environment & tourism

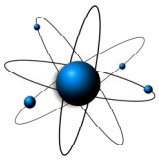
Department:
Environmental Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

NATIONAL POLICY DEVELOPMENT PROCESS FOR HIGH TEMPERATURE WASTE INCINERATION AND AFR CO-PROCESSING IN CEMENT PRODUCTION

AIR EMISSION STANDARDS FOR THE CO-PROCESSING OF WASTE AS ALTERNATIVE FUELS OR RAW MATERIALS (AFR) IN CEMENT PRODUCTION

PROPOSAL TO THE NATIONAL AIR EMISSION STANDARDS DEVELOPMENT PROGRAMME

Prepared by:



ENVIRONMENTAL
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1 INTRODUCTION

This document contains the proposal for South African air emission standards (AES) for the co-processing of general and hazardous waste as alternative fuels and raw materials (AFRs) in cement kilns. The proposed standards were developed as part of the Department of Environmental Affairs and Tourism's (DEAT) National Policy Development Process for High Temperature Waste Incineration, and AFR Co-processing in Cement Production. The main objectives of this project are as follows:

- Development of a national policy statement on general and hazardous waste treatment / destruction through high temperature thermal technologies, in consultation with provincial environmental departments and other stakeholders;
- Development of a detailed, technical sector guideline specific to the co-processing of selected general and hazardous waste streams as alternative fuels or raw materials (AFRs) in cement production, in line with the above policy;
- Providing technical support and comments to provincial environmental departments through the joint review and consideration of current EIA applications for the use of AFRs in cement kilns; and
- Development of detailed technical and procedural EIA review guidelines for applications for the use of AFRs in cement kilns and similar technologies.

The proposed emission standards are based on, among others, the findings of a number of literature reviews conducted as part of the project, consideration of international best practice and best available technology, international emission standards, and the current South African context in terms of existing cement kiln technology, existing emission standards and permits.

The proposed emission standards would be formalised in terms of Section 21 of the National Environmental Management: Air Quality Act (NEMAQA), and will accordingly be presented as recommendation to the current DEAT AQA Implementation Project for incorporation into the Listed Activities and Minimum Emission Standards Programme (in line with the 'National Air Quality Management Framework' (DEAT, 2007a)).

2 METHODOLOGY

2.1 LEGISLATIVE FRAMEWORK

2.1.1 Listing of Activities and Setting Standards

It is proposed that emission standards in this document be formalized in terms of Section 21 of the NEMAQA, which provides for the listing of activities resulting in atmospheric emissions:

(1) The Minister must, or the MEC may, by notice in the *Gazette* –

(a) publish a list of activities which result in atmospheric emissions and which the Minister or MEC reasonably believes have or may have a significant detrimental effect on the environment, including health, social conditions, economic conditions, ecological conditions or cultural heritage; and

(b) when necessary, amend the list by -

(i) adding to the list activities in addition to those contemplated in paragraph (a);

(ii) removing activities from the list; or

(iii) making other changes to particulars on the list.

(2) A list published by the Minister applies nationally and a list published by the MEC applies to the relevant province only.

(3) A notice referred to in subsection (1) –

(a) must establish minimum emission standards in respect of a substance or mixture of substances resulting from a listed activity and identified in the notice, including -

(i) the permissible amount, volume, emission rate or concentration of that substance or mixture of substances that may be emitted; and

(ii) the manner in which measurements of such emissions must be carried out;

(b) may contain transitional and other special arrangements in respect of activities which are carried out at the time of their listing; and

(c) must determine the date on which the notice takes effect.

2.1.2 Controlled Fuels

Section 26 of NEMAQA provides for the Minister to declare certain substances as Controlled Fuels, when used as fuel in a combustion process and which may result in atmospheric emissions. Section 27 further provides for the prohibiting the manufacture, use or sale of certain Controlled Fuels, and the establishment of standards or specifications for, among others:

- the use of the controlled fuel in combustion processes;
- manufacture or sale of the controlled fuel; and

- maximum or minimum levels or concentrations of the constituents of substances or mixtures of substances, for the composition of controlled fuels.

The provisions for regulating the use of controlled fuels as contained in Section 27 does not seem to evidently provide for setting emission standards (particularly compared with Section 21), but rather for setting standards regulating the use up to the point of introduction into the process, and the composition of the fuel.

In addition, although certain AFRs could be considered to be Controlled Fuels (where used as alternative energy source and substituting coal), AFR also includes various substances that would be used as raw materials, thereby substituting conventional mineral materials. It is therefore believed that Section 27 would not be the appropriate mechanism for the establishment of air emission standards for AFR co-processing in cement production. Section 27 may however be applied to set specific requirements pertaining to blended fuels.

2.1.3 NEMA

The National Environmental Management Act (No. 107 of 1998) requires the use of the "best practicable environmental option" (BPEO) in environmental management; meaning "the option that provides the most benefit or causes the least damage to the environment as a whole, at a cost acceptable to society, in the long term as well as in the short term". The BPEO comprises the following:

- **'Best'** – Meaning state of the art, most beneficial or most effective, informed by peer reviewed local and international literature.
- **'Practicable'** – Feasible, possible, realistic, workable, practical or viable, informed by cost-benefit, accessibility, affordability, availability and other information in peer reviewed local and international literature.
- **'Environmental Option'** – Measured in terms of impact on the environment defined in its broadest sense.

In line with the above, the European Union (EU) definition of "best available technique" (BAT) contains three key terms defining the above:

- **'Techniques'** shall include both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned,
- **'Available'** techniques shall mean those developed on a scale which allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages, whether or not the techniques are used or produced inside the [country] in question, as long as they are reasonably accessible to the operator,
- **'Best'** shall mean most effective in achieving a high general level of protection of the environment as a whole.

2.2 APPROACH

DEAT's Chief Directorate: Air Quality Management and Climate Change (Environmental Quality and Protection Branch) has embarked on a national NEMAQA Implementation Process, which includes the listing of activities and setting of air emission standards (AES). A number of documents have been produced as part of this project through a participatory process, which had been consolidated into a project Review Report (DEAT, 2007b). The national process specifically considers case studies related to emission standards in the United States, European Union and New South Wales (Australia). Some of the key recommendations from the report and the links (as relevant) with the National Policy Development Process for High Temperature Waste Incineration and Co-processing of AFRs in Cement Production, are discussed below.

(1) Adoption of a Phased Approach to Emission Standard Setting

Considering the requirements of the NEMAQA, the experience of other countries, and of preliminary consultation undertaken with some affected sectors, a stepped approach to emission standard setting is recommended, comprising among others:

- Consultation with industry, trade bodies and other affected parties;
- Collation of sector guidance documents comprising information on best available technology, including associated emission standards and monitoring requirements international BAT documentation and industry-specific information;
- Draft emission standards in consultation with stakeholders for consideration by DEAT.

The current proposed standards forms part of the larger consultative policy process, and has been developed considering Best Available Technology (BAT) and Best Environmental Practice (BEP).

(2) Selection of Industry Sector Sub-set for Initial Listing

Based on the conclusions reached in the Interim project, a list of industry types are proposed for inclusion in the initial list of activities requiring prioritised national emission standard setting, with industries presently not significantly represented in South Africa to be removed or noted for subsequent listing and emission standard setting.

The cement industry and waste incineration are included in the list of activities identified.

(3) Restriction of Emission Standard Setting to Priority Pollutants

It is recommended that only those pollutants recognised to pose a potential health threat be selected for the setting of emission standards for each industry type selected (with the exception of incineration for which an extended number of substances should be regulated in line with current local and international experience. Reference should be made to information on the US, UK and New South Wales (NSW) approaches in the selection of the most suitable substances to target.

A complete, detailed list of emission standards are proposed in line with international approach, specifically the EU.

(4) Adopt Best Available Technology (BAT) as the Basis for Emission Standards

It is commonplace in best practice legislative environments to require that emission standards take into account best available technologies and ambient air quality limits. In practice, minimum nationally-set emission standards tend to be based on best available technology, with the requirement that more stringent emission standards be set at lower tiers of government taking into account ambient air quality limits. In addition to this, the use of environmental impact assessments for informing emission standards for new and modified facilities is widely accepted. This provides a safety net in cases where minimum emission standards best on BAT are not sufficient to protect local environments. Given that provision is made in the NEMAQA for the setting of more stringent emission standards by provincial and local authorities, it is recommended that the national minimum emission standards be based on best available technology.

The emission limits proposed, based on the European Communities' Directive 2000/76/EC of 4 December 2000 ('EC Directive') on the incineration of waste, are considered to be stringent, and together with the provisions of the Guidelines for Treatment of Hazardous Wastes and Co-processing of AFRs in Cement Kilns (Karstensen, 2008), the South African regulatory framework for this activity would be the most stringent in the world.

(5) Format for Expressing Emission Standards

The NEMAQA stipulates that emission standards "must include the permissible amount, volume, emission rate or concentration of that substance or mixture of substances that may be emitted and the manner in which measurements must be carried out". It is recommended that emission standards be expressed either as an emission concentration or a performance standard (i.e. amount of pollutant emitted per unit of activity) or, where appropriate, a combination of both with the actual concentration or level of performance taken from BAT. Total masses of emissions permissible can be included in the Atmospheric Emissions Licenses of Listed Activities.

The proposed standards are given as concentration values for individual elements.

(6) Emission Monitoring Specified on the Basis of Best Practice

The emission monitoring required clearly depends on the nature of the source, the pollutant and the emission standard. Emission standards expressed as emission concentrations require direct stack monitoring. The sector-specific monitoring method and frequency should be taken from the best practice documentation (e.g. EU's Monitoring BREF). In most cases, continuous emissions monitoring is prescribed for the larger sources of criteria pollutants as is typically best practice, with periodic (e.g. annual) testing campaigns stipulated for metals, persistent organic compounds (etc.).

The standards proposed includes monitoring provisions, such as baseline and continuous on-line emission monitoring of certain emissions, but would also be subject to the monitoring and reporting requirements set by the national programme.

(7) Emission Standards should be varied to account the Age of Facilities

The setting (retention) of less stringent emission standards for older facilities has a place in the regulatory process of most of the countries considered It is however notable that these emission standards are not static, but that there are timeframes within which facilities are expected to meet firmer standards. Generally, the approach adopted is to link required improvements to major plant modifications and to take advantage of industry cycles. This is most readily expressed in the NSW regulations where older plants are given five year timeframes to institute upgrades which will bring them in line with more stringent emission standards.

Less stringent emission standards are proposed only for a limited number of pollutants and are valid for a limited time to provide for a feasible transitional period in the implementation of the EU standards.

(8) Compliance Schedules should be Informed by Industry Cycles

Based on international experience, an effective approach would be to set minimum timeframes for compliance nationally (taking account of industry cycles), with provision being made for more restricted compliance schedules to be specified by lower government tiers for industries within their jurisdictions and/or stricter timetables being negotiated for inclusion in permits. Typical compliance timeframes, based on the US, EU and NSW case studies would be 2 to 3 years in the case of new or substantially modified facilities, or 5 to 10 years in the case of existing facilities, potentially differentiated by age.

The proposed standards provide for a transitional period to achieve compliance, based on international experience and the South African context (limited to emissions that are not expected to be significantly affected by AFR co-processing).

(9) Provision for Extensions to Compliance Timeframes on a Case-by-case Basis

Given potential economic implications of emission standards, and mindful that emission standard setting in SA is unlikely to be based on comprehensive sector-based CBAs (at least not for the initial group of 'listed activities'), it is recommended that provision be made for industries to apply for possible extensions to compliance timeframes.

It is believed that the transitional arrangements provided for in the proposed standards are reasonable, and no specific provision for exemptions has been included. Any application for exemptions would be subject to the provisions of the National Air Quality Management Framework.

(10) Considerations during Emission Standard Implementation

In the implementation of emission standards, best practice necessitates comprehensive compliance monitoring and enforcement functions and the regular review of such standards in line with BAT developments. Provision should be made for these functions to be implemented and maintained after the initial standard setting activity has been completed.

Apart from stringent monitoring requirements included in the proposed emission standards, the current policy development project would include the development of a detailed implementation plan for DEAT focussed on interim compliance and enforcement resource requirements.

3 EXISTING AIR EMISSION STANDARDS

3.1 INTERNATIONAL STANDARDS

An overview of local and international standards and best practice guidelines for emissions from waste incinerators and cement kilns co-processing AFR informed the setting of proposed standards. The two main sets of international standards considered were:

- European Communities' Directive 2000/76/EC of 4 December 2000 ('EC Directive') on the incineration of waste, which includes emission limits for incineration in Annex 5, and special provisions for cement kilns 'co-incinerating' waste in Annex 2 of the Directive.
- The New South Wales' (NSW) Protection of the Environment Operations (Clean Air) Regulation (30 August 2002), specifically:
  - Schedule 3 – Standards of concentration for scheduled premises: Activities and plant used for specific purposes (Cement or lime production or handling, which includes specifications for kilns fired on a "non-standard fuel").
  - Schedule 4 – Standards of concentration for scheduled premises: General activities and plant.

Other standards (e.g. United States and Canadian) and information contained in guidance documents (e.g. the BAT Reference Document on Best Available Techniques in the Cement and Lime Manufacturing Industries, (IPPC, 2001)). The consideration of international standards was focussed on Europe due to, amongst others, relatively recent and detailed standards on waste co-processing in cement kilns.

The NSW Clean Air Regulation provided additional context and alternative options in the application of new standards for the specific activity. Specifically, the sets specific limits based on the age of installations or plants, being divided into 6 groups based on date of commencement of operations:

- Group 1: Commenced before 1 January 1972, or after 1 January 1972 as a result of a pollution control approval granted (under the 'old' Pollution Control Act 1970) for which an application was made before 1 January 1972;
- Group 2: Commenced on or after 1 January 1972 as a result of a pollution control approval granted for which an application was made on or after 1 January 1972 and before 1 July 1979;
- Group 3: Commenced on or after 1 July 1979 as a result of a pollution control approval granted for which an application was made on or after 1 July 1979 and before 1 July 1986;
- Group 4: Commenced on or after 1 July 1986 as a result of a pollution control approval granted for which an application was made on or after 1 July 1986 and before 1 August 1997;
- Group 5: Commenced on or after 1 August 1997 as a result of:

  - A pollution control approval granted for which an application was made on or after 1 August 1997 and before 1 July 1999, or
  - An environment protection licence granted under the 'new' Protection of the Environment Operations Act (1997) for which an application was made on or after 1 July 1999 and before 1 September 2005;
- Group 6: Commenced on or after 1 September 2005, as a result of an environment protection licence for which an application was made on or after 1 September 2005.

The Regulation also includes provisions for the 'phasing out' of older groups, by implication requiring compliance with stricter standards over a period of time (summarised as follows):

- On and from 1 January 2008, any activity or plant that, immediately prior to that date, belonged to Group 1 is taken to belong to Group 2.
- On and from 1 January 2012, any activity or plant that, immediately prior to that date, belonged to Group 2 (including any activity or plant previously in Group 1) is taken to belong to Group 5.

Tables 1 and 2 provides an overview of relevant international air emission standards (or emission limit values – ELV).

Table 1: Overview of EC Directive and other international ELVs

ELVs / EMISSIONS	EC Directive – Waste Incineration Plants [1]	EC Directive – Cement Kiln Co-Incineration[7]	Range of EU Country-Specific ELVs for Cement Production [11]	Long Term Average European Kiln Emissions [13]	New South Wales Clean Air Regulation [14,15]
Dust	10 (20) [2]	30 [8]	50 – 150	20 – 200	400 (I) 250 (II, III, IV) 100 (V) 50 (VI)
TOC	10	10 [9]		10 – 100	– (I-V) 40 (VI) (VOCs)
CO	50	– [10]		500 – 2000	
HCl	10	10	30	<25	400 (I-IV) [16] 100 (V,VI)
HF	1	1	1 – 5	<5	100 (I) 50 (II-VI)
SO_2	50	50 [9]	150 – 600 (400 – 1800) [12]	10 – 2500	200 (I) [16] 100 (II-VI) (SO_3)
NOx	400 (500) *[Existing plants, <6t/h]* [2,3] 200 (400) *[New or existing plants, >6t/h]* [2,3]	800 (existing) [8] 500 (new)	500 – 1800	500 – 2000	2500 (I-IV) 2000 (V) 500 (VI)
Cd + Tl	0.05 [4] (0.1) [5]	0.05		<0.1	– (I,II,III) 3 (IV) 1 (V) 0.2 (VI) (indiv. conc. Hg, Cd)
Hg	0.05 [4] (0.1) [5]	0.05			
Sb+As+Pb+Cr+ Co+Cu+Mn+Ni+ V (*Sum of all*)	0.5 [4] (1) [5]	0.5		<0.3	20 (I, II, III) 10 (IV) 5 (V) 1 (VI)
PCDD/PCDF (ng/m^3 I-TEQ)	0.1 [6]	0.1	0.1	<0.1	– (I-V) 0.1 (VI)

[Refer to next page for table notes]

Notes:

1. Overview of provisions in Annex V to the EC Directive. ELVs expressed as mg/m^3 daily average values, unless otherwise stated, standardised at 273 K (0 ºC), 101.3 kPa, 11% O_2, dry gas.
2. Certain exemptions to the standard may be authorised provided that the maximum daily average values do not exceed the limit in brackets. The provisions for exemption from the standards for dust and NOx applied until January 2008 or January 2010 (for NOx depending on plant capacity).
3. Without prejudice to local legislation (e.g. see column 3), ELVs for NOx did not apply until January 2007 for plants incinerating hazardous waste only.
4. Average values over a sample period of minimum 30 minutes and maximum 8 hours. The values include gaseous and vapour forms of the relevant heavy metals, as well as their compounds.
5. Limits valid until January 2007 for plants permitted before December 1996, which incinerates hazardous waste only.
6. Average value measured over a sample period of minimum 6 hours and maximum 8 hours.
7. Overview of provisions in Annex II (S II.1) to the EC Directive. ELVs expressed as mg/m^3 daily average values, unless otherwise stated, standardised at 273 K (0 ºC), 101.3 kPa, 10% O_2, dry gas.
8. Until January 2008, exemptions from the ELVs for dust and NOx were possible, provided that the kiln burns less than 3 tonnes of waste per hour, and the emissions do not exceed 50 mg/m^3 for dust or 1200 mg/m^3 for NOx.
9. Exemption may be authorised where TOC and SO_2 do not result from incineration of waste (i.e. emission due to particular composition of fuel or raw materials).
10. Emission limit values for CO can be set by the competent authority.
11. Overview of certain national emission limits (country specific national or regional law, or typical permits) for production of cement in dry process kilns within 15 EU countries (in part from IPPC BREF, December 2001). Ranges of limits shown exclude individual standards that are in some cases significantly different to the rest, and therefore the apparent norm (non-statistical) is indicated.
12. Limits when sulphur rich raw materials are used.
13. From Karstensen (2007a).
14. Standards in Schedules 3 and 4 to the Protection of the Environment Operations (Clean Air) Regulation, 2002.
15. Specific concentrations are stipulated per groups depending on age of installations (Groups to which limit applies indicated in brackets).
16. ELVs that are not specifically prescribed for cement production processes, but form part of general ELVs in Schedule 4 of the Clean Air Regulation (Standards of concentration for General activities and plant).

Table 2: Comparative Summary of Municipal Waste Incinerator Emission Limits (Durham/York Residual Waste Study, 2006)

Contaminant	Concentration Units	Ontario MOE A-7 (February 2004)	Canadian Council of Ministers of the Environment (CCME)	US EPA 40 CFR Part 60 (May-10-06 Edition) Standards of Performance for Large Municipal Waste Combustors (New Facilities) (b), (c)	EU Directive 2000/76/EC of the European Parliament And Council on the incineration of waste (c)	Typical Performance of Modern EFW Facilities
Total Particulate Matter (TPM)	mg/Rm3 @ 11% O2	17	20 (p)	14.0	9.2 (n)	6.9
Sulphur Dioxide (SO2)	mg/Rm3 @ 11% O2	56	260 (q)	55.0 (d)	45.8 (n)	10.8
Hydrogen Chloride (HCl)	mg/Rm3 @ 11% O2	27	75 or 90% removal (p)	26.1 (e)	9.2 (n)	10.0
Nitrogen Oxides (NOx) (as NO2)	mg/Rm3 @ 11% O2	207	400 (q)	197.5 (g)	183.2 (n)	94.8
Carbon Monoxide (CO)	mg/Rm3 @ 11% O2	N.Def.	57 (114 for RDF Systems) (p)	41 to 200 (m1)	45.8 (n)	10.5
Cadmium (Cd)	ug/Rm3 @ 11% O2	14	100 (q)	7.0	N.Def.	4.9
Lead (Pb)	ug/Rm3 @ 11% O2	142	50 (q)	98.0	N.Def.	44.5
Mercury (Hg)	ug/Rm3 @ 11% O2	20	20 (r)	35.0	45.8 (o)	10.0
Cd + Tl	ug/Rm3 @ 11% O2	N.Def.	N.Def.	N.Def.	45.8 (o)	N.Def.
Sum (Sb, As, Pb, Cr, Co, Cu, Mn, Ni,	ug/Rm3 @ 11% O2	N.Def.	N.Def.	N.Def.	458.1 (o)	N.Def.
PCDD/F TEQ (l)	ng/Rm3 @ 11% O2	0.08	0.08 (s)	9.1 (k)	0.092	0.020
Organic Matter (as Methane)	ppmv undiluted	100				1.1
	mg/Rm3	65.6				

Concentration units: Mass per reference cubic metres corrected to 11% oxygen. Reference conditions: 25 deg. C, 101.3 kPa.
N.Def. = Not Defined

[Refer to next page for table notes]

Notes (Durham/York Residual Waste Study, 2006):

(a) 'Small' = Small municipal waste combustion (MWC) units with an individual MWC capacity of 250 tons/d or less
(b) 'Large' = Large MWC units with an individual MWC capacity greater than 250 tons/d
(c) Units have been converted to Ontario MOE A-7 concentration units to allow direct comparison
(d) or 80% reduction by weight or volume of potential SO2 emissions, whichever is less stringent
(d1) or 90% reduction by weight or volume of potential SO2 emissions, whichever is less stringent
(d2) or 75% reduction by weight or volume of potential SO2 emissions, whichever is less stringent
(e) or 95% reduction of potential HCl emissions by weight, whichever is less stringent
(e1) or 97% reduction of potential HCl emissions by weight, whichever is less stringent
(e2) or 98% reduction of potential HCl emissions by weight, whichever is less stringent
(f) Limit for Class I MWC. Class I = small MW combustion unit located at MW combustion plant with an aggregate plant combustion capacity of more than 250 tons/d of MSW
(g) 180 ppmdv @ 7% O2 for 1st year of operation, 150 ppmdv @ 7% O2 after 1st year of operation
(g1) NOx limit varies by combustor type: 158 ppmdv @ 7% O2 for Mass Burn Rotary Waterwall, 180 ppmdv @ 7% O2 for Fluidized Bed, 205 ppmdv @ 7% O2 for Mass Burn Waterwall, 219 ppmdv @ 7% O2 for Refuse-derived fuel, no limit for Mass Burn Refractory (after Apr. 28, 2009)
(g2) NOx limit varies by combustor type: 210 ppmdv @ 7% O2 for Mass Burn Rotary Waterwall, 180 ppmdv @ 7% O2 for Fluidized Bed, 205 ppmdv @ 7% O2 for Mass Burn Waterwall, 250 ppmdv @ 7% O2 for Refuse-derived fuel, no limit for Mass Burn Refractory (after Apr. 28, 2009)
(h) Limit for Class II MWC. Class II = small MW combustion unit located at MW combustion plant with an aggregate plant combustion capacity no more than 250 tons/d of MSW
(i) CO limit varies per technology: 41 mg/Rm3 @11% O2 for Modular Starved-Air & Excess Air Unit; 163 mg/Rm3 @11% O2 for Fluidized Bed, Mixed Fuel, (Wood/Refuse Derived Fuel) Unit
(j) or 85% reduction by weight of potential Hg emissions, whichever is less stringent
(j1) or 90% reduction by weight of potential Hg emissions, whichever is less stringent
(k) Limit not comparable to Canadian and European limits. Dioxins/furans on total mass basis measured as tetra- through octachlorinated dibenzo-p-dioxins and dibenzofurans. Not TEQ values
(l) TEQ = Toxity Equivalent. Per MOE, International Toxicity Equivalency Factors (I-TEFs) are applied to 17 dioxin and furan isomers of concern to convert them into 2,3,7,8-TCDD (tetrachlorobenzo-p-dioxin) toxicity equivalents (most toxic compound). The conversion involes multiplying the concentration of each isomer by the appropriate I-TEF to yeild the TEQ for each isomer. Summing the individual TEQ values for each isomer of concern provides the total toxicity equivalent level for the sample mixture. The I-TEF scheme is intended to be used with isomer specific analytical results, rather than results reported by congener group only.
(m) CO limit varies per technology: 40 mg/Rm3 @11% O2 for Modular Starved-Air & Excess Air Unit; 120 mg/Rm3 @11% O2 for Spreader Stoker, Mixed Fuel-Fired (Coal/Refuse-derived fuel)
(m1) CO limit varies per technology: 40 mg/Rm3 @11% O2 for Modular Starved-Air & Excess Air Unit; 200 mg/Rm3 @11% O2 for Spreader Stoker Refuse-derived fuel
(n) Daily average value
(o) Average values over the sample period of a minimum of 30-minutes and a maximum of 8 h
(p) CCME Operating & Emissions Guidelines for MSW Incinerators Report CCME-TS/WM-TRE003, June 1989. Table 4.2: Stack Discharge Limits (at 11% O2)
(q) CCME Operating & Emissions Guidelines for MSW Incinerators Report CCME-TS/WM-TRE003, June 1989. Table 4.3: Anticipated Emissions From MSW Incinerators Operating Under Good combustion conditions and equipped with dry scrubber fabric filter systems (at 11% O2)
(r) CCME Canada-Wide Standards for Mercury Emissions (2000)
(s) CCME Canada-Wide Standards for Dioxins & Furans (2001)

3.2 SOUTH AFRICAN STANDARDS

- South African guideline standards for waste incineration – Process 39 as identified in the Second Schedule to the Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965).
- Current emission limits for South African cement kilns as set in respective Registration Certificates issued in terms of the Atmospheric Pollution Prevention Act, 1965 (Act 45 of 1965).
- Environmental performance requirements for controlled combustion facilities as specified in Schedule 3 to the provincial Gauteng Health Care Waste Management Regulations (17 August 2004).
- Proposed emission standards being developed as part of DEAT's NEMAQA Implementation Programme (DEAT, 2008).

Table 3: Overview of South African ELVs, APPA Registration Certificate Requirements and Emissions from Cement Kilns

ELVs / EMISSIONS	APPA Process 39 Emission Guideline [1,2]	APPA Process 22 Emission Guideline [1,4]	Current Registration Certificates [6]	Range of Current SA Cement Kiln Emissions [8]	Gauteng HCW Management Regulations	*Proposed NEMAQA Emission Standard-Cement* [10,11]	*Proposed NEMAQA Emission Standard-Incineration* [12]
Dust	120 (Class 1)[3] 180 (Class 2)	200 150 120 [5]	30 – 350 (mostly 100/200; Average 130)	9 – 250	25	50	25
TOC			10	2 – 5 [9]			
CO					50		100
HCl	30		10	1 – 13	30		30
HF	30		1	<0.1 – <1			
SO_2	25		50	2 – 200	25	250	50
NOx			650 – 800	450 – 1400		1200 (2000)	
Cd + Tl + Hg	0.05		0.012 & 0.018 [7]; 150 ppm	0.0057 – 0.035	0.05		0.1 (Cd/Tl only)
Cr,Be,As,Sb,Ba, Pb,Ag,Co,Cu, Mn,Sn,V,Ni (sum)	0.5		0.03 [7]; 3000 ppm	0.0077 – 0.11	0.5		0.5 (incl. Hg)
PCDD/PCDF (ng/Nm^3 I-TEQ)	0.2		0.1	0.0016 – 0.001	0.2		0.1 ng TE/Nm^3

[Refer to next page for table notes]

Notes:

1. Concentration expressed as mg/Nm^3, unless otherwise stated, and at 'normalised' conditions of 11% O_2, 101.3 kPa, 273 K / 0 ºC, dry gas.
2. Process 39: Waste Incineration.
3. Class 1: Waste serves as fuel/supplementary fuel in an industrial process. Class 2: Incinerators for hazardous or medical waste.
4. Process 22: Cement Processes.
5. Dust emission limits for plants erected after 1973, after 1980 and after 1988 (200, 150 and 120 mg/m3 respectively).
6. Emission limits (mostly limited to dust) prescribed by current APPA Process 22 Registration Certificates for cement kilns in SA (11 plants, 20 kilns). Limits are not prescribed for all emissions at all kilns, and different limits are frequently specified for the same emission in different cases.
7. Metal concentration in total suspended particulate (TSP).
8. Overview of current emissions from cement kilns in SA (monitoring intervals ranges from once-off/infrequent to continuous, and not all emissions are/have been monitored at all kilns). From Karstensen, 2007b.
9. Based on continuous monitoring at 3 kilns. A once-off measurement at another kiln (recording 25 mg/m^3 TOC) not considered reliable.
10. As proposed in "Listed Activity Category 5: Mineral Processing Industry. 5.3 – Cement Production" (DEAT, 27 February 2008).
11. Standards for new plants and standards for existing plants (in brackets).
12. As proposed in "Listed Activity Category 8: Incineration Processes Including Hazardous Waste" (DEAT, January 2008).

4 PROPOSED EMISSION STANDARDS & REQUIREMENTS

4.1 INTRODUCTION

The development of the specific emission standards as proposed (see 4.2 below) have considered, among others:

- Relevant existing local and international standards and best practice;
- Current emission requirements imposed on cement kilns;
- Current emissions from cement kilns in South Africa;
- Proposed local emission standards for cement kilns;
- Technical aspects related to hazardous waste treatment and AFR co-processing in cement kilns.

Transitional arrangements for compliance with the proposed standards are only associated with particulate and NOx emissions. All other emission standards have to be complied with. In short, existing kilns that would co-process AFR must comply with the complete standards as from June 2018. New kilns commissioned after June 2008 that would co-process AFR, and existing kilns that would treat hazardous waste that contains Persistent Organic Pollutants (POPs; excl. low-level POPs hazardous waste), would be required to comply with the complete standard, as well as the Destruction Efficiency requirement. The transitional arrangements are as follows:

- Existing kilns for AFR co-processing (excluding POPs waste) must reduce particulate emissions to 80 mg/Nm^3 by June 2011, and to 30 mg/Nm^3 by June 2018, provided that current particulate emissions are not increased by the introduction of waste or AFR.

- Existing kilns for AFR co-processing (excluding POPs waste) must reduce NOx emissions to 800 mg/Nm^3 by June 2018, provided that current NOx emissions are not increased by the introduction of waste or AFR.

4.2 PROPOSED EMISSION STANDARDS

Table 4: Proposed Emission Standards for AFR Co-processing in Cement Kilns

EMISSIONS	PROPOSED AIR EMISSION STANDARD [1]
PM (Total Particulate Matter)	30 [2] (80) [3]
TOC	10 [4]
HCl	10
HF	1
SO_2	50 [4]
NOx	500 [5] (800) [6]
Hg	0.05
Cd + Tl	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V (Sum total)	0.5
PCDD/PCDF (ng/Nm^3 I-TEQ)	0.1

1. Concentration expressed as mg/Nm^3 (Daily Average) unless otherwise stated, and at 'normalised' conditions of 10% O_2, 101.3 kPa, 273 K / 0 ºC, dry gas.
2. PM limit for (i) new kilns (commissioned after June 2008) co-processing AFR, and for (ii) existing kilns co-processing AFR after June 2018.
3. PM limit effective from June 2011 until June 2018 for existing kilns co-processing AFR (excluding POPs waste), provided that current particulate emissions (as established through baseline monitoring) are not increased by the introduction of AFR.
4. Limits for TOC or SO_2 do not apply where elevated emissions result from conventional fuels or raw material, i.e. not from the co-processing of AFR, provided that current TOC and SO_2 emissions (as established through baseline monitoring) are not exceeded by the introduction of AFR.
5. NOx limit for new kilns (commissioned after June 2008) co-processing AFR.
6. NOx limit for existing kilns co-processing AFR (excluding POPs waste) after June 2018, provided that current NOx emissions (as established through baseline monitoring) are not increased by the introduction of AFR.

4.3 AIR QUALITY REGULATORY MEASURES

- Interim regulatory measures until finalisation of NEMAQA S21 Listed Activities and Minimum Emission Standards Programme include the consideration of any relevant Policy provisions, and standard conditions developed as part thereof, for inclusion into Atmospheric Emission Licences / Registration Certificates as relevant.
- Baseline monitoring of all emissions in the standard is required as part of EIA process.
- Measurement equipment shall be installed and acceptable techniques used in order to accurately monitor the parameters, conditions and mass concentrations relevant to the co-processing of AFR.
- All emission monitoring results to be reported as a Daily Average concentration expressed as mg/Nm3, or ng/Nm3 I-TEQ for PCDD/PCDF, and at 'normalised' conditions of 10% O2, 101.3 kPa, 273 K / 0 ºC, dry gas.
- Exit gas temperatures to be maintained below 200 ºC.
- Pollution control devices (exhaust gas cooling and bag filter or ESP) to be available 98% of the time each day (i.e. maximum downtime of 2% or 30 minutes per day). The cumulative annual downtime (total downtime over a one year period) may however not exceed 60 hours.
- Continuous, on-line measurement of the following emissions and operating parameters:
  - Particulate matter (total particulate);
  - O2;
  - CO;
  - NOx;
  - SO2;
  - HCl;
  - HF;
  - VOC/TOC;
  - Emission exhaust volume (e.g. Nm3/hr) and flow rate (e.g. m/s);
  - Water vapour content of exhaust gas (humidity);
  - Exhaust gas temperature;
  - Kiln temperature;
  - Pressure; and
  - Availability of air pollution control equipment (exit gas cooling and ESP/bag filter).
- Appropriate installation and functioning of automated, continuous monitoring equipment for emissions to air, which are subject to quality control and to an annual surveillance tests. Independent calibration by means of parallel measurements with the reference methods at least every three years.

- Periodic measurements of heavy metals and dioxin and furan emissions (bi-annual) by independent/external, accredited specialists during the first 12 months of AFR co-processing, and annually thereafter.
- Average emission values for heavy metals to be measured over a minimum sample period of 30 minutes and maximum of 8 hours, and average values for dioxins and furans (expressed as I-TEQ) over a sample period of a minimum of 6 hours and maximum of 8 hours.
- Periodic measurements of air emissions to be carried out representatively to provide accurate and scientifically correct emission data and results, and sampling and analysis must be carried out by independent, accredited laboratories.
- To ensure valid monitoring results are obtained, no more than five half-hourly average values in any day, and no more than ten daily average values per year, may be discarded due to malfunction or maintenance of the continuous measurement system.
- All measurement results to be recorded, processed and presented in an appropriate manner in order to enable verification of compliance with permitted operating conditions and air emission standards. Quarterly Emission Monitoring Reports must include, amongst other:
  - Daily average results of all continuous, on-line emission monitoring parameters, reported on line graphs that include individual, daily average data points, and indicating the relevant air emission limit if applicable;
  - Results of all continuous, on-line operational monitoring parameters, reported on line graphs that correspond in scale with the emission monitoring results;
  - Results of periodic emission measurements of heavy metals, and dioxins and furans;
  - Confirmation of residence times and temperatures of specific wastes co-processed as determined by the specific feed points, kiln dimensions and material and gas flow rates;
  - Discussion on availability or air pollution control equipment, together with reasons for and management of downtime;
  - All relevant results must be compared with baseline measurements taken prior to the co-processing of AFR or hazardous waste; and
  - Detailed evaluation and discussion of any non-compliance during the reporting period.
- Co-processing of High Level POPs Containing Waste (as defined by the Stockholm and Basel Conventions) are to be preceded by an independently monitored Performance Verification Test to determine the Destruction Efficiency (DE) and Destruction and Removal Efficiency (DRE) of principal organic hazardous compounds (POHC).
- A detailed, independent report documenting and interpreting the results of the Performance Verification Test must be compiled. As a minimum, a DE/DRE of 99.9999% would be required, as well as compliance with Air Emission Standards.
- Development of an Air Quality Improvement Plan for achieving emission limits over time (if transitional arrangements apply).

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