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NATIONAL POLICY ON HIGH TEMPERATURE THERMAL WASTE TREATMENT AND CEMENT KILN ALTERNATIVE FUEL USE

Guidelines for treatment of hazardous wastes and co-processing of AFRs in cement kilns

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Table of content

1. Introduction

Cement kilns have for more than three decades been used to recover energy and materials, to co-process alternative fuels and raw materials and to treat organic hazardous wastes in a number of countries. This practise normally combines energy and resource savings with effective waste management, and can be extremely attractive and cost-efficient, especially for emerging economies having insufficient waste treatment capacity. Disposal of organic hazardous wastes is however controversial among some stakeholders, claiming that the cement industry, especially in developing countries, have inadequate technology and competence of doing this in a safe and sound manner.

The absence of uniform operation and performance standards for cement kilns contributes to this perception and has lead some cement companies to develop their own internal guidelines in an effort to raise the performance level as well as the acceptance for such practise (GTZ-Holcim, 2006). Other guidelines have been developed, but the objective and coverage has varied (World Business Council for Sustainable Development, 2006; Basel Convention, 2007; Stockholm Convention, 2007).

1.1 Objective

The overall objective of these guidelines is to develop a uniform standard that can be applied by the cement plants co-processing AFRs and treating hazardous wastes in South Africa. These guidelines are based on lessons learned, best practises and state of the art, and will ensure that complying cement plants will be feasible, qualified and be operating according to environmentally sound management principles. The standard covers all aspects of hazardous waste management but may also be adopted and used by the cement industry recovering energy and materials, as well as co-processing alternative fuels and raw materials.

The fundamental and overarching principle of these guidelines is to prevent that cement kilns are abused for treatment of inappropriate wastes, nor shall increased emissions, non compliance with regulations or inferior practise be tolerated. These guidelines recommend external auditing, transparent information disclosure of performance and the implementation of a continuous improvement system.

1.2 A hybrid

These guidelines are integrating "the best" elements of the Stockholm Convention BAT/BEP Guidelines for Cement Kilns Firing Hazardous Wastes (2007), the Basel Convention Technical Guidelines for the Environmentally Sound Management of POPs (2007), the Integrated Pollution Prevention and Control Reference Document on the Best Available Techniques for Waste Incineration (2006), the Organization for Economic Cooperation and Development recommendation on the Environmentally Sound Management (ESM) of Wastes (2004), the GTZ-Holcim Guidelines on Co-processing Waste Materials in Cement Production (2006), and the World Business Council for Sustainable Development Guidelines for the Selection and Use of Fuels and Raw Materials in the Cement Manufacturing Process (2006), as well as other lessons learned (Karstensen, 1994; 2001; 2007; Karstensen et al., 2006). It must however be emphasised that local permits and regulatory requirements can vary and will take precedence over these guidelines if stricter.

1.3 Policy elements

The guidelines recommends that a national policy on waste management is in place to ensure that the development, implementation of strategies, legislation, guidelines, plans, treatment options and other elements of waste management will be exercised in accordance with the following guiding principles:

A. Hazardous wastes are a major environmental problem and priority should be given to prevention of dangerous impacts on human, the environment and the ecosystem;

B. The prevention and reduction of hazardous waste generation is the most beneficial approach to hazardous waste management and should be given priority;

C. Choice of waste management options should be based on the following hierarchy/priority:

1. Avoidance, prevention and minimisation;
2. Reuse and recycling to the highest degree possible;
3. Recovery of energy and resources;
4. Disposal, treatment and destruction;
5. Final environmental sound and safe treatment;

D. A hazardous waste minimisation strategy comprising waste prevention, cleaner production, reuse and recovery of materials and energy should be established;

E. Cement kilns shall primarily be used for recovering energy and materials, and for co-processing alternative fuels and raw materials, which can substitute parts of the fossil fuel and/or virgin raw materials;

F. In lack of available treatment options and urgent needs, a certified cement kiln can be used for treatment of organic hazardous constituents provided that this is done under strict control and Government guidance. Such activities must have a special permit and must comply with these guidelines;

G. The national policy should aim for sustainable resource and energy consumption as well as integrating all relevant elements of and complying with the Montreal Protocol aimed at eliminating ozone-depleting substances (1987), the Basel Convention on the Control of Transboundary Movements of hazardous Wastes and their Disposal (1989), the Convention on Biological Diversity (1992), the Aarhus Protocol on Persistent Organic Pollutants (1998), the Rotterdam Convention on the Prior Informed Consent Procedures for Certain hazardous Chemicals and Pesticides in International Trade (1998) and the Stockholm Convention on Persistent Organic Pollutants (POPs) (2004).

1.4 Requirements and prerequisites

The largest potential risks with the treatment of hazardous wastes and co-processing of AFRs in cement kilns are connected to possible accidents, spills and exposure during: a) collection and transport of hazardous wastes to the plant; b) handling/pre-treatment, preparation and feeding; c) emissions to air; and d) contamination of the product. The following requirements and prerequisites should be in place to prevent and reduce the risks to the greatest extent possible prior to commencing on with treatment of hazardous wastes in cement kilns on a routine basis:

1. An approved EIA and all necessary national/local licences;
2. Compliance with all relevant national and local regulations;
3. Compliance with the Basel and the Stockholm Convention;
4. Approved location, technical infrastructure and processing equipment;
5. Reliable and adequate power and water supply;
6. Adequate air pollution control devices and continuous emission monitoring ensuring compliance with regulation and permits;
7. Exit gas conditioning/cooling and low temperatures (<200^0C) in the air pollution control device to prevent dioxin formation;
8. Clear management and organisational structure with unambiguous responsibilities, reporting lines and feedback mechanism;
9. An error reporting system for employees;
10. Qualified and skilled employees to manage hazardous wastes and health, safety and environmental issues;

11. Adequate emergency and safety equipment and procedures, and regular training;

12. Authorised and licensed collection, transport and handling of hazardous wastes;

13. Safe and sound receiving, storage, preparation and feeding of hazardous wastes;

14. Adequate laboratory facilities and equipment for hazardous waste acceptance and feeding control;

15. Demonstration of hazardous wastes destruction performance through test burns;

16. Adequate record keeping of hazardous wastes and emissions;

17. Adequate product quality control routines;

18. An environmental management and continuous improvement system certified according to ISO 14001, EMAS or similar;

19. Regular independent audits, emission monitoring and reporting;

20. Regular stakeholder dialogues with local community and authorities, and for responding to comments and complaints;

21. Open disclosure of performance reports on a regular basis.

2. General considerations

This chapter summarise general measures and considerations, which needs to be in place when introducing treatment of hazardous wastes in cement plants.

2.1 Compliance with regulations

Relevant and appropriate legislative and regulatory framework has to be in place to guarantee a high level of environmental protection. The regulations must be enforced and the cement plant operator must:

a) Identify all relevant laws, regulations, standards, and company policies relating to safety, health, environment, and quality control, and compliance continually reviewed;

b) Share this information with the employees and make sure that they are aware of their responsibilities under them.

2.2 Location, health and safety aspects

Site location and suitability should be carefully considered as this may avoid risks associated with proximity to populations of concerns, impact of releases, logistics, transport, infrastructure, as well as having in place technical solutions for vapours, odours, infiltration into environmental media, etc. Sites must:

a) Develop robust emergency procedures as well as procedures for operation and maintenance that cover safety of workers and installations;

b) Operation and maintenance procedures must be systematically reviewed.

2.3 Involvement and communication

Adequate documentation and information are mandatory, providing an informed basis for openness and transparency about health and safety measures and standards, and ensuring that employees and authorities have such information well before starting any use of hazardous waste. All relevant authorities have to be involved during the permitting process, and the cement plant operator must:

a) Establish credibility through open, consistent, and continuous communication with the authorities and other involved stakeholders. All necessary information must be provided to allow stakeholders to understand the purpose of the treatment of hazardous wastes in a cement kiln, the context, the function of the parties involved and decision-making procedures;

b) Provide necessary information to ensure that authorities are able to evaluate the treatment of hazardous wastes;

c) A stakeholder engagement plan should be established for working with the local community and authorities, including procedures for responding to community interests, comments, or complaints; feedback should be given promptly.

2.4 Training

Sufficient resources and training must be provided to operate and manage safety, health, and environment and quality systems efficiently. All employees involved in pre-processing and waste treatment operation must be trained, ensuring the following minimum training content:

a) Process and work areas: signs on precautions and required personal protective equipment (PPE);

b) Waste labelling (composition, storage requirements and risks);

c) Compliance with existing permits for working with hazardous waste;

d) Use and maintenance of PPE;

e) Detection of warning indicators such as barrel expansion, smoke from stockpiles, spillages or leaks;

f) Emergency response required by permits and local regulations;

g) Take measures to ensure the necessary segregation of incompatible wastes (such as minimum distances, firewalls and containment cells).

2.5 Waste acceptance

The plant must identify the safety and health risks of any waste, prior to signing a commercial contract and make sure that:

a) The waste generator, collector, pre-processor provides adequate information on composition and risks of the material;

b) They do not accept any substances, compounds or preparations which are on the "negative list";

c) They prohibit blending of incompatible materials and perform compatibility tests if needed;

d) They perform sampling on the site of the generator, collector, pre-processor and analysis before acceptance of commercial contracts. Sampling and analysis can be done by own or external, certified laboratories;

e) They do not start transportation to plant site before completion of the acceptance process. This acceptance process does not replace sampling and analysis of waste deliveries at the plant sites;

f) They communicate the inherent safety and health risks indicated by the waste generator, collector, pre-processor or identified by the sample analysis to the downstream operations (transport, pre- and co-processing) to ensure that PPE and installations are adapted accordingly;

g) They provide simple, clear and practical handling procedures, based on the material properties, to each person who will work with the waste;

h) They provide the commercial employees with adequate training in chemistry to allow them to enforce the waste acceptance criteria.

2.6 Waste transport

Waste transport, handling and storage must be effectively monitored, and be in full compliance with existing regulatory requirements; only qualified, authorised and licensed transport companies shall be used.

2.7 Waste storage

Limit waste volume in storage and waste storage time to a minimum, i.e. maximum allowed waste storage need to be based on installed fire protection systems (which should include early warning sensors like temperature and smoke detectors).

Limits for waste and processed wastes storage times per type of material have to be formally defined and respected, taking into consideration the corresponding health and safety risks (toxicity, reactivity, flammability/explosion potential, and storage conditions) and local regulations.

2.8 Waste information

Only hazardous wastes from trustworthy parties throughout the supply chain should be accepted, with traceability ensured prior to reception by the facility and with unsuitable hazardous wastes refused. The operator must develop an evaluation and acceptance procedure that includes the following features:

a) Each hazardous waste supplier must prepare a sample, which will be used to evaluate possible impacts before delivering it to the plant. This should include a datasheet detailing the chemical and physical properties of the hazardous waste being supplied, information on relevant health, safety, and environmental considerations during transport, handling, and use, and a typical sample of the material. It should also specify the source of the particular shipments being made;

b) The sample's physical and chemical characteristics should be tested and checked against specifications.

2.9 Assessment of impacts

When the operator has received information about the waste, he should then:

a) Assess the potential impact of transporting, unloading, storing, and using the material on the health and safety of employees, contractors, and the community. Ensure that equipment or management practices required to address these impacts are in place;

b) Assess what personal protective equipment will be required for employees to safely handle the hazardous waste on site;

c) Assess the compatibility of the new hazardous wastes with those currently in use. Reactive or non-compatible hazardous wastes should not be mixed;

d) Assess the effect the hazardous waste may have on the process operation. Chlorine, sulphur, and alkali content in wastes may build up in the kiln system, leading to accumulation, clogging, and unstable operation; excess in chlorine or alkali may produce cement kiln dust or bypass dust (and may require installation of a bypass) which must be removed, recycled or disposed of responsibly. The heat value is the key parameter for the energy provided to the process. Hazardous wastes with high water content may reduce the productivity and efficiency of the kiln system and the ash content affects the chemical composition of the cement and may require an adjustment of the composition of the raw materials mix;

e) Assess the potential impact on process stability and quality of the final product;

f) Assess the effect the hazardous waste may have on plant emissions and whether new equipment or procedures are needed to ensure that there is no negative impact on the environment;

g) Determine what guidelines or materials analysis data the supplier will be required to provide with each delivery, and whether each load should be tested prior to off-loading at the site.

2.10 Restricted wastes

The following wastes and materials should not be treated:

a) Electronic waste;

b) Entire Batteries;

c) Infectious and biological active medical waste;

d) Mineral acids and corrosives;

e) Explosives;

f) Asbestos;

g) Radioactive waste;

h) Unsorted municipal waste;

i) Unknown/unidentified wastes.

Individual companies may exclude additional materials depending on local circumstances and company policy.

Shipments crossing international boundaries and classified as hazardous waste under the Basel Convention must meet with the requirements of the Convention.

2.11 Emissions

Emission monitoring is obligatory in order to demonstrate compliance with existing laws, regulations, and agreements. Emission monitoring is also needed for controlling the input of conventional materials and their potential impacts. Sulphides in raw materials may result in the release of SO_2 and organic carbon in raw materials will result in CO, CO_2 and volatile organic compound (VOC) emissions.

Heavy metals in fuel and raw material, especially volatile heavy metals, which are not completely captured in the clinker, must be assessed, monitored and controlled.

2.12 Cement quality:

Treatment of hazardous wastes and co-processing of AFRs shall not affect the cement quality and this must be documented. The operator must be aware that fluorine, phosphate and zinc influences setting time of the cement, that chlorine, sulphur and alkalis affect overall product quality and that chromium may cause allergic reactions in sensitive users.

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3. Operational guidelines

This chapter describes specific measures, which need to be in place when introducing hazardous waste management in cement plants.

Due to the very wide variety of hazardous wastes, their high potential hazard, and elevated uncertainties over the precise knowledge of the waste composition, significant effort is required to assess, characterise and trace incoming wastes through the entire process.

The systems adopted need to provide a clear audit trail that allows the tracing of any incidents to their source. The exact procedures required for waste acceptance, storage, handling and feeding depends on the chemical and physical characteristics of the waste.

3.1 Pre-acceptance of waste –information needed

The aim of the pre-acceptance procedures is to set the outer boundaries and limits for wastes, which can be accepted by the particular kiln and the conditions and requirements for their preparation and delivery specification.

Any waste fed to the kiln must:

a) Be homogenous;

b) Have stable heat content;

c) Have stable composition;

d) Have a pre-specified size distribution.

The waste acceptance specifications must be clearly revealed by the cement plant and the subsequent requirements must be communicated and agreed with the waste owner prior to any deliverables.

For each type of hazardous waste, a declaration of the nature of the waste made by the waste producer must be submitted so that the plant can then decide whether the treatment of each specific type of waste is possible. Such a declaration should include:

e) Data on the waste producer and responsible persons;

f) Data on the waste designations for the waste;

g) Data on the origin of the waste;

h) Analytical data on particular toxic materials;

i) General characteristics, including combustion parameters, such as: Cl, S, calorific value, water content, and other safety/environmental information;

j) A legally binding signature.

Additional data should be provided upon request from the plant. See also chapter 2.7, 2.8 and 2.9.

3.1.1 Pre-acceptance of waste – additional information

Homogeneous, production-specific waste can often be adequately described in general terms, but some types of waste require additional treatment and investigation. Additional measures are usually required for waste of less well-known composition, including the investigation of each individual waste container.

When the waste composition cannot be described in detail (e.g. small amounts of pesticides or laboratory chemicals), the plant may agree with the waste producer on specific packaging requirements, making sure that the waste will not react during transport, or within containers. For example, risks may arise from:

a) Wastes with phosphides;

b) Wastes with isocyanates;

c) Waste with peroxides;

d) Wastes with alkaline metals (e.g., or other reactive metals);

e) Cyanide with acids;

f) Wastes forming acid gases during combustion;

g) Wastes with mercury.

Delivered wastes generally undergo specific admission controls, whereby the previously received declaration by the waste producer provides the starting point. After comparison by visual and analytical investigations with the data contained in the declaration, the waste is either accepted, allocated to the appropriate pre-treatment and/or storage area, or rejected in the case of significant deviations.

3.2 Pre-treatment and mixing of wastes – general considerations

Because wastes used in cement kilns must be homogenous and have stable composition and heat content, and a pre-specified size distribution, pre-treatment and preparation with the objective of providing a more homogeneous feed and more stable combustion conditions may be necessary. Such pre-treatment can include drying, shredding, grinding or mixing depending on the type of waste.

Techniques used for waste pre-treatment and mixing are wide ranging, and may include:

a) Mixing of liquid hazardous wastes to meet input requirements, e.g. viscosity and/or heat content;

b) Shredding, crushing, and shearing of packaged wastes and bulky combustible wastes;

c) Mixing of wastes in a bunker using a grab or other machine (e.g. sprelling machines for sewage sludge);

d) Production of refuse derived fuel (RDF) – usually produced from source separated waste and/or other non hazardous waste.

Mixing and homogenisation of wastes will generally improve feeding and combustion behaviour, but mixing of hazardous waste can involve risks. Mixing of different waste types should be carried out according to a prescribed recipe.

Solid heterogeneous wastes (e.g. packaged hazardous wastes) can be mixed in a bunker or a pit prior to loading into feed systems. In bunkers, the mixing involves blending of wastes using cranes and the crane operators can identify potentially problematic loads (e.g. baled wastes, discrete items that cannot be mixed or will cause loading/feeding problems) and ensure that these are removed, shredded or directly blended (as appropriate) with other wastes. Crane capacity must be designed so that it is sufficient to allow mixing and loading at a suitable rate.

Some equipment can be sealed under a nitrogen blanket to reduce fire and explosion risks.

3.3 Waste collection and transport

Use only appropriate vehicles and equipment to transport fuels and raw materials. The transport provider (including in-house transport) should be qualified, authorised and must document maintenance and operator training. Personnel involved in transportation, should be adequately trained.

Wastes consisting of, containing or contaminated with hazardous materials must be packaged prior to transport. Liquid hazardous wastes should be placed inter alia in double-bung steel drums. Regulations governing transport often specify containers of a certain quality (e.g. 16-gauge steel coated inside with epoxy). Therefore, containers used for storage should meet transport requirements in anticipation that they may be transported in the future.

Drums may be placed on pallets for movement by forklift truck and for storage, but must be strapped to the pallets prior to movement.

All drums and containers must be clearly labelled with both a hazard warning label and a label that gives the details of the drum. The details include the contents of the drum, the type of waste, and the name and telephone number of the responsible person.

Transportation of dangerous goods and hazardous wastes is regulated in most countries. Transboundary movement of wastes is controlled by the Basel Convention.

Only authorised and licensed transport companies shall be used for collection and transport of hazardous wastes, and the plant operator should ensure that:

a) Vehicles are fit for operation according to local regulations and waste specifications;

b) Vehicles are clean (no spillage or residues);

c) Drivers have received appropriate training in the transport of waste/hazardous substances including emergency response, based on local regulations (at a minimum).

d) Drivers have been instructed to refuse to load and transport barrels, big bags or other waste packages which are damaged, leaking or showing other conspicuous warning signs (e.g. barrel expansion from pressure build-up, elevated temperature etc.).

3.3.1 Waste handling – general measures

The main concerns when handling hazardous wastes are human exposure, accidental release to the environment and contamination of other waste streams. Hazardous wastes should be handled separately from other waste types in order to prevent contamination and recommended practices for this purpose include:

a) Inspecting drums and containers for leaks, holes, rust, and high temperature;

b) Handling hazardous wastes at temperatures below 25 ^{o}C, if possible, due to the increased volatility at higher temperatures;

c) Ensuring that spill containment measures is adequate and would contain liquid wastes if spilled;

d) Placing plastic sheeting or absorbent mats under containers before opening containers if the surface of the containment area is not coated with a smooth surface material (paint, urethane, epoxy);

e) Removing liquid hazardous wastes either by removing the drain plug or by pumping with a peristaltic pump and Teflon or silicon tubing;

f) Using dedicated pumps, tubing and drums, not used for any other purpose, to transfer liquid wastes;

g) Cleaning up any spills with cloths, paper towels or absorbent;

h) Triple rinsing of contaminated surfaces with a solvent such as kerosene to remove all of the residual hazardous wastes;

i) Treating all absorbents and solvent from triple rinsing, disposable protective clothing and plastic sheeting as hazardous wastes.

Staff must be trained in the correct methods of handling hazardous wastes.

3.4 Checking, sampling and testing incoming wastes – general considerations

A suitable regime must be applied for the assessment of incoming waste. The assessments carried out are selected to ensure:

a) That the wastes received are within the range suitable for the installation;

b) Whether the wastes need special handling/storage/treatment/removal for off-site transfer;

c) Whether the wastes are as described by the supplier (for contractual, operational or legal reasons).

3.4.1 Checking, sampling and testing incoming wastes – techniques

The techniques adopted vary from simple visual assessment to full chemical analysis. The extent of the procedures adopted will depend upon:

a) Nature and composition of waste;

b) Heterogeneity of the waste;

c) Known difficulties with wastes (of a certain type or from a certain source);

d) Specific sensitivities of the installation concerned (e.g. certain substances known to cause operational difficulties);

e) Whether the waste is of a known or unknown origin (should be avoided);

f) Existence or absence of a quality controlled specification for the waste;

g) Whether the wastes have been dealt with before and the plants experiences with it.

3.4.2 Checking, sampling and testing incoming wastes – inspection

The following inspection scheme should be applied:

a) Control and comparison of data in the declaration list in comparison with delivered waste;

b) Sampling/analysis of all bulk tankers;

c) Random checking of drummed loads;

d) Unpacking and checking of packaged loads;

e) Assessment of combustion parameters;

f) Blending tests on liquid wastes prior to storage;

g) Control of flashpoint for wastes in the bunker;

h) Screening of waste input for elemental composition e.g. by XRF and/or other appropriate techniques.

3.4.3 Detectors for radioactive materials

The inclusion of radioactive sources or substances in waste, can lead to operational and safety problems. Very low "background" levels of radioactivity are present throughout the natural environment and are also to be found in wastes – such levels do not require specific measures for their detection and control. However, some wastes are at risk of containing higher levels.

Radioactive materials can often be detected using specific detectors situated at, for example, the entrance to the plant. Tests of waste loads that may have a higher risk of contamination can also be carried out. Plastic scintillation detectors are one type of detector used; these measure photons from gamma emitting radio nuclides and to a lesser extent from beta emitters.

3.5 Identification and analysis of wastes

Delivered wastes undergo specific admission controls, whereby the previously received declaration by the waste producer provides the starting point. Sample and analyze vehicle loads once on site according to the frequency and protocol defined in the site control plan; check agreement with site specifications according to the plan of control. Hazardous wastes can be accepted once their properties are confirmed to agree with specifications.

3.5.1 Vehicles control at the gate

Vehicles carrying hazardous wastes must stop upon arrival at site and make the necessary identifications. Such vehicles should be:

a) Weighed in and out of the site and deliveries must be recorded;

b) Documents relating to vehicles carrying hazardous waste must be checked and the compliance with site acceptance specifications and regulations determined;

c) Document checks should cover waste certificates, transport certificates, etc.;

d) A vehicle found not to comply should not be allowed to enter the site.

3.5.2 Vehicles unloading

Instructions for unloading, including safety and emergency instructions, should be provided in due time to vehicle drivers.

3.6 Reception and handling of hazardous wastes

There should be written procedures and instructions in place for the unloading, handling, and storage of the solid and liquid hazardous wastes used on site, i.e.:

a) Designated routes for vehicles carrying specified hazardous wastes should be clearly identified within the site;

b) Relevant employees should be trained in the company's operating procedures, and compliance with such procedures should be audited regularly;

c) Appropriate signs indicating the nature of hazardous wastes should be in place at storage, stockpiling, and tank locations;

d) Storage facilities should be operated in such a way as to control emissions to air, water, and soil.

Hazardous wastes received in drums at the plant must be packed, labelled and loaded properly to ensure that waste material reaches the plant in good condition. The transport of packed waste, typically waste in drums should present detailed instructions on the types of material. All hazardous wastes received at the plant should initially be treated as being unknown and hazardous until compliance with specifications has been positively verified.

3.6.1 Management for non-compliant deliveries

Make written instructions available that describe measures to be implemented in case of non-compliance with specifications set for hazardous wastes. The producer of hazardous waste must be informed about non-compliant deliveries. If non-compliance cannot be cleared with producer, the shipment must be rejected and if required in the permit, authorities must be notified.

Deliveries should be evaluated for each producer on a statistical basis in order to assess the performance and reliability of the hazardous waste producers; periodically review contracts accordingly.

3.6.2 General design considerations

Carefully consider plant layout to ensure access for day-to-day operations, emergency escape routes, and maintainability of the plant and equipment.

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. Document any modifications to installations and equipment.

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. 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.

3.6.3 Design for reception and storage of hazardous wastes

Establish suitable and safe transfer systems from transportation to the storage area to avoid risks from spillage, fugitive emissions or vapour. Suitable vapour filtration and capture equipment should be in place to minimize impact to the reception point and surrounding areas from unloading activities.

Transfer and storage areas must be designed 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 as follows:

a) All ground area within diced, storage areas must be sealed so that spills will not penetrate the ground;

b) Sealed concrete surfaces with well controlled drainage are recommended;

c) All leaks, spills, rainwater etc. should be easily collected and saved for destruction;

d) No runoff water from the waste chemical storage area should be discharged to sewers. Any such runoff should be redirected into storage tank for subsequent high temperature destruction in the kiln;

e) Leak free design should be specified whenever possible;

f) Methods to contain and recover piping leaks without environmental contamination should be provided;

g) Adequate alarms for abnormal conditions should be provided.

Monitoring systems capable of detecting volatile organic vapours should be placed at key process locations to signal accidental waste fuel leaks. Periodic monitoring for volatile organic compound emissions should be provided. All volatile organic emissions from hazardous waste storage and handling facilities could be exhausted to the cement kiln for complete destruction. Alternatively, a closed vapour line between the storage tank vents and the tank trucks should be provided to return the displaced volatile organic vapours from the storage tanks to the tank truck, when loading the tanks. A back up carbon adsorption vapour control system could be provided to control volatile organic compound storage tank breathing emissions. Explosion proof safety valves should be used.

3.6.4 Housekeeping

General tidiness and cleanliness contribute to an enhanced working environment and can allow potential operational problems to be identified in advance. The main elements of good housekeeping are:

a) The use of systems to identify and locate/store wastes received according to their risks;

b) The prevention of dust emissions from operating equipment;

c) Effective waste water management;

d) Effective preventive maintenance.

3.7 Storage – an introduction

Assure that storage facilities fit their purpose. In general, the storage of wastes needs, additionally, to take into account the unknown nature and composition of wastes, as this gives rise to additional risks and uncertainties. In many cases, this uncertainty means that higher specification storage systems are applied for wastes than for well-characterised raw materials.

A common practice is to ensure, as far as possible, that hazardous wastes are stored in the same containers (drums) that are used for transport; thus avoiding the need for additional handling and transfer.

Good communication between the waste producer and the waste manager help to ensure wastes are stored and transferred, etc., such that risks all along the chain are well managed. It is also important that only well characterised and compatible wastes are stored in tanks or bunkers.

Appropriate waste assessment is an essential element in the selection of storage and loading options. Some issues to note are:

a) For the storage of solid hazardous waste, many plants are equipped with a bunker from where the waste is fed into the installation by cranes or feed hoppers;

b) Liquid hazardous waste and sludge's, these are usually stored in a tank farm. Some tanks have storage under an inert (e.g. N_2) atmosphere. Liquid waste is pumped via pipelines to the kiln. Sludge's can be fed by using special "viscous-matter" pumps. Appropriate storage for liquids should meet relevant safety and design codes for storage pressures and temperatures and should have adequate secondary containment;

c) Some kilns are able to feed certain substances, such as toxic, odorous liquids, by means of a direct injection device, directly from the transport container into the kiln.

Chemical wastes should be stored in an isolated area, preferable well fenced and locked, to provide good security from intruders and vandals. Incompatible wastes must be kept separate. The waste liquid storage sump area should be enclosed and all went gases from such area and storage tank should be vented to an emission control system. Solid materials handling systems should have adequate dust control systems.

3.7.1 Storage time

Storage design should be appropriate to maintain the quality and storage time of the materials. The design should prevent build-up of old materials for solids and apply mixing or agitation to prevent settlements in liquids.

Storage of hazardous waste should be for as brief a period as possible and in accordance with the permit and regulation. Recommended maximum storage times are:

a) 10 days for waste mixtures, and hazardous wastes;

b) 21 days for hazardous waste impregnated substrates;

c) For non-hazardous AFR, storage time is limited by the designed storage capacity and installed fire suppression systems.

3.7.2 Storage of solid hazardous waste

Solid and un-pumpable pasty hazardous waste that has not been degassed and does not smell can be stored temporarily in bunkers. Storage and mixing areas can be separated in the bunker. This can be achieved through several design segments. The bunker must be designed in such a way that ground emissions can be prevented.

The bunker and container storage must be enclosed unless health and safety reasons (danger of explosion and fire) exist. The air in the bunker is usually removed and ducted to the kiln. In anticipating fires, monitors such as heat-detecting cameras are used, in addition to constant monitoring by personnel (control room, operator).

3.7.3 Storage of pumpable hazardous waste

Larger amounts of fluid and pumpable pasty wastes are temporarily stored in tanks that must be available in sufficient numbers and sizes to accommodate reacting liquids separately (danger of explosion, polymerisation).

Tanks, pipelines, valves, and seals must be adapted to the waste characteristics in terms of construction, material selection, and design. They must be sufficiently corrosion-proof, and offer the option of cleaning and sampling. Flat bed tanks are generally only deployed for large loads.

It may be necessary to homogenise the tank contents with mechanical or hydraulic agitators. Depending on the waste characteristics, some tanks must be heated indirectly and insulated. Tanks are set in catch basins that must be designed for the stored material, with bund volumes chosen so that they can hold the liquid waste in the event of leakage.

3.7.4 Storage for containers and tank containers

For safety reasons, hazardous waste is often accumulated in special containers, which can be delivered directly to the plant. Delivery is also taken of bulk liquids.

The delivered containers may be stored or the contents transferred. In some cases, according to a risk assessment, the waste may be directly injected via a separate pipeline into the kiln. Heated transfer lines may be used for wastes that are only liquid at higher temperatures.

Storage areas for containers and tank containers are usually located outside, with or without roofs. Drainage from these areas is generally controlled, as contamination may arise.

3.7.5 Safety aspects of storage

The following measures will strengthen safety:

a) Storage areas should be kept clear of uncontrolled combustible materials;

b) Clear safety warnings, no smoking, fire, evacuation route, and any procedures signs should be clearly posted;

c) An emergency shower and eye washing station should be clearly marked and located near the storage of liquid alternative fuels;

d) 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);

e) Adequate alarms should be provided to alert all personnel about emergency situations;

f) Communications equipment should be maintained at the site so that the control room and the local fire department can be contacted immediately in case of a fire;

g) Equipment should be grounded and appropriate anti-static devices and adequate electrical devices selected (e.g. motors, instruments, etc.).

3.7.6 Segregation of waste types for safe processing

Waste acceptance procedures and storage depend on the chemical and physical characteristics of the waste. Appropriate waste assessment is an essential element in the selection of storage and input operations and is strongly related to the checking, sampling and assessment of incoming wastes.

The segregation techniques applied vary according to the type of wastes received at the plant. Segregation relates to maintaining separation of materials so that hazardous mixtures are avoided. Extensive procedures are required to separate chemically incompatible materials.

1	Oxidising Mineral Acids	1											
2	Caustics	H	2										
3	Aromatic Hydrocarbons	H F		3									
4	Halogenated Organics	H F GT	H GF		4								
5	Metals	GF H F			H F	5							
6	Toxic Metals	S	S				6						
7	Sat Aliphatic Hydrocarbons	H F						7					
8	Phenols and Cresols	H F							8				
9	Strong Oxidising Agents		H	H F		H F		H		9			
10	Strong Reducing Agents	H F GT			H GT				GF H	H F E	10		
11	Water and Mixtures containing Water	H			H E		S				GF GT	11	
12	Water Reactive Substances	← Extremely reactive, do not mix with any chemical or waste material →											12

E	Explosive
F	Fire
GF	Flammable Gas
GT	Toxic Gas
H	Heat Generation
S	Solubilisation of Toxins

Table 1 Compatibility and reactions

Proper labelling of the wastes (e.g. in accordance with the European Waste Catalogue) that are delivered in containers, assists their identification and traceability, and ensures:

a) Knowledge of waste content, which is required for choice of handling/processing operations;

b) The operators ability to trace sources of problems and then to take steps to eliminate or control them;

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c) The ability to demonstrate conformance with restrictions on waste types and quantities received/processed.

Bar code systems and scan readers can be used for packaged and liquid wastes. The costs of such systems are low in relation to the benefits.

3.7.7 Labelling

In general, waste delivery is accompanied by a suitable description of the waste; an appropriate assessment of this description and the waste itself forms a basic part of waste quality control. An indicative list of the most important parameters for labelling includes:

a) Name and address of the deliverer;

b) Origin of the waste;

c) Volume;

d) Water and ash content;

e) Calorific value;

f) Concentration of chlorides, fluorides, sulphur and heavy metals.

3.7.8 The use of fire detection and control systems

Automatic fire detection systems are used in waste storage areas as well as for fabric and static filters, electrical and control rooms, and other identified risk areas.

Automatic fire control systems are applied in some cases, most commonly when storing flammable liquid waste although also in other risk areas.

Foam and carbon dioxide control systems provide advantages in some circumstances e.g. for the storage of flammable liquids. Foam nozzles are commonly used in MSW incineration plants in the waste storage bunker. Water systems with monitors, water cannons with the option to use water or foam, and dry powder systems are also used. Nitrogen blanketing may be used in fixed coke filters, fabric filters, tank farms, or for the pre-treatment and kiln loading facilities for hazardous wastes.

Continuous automatic measurement of temperature can be carried out on the surface of wastes stored in the bunkers. Temperature variations can be used to trigger an acoustic alarm. There are also other safety devices, such as:

a) Nozzles above the waste feed hoppers;

b) Fire resistant walls to separate transformers and retention devices under transformers;

c) Gas detection above gas distribution module.

When ammonia is used, its storage requires specific safety measures, i.e. NH_3 detection and water spray devices to absorb releases.

3.8 Input control – general rules

Use hazardous wastes only after the supplier, and the chemical and physical properties and specifications of the materials have been clearly identified.

Consistent long-term supply of appropriate hazardous waste is required to maintain stable conditions during operation. Content of sulphur, nitrogen, chlorine, metals and volatile organic compounds needs to be specified and carefully controlled. Limitations with respect to the product and/or the process should be established.

Feeding of waste to the kiln must ensure:

a) Sufficient temperature;

b) Sufficient retention time;

c) Sufficient mixing conditions;

d) Sufficient oxygen.

The waste type and composition will determine the adequate feeding point; i.e. the main burner or the secondary burner in precalciner/preheater will ensure temperature > 900 ^{o}C. No waste feed as part of raw mix feed if it includes organics, and no waste feed during start-up and shutdown.

Handling and feed systems should be appropriate to the hazardous waste used and must ensure stable and controlled input to the kiln. 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.

Automated monitors should be employed to alert operators in the event of a waste handling problem. A pressure transducer located in the waste piping at the entrance of the kiln should be provided to turn off the waste fuel pump automatically in the event of a sudden pressure drop due to pipe rupture or pump failure.

Interlocks should be provided to stop the flow of waste automatically if either normal fuel supply or combustion air flow is interrupted, or if carbon monoxide levels indicate less than 99.9% combustion efficiency.

3.8.1 Selection of feed point

The feed point for hazardous wastes into the kiln should be selected according to the nature (and, if relevant, hazardous characteristics) of the hazardous wastes used. Hazardous wastes should be introduced in the high-temperature combustion zone of the kiln system, i.e. the main burner, the precalciner burner, the secondary firing at the preheater, or the mid-kiln (for long dry and wet kilns). The following is valid:

a) Highly chlorinated organic compounds should be introduced at the main burner to ensure complete combustion due to the high combustion temperature and long retention time. Other feed points are appropriate only where test have shown high destruction and removal efficiency rates;

b) 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;

c) Mineral inorganic wastes free of organic compounds can be added to the raw meal or raw slurry preparation system. Mineral wastes containing significantly quantities of organic components are introduced via the solid fuels handling system, i.e. directly to the main burner, to the secondary firing or, rarely, to the calcining zone of long wet or dry kilns;

d) Mineral additions such as granulated blast furnace slag, fly ash from thermal power plants or industrial gypsum can be fed to the cement mill.

3.8.2 Quality control

Develop a plan of control that covers fuels, raw materials, and any hazardous wastes entering, processed at, or produced at the site. The plan should provide detailed instructions for:

a) Sampling;

b) Personnel assignment;

c) Frequency of sampling and analysis;

d) Laboratory protocols and standards;

e) Calibration procedures and maintenance;

f) Recording and reporting protocol.

The plan should include specifications for each hazardous waste and will depend on the nature and origin of the hazardous wastes.

3.8.3 Laboratory

The plant needs an adequate laboratory, with sufficient infrastructure, sampling equipment, instrumentation and test equipment. Inter-laboratory tests should be carried out periodically in order to check and improve the performances and maintenance of the laboratory. Personnel must be competent and should be trained according to their specific needs and to the nature of the hazardous wastes used

3.9 Operations

There should be written procedures and operating instructions in place for the use of conventional and hazardous wastes; such operating instructions should cover 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.

The monitoring and reporting of emissions must be carried out according to company specific, national and local regulations and requirements.

3.9.1 Process control for hazardous wastes

The use of hazardous wastes should not detract from smooth and continuous kiln operation, product quality, or the site's normal environmental performance. Therefore, a constant quality and feed rate of the hazardous waste materials must be ensured.

Operating requirements should be developed to specify the acceptable composition of the waste feed, including acceptable variations in the physical and/or chemical properties of the hazardous waste. For each hazardous waste, the operating requirements should specify acceptable operating limits for feed rates, temperatures, retention time, oxygen etc.

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 and should cover:

a) Free lime;

b) Oxygen concentration;

c) Carbon monoxide concentration.

3.9.2 Kiln operation

The plant should characterize a good operation and use this as a basis to improve other operational performance.

Having characterized a good kiln, establish reference data by adding controlled doses of waste, and look at changes and required controls and practice to control emissions. The impact of hazardous wastes 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.

The kiln process must be operated to achieve stable conditions, which may be achieved by applying process control optimization (including computer-based automatic control systems) and use of modern, gravimetric solid fuel feed systems.

Energy use should be minimised by means of preheating and precalcination as far as possible, considering the existing kiln system configuration. Modern clinker coolers are recommended to enable maximum heat recovery from waste gas.

For start-up, shut-down, or upset conditions of the kiln, written instructions should be issued, describing conditions of use of hazardous wastes. Kiln operators should know and understand these instructions.

Procedures for stopping hazardous waste feed in the event of an equipment malfunction or other emergency must be implemented and the set points for each operating parameter that would activate feed cut-off must be specified. The waste feed must also be cut off when operating conditions deviate from limits established in the permit.

No hazardous waste burning should take place unless the cement kiln is operating at normal temperatures in the range of 1100 ^{o}C to 1600 ^{o}C and instrumentation must be provided to record continuously the rate of flow of these wastes.

Feeding of hazardous wastes should not be permitted during periods of kiln start-up, shutdown, major upset or conventional (coal) fuel interruption.

Kiln coating temperature should be measured by a recording optical pyrometer and conventional (coal) fuel flow should be continuously measured and recorded.

System controls should provide for automation shutdown of introduction of hazardous wastes in the event any of the following conditions occur:

a) Cement kiln temperatures fall below 1100 ^{o}C;

b) Conventional (coal) flow interruption;

c) Kiln speed decrease to below 60 RPH;

d) Loss of draft in the firing hood;

e) Exhaust gas oxygen content less than 1.5%;

f) If the outside skin temperature of the kiln exceeds 500 ^{o}C, the feed of hazardous wastes should be stopped and shutdown should be initiated for repair of the refractory. Reintroduction of hazardous wastes should not take place until such lining repairs are completed;

g) Hazardous waste introduction into the kiln should cease in the event of kiln ring formation;

h) The kiln should be operated at all times in an oxidizing atmosphere. Oxygen in the kiln exhaust gases must be maintained at a level of not less than 1.5% and be continuously recorded;

i) Hazardous wastes must not be used during failure of the air pollution control devices. The kiln exhaust gases must be quickly conditioned and cooled the lower than 200 °C to avoid formation and release of dioxins and other POPs;

j) Fugitive emissions must be prevented and controlled and the off-gas dust from the filters should be fed back into the kiln to the maximum extent practicable, in order to reduce issues related to treatment and emissions. Dust that cannot be recycled should be managed in a manner demonstrated to be safe.

3.10 Cement quality

The cement plant must on a routine basis carry out chemical and physical analysis for all relevant parameters with regards to cement quality and potential clinker contamination. All data must be recorded.

3.11 Emission limits and monitoring

For emissions to air, cement kilns treating hazardous wastes in Europe must comply with the EU Directive 2000/76/EC and must meet an emissions limit for PCDD/PCDF in flue gases < 0.1 ng TEQ/Nm^3, corrected to 273 K, 101.3 kPa, 10% O_2 and dry gas.

3.11.1 Continuous emission measurements

To monitor the process and accurately quantify the emissions, continuous emission measurements are recommended for the following parameters:

a) Exhaust volume;

b) Humidity;

c) Temperatures;

d) Particulate matter;

e) O_2;

f) NO_x;

g) SO_2;

h) CO;

i) Volatile organic compounds (VOC);

j) HCl;

k) Pressure.

Table 2 The European Directive 2000/76/EC incineration of waste (Daily average values 10% O_2, dry gas; all values in mg/m^3 dioxins and furans in ng/m^3)

Pollutant	C
Total dust	30
HCl	10
HF	1
NO_x	500[1)]/800[2)]
Cd + Tl	0.05
Hg	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	0.5
Dioxins and furans	0.1
SO_2	50[3)]
TOC	10[3)]

1) new plants

2) existing plants

3) exceptions may be authorized by the component authority in cases where SO_2 and TOC do not result from the waste.

3.11.2 Regular monitoring

Periodical monitoring should be conducted for the following substances on a regular basis:

a) Metals and their compounds;

b) Total organic carbon;

c) HF;

d) NH_3;

e) PCDD/PCDF;

f) Chlorobenzenes, HCB and PCBs including coplanar congeners and chloronaphthalenes.

3.11.3 Occasional monitoring

Measurements of the following substances may be required occasionally under special operating conditions:

a) Demonstration of the destruction and removal efficiency (DRE) and the destruction efficiency (DE);

b) Benzene, toluene and xylene;

c) Polycyclic aromatic hydrocarbons;

d) Other organic pollutants.

It is especially important to measure metals when wastes with higher metal content are used as raw materials or fuels.

3.11.4 Additional measures for exit gas cleaning

Activated carbon filter has high removal efficiency for trace pollutants (> 90%). Pollutants such as sulphur dioxide (SO_2), organic compounds, metals, ammonia (NH_3), ammonium (NH_{4+}) compounds, hydrogen chloride (HCl), hydrogen fluoride (HF) and residual dust may also be removed from the exhaust gases by adsorption on activated carbon.

Selective catalytic reduction can be applied for NO_x control. The process 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, which imply heating of the exhaust gases.

3.12 Test burn and performance verification

Test burns are recommended for the verification of the destruction and removal efficiency (DRE) and the destruction efficiency (DE) of certain principal organic hazardous compounds (POHC) in a cement kiln. The DRE is calculated on the basis of mass of the POHC content fed to the kiln, minus the mass of the remaining POHC content in the stack emissions, divided by the mass of the POHC content within the feed.

The DRE considers emissions to air only. The DE considers all out-streams (liquid and solids) in addition to the air emissions and is the most comprehensive way of verifying the performance. Test burns with hazardous compounds require professional supervision and independent verification.

The following conditions should be fulfilled in a test burn:

a) The destruction and removal efficiency for hazardous compound should be at least 99.99%. Chlorinated aromatic compounds should be chosen as a test compound if available because they are generally difficult to destroy. For POPs, a DRE/DE of ≥99.9999% should be achieved.

b) The cement kiln should meet an emissions limit for PCDDs/PCDFs of 0.1 ng TEQ/Nm^3 both under baseline and test burn conditions.

c) The cement kiln should comply with existing national emission limit values.

Test burns with non-hazardous hazardous waste are usually not a regulatory requirement but are sometimes done to evaluate the behaviour of the process and the influence on main gaseous emissions and the cement clinker quality when feeding waste to the kiln. Such simplified tests are usually conducted by process engineers at the cement plant using already installed on-line monitoring equipment and process operational data.

3.13 On-site security and safety

Adequate systems and procedures should be in place to minimize the risk of unauthorized access to hazardous wastes used on-site. An emergency response plan should be in place, which:

a) Identifies potential spill or contamination areas;

b) Defines clean-up procedures;

c) Identifies areas of high risk on site or in the local community;

d) Provides written instructions in the event of an emergency;

e) Documents equipment required in the event of an emergency;

f) Assigns responsibilities to employees and local officials;

g) Details emergency response training requirements;

h) Describes reporting and communication requirements both within the company and with interested external stakeholders.

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

Safety and emergency instructions, such as Material Safety Data Sheets, must 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. Automated handling equipment should be used wherever possible.

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:

a) Helmet;

b) Glasses;

c) Gloves;

d) Hearing protection;

e) Safety shoes;

f) Respiratory protection;

g) Other protective equipment specified in the Material Safety Data Sheets.

Emergency equipment, such as fire extinguishers, self contained breathing masks, sorbent materials and shower stations should be sited in the immediate vicinity of the waste chemical storage area. Employees should be trained in their proper use.

The plant needs to have specially trained and authorized personnel at the storage and pumping site for unloading and storage of hazardous wastes. When authorized operating personnel are not on site, the storage and pumping area should be made sufficiently secure to prevent site access and operation of the storage and unloading system.

Wherever a contact risk such as infection or skin irritation exists, the company should provide appropriate facilities for operators to take required hygiene precautions.

Maintenance work should be authorized by plant management, and carried out once a supervisor has checked the area and necessary precautions have been taken.

Special procedures, instructions, and training should be in place for such routine operations as:

h) Working at height, including proper tie-off practices and use of safety harnesses;

i) Confined space entry where air quality, explosive mixtures, dust, or other hazards may be present;

j) Electrical lock-out, to prevent accidental reactivation of electrical equipment undergoing maintenance;

k) "Hot works" (i.e. welding, cutting, etc.) in areas that may contain flammable materials.

3.14 Training

The company must develop and implement appropriate documented training programs for employees to be trained in safety, health, environment and quality issues relevant to their jobs. New employees should be trained during an induction process and personnel reporting to work on a site for the first time should be trained through a site induction program.

Training records should be kept on file. The training program should include the following:

a) General and job specific safety rules;

b) Safe operation of equipment;

c) Details of the site emergency plan;

d) Procedures for handling hazardous wastes and alternative fuels and raw materials;

e) Use of personal protective equipment.

Such training programs should also be given to contractors and, in some instances, suppliers.

3.15 Stakeholder communications

Effective, open, and transparent communication with all stakeholders is essential. Companies must develop and implement a stakeholder engagement program and policy that includes specific reference to the use of hazardous wastes. At site level, management should provide opportunities for stakeholders to express their concerns, listen to and understand those concerns, and build trust with the community through active engagement.

3.16 Reporting performance

Building trust with stakeholders requires both transparency and accountability in company and site operations. The production of regular reports on performance in all areas of interest helps to provide key stakeholders with the information they need to make a fair and balanced judgment of the company's or site's activities and performance.

3.17 Environmental management system

The plant should have an environmental management system (EMS) in place, ensuring continuous improvement of its performance.

Environmentally Sound Management, (ESM) is a policy concept which more broadly applies to hazardous wastes within the Basel and Stockholm conventions.

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4. Environmental management system

The two most frequently used guidelines for EMS design and guidelines are the international standard, ISO 14001, and the European standard, EMAS.

In brief, ISO 14001 and EMAS have different aims. ISO 14001 provides guidelines that can be implemented by almost any type of organization in any country and was designed primarily to improve management. EMAS, on the other hand, is designed to bring about changes in environmental performance.

4.1 Environmentally Sound Management under the Basel Convention

In its article 2, paragraph 8, the Basel Convention (1989; 2006) defines ESM of hazardous wastes or other wastes as "*taking all practicable steps to ensure that hazardous wastes or other wastes are managed in a manner which will protect human health and the environment against adverse effects which may result from such wastes.*"

In article 4, paragraph 2 (b) the convention requires that each Party take the appropriate measures to "*ensure the availability of adequate treatment facilities for the environmentally sound management of hazardous or other wastes, that shall be located, to the extent possible, within it, whatever the place of their treatment,*" while in paragraph 2 (c) it requires each Party to "*ensure that persons involved in the management of hazardous wastes or other wastes within it take such steps as are necessary to prevent pollution due to hazardous wastes and other wastes arising from such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment.*"

OECD has adopted a recommendation on the ESM of wastes, which includes various items, inter alia core performance elements of ESM guidelines applying to waste recovery facilities, including elements of performance that precede collection, transport, treatment and storage, as well as elements subsequent to storage, transport, treatment and treatment of pertinent residues.

4.1.1 General requirements of Environmentally Sound Management

To comply with ESM criteria, it is recommended that a number of legal, institutional and technical conditions be met, in particular that:

a) A regulatory and enforcement infrastructure ensures compliance with applicable regulations;

b) The facility should be authorized and have an adequate standard of technology and pollution control to deal with hazardous wastes;

c) The facility should have an applicable environmental management system (EMS) in place;

d) The facility should take sufficient measures to safeguard occupational and environmental health and safety;

e) The facility should have an adequate monitoring, recording and reporting programme;

f) People involved in the management of hazardous wastes are capable and adequately trained in their capacity.

g) That the facility should have an adequate emergency plan; and

h) The effects of the activities needs to be monitored and appropriate action should be taken in cases where monitoring gives indications that the management of hazardous wastes has resulted in unacceptable releases.

4.2 General requirements of Environmental Management System

Preparing for and complying with ISO 14001 involves several steps:

a) Conducting an initial environmental review;

b) Identifying environmental aspects and impacts;

c) Setting an environmental policy;

d) Understanding and complying with local environmental legislation and regulations and other standards to which the organization subscribes;

e) Setting environmental objectives and targets;

f) Setting and implementing an environmental management program;

g) Setting and implementing environmental procedures;

h) Establishing environmental training and awareness;

i) Establishing an environmental communication system;

j) Establishing a system for document and operational control;

k) Installing an emergency preparedness and response plan;

l) Monitoring and measuring;

m) Understanding non-conformance and implementing correction and prevention;

n) Having an audit, and

o) Management review and control.

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