. Given the distance between the preheater exit and the controlled water injection system at Dwaalboom Kilns 1 and 2, the gas will typically take less than 1 second to reach the water injection system where the temperature will drop rapidly, and approximately 3 seconds to the raw mill or gas cleaning equipment. This depends on whether the raw mill is being run in-line (usually 85% of the time) or not. Thus the time available for dioxin *de novo* formation is limited to a few seconds, prior to rapid gas cooling. As stated before, the dioxin formation potential is not expected to be any greater with or without secondary materials as the Cl and VOCs at this stage of the process will be almost entirely originating from the raw material passing through the preheater structure.

The Electrostatic Precipitators (ESP's) at PPC's operations achieve an effective removal efficiency of dust particles in excess of 99.4%. This combined with the water injection system, the alkaline scrubbing nature of the preheaters and the kiln material, presents an effective means of minimising all emissions from the kilns, except for volatile metals such as Hg, Cd and Tl. It is for this reason that particular attention will be paid to the input quantities of these volatile metals in the secondary materials (see Section 3.2). No alterations to the existing emissions control equipment is therefore envisaged by PPC as part of this Secondary Materials Project.

4.6 EMISSIONS MONITORING DURING OPERATION

As discussed in Section 3.12, Opsis on-line gas monitoring is being installed at each of PPC's kilns that will be implementing secondary materials, in addition to the Codel monitors which measure the particulate matter leaving the stack. ***No burning of secondary materials will occur post trial-burn until these Opsis monitors are installed and calibrated. This has been completed at Dwaalboom Kiln 1.*** The Opsis monitor will measure the following parameters: NO, NO_2, SO_2, HCl, HF, CO and benzene. The Codel monitors currently installed at each stack will continue to monitor the particulates concentrations on-line.

Any measurement of emissions will have to be reported at a specified oxygen level (typically 10%) and dry (i.e. no water vapour). PPC will need to ensure that this is communicated to any external specialists performing such measurement, and that their Opsis on-line emission monitors will be able to accommodate such. The conversion formulae back to 10% O_2 will need to be approved by CAPCO.

All monitoring shall include isokinetic sampling and analysis at SANAS- or equivalent accredited laboratories according to ISO, EPA or ASTM methods for the following parameters:

a) CO, CO_2,

b) NO_x, SO_2,

c) HCl, HF,

d) All metals (as per standard ICP analysis) and Mercury and Thallium,

e) Total Chromatographable Organics or TCO (which includes all VOC's and SVOC (semi-volatile organics)),

f) Dioxins and furans, PCB's, PAH (polycyclic aromatic hydrocarbons). This is compulsory for the baseline and trial burn monitoring, but for further monitoring, please refer to the next point (5).

g) Total Particulate Matter (TPM, or cement kiln dust).

With the exception of dioxins, TCO, PCB's and PAH's, the monitoring frequency for the above, post-trial burn, will be one month after full production secondary materials co-processing ***per waste stream***, and annually thereafter. If a new waste stream is added to the secondary material programme, then the monitoring schedule resets itself, and monitoring should be performed one month after full production recommences with the new waste stream, etc.

TCO, PCB's and PAH measurements, given their cost, will be performed only when required, i.e. if these compounds are present in the secondary materials being fed to the kiln. Dioxin measurements, given their cost, will be performed only when required based on the nature of the secondary materials and their entry into the kiln system. As per the previous sections, therefore, dioxin measurements will only be performed ***if*** the secondary materials contain chlorides or carbon in any quantities (as detected by the sampling programme described in Section 3.1), ***and*** are being introduced into the back-end (i.e. the raw material feed side) of the kiln. When dioxin measurements are required on this basis, the following dioxin monitoring schedule should be adhered to for each waste stream introduced to the kiln:

a) Before (i.e. baseline) and during the trial burn, as well as

b) After one month of running full scale secondary materials consumption, and

c) Annually thereafter.

All the above scenarios will be performed with the raw mill running and the raw mill down (in the case of in-line mill system) for the first year of sampling.

4.7 AUDITING AND REPORTING DURING OPERATION

Once the full-scale operation has received written approval from the authorities, and the storage and feeding systems implemented and tested, PPC shall employ an independent environmental auditor to audit the operations against the conditions of the Record of Decision and legal requirements, on the following frequency:

- During the trial burn (please refer to Section 11.3);
- Commencement of full-scale production;
- Six months after commencement of full-scale production;
- One year after commencement of full-scale production, and
- Annually thereafter.

It is noted that this is the same schedule as the emissions monitoring programme, and is designed to coincide with such.

The scope of the audit shall cover all operations and supporting paperwork of the sourcing, sampling and analysis, acceptance, transportation, storage and preparation on site, operation, monitoring, reporting, staff training, emergency preparedness and response procedures and processes.

A report shall be compiled by the auditor within 2 weeks of completing the audit, documenting his/her findings and recommendations. This report shall be made available to the following parties:

- National Government (Department of Environmental Affairs and Tourism) and
- Provincial Department of Environmental Affairs.

4.8 EMERGENCY PREPAREDNESS AND RESPONSE

An emergency response plan should be in place which:

1. Identifies potential spill or contamination areas;
2. Defines clean-up procedures;
3. Identifies areas of high risk on site or in the local community;
4. Provides written instructions in the event of an emergency;
5. Documents equipment required in the event of an emergency;
6. Assigns responsibilities to employees and local officials;
7. Details emergency response training requirements, and
8. Describes reporting and communication requirements both within the company and with interested external stakeholders.

The emergency response plan shall be reviewed with relevant external emergency services. Emergency drills shall be arranged with the local community emergency response services to ensure a coordinated response under emergency conditions.

4.9 HEALTH AND SAFETY

The following requirements pertain to protecting the health and safety of workers associated with secondary materials and will form part of PPC's Health and Safety Management System:

1. Safety and emergency instructions, such as Safety Data Sheets, should be provided to employees and contractors in due time, and should be easily understandable. Hazards relating to new materials should be reviewed with operating staff prior to using such materials in the facility. Conducting a job safety analysis is one approach to identifying hazards and potential exposures, along with appropriate control practices and techniques.
2. Adequate personal protective equipment should be made available to employees and contractors, and to individuals visiting the installation. Its use should be required. This includes but is not limited to: helmet, glasses, gloves, hearing protection, safety shoes, respiratory protection, and other protective equipment specified in the Safety Data Sheets.
3. Automated handling equipment should be used wherever possible.
4. Wherever a contact risk such as infection or skin irritation exists, the company should provide appropriate facilities for operators to take required hygiene precautions.
5. Maintenance work should be authorized by plant management, and carried out once a supervisor has checked the area and necessary precautions have been taken.
6. Special procedures, instructions, and training should be in place for such routine operations as:
    - Working at height, including proper tie-off practices and use of safety harnesses;
    - Confined space entry where air quality, explosive mixtures, dust, or other hazards may be present;

- Electrical lock-out, to prevent accidental reactivation of electrical equipment undergoing maintenance; and
- "Hot works" (i.e. welding, cutting, etc.) in areas that may contain flammable materials.

4.10 EMPLOYEE TRAINING

The company should develop and implement appropriate documented training programmes for employees to be trained in SHEQ issues relevant to their jobs. New employees should be trained during an induction process. Such training programmes should be given to contractors and, in some instances, suppliers. Personnel reporting to work on site for the first time should be trained through a site induction programme. Training records should be kept on file. The training programme should include the following:

1. General and job specific safety rules;
2. Safe operation of equipment;
3. Details of the site emergency plan;
4. Procedures for handling alternative fuels and
5. Raw materials, and
6. Use of personal protective equipment.

4.11 TRIAL BURN

4.11.1 Schedule of trial burns

It is a recommendation of this Report that the EIA Record of Decision, if positive, state that a trial burn be conducted prior to the full-scale implementation of the project. The trial burns will be performed at a pre-announced date and relevant government officials will be invited to attend the burn. In addition, the trail burn will be subject to an independent audit and emissions monitoring by an independent contractor. A report will be compiled and submitted to all relevant authorities. As the trial burn will therefore follow the issuing of a Record of Decision by the authorities, fixed dates for the burn are not available. PPC shall, however, ensure that the date of this trial burn is communicated to the regulatory authorities.

One of the challenges of the trial burn will be to minimise interruptions to the normal production of cement. Currently, PPC is importing cement to overcome the supply constraints in the face of excessive demand, particularly given the government's ASGISA[44] initiative and the preparations for the 2010 World Cup. Trial burns could therefore be scheduled into the normal 24-hour shutdowns which are scheduled for each kiln as part of their regular maintenance programme. Feed equipment will be prepared in advance and tie-in's to the kiln connected during these shutdown periods.

[44] *Accelerated and Shared Growth Initiative for South Africa*

4.11.2 Waste to be sourced

In order to ensure that the waste streams to be burnt in the trial burn are representative, as far as practicable, of the normal operational scenario, PPC will ensure the following:

Table 4-5: Waste Streams to be sourced for Trial Burn

Waste Stream	Source of Waste Stream
Waste tyres	As the chemical composition of tyres does not deteriorate significantly with time, there are no specific requirements relating to the age of the sample.
Sewage Sludge Pellets	Fresh (i.e. 1 month old) pellets shall be prepared off-site by an independent contractor/municipality from a normal sample of sewage over several days. The preparation process shall be inspected by the independent auditor for the presence of any other contaminants or pre-treatment.
Pulp and Paper Waste:	Industrially produced paper waste will be sourced or paper waste generated at Dwaalboom, and prepared to the requirement of the kiln concerned.
Plastic waste:	Unrecyclable plastic waste will be sourced from municipalities after being sorted. The material will be shredded and analysed to ensure that the waste is suitable for the kiln process.
Hydrocarbon sludges and liquids:	Fresh arisings from an industrial source will be used.

4.11.3 Blending of Wastes for Trial Burn

Not all the five waste streams applied for in terms of this application will be burnt at all five kilns at the same time. They will rather be phased in according to their availability in the respective regions. For this purpose, the following trial burn programme is proposed by PPC:

1. Following receipt of a Record of Decision for a kiln, and installation of the Opsis monitoring system for that kiln, a trial burn will be performed for a waste stream (Waste 1). All the monitoring, measurements and audits will be complied with, as recommended in this report and prescribed in terms of the Record of Decision.
2. The results of the trial burn shall be communicated in a formal report to the authorities. Following approval from the authorities to proceed with full-scale implementation, PPC will only commence with the waste stream category for which the trial burn was performed (i.e. Waste 1).
3. Only once stable operation is attained for cement production with Waste 1, will PPC consider application of a second waste stream category (which will be one of the other 5 waste streams included in this application), i.e. Waste 2. This will commence with a trial burn, following the same monitoring, measurement and auditing procedures as detailed in this chapter, for Waste 2.
4. Step 2 above shall therefore be repeated for the addition of Waste 2 (with the continuing burning of Waste 1).
5. Only once authorisation is granted for Waste 2, will full-scale implementation of Waste 2 commence. This will involve PPC bringing the kiln to stable operation with Waste 1 and Waste 2, plus their normal fuels and raw materials (which will be slightly reduced due to the addition of the waste streams).
6. Before considering any additional waste streams, the entire process shall be repeated.

Thus PPC shall implement a cautionary, step-by-step process of gradually adding a waste stream through the “trial burn-approval-stabilising of kiln” process before commencing the same process with

another waste stream. Under no circumstances will a new waste stream be introduced without stable kiln operation (whether or not waste streams are currently being burnt), a proper trial burn and reporting to the authorities and independent audit.

4.11.4 Storage and Feed to Kiln

For the purposes of the trial burn, PPC may perform preparation of the waste streams in order to facilitate the safe feeding and metering of such to the kiln. Such preparation will be limited to physical preparation in such a manner as to avoid the generation of noxious or offensive gases and any chemical alteration of the waste streams.

Given the minor quantity of wastes to be burnt in the trial burn, a dedicated storage area shall be constructed adjacent to the kiln facility. This area shall be equipped with a compacted limestone base and cemented bund walls.

The waste streams shall be present on-site for no longer than 90 days, and residual waste not consumed in the trial burn shall be removed from site and disposed of to a suitably permitted facility within 2 days of completion of the trial burn.

The feeding of the waste streams to the kiln during the trial burn shall occur by means of formal feeding equipment to the kiln only (as described in Section 11.3). Temporary or informal conveying systems to these feed systems shall be employed only for the trial burn.

During trial burn planning (i.e. ***before*** the trial burn commences), the maximum safe feed rate for the waste material will be calculated by PPC using:

1. International experience of the use of the material, and
2. Kiln-specific mass balance considering the specific waste stream (using the detailed waste identification analysis data gathered as per the Environmental Technical Review (Appendix D1)).

The maximum safe feed rate (MSF) is therefore defined as the maximum flow rate of the proposed waste stream, or combination of waste streams, which will not disturb the kiln stability and which will produce emissions compliant to that accepted by PPC in terms of this proposal.

During the trial burn, the MSF will therefore be confirmed for each trail burn according to the following:

1. The process impacts of the secondary materials;
2. The impacts on emissions;
3. Health and safety effects and risks, and
4. Product quality.

During the trial burn, therefore, the calculated MSF will be verified with practical tests using the actual waste stream on Kilns 1&2. If it is found that the calculated MSF results in kiln instability, degradation of product or excessive emissions, then the feed rate will be reduced, while monitoring continues, to determine an acceptable feed rate. If it is established during the trial burn that more waste will be accepted without negative effects on kiln stability, emissions, health and safety of the staff or product quality, the feed of the waste will be increased until an acceptable maximum rate is reached. Thus the optimal or maximum safe feed rate of the respective waste stream will be determined during the trial burn.

During normal operation the MSF will not be exceeded without another trial burn being conducted. The intention to do so will be communicated by PPC in writing to DEAT and CAPCO beforehand.

4.11.5 Process Monitoring

The process monitoring during the trial is carefully laid out in the trial plan and an independent auditor will agree on the monitoring plan prior to its commencement. The monitoring plan shall in minimum consist of the following:

a) Constant monitoring:

- Kiln feed, fuels and clinker rates;
- Back end temperature;
- Shell temperature;
- Gas analysis at kiln back end;
- Kiln back end pressures;
- Preheater – calciner temperatures and pressures; and
- ESP or Bag Filter performance.

b) Sampling

Sampling of input, output and process materials for analysis will be performed during the burn. Kiln Dust and hot meal will be included in this sampling. Preheater-stage sampling will be performed if required according to the nature of the secondary material (i.e. if carbon and chloride is present in the secondary material). Isokinetic sampling of stack will be performed throughout the burn as described in Section 4.6.

4.11.6 Independent audit

PPC shall employ an independent environmental auditor to witness the entire trial burn, including the baseline measuring, for compliance against legal requirements, competence of staff during handling and feeding of waste streams, and the trial burn itself.

4.11.7 Emissions Monitoring and Reporting

The following emissions monitoring and reporting programme shall be implemented for the trial burn:

a) A full baseline assessment shall be conducted prior to the introduction of the waste streams, using normal fuels (i.e. coal) and feed material. This shall involve isokinetic sampling and analysis at accredited laboratories according to ISO, EPA or ASTM methods for the following parameters:

- CO, CO_2;
- NO_x, SO_2;
- HCl, HF;
- All metals;
- Total Chromatographable Organics or TCO (which includes all VOC's and SVOC (semi-volatile organics));
- Dioxins and furans, PCB's, PAH (polycyclic aromatic hydrocarbons)[45]; and
- Total Particulate Matter (TPM, or cement kiln dust).

b) It is important that the coal and feed material quality remains constant during the entire trial

[45] *Dioxin, TCO, PCB and PAH measurements, given their cost, will be performed only when required based on the nature of the secondary materials and their entry into the kiln system. Based on the previous sections, therefore, dioxin measurements will only be performed if the secondary materials contain chlorides or carbon in any quantities (as detected by the sampling program described in section 4.1), and are being introduced into the back-end (i.e. the raw material feed side) of the kiln.*

burn so as to avoid introducing any variables into the process. PPC will therefore ensure the consistency of such feed in advance (such as moisture content of feed, etc) by monitoring weather and preparation conditions.

c) During the burning exercise, the waste shall be fed at a constant rate, most closely resembling that of anticipated operating conditions. The emissions monitoring exercise conducted for the baseline assessment shall be repeated in exactly the same fashion as for the baseline monitoring.

d) The analysis results shall be provided directly from the emissions sampling contractor to the independent auditor, along with original laboratory results. The auditor shall then compile a report on the trial burn, and provide this to the authorities within 30 days of the date of the trial burn.

e) No further burning of waste streams may occur until:

- Written confirmation has been received from the authorities to proceed with full-scale operations; and
- Formal storage and feed systems have been constructed and tested on site.