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

South African Hazardous Waste Profile

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Executive Summary

The objective of this report is to

- provide an overview of types of hazardous waste generated in SA,
- estimate volumes and compare the hazardous waste generated in South Africa with international hazardous waste with focus on using waste as fuel replacement,
- assess possible interventions that could be made to improve the profiling system and which would assist waste treatment and reuse.

In order to do so this report compares the South African hazardous waste with hazardous waste generated in Europe. The report analyses South African waste surveys made in 1992 and in 1997 and tries to determine the types and quantities of organic hazardous waste disposed of in 2007 in South Africa and compares the types of waste found in these surveys with the known types of waste generated in Europe. Furthermore, it is estimated how large quantities of hazardous waste may be treated by incineration with an advantage.

In 1992 an interview survey was conducted that resulted in the report "Hazardous Waste in South Africa". The overall result of the study is referred to in chapter 3, but based on that study it can be found that in 1992 approx. 3-400,000 tons of organic hazardous waste that may be incinerated was registered.

The study from 1992 was followed-up with another baseline waste study from 1997. The study is referred to in chapter 4. Based on this study it can be estimated that out of nearly 7 million m^3 waste about 160,000 m^3 may be incinerated.

In the present study (2007), waste managers from South African industry associations and waste management companies were contacted directly and via e-mail.

The result of the present waste study was that five companies sent us data, whereof the data from one company was especially valuable, because it covered a total of about 415,000 tons of different hazardous waste from the central part of the country. The data was compiled from a period of 2 years.

Because of the amount of data and because this company deals with waste treatment these data give a good idea of the different types of waste that may be found in South Africa.

The data only covered hazardous waste from the provinces Western Cape, Kwa-Zulu Natal, Gauteng and Eastern Cape.

In total, 415,000 tons of waste approximately from 2 years has been analysed. Data covering more than 50,000 loads of South African waste has been divided into a system of waste groups. Such an amount of waste gives a good idea of the South African Hazardous Waste types. In total from the 5 companies, the amount disposed of was 710,000 tons. Of this quantity more than 117,000 tons in 2007 could be identified as organic hazardous waste usable for high temperature treatment.

In order to get an overview of the South African Waste profile in a context where a certain part of the waste may be incinerated, a waste sorting scheme has been used where the waste is sorted into different waste groups in order to improve final treatment. The system from the Danish National hazardous waste treatment company - Kommunekemi - has been used as paradigm for this sorting scheme.

The Danish system is used because of possible access to existing data of the Danish waste profile from 1997. Furthermore, according to a report from the European Topic centre from 2001, the Danish Waste types can be compared to other European Waste Types, as the same types may be found in the European countries although in different quantities in the different countries.

From this analysis and comparison with known figures of Danish waste groups it can be concluded that the main types of the existing South African hazardous wastes are comparable in type and share with Danish hazardous wastes and hereby in this sense comparable with European hazardous wastes.

Special difficult waste streams may also be found among the RSA waste types, but again in all countries difficult wastes are found, and normally through co-operation between waste generators and waste treatment plants a solution may be identified either how to deal with these special wastes in an environmentally sound manner or a way may be identified how to avoid generating these waste streams in the future.

In order to suggest a possible method to assist in an approved waste management system, a waste classification system has been attempted sketched in chapter 7, and it is suggested that the proposed classification in this report is scrutinised further by DEAT. The new proposed system is a further development of the existing classification system based on the UN classification system for transport of dangerous goods.

1 Introduction

The objective of this report is to characterise the types of South African hazardous waste in an incineration context and more over compare the South African hazardous waste with hazardous waste found internationally e.g. in Europe. The report will try to answer the question if the South African hazardous waste differs most from - or is most alike to - international hazardous waste and through that identify the types of SA hazardous wastes that may be treated by thermal treatment. Furthermore, the report will try to estimate the amount of organic hazardous waste that may be treated by high temperature thermal treatment.

1.1 Methodology

In order to get an impression of the existing waste system, two surveys from 1992 and 1997 have been analysed and reported. To get an overview over the existing situation (2007) some of the biggest chemical industries generating waste streams, which may be used as substitute fuels, have been consulted.

The industries were asked about the amounts of organic hazardous waste they disposed of on public hazardous waste landfills and on private owned landfills. Quantities of the various waste streams have been either determined or estimated based on best available information. The focus has been on the possibility of diverting organic hazardous waste from landfills to high temperature treatment.

The review includes an assessment of the following:

- the waste profiling (classification) methods used in South Africa including the limitations and consequences of the system (see section 2.3),
- the profiling (classification) method in relation to how international countries use waste as fuel replacement profile waste (see section 2.4),
- possible interventions that could be made to improve the profiling (classification) system which would assist waste treatment and reuse (see section 7).

The output of this assessment includes recommendations of a proposed waste profiling system for blending of wastes suitable for use as replacement fuels.

Although it has also been the wish to obtain decisive information about the amount of hazardous waste generated in South Africa this was proven not to be possible and therefore the amounts of hazardous waste must await a country wide inventory to be implemented in another project.

1.2 The White Paper on Integrated Pollution and Waste Management

In the "White Paper on Integrated Pollution and Waste Management"/1/ from March 2000 the Department of Environmental Affairs and Tourism together with the Department of Water Affairs and Forestry outline the Government's new proposed policy position in relation to pollution and waste management. This White Paper focuses on the importance of preventing pollution and waste and to avoid environmental degradation.

Within the framework of the overarching goal, the government has identified seven strategic goals for achieving integrated pollution and waste management. These goals are interdependent and implementation must address all of them to be effective, since environmental issues cut across various sectors and functions. The strategic goals and their supporting objectives indicate the broad deliverables of the strategy, which address the major issues the government faces in its drive to achieve and ensure integrated pollution and waste management.

The seven strategic goals of the policy areas are:

- Goal 1: Effective Institutional Framework and Legislation
- Goal 2: Pollution Prevention, Waste Minimisation, Impact Management and Remediation
- Goal 3: Holistic and Integrated Planning
- Goal 4: Participation and Partnerships Management Governance in Integrated Pollution and Waste
- Goal 5*:* Empowerment and Education in Integrated Pollution and waste Management
- Goal 6: Information Management
- Goal 7: International Cooperation.

Under Goal 2 it is stated:

It is a goal to develop a system for the safe collection and transportation of hazardous waste, including the development of guidelines for provincial environmental department registration and certification of contractors, implementation of the waste manifest system and possibly a network of collection point

and

to initiate the establishment of adequate hazardous waste disposal facilities for all parts of the country, to be carried out by the provincial environmental departments, in collaboration with municipalities.

A precondition for developing a hazardous waste management system is to have a good knowledge of the types of hazardous waste to be managed and not least the amount of hazardous waste that must be managed. If the amounts of hazardous waste are not known there is a risk to plan the facilities either too small or too big, and if the types are not known, the wrong kind of equipment/facilities may be installed.

However, for the current purpose of developing a policy position on thermal waste treatment, AFR uses as a management option for SA hazardous waste. Detailed information of hazardous waste amount is not necessarily required, because the Government is not developing a hazardous waste management system or strategy, or planning a facility at this stage.

In this first stage of the new policy, the purpose is to create an overall legislative frame for the private industry or private waste management companies to be able to deal with hazardous waste in an environmental sound manner.

2 Hazardous Waste Definition

Hazardous waste definition is difficult and many different solutions have been introduced all over the world.

Once hazardous waste has been defined, waste must also be classified for governmental and statistical reasons in order for a Government to make sure that the proper legislation is in place to regulate collection, packaging, handling, transport and treatment of the hazardous waste. The Government also needs to know where and what kind of waste is produced and in what amounts.

The principles for the classification are not necessarily in agreement with the principles of how the treatment company wants to group the hazardous waste in order to give the optimal treatment. Different treatment technologies may in fact give reason to different grouping of the hazardous waste.

In Europe this has caused many problems as the hazardous waste classification is based on a compromise between different requirements. Thus the same type of waste can appear in different places in the European Waste Catalogue (EWC) depending on the process or industry it stems from.

2.1 The European waste Catalogue (EWC)

Waste was originally defined in the Council Directive of 15 July 1975 on Waste /3/. Later the European Council Directive 91/689/EEC (the Hazardous Waste Directive or HWD) set the framework within Member States of the European Community for provisions to control the movement of hazardous wastes.

The EU definition of hazardous waste is directly linked with three annexes of the EU Hazardous Waste Directive 91/689/EEC (categories of hazardous waste, constituents of hazardous waste and hazardous properties), as well as with the List of Waste 2000/532/EC drawn up on the basis of these annexes /26/.

In the EU Hazardous Waste Directive 91/689/EEC 'hazardous waste' means:

*Wastes featuring on a **list** to be drawn up [...] on the basis of Annexes I and II to this Directive [...]. These wastes must have one or more of the **properties** listed in Annex III. The list shall take into account the origin and composition of the waste and, where necessary, **limit values of concentration**. [...] plus any*

other waste which is considered by a Member State to display any of the properties listed in Annex III. [...].

More popular phrased this means that all waste may be hazardous waste depending on the concentration (or other properties) of the constituents in the waste. It is the responsibility of the waste generator to classify his waste.

The European waste catalogue (EWC) was established in December 1993 by Council Decision 94/3/EC and included at that time 645 waste types. The hazardous waste list (HWL) was subsequently established in December 1994 by Council Decision 94/904/EC. The HWL is a subset of the EWC and consisted of 236 of the 645 EWC waste types, which were considered by the EU to be hazardous at the time the list was agreed /25/.

The EWC is a hierarchical list of waste descriptions updated by Commission decision 2000/532/EC2. It is divided into twenty main chapters, most of which are industry-based, but some of which are based on materials and processes. Each of these has a two digit code between 01 and 20. Chapters have one or more subchapters (with four figure codes, the first two of which are the two digits of the chapter). Within these there are codes for individual wastes each of which is assigned a six figure code. Hazardous wastes are signified by entries where the code is followed by an asterisk /24/. (See also Appendix 1).

In a report from 2001 examining the implementation of the EU legislation in each of the countries and regions, a relatively small number of waste types represent a large proportion of the total hazardous waste generation. On average, the 20 largest generated waste types represent between 67 % and 93 % of the total hazardous waste generated with an average of 75 % of hazardous waste being attributable to these top 20 waste types in each country or region /25/.

In general, the implementation of the EWC and HWL has been slow. In some countries, the EWC and HWL have been fully implemented into national legislation and data registration systems. In other countries, the EWC and HWL are used more as reference lists. A major problem for several Member States has been the fundamental difference between the national substance-based waste lists and the source/process approach used for the EWC and HWL. This is because the same waste material can appear several times in the HWL, when it is produced by several sources /25/.

In fact the European Waste Catalogue has three problems /13/:

- Treatment companies have a need to get an unambiguous connection between one type of hazardous waste and the matching waste code. This is not so in the EWC.

- The industry or the hauliers have a need to define the matching waste code from the process and/or industry trade. This is not so in the EWC.

- The regional administrations have a need to connect different types of waste to existing industries, but that is neither covered by the EWC as only certain industries is included.

An idea for a practical classification system for waste would be to identify the groups in accordance with the way the waste is defined to be treated. This would prompt a source sorting of the waste followed by an accepted treatment method. If the same waste may be treated in two accepted different ways, then a central decided (by the authorities) waste code must be applied. In our computer time, all statistical information of industry, process, country and other can be attached to this simple system.

The definition of hazardous waste has considerable impact upon industry in determining how their waste is regulated and affects them in terms of charging, monitoring and inspection.

2.2 The South African definition of Hazardous Waste

According to the draft Waste Bill /22/ hazardous waste is defined as:

- "hazardous waste'' means any waste that may, by circumstances of use, quantity, concentration or inherent physical, chemical or toxicological characteristics, have **a** significant adverse affect on health and the environment.

According to the South African "Minimum requirements /2/", *General Waste* refers to any waste that does not fall within the definition of hazardous waste and

Hazardous Waste is defined as:

"an inorganic or organic element or compound that, because of its toxicological, physical, chemical or persistency properties, may exercise detrimental acute or chronic impacts on human health and the environment. It can be generated from a wide range of commercial, industrial, agricultural and domestic activities and may take the form of liquid, sludge or solid. These characteristics contribute not only to degree of hazard, but are also of great importance in the ultimate choice of a safe and environmentally acceptable method of disposal."

Hazardous Waste is further classified as waste that directly or indirectly represents a threat to human health or the environment if not correctly managed, by introducing one or more of the following risks:

- explosion or fire;
- infections, pathogens, parasites or their vectors;
- chemical instability, reactions or corrosion;
- acute or chronic toxicity;

- cancer, mutations or birth defects;
- toxicity, or damage to the ecosystems or natural resources;
- accumulation in biological food chains, persistence in the environment, or multiple effects to the extent that it requires special attention and cannot be released into the environment or be added to sewage or stored in a situation which is either open to air or from which aqueous leachate could occur.

The South African definition of Hazardous Waste complies with the UNEP definition[1], primarily because of its content and scope, but also in order to obtain international acceptance for South African Waste Management Legislation Practice.

2.3 The South African waste classification system

The existing South African SANS 10228: **"The Identification and Classification of Dangerous Goods for Transport",** is a system for classifying hazardous substances for transport purposes. In SANS 10228, hazardous substances are given an identification number and divided into nine classes:

Table 1: SANS 10228 Classes

Class	Description
Class 1	Explosives
Class 2	Gases: compressed, liquefied or dissolved under pressure
2.1	Flammable gases
2.2	Non-flammable, non-toxic gases
2.3	Toxic gases
Class 3	Flammable liquids
3.1	Low flashpoint group of liquids; flashpoint below – 18°C
3.2	Intermediate flashpoint group of liquids; flashpoint of –18°C up to, but not including 23°C
3.3	High flashpoint group of liquids flashpoint of 23°C up to, and including, 61°C

[1] According to a UNEP training manual Hazardous Waste is any waste containing significant quantities of a substance which may present danger

- to the life and health of living organisms when released into the environment
- to the safety of humans equipment in disposal plants if incorrectly handled

Hazardous Properties include toxic, carcinogenic, mutagenic or teratogenic characteristics, as well as flammability, chemical reactivity or other biologically damaging properties (including radioactivity)/17/.

Class	Description
Class 4	Flammable solids or substances
4.1	Flammable solids
4.2	Flammable solids liable to spontaneous combustion
4.3	Flammable solids which emit flammable gases when in contact with water
Class 5	Oxidising substances and organic peroxides
5.1	Oxidising substances
5.2	Organic peroxides
Class 6	Toxic and infectious substances
6.1	Toxic substances
6.2	Infectious material
Class 7	Radioactive substances
Class 8	Corrosive substances
Class 9	Other miscellaneous dangerous substances, that is any other substance which experience has shown, or may show, to be of such dangerous character that the provisions of this Section should apply to it.

Waste classification in SA as per Minimum Requirements are based on this system, but also includes hazard ratings, site specific risk approach etc. According to that

- Class 1 - explosives waste - are hazardous waste (HW)
- Class 2 - waste gasses - organic gasses are HW
- Class 3 - waste flammables - when flash point < 61 C - is HW
- Class 4 - waste flammable solids - solids is HW if hazard according class 6
- Class 5 - waste oxidising substances - is HW if hazard according to class 6
- Class 7 - radioactive waste
- Class 8 - corrosives - HW when 6> pH > 12
- Class 9 - miscellaneous is HW if hazard according to class 6
- Class 6 - toxic waste - hazard calculation based on LD50 and LC50

The toxic waste is classified according to the scheme presented in Appendix 3. According to this scheme waste may be classified as hazardous or non hazardous.

The classification is an Integrated Waste Management Approach with the aim to curtail the risks associated with handling and disposal of waste (especially to landfills) to the point where they are acceptable to humans and the environment.

In connection to the change in treatment from landfill to high temperature treatment, it is though recommended to change from actually measuring the LD50 or LC50, and instead start to use percentage content of certain groups of

constituents, and to use a sum formula in case of more hazardous substances in the same waste, making it possible to calculate if the waste is hazardous or not.

It is recommended that the future South African classification system for hazardous waste is made so that a waste type can be classified as far as possible with the use of existing knowledge, so that biological measurements should not be necessary.

2.4 International Classification System used on the South African Hazardous Waste

In order to be able to sort the waste so it fits into the treatment regime of an incineration plant, a system of Waste Groups is introduced here. The system has the same objective as the system of waste classification in SA as per Minimum Requirements including hazard ratings etc. In order to get an overview of the South African Waste profile in a context where a certain part of the waste may be incinerated, a new waste sorting scheme has been used, where the waste is sorted into different waste groups in order to improve final treatment.

2.5 Definition of Waste Groups

The system from the Danish National hazardous waste treatment company - Kommunekemi - has been used as paradigm for this sorting scheme. This system (in Danish) can be found on the internet /11/.

It is a practical system and because there exist available data on hazardous waste sorted according to this system for a whole country (Denmark) it makes sense to use this system on South African Waste and see how much the types of waste in South Africa differentiates from this. The Danish national treatment plant receives about 90,000 tons of Danish hazardous waste every year. Out of this about 85 % is incinerated. Therefore the idea is to compare the South African hazardous waste with hazardous waste from a system with a high degree of incineration (as the Danish system).

In **Norway,** where they have an extended use of cement kilns for hazardous waste incineration, they use a list that reminds very much about the list developed by Kommunekemi /23/.

The overall types of AFR used in the **European** Cement Industry and in **Japanese** Cement Industry can be seen in chapter 6. In the same chapter is described that the cement industry prefers large continuous waste streams with a high calorific value. In order to produce that, the cement industry implements blending platforms that pre-treats hazardous waste to make these continuous streams of high calorie containing waste streams. By help of the waste group system it will be easier to divide the hazardous waste up in groups that may be used in the blending platform.

The Danish system is also used because of possible access to existing data of the Danish waste profile from 1997 /13/. Furthermore according to a report

from the European Topic centre from 2001, the Danish Waste types can be compared to other European Waste Types, as the same types may be found in the European countries, although there seems to be big differences between the amounts of the biggest fraction of various waste types in the different European countries/19/.

Table 2: Definition of waste groups

Waste Groups	Description
O	**O**rganic peroxides, strong oxidizing compounds forms part of the waste
R	**R**eactive compounds that e.g. react with water generating burnable or acidic gases forms part of the waste
M	**M**ercury is part of the waste e.g. mercury batteries, fluorescent lamps, thermometers, COD-liquids etc.
V	**V**arious waste for sorting, e.g. waste in small packagings from laboratories or households, empty packagings for recycling, pressure bottles, spray cans, asbestos, medicine, iso-cyanates, batteries without mercury etc.
P	**P**esticides are part of the waste e.g. empty pesticides packagings.
I	**I**norganic waste is the only compounds (no organic waste), e.g. hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, cyanide baths or metal salts etc.
W	**W**aste oil without any emulsifying compounds as lubricating oil, heating oil, diesel oil perhaps mixed with water, soil or sand.
H	**H**alogenated solvents and compounds with sulphur that by incineration generate acidic gasses e.g. compounds containing sulphur, chlorine, iodine, bromine or iodine e.g. trichlor-, Freon, carbon-disulfide, mercaptans, PCB etc.
S	**S**olvents without halogens and sulphur - must be able to be pumped and have a heating value of more than minimum (12 MJ/kg (must be defined) and with less than 50 % water.
A	**A**ll other hazardous chemical waste.
AE	**A**ll **E**mpty containers from hazardous chemical waste.
L	**L**andfill.

Waste Groups	Description
C	**C**linical waste.
U	**U**nknown waste - waste where it is necessary to take contact to the waste generator to find out the correct composition of the waste.
X	**Ex**traordinary waste is waste that mostly is mixed in an wrong way that makes it difficult to treat or waste that is unfamiliar to the author of this report e.g. construction rubble mixed with heavy metals or salt dross. In the future this waste should preferably be avoided or special treatment should be found for some special waste streams.
MW	**M**unicipal **w**aste.
CW	**C**onstruction **w**aste is waste that may be broken down and reused.
SW	**S**teel containing **w**aste is waste that most likely may be reused in a metal producing company.
WEEE	**W**aste of **E**lectric and **E**lectronic **E**quipment.

According to this system all the waste is divided into hazardous waste (O, R, M, V, P, I, W, H, S, A, AE, L, WEEE), clinical waste (C), municipal waste (MW), construction and demolition waste (CW), steel (metal) containing waste (SW).

The waste streams from U and X shall be examined and directed to one of the other groups.

The waste group AE is part of the waste group A, but is separated out here just to be able to see the size of the empty containers and bags.

In this report, the clinical waste also includes dead animals, but carcasses normally go to special treatment and should be separated from waste group C.

The waste groups O, R and P only exist because it is important to pre-treat these compounds separately from the other waste to exclude chemical reactions.

Waste group V includes waste that needs hand sorting like waste in small packagings from laboratories or households, empty packaging for recycling, pressure bottles, spray cans, asbestos, medicine, isocyanates, batteries without mercury etc. Every waste type must be sorted or pre-treated in order to be able to treat it correctly. E.g. isocyanates may be divided into smaller portions before

incineration; medicine may be divided in groups with or without halogens, and again incinerated in smaller portions etc.

Waste group M - mercury containing waste exists because treatment of organic waste mixed with mercury is very difficult and very costly. So waste containing mercury becomes very expensive to treat, and therefore it is also the idea to educate the waste generator not to mix mercury with organics. Pure mercury or pure inorganic mercury salts is much cheaper to deal with.

Waste group I - inorganic waste must be treated separately by either recycling or neutralization and precipitation and land filling of the filter cake of precipitated heavy metals.

Waste group W - waste oil is there in order to be able to pre-treat the waste oil to get high calorific fuel for the incineration by dewatering. As dewatering is difficult in the presence of emulsions, emulsions must be avoided in this waste group and sent to waste group A instead.

Waste group H - halogenated solvents exist in order to be able to dose the amounts of acid creating substances to the incineration chamber in order for the scrubber system to be able to follow the scrub out of the acids.

Waste group S is solvents with a certain heat value (above 12-18 MJ/ton) so that the solvents also can be used to keep up the temperature in the incineration chamber on line with waste group W.

Waste group A contains all other waste streams that have not been mentioned above. Waste group A can contain water with small amounts of solvents that shall be incinerated or solid waste such as sludge or empty paint container or other empty packagings. Waste from this group may be lead into the rotary kiln via the pit, via sluice or via lances. Waste from group A may contain very high heating values (like tar) or very low (as polluted water), so the waste must be dosed correctly.

Waste group L - is waste for landfills, and the general rule here follows the rules for hazardous waste going to landfills in Europe hereunder:

- avoiding the disposal of raw, untreated wastes which are likely to produce toxic/hazardous leachate
- reducing the use of landfill for biodegradable wastes, which produce both methane (adding substantially to the global warming problem) and strong leachate
- ensuring that landfills that are needed are engineered, monitored and controlled, both in operational and aftercare phases, as well as possible.

The remaining waste groups (clinical waste (C), municipal waste (MW), construction and demolition waste (CW), steel (metal) containing waste (SW) and waste containing electric and electronic equipment (WEEE) are self explaining

and must be managed in other waste management systems than the hazardous waste management system.

3 Hazardous Waste - 1992 Study

In 1992 DEAT published a report named "Situation Analysis of Hazardous Waste in South Africa" with the purpose of developing a strategy and action plan for hazardous waste management in South Africa prepared by Foundation for Research Development and (later) by CSIR/4/. The primary aim of the survey was reliability of the information for planning purposes rather than completeness or accuracy. The information was collected through interviews and around 200 interviews were conducted with possible waste generators. The conclusion of the study was that there were several limitations to the reliability of the results. Problems encountered were:

- A widespread lack of knowledge of the subject encountered among respondents.
- Lack of information on the composition of waste.
- Lack of information even on the materials purchased and sold.
- Requirement of major generators for confidentiality.

The survey was carried out in 1990/91 so the amount identified 17 years ago may of course have changed both in types and in quantity. The result presented in 1992 showed however:

3.1 Amount of waste - 1992

Table 3: Industrial and mining waste in air emissions, in wastewater and as solid/liquid waste (t/a excluding water)

Industrial Sector Groups	Total (t/a)	Air emissions (t/a)	Wastewater (t/a)	Solid/liquid waste (t/a)
Non-metallurgical manufacturing industries	15,373,009	323,358	602,027	14,447,624
Metallurgical and metal industries	4,901,539	12,611	14,460	4,872,468
Service industries	21,891,399	1,609,240	6,759	20,275,400
Mining	376,639,051	27,000	1,556,297	375,055,754
Total	418,804,998	1,972,209	2,181,543	414,651,246

Table 3 shows that waste emitted to the air and discharged in wastewater when reported this way, accounts for relatively small proportions of the total industrial waste stream, respectively 4.7 % and 5.2 % of the total.

Of these 418,804,998 tons/year about 1,892,681 tons/year was rated as hazardous waste with 22493 tons/year in hazard group 1 and 1,228,005 tons/year in hazard group 2 and 642,183 tons/year in hazard group 3.

3.2 Hazardous Waste Divided on Different Sectors

In Table 4 can be seen how the generation of hazardous waste is distributed on different industrial sectors. However, different sectors can easily produce the same types of waste, and therefore the amount of same types of waste that needs the same type of treatment is not revealed.

Table 4: Hazardous waste generated (t/a excluding water) in non-metallurgical sectors in South Africa

Industrial Manufacturing Sector	Hazardous waste (t/a)
Adhesive-sealant	925
Chemical process industry	382,298
Electronics	504
Explosives	227
Food and beverage	0
Household products	80
Industrial cleaning products	0
Ink & printing paste	779
Leather industry	7260
Non-metallic products	500
Paint and coating	20920
Pharmaceutical industry	3581
Photographic chemical industry	0
Plastic and rubber processing	140
Printing industry	0
Pulp and paper industry	0
Textile and wool industry	34,461
Timber production	10
Total	**451,689**

As can be seen, the amount of hazardous waste from the non-metallurgical sectors in SA is about 450,000 tons/year in the 1992-report. The amount of 1,892,681 tons/year shown under Table 3 covers also the metallurgical industries.

3.3 Re-grouping types and amounts of hazardous waste from 1992 report

In order to look at the waste with the eyes of a treatment company, the types and amounts of waste in table 7 in "Situation Analysis" report from 1992 /4/, have been re-grouped. In Table 5 the re-grouped waste types (hazardous waste) are listed. Furthermore, the amount of the different types of waste are summed independently of the industry sectors and finally the amounts from the different regions are added to one country sum.

Table 5: Re-grouping types and amounts of hazardous waste (generation in t/a excluding water).

Overall Waste types	Waste types sub groups	Estimated amounts tons/year
1. Peroxides - waste comprising organic peroxides, powerful oxidizing substances		
2. Reactive - waste reacting with water under formation of flammable or acid fumes		
3. Mercury - waste containing mercury	Mercury containing sludge	142,000
4. Mixed waste	Aerosol containers	240
	Old medicine etc	3,500
	Used packing materials	22,000
	Total	167,740
5. Pesticides containing waste		
6. Inorganics - waste only containing inorganic substances	Catalyst waste	900
	Inorganic waste from refinery pans	194,000
	Cyanide containing sludge	7,200
	Gypsum waste from phosphoric acid production	3,882,600
	Chromium containing sludge	175
	Total	4,083,975
7. Oil - waste only containing mineral oil products and no emulsifying agents,	Crude oil sludge	2,500
	Total	2,500
8. Halogenated waste: waste containing substances with sulphur, fluorine, chlorine, bromine, or iodine.	Chlorinated Tarry organic waste	2,360
	Liquid chlorinated waste	925
	Chlorinated solid organic waste	85
	Fluoride-containing inorganic sludge	16,200

Overall Waste types	Waste types sub groups	Estimated amounts tons/year
	Sulphur filter cake	7,300
	CFC-gases	2,000
	Fluoride emissions (?)	124,000
	Total	152,870
9. Solvents - waste solvents without halogens and with a heat value of minimum 12 GJ/ton	Solvents non halogenated	17,630
	Leaded hydrocarbons	15
	Hydrocarbon sludges	6,850
	Polymeric waste (halogen free)	275
	Liquid organic waste	1,220
	Solvent vapours	194,550
	Total	220,540
10. POPs - waste containing POPs		
11. Incineration residues		
12. Contaminated soil		
13. Other solid hazardous waste	Gasses	1,860
	Refinery sludge	1,510
	Coal tar	44,000
	Coal tar pitch	28,600
	Coal fines	110,000
	Coal ash	9316,200
	Dust	170
	Asbestos	500
	Solid organic waste	7,850
	Plastic raw material waste	6,700
	Lime dust	700,000
	Total	10,217,390
14. Water containing waste	Effluent waste	495
	Polymer emulsion sludge (20 % Water)	2,200
	Carbon Black sludge	350
	Mn-containing sludge	20,550
	Chemical processing wastewater	35,000
	Sulphate wastewater	275,000
	Sludge and slurries	21,945
	Food beverage wastewater	134,000

Overall Waste types	Waste types sub groups	Estimated amounts tons/year
	Industrial wastewater	156,680
	Tanning waste	7,250
	Total	653,470
15. Explosives	Waste	27
	Total	27
	Total amount of waste	**15,498,512**

As can be seen, the total amount of hazardous waste in Table 5 is much bigger than the amounts mentioned in Table 3 and in Table 4. This table is in fact a bit confusing as it excludes wastewater, but still includes industrial wastewater. Furthermore, the title of the table says it is waste generation in non-metallurgical sectors, but still there are large quantities of inorganic waste. However, this is the data reported in the 1992 report and the different types and amounts of waste have been re-grouped.

By this regrouping, it is easier for the treatment company to see how the waste may be treated and e.g. see which waste may be incinerated directly (group 7 and 9), which waste may be incinerated under certain considerations (group 1 4,5,8,10, 13 and 14), which waste also must be treated individually (group 1,2, 3, 5, (8), 10, 13, and 14) and which waste may not be accepted (group 15 (explosive waste) plus normally infective waste and radioactive waste).

The differences from Table 4 to Table 5 in the amounts are as mentioned confusing. One parameter is that the result from Table 5 includes nearly 10 million tons coal ash and about 4 million tons of metallurgic waste, which is strange as the table headline in the report says that metallurgical sectors are not included.

If coal waste is excluded (about 10 million tons in point 13), then the amount of hazardous waste to be treated is about 5 million tons out of which there is about 4 millions tons of inorganic waste and about 600,000 tons of wastewater. Therefore, based on these figures, there are about 300,000 - 400,000 tons of organic hazardous waste for further treatment, hereunder incineration. The figures are however old and unreliable, there may be more hazardous waste that needs treatment today.

4 Hazardous Waste - 1997 Study

In 1997, the Department of Water Affairs and Forestry and Department of Environmental Affairs and Tourism, with the financial assistance from the Danish Co-operation for Environment and Development (DANCED), commissioned a series of baseline studies to provide a better understanding of waste management in South Africa. These studies served as guidance for the development of a National Waste Management Strategy (NWMS) for South Africa /16/.

The study was a follow up on the 1992 study on waste generation.

Table 6: Waste generation rates (million tons per year) in South Africa in 1992 and 1997.

Waste stream	1992 study	1997 study
Mining	378.0	468.2
Industrial	23.0	16.3
Power generation	20.0	20.6
Agriculture and forestry	20.0	20.0
Domestic and trade	15.0	8.2
Sewage sludge	12.0	0.3
Total	468.0	533.6

As can be seen from Table 6, the total figure of 468 million tons of waste in 1992 is increased from Table 3 where the figures are 418 million tons. In Table 6 also waste from power generation + agriculture and forestry and sewage sludge apparently have been included.

As furthermore can be seen, there is a general increase in waste amounts from 468 million tons to 534 million tons from the 1992 study to the 1997 study, especially waste from mining has increased whereas there had been a fall in waste from industry and from domestic households and trade.

But also some inconsistence may be found between the reported amounts. E.g. the fall in domestic and trade waste from 15 million tons to 8.2 million tons seems strange. If we try to calculate by using known figures from Erkhurleni in 2003/2004 where all waste have been weighed and the population is known we

find a relative value of 23 million tons that is more likely. The data was retrieved via questionnaire, which may by unreliable.

Table 7 Generation of MW in 2003/2004 in South Arica

Area	Inhabitants	MW - tons
Erkhurleni	2,327,004	1,234,518
South Africa (2003/2004)	44,000,000	23,342,800

In the 1997 report can be found a summary scheme over hazardous waste generated.

Table 8 Overall hazardous waste generation per province, 1997

Province	Hazardous waste		
	Waste generated as m^3/year		Waste disposed of in landfills t/year
	Landfill	Other	
Eastern Cape	19,719	17,869	81,000
Free State	14,707	15,823	-
Gauteng	168,758	1,619,885	232,000
Kwa-Zulu Natal	43,896	1,637,038	115,000
Mpumalanga	2,923	3,413,950	-
Northern Cape	937	212	-
Northern Province	1,491	4,323	-
North West	1,889	1,495	-
Western Cape	76,786	203,101	131,000
Totals	331,106	6,913,696	559,000

As can be seen, the total amount of waste generated per year is 7,244,802 m^3 and of this 331,106 m3/ year is disposed of in landfills corresponding to 559,000 tons/year. However, it seems that much more hazardous waste is generated. The report gives no explanation of where this waste is disposed.

In the 1997 study is a list of the amount of waste from different industries and from different provinces. However, comparisons between the waste volumes received at landfill sites and the waste generation volume for given local authorities in some cases indicated major variances. However, it is still possible to divide the different main waste streams into different waste groups, in order to compare the South African waste profile with European waste profile.

If we look at the waste generated in the provinces we get the following:

Table 9: Volume of waste pr. province per year

Province	HW volumes m^3/year
Eastern Cape	17,815
Free State	28,670
Gauteng	1,741,523
KwaZulu-Natal	833,612
Mpumalanga	3,414,689
North West	2,338
Northern Cape	303
Northern Province	876
Western Cape	237,387
Grand Total	**6,277,214**

As can be seen, the grand total is smaller than the total of 7,244,802 m^3 found above. By looking at the total material, it looks like the biggest lack of data is caused by some steelmaking slag (725,000 m^3). This has therefore been added to the database now ending on 7,002,214 m^3. This sum may not be completely correct, but accepted considering the general inaccuracy of the data. Therefore all the tables and figures hereunder are based on the overall amounts in Table 10.

Table 10: Volume of waste per province in 1997

Province	HW volumes m^3/year
Eastern Cape	17,815
Free State	28.670
Gauteng	1,741,523
KwaZulu-Natal	1,558,612
Mpumalanga	3,414,689
North West	2,338
Northern Cape	303
Northern Province	876
Western Cape	237,387
Grand Total	**7,002,214**

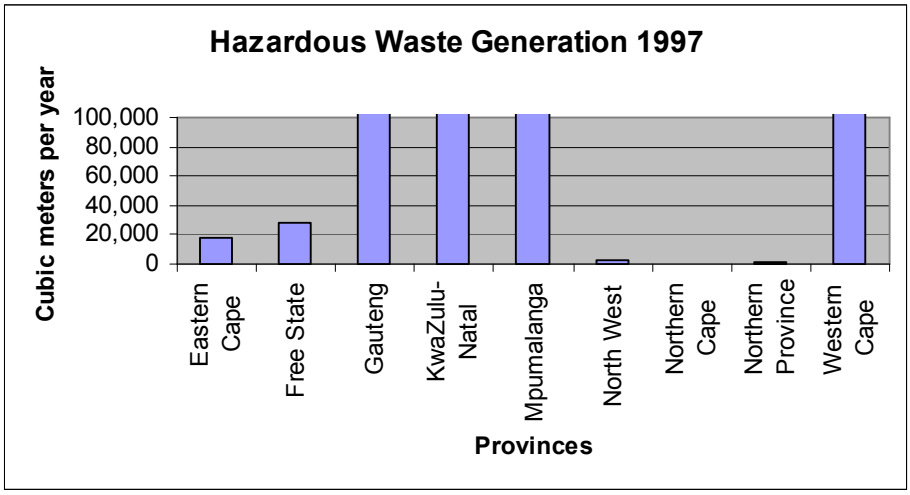

Figure 1 Volume of waste per province (fine scale)

As can be seen, the biggest volume of waste originates from Gauteng, KwaZuluNatal and Mpumalanga. The scale of Figure 1 is restricted to 100,000 tons in order to be able to see the smaller amounts from the other provinces.

After having divided all the waste streams out on waste groups (according to Table 2) it may be seen that the biggest fraction of waste is waste for landfill and inorganic waste. The same result is presented in 2 figures (course scale & fine scale) with different scales in order to be able to see the smaller amounts in some of the waste groups.

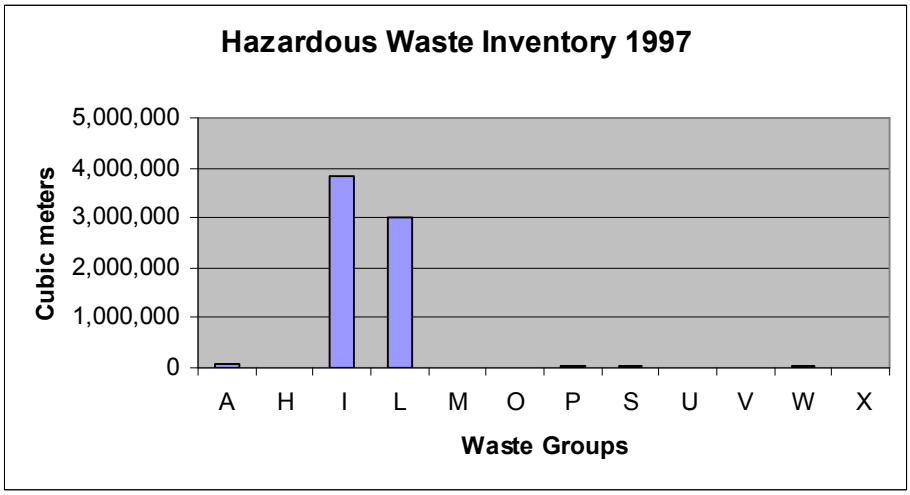

Figure 2 Volume of waste types (coarse scale)

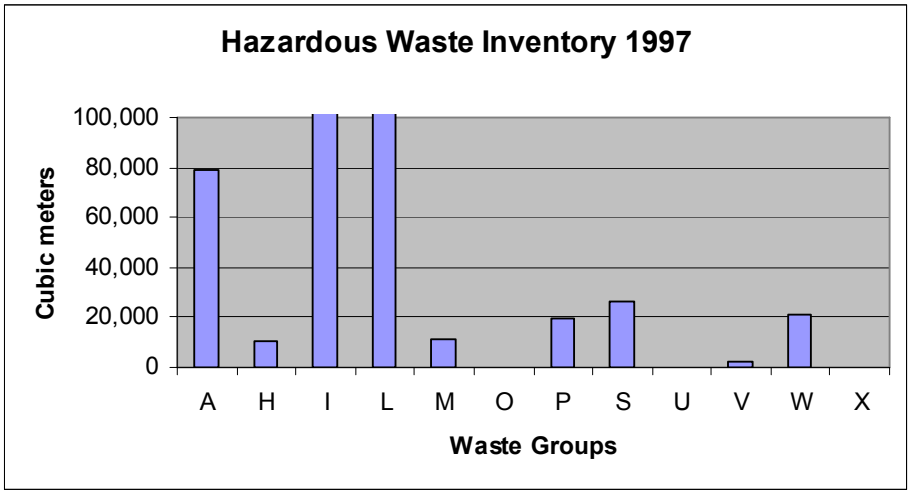

Figure 3: Volume of waste types (fine scale)

If we look at the waste streams it is obvious from the data that the gypsum production and the steelmaking slags are very big fractions as can be seen in Table 11:

Table 11: Gypsum and Steelmaking slag generation 1997

Province	Waste stream	m^3/annum	Class	Waste Group
KwaZulu-Natal	Steelmaking slags	725,000	9	L
KwaZulu-Natal	Gypsum waste ex phosphoric acid manufacturing.	700,000	9	I
Mpumalanga	Gypsum waste ex phosphoric acid manufacturing.	2,000,000	9	I
Mpumalanga	Gypsum waste ex phosphoric acid manufacturing.	1,000,000	9	I
Gauteng	Gypsum waste	104	9	I
Gauteng	Steelmaking slags	1,566,000	9	L
Gauteng	Steelmaking dust and sludge (dry basis)	94,500	9	L
KwaZulu-Natal	Steelmaking dust and sludge (dry basis)	42,900	9	L
Mpumalanga	Steelmaking slags	300,000	9	L

Province	Waste stream	m^3/annum	Class	Waste Group
Mpumalanga	Steelmaking dust and sludge (dry basis)	85,800	9	L
Western Cape	Steelmaking slags	150,000	9	L
Western Cape	Steelmaking dust and sludge (dry basis)	42,900	9	L
	Total	**6,707,204**		

The gypsum and the steelmaking slag total **6,707,204** m^3. The rest is mostly ordinary oil and chemical waste and make up about **295,000** m^3 in 1997. Some of this is still inorganic waste and others that cannot be incinerated, but must be treated in different ways before land filling.

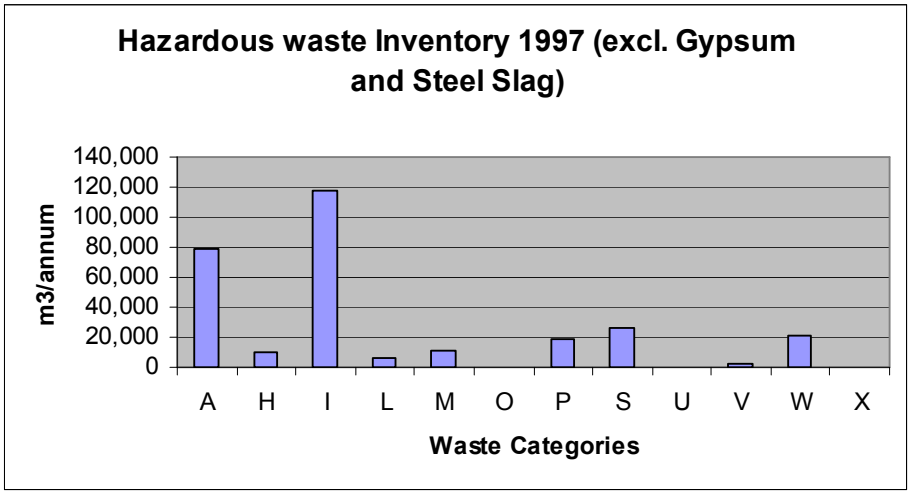

Figure 4 Hazardous Waste Study divided into Waste Groups (excl. Gypsum and Steel Slag).

As can be seen in Figure 4, the waste is distributed among all the waste groups with waste group A and I by far the biggest groups. This picture resembles very much the picture of Danish waste in
Figure 10, except from the large amount of inorganic waste in the South African waste profile.

If we look at the waste types that may be incinerated, we can see they may be found in different waste groups that shall have different kinds of pre-treatment before incineration.

Table 12: Waste that may be incinerated - 1997 study

Waste Group	HW generation m^3/year
A	79,201
H	10,624
O	20
P	19,302
S	26,629
V	2,436
W	20,969
Total	**159,181**

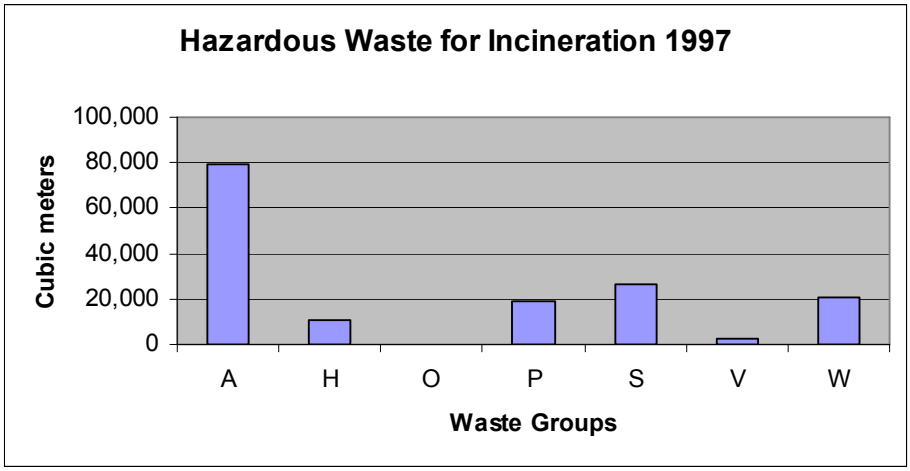

Figure 5: Hazardous Waste for Incineration Divided on Waste Groups - 1997 Study

Out of about 7 million m^3 waste in 1997, around 160,000 m^3 seem to be waste types that may be incinerated. This analysis must however be taken with all kinds of reservation as the analysis has been made based on data not suited for this purpose.

5 Hazardous Waste - 2007

In order to carry out this study, waste managers from South African industry associations and waste management companies were contacted via direct contact and via e-mail. The companies were asked for how much hazardous waste was disposed of at a hazardous waste landfill (public or private) or at own premises (local landfill).

Several of the larger companies told that they send all their organic hazardous waste for hazardous waste landfill. Others either incinerated or disposed their organic hazardous waste at local landfill.

One company stated that "*a tremendous amount of organic hazardous waste is being disposed off at small disposal sites. These waste streams can be delisted in South Africa to a GLB+ site and will not be reflected at the bigger hazardous landfill sites. The majority of all oil wastes (as example) will reflect as disposal at a lined General Landfill site due to our legislation*".

Another important waste company estimated the amount for 2003/4 to 20-30 thousand tons per year, whereof hazardous waste (1-4) was 5-10 % ~ 2-3 thousand tons. As this company could not give an estimate over the amount disposed of in 2006 and 2007, this amount has been estimated based on the given information.

The conclusion of this (small) investigation is that for certain there will be more organic hazardous waste generated than reported here, and in order to have the amount registered, the authorities - via the legislation - must force the companies to report the amount of waste types generated to the new waste information system being build up in South Africa.

However, based on the available information we can report the following amounts (all figures are rounded off to nearest 500 tons).

Table 13 Amounts of disposed hazardous waste (reported)

Company	2006 (tons)	2007 (tons)	Comments
No 1	160,000	255,000	Inorganic and organic
No 2		4,000	Estimate - Organic
No 3		11,000	Organic
No 4		438,000	Inorganic in local landfill
No 5		2,500	Organic
Total		**710,500**	

Of these 710,500 tons of hazardous chemical waste disposed of in 2007, about 117,500 tons (or more) is organic hazardous waste that may be incinerated (in 2006 the amount is estimated to about 84,500 tons (or more)).

Table 14 Amount of disposed organic hazardous waste reported

Company	2006 (tons)	2007 (tons)
No 1	68,000	100,000
No 2	4,000	4,000
No 3	10,000	11,000
No 4	0	0
No 5	2,500	2,500
Total	**84,500**	**117,500**

As can be seen, the public disposed hazardous waste is reported merely from one big company. If we sort the amounts of hazardous waste received from this company no. 1 in 2006 into waste groups then we get:

Table 15 Tons of disposed hazardous waste in 2006 disposed by company 1

Waste Groups	ECAI	GAUI	KZNI	WCAI	Total
A	2,519	36,265	4,962	1,378	45,000
AE	79	923	533	10	1,500
C	0	27	114	164	500
CW	0	778	4	21	1,000
H	17	5,074	3,783	70	9,000
I	113	7,147	2,280	259	10,000
L	64	16,344	294	691	17,500
M	1	51	18	0	0

Waste Groups	ECAI	GAUI	KZNI	WCAI	Total
MW	289	1,002	1,191	1,230	3,500
O	1	425	42	39	500
P	495	188	6	13	500
R	30	2,321	135	0	2,500
S	268	975	1,590	591	3,500
SW	0	736	12	3	1,000
U	202	17,759	445	10,265	28,500
V	221	2,496	535	415	3,500
W	981	1,803	994	268	4,000
WEEE	0	36	3	2	0
X	104	23,573	4,240	102	28,000
Total	5,500	118,000	21,000	15,500	**160,000**

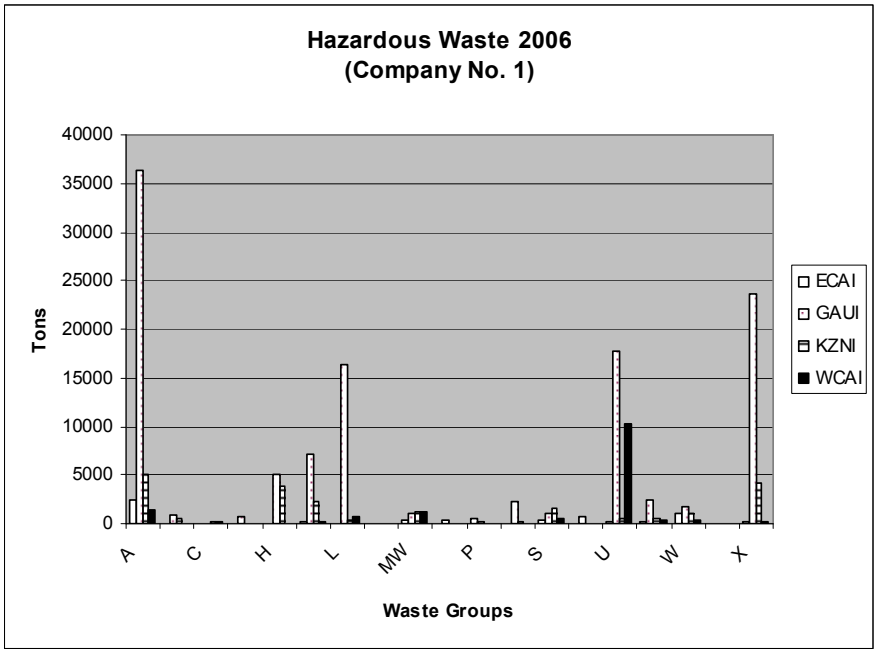

Figure 6: Disposed hazardous waste divided on waste groups 2006 from company no. 1

This company is reporting hazardous waste merely from the 4 regions Gauteng (GAUI), Kwazulu-Natal (KZNI), Western Cape (WCAI) and Eastern Cape (ECAI). As can be seen from

Table 16 and Figure 7, far the biggest category of waste is waste group A (solid HW), and that the biggest amounts are generated in Gauteng. In Figure 7 the HW generation in the 4 regions has been illustrated.

Table 16 Organic hazardous waste 2006 disposed from company no. 1

Waste Groups	ECAI	GAUI	KZNI	WCAI	Total (tons)
A	2,519	36,265	4,962	1,378	45,000
AE	79	923	533	10	1,500
H	17	5,074	3,783	70	9,500
O	1	425	42	39	500
P	495	188	6	13	500
S	268	975	1,590	591	3,500
V	221	2,496	535	415	3,500
W	981	1,803	994	268	4,000
Total (tons)	4,500	48,000	12,500	3,000	**68,000**

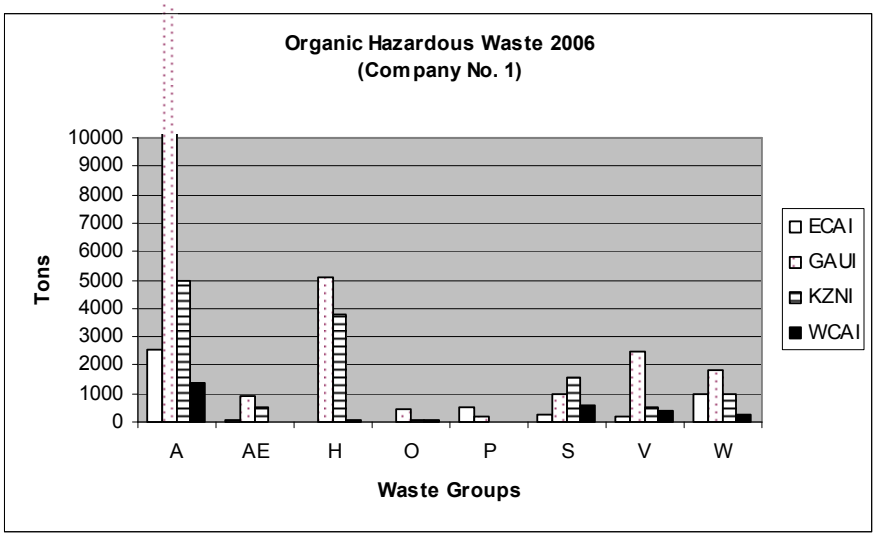

Figure 7: Organic hazardous waste 2006 disposed from company no 1

If we look at the amount of waste disposed of in 2007 from the same company no. 1, it may be seen that the amount of disposed HW has risen from 160,000 tons in 2006 to 255,000 tons in 2007. This is a rise of almost 60 % from 2006 to 2007. Such a rise may be difficult to understand, but may stem from a raised awareness following the politic discussion about hazardous waste in the country. Another explanation may be that the South African industry are producing more goods and thereby creating more hazardous waste.

Table 17: Tons of hazardous waste in 2007 disposed by company no.1

Waste Groups	ECAI	GAUI	KZNI	WCAI	Total (tons)
A	3,819	53,798	10,356	2,715	71,000
AE	28	1,988	825	11	3,000
C	55	73	333	1,332	2,000
CW	0	1,429	211	37	1,500
H	23	3,511	2,431	69	6,000
I	181	18,877	4,214	1,239	24,500
L	313	29,496	5,809	992	36,500
M	31	413	102	35	500
MW	290	1,663	2,336	1,052	5,000
O	18	181	323	21	500
P	6	651	171	0	1,000
R	0	3,320	184	0	3,500
S	304	1,860	1,812	687	4,500
SW	10	896	258	0	1,000
U	663	39,919	6,526	2,251	50,000
V	128	4,928	969	531	6,500
W	541	2,378	755	233	4,000
WEEE	0	47	48	1	0
X	251	27,822	5,898	142	34,000
Total (tons)	6,500	193,000	43,500	12,000	**255,000**

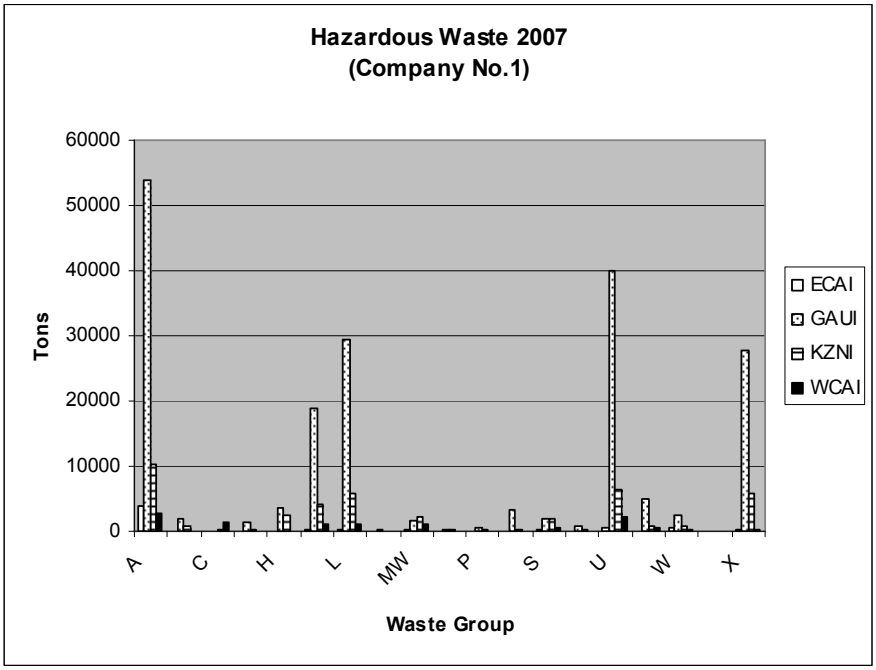

Figure 8: Disposed hazardous waste divided on waste groups 2007 from company no. 1

Also from 2007 the amount of organic hazardous waste disposed of in hazardous waste has been calculated from the 4 regions Gauteng (GAUI), Kwazulu-Natal (KZNI), Western Cape (WCAI) and Eastern Cape (ECAI). As can be seen from Table 18 and Figure 9, far the biggest category of waste is again waste group A (mostly solid HW), and that the biggest amounts are generated in Gauteng.

Table 18 Organic hazardous waste 2007 disposed from company no. 1

Waste Group	ECAI	GAUI	KZNI	WCAI	Total (tons)
A	3,819	53,798	10,356	2,715	70,500
AE	28	1,988	825	11	3,000
H	23	3,511	2,431	69	6,000
O	18	181	323	21	500
P	6	651	171	0	1000
S	304	1,860	1,812	687	4,500
V	128	4,928	969	531	6,500
W	541	2,378	755	233	4,000
Total (tons)	5,000	69,000	17,000	4,000	**96,000**

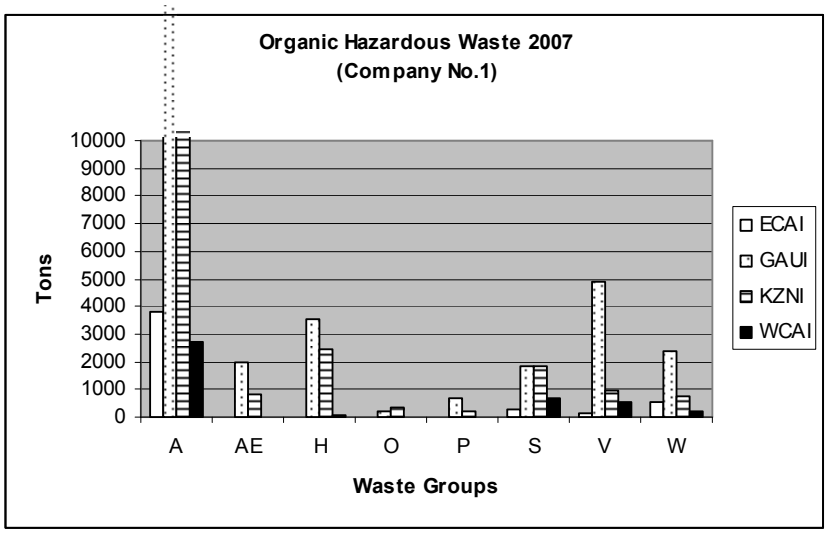

Figure 9 Organic hazardous waste 2007 disposed from company no 1

5.1 SA-Waste Sorted According to Waste Groups

If all the waste information from company 1 for 2006 and 2007 is divided out on waste groups it looks like the table below. It is important to notice that this amount of hazardous waste does not cover all waste in South Africa, but because the figures are as large as they are, they give a good hint about which waste types must be expected in South Africa.

Table 19: Waste from Company 1 sorted out on waste groups

Waste Group	Total tons 2006+2007	Percentage
A	115,812	27,9
AE	4,396	1,1
C	2,098	0,5
CW	2,481	0,6
H	14,978	3,6
I	34,310	8,3
L	54,003	13,0
M	651	0,2
MW	9,054	2,2
O	1,051	0,3
P	1,530	0,4
R	5,991	1,4
S	8,087	1,9

Waste Group	Total tons 2006+2007	Percentage
SW	1,915	0,5
U	78,032	18,8
V	10,223	2,5
W	7,954	1,9
WEEE	137	0,0
X	62,133	15,0
Total tons	415,000	100,0

As it can be seen from Table 19, about 29 % is waste group A (+AE) waste. In Denmark this group is around 40-50 %, but the group may also here in SA easily grow when group U and group X have been divided out on the correct waste groups.

The second largest group, inorganic waste for land filling (L) accounts for about 13 % of the waste (this group may also grow when U and X are divided).

The third largest group is I - inorganic waste (for treatment) accounting for 8 % which just shows how important it is to get this group of waste collected and treated. However, even though the reactive waste groups only constitute a small percentage of the total waste amounts (O, P, R is 2-3 %) it is very important to have them sorted out of the general waste stream in order to avoid unwanted chemical reactions. Also M - mercury containing waste is important to control in order to avoid unwanted pollution with this heavy metal.

If the South African waste types are compared with Danish waste types (from 1997 - /13/) they look very much alike. In fact it is striking how much alike the South African hazardous waste profile in Figure 11, based on 198,000 tons hazardous waste from 2006 and 2007 from company 1, is to the Danish waste profile in Figure 10 based on about 84,000 tons from 1997.

Table 20: Comparison of received RSA-waste amounts with Danish 1997 waste amounts

Waste Group	Total-DK 1997 - ton	DK-Data w/w %	RSA-Data w/w %	Data-RSA ton (2006+2007)
A	42,911	51	60,6	120,208
H	3,464	4	7,6	14,978
I	11,279	13	17,3	34,310
O	42	0	0,5	1,051
P	825	1	0,8	1,530
S	10,304	12	4,1	8,087
V	3,090	4	5,2	10,223
W	12,285	15	4,0	7,954
Grand Total	**84,200**	**100**	100,0	198,342

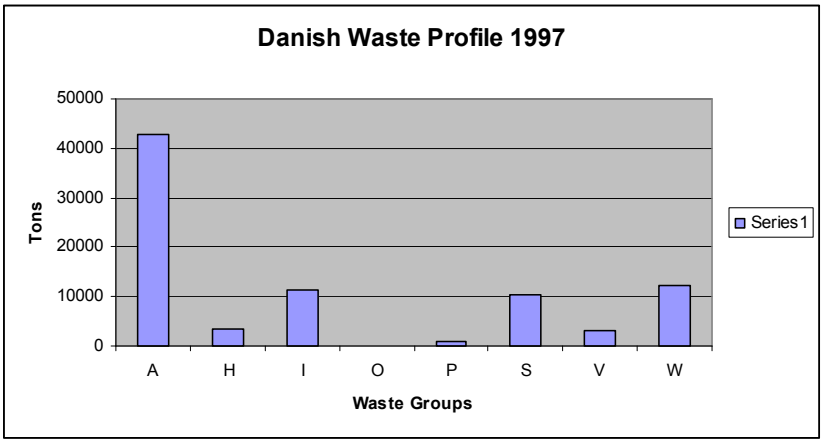

Figure 10: Danish Waste Profile - 1997 /13/

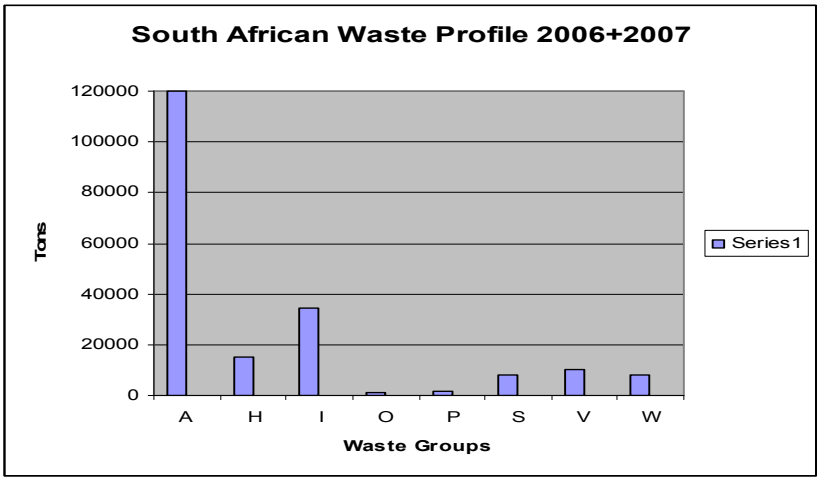

Figure 11: South African Waste Profile - 2006-07

6 Alternative Fuels and Raw Materials

The cement industry prefers big continuous waste streams with a high calorific value as alternative fuels. In order to produce that, the cement industry implements blending platforms, that pre-treats hazardous waste to make these continuous streams of high calorie containing waste streams. By help of the waste group system it will be easier to divide the hazardous waste into groups that may be used in the blending platform. Below can be seen examples of the types of waste that are used as AFRs in the European and Japanese cement industry.

In Table 24 can be seen how the waste grouping fits into the definition of AFRs.

Alternative Fuels and Raw Materials (AFR) have been co-processed in cement kilns in Europe, Japan, USA, Canada and Australia since the beginning of the 1980s, and a special "Guidelines on Co-processing Waste Materials in Cement Production" has been prepared by the Holcim Group and by the "Deutshe Gesellschaft für Technische Zusammenarbeit (GTZ) 2006 /20/.

From these guidelines can be seen that the following waste types are used for AFR today:

Table 21: Utilization of alternative fuels in the European cement industry (2002)

Alternative fuels	Quantity in kT/y	Energy in TJ	Substitution rate
Solid Fuels (75%)	3'282	63'810	8.5%
Animal meal & bone meal & animal fat	760	15'000	2.0%
Tires	500	13'200	1.8%
Other hazardous	360	6'500	0.9%
Plastic	210	5'000	0.7%
Paper/ cardboards/ wood/ PAS	180	2'800	0.4%
Impregnated saw dust	165	1'900	0.3%
Coal slurries/ distillation residues	110	1'650	0.2%
Sludge (paper fiber, sewage)	100	970	0.1%
Fine/ anodes/ chemical cokes	90	1'600	0.2%
RDF	40	530	0.1%
Shale/ oil shale	15	130	< 0.1%
Packaging waste	12	260	< 0.1%
Agricultural & organic wastes	10	170	< 0.1%
Other non hazardous	730	14'100	1.9%
Liquid fuels (25%)	810	21'700	2.9%
Waste oil and oiled water	380	13'500	1.8%
Solvents and others	260	3'900	0.5%
Other hazardous liquid fuels	170	4'300	0.6%
Total	**4'092**	**85'510**	**11.4%**

Table 22: Utilization of alternative raw materials in the European cement industry (2002)

Alternative raw materials		Quantity in kT/y	Substitution rate
Silicon (Si)	Foundry sand	131	2.2%
	Sand	93	1.6%
Calcium (Ca)	Ca-sources	396	6.7%
	Waste limestone	438	7.4%
Iron (Fe)	Fe-containing material	699	11.8%
	Blastfurnace & converter slag	215	3.6%
	Pyrite ash	438	7.4%
Aluminum (Al)	Al-containing materials	150	2.5%
	Industrial sludge	137	2.3%
Si – Al - Ca	Other Si-Al-Ca containing material	247	4.2%
	Fly ash	1140	19.3%
	Others	1823	30.8%
	TOTAL	**5907**	

Table 23 Utilization of alternative fuels in the Japanese cement industry (2001)

Type of waste	Use at cement plant	Weight ('000 ton)
Blast Furnace	Raw Material, Mixing Material	11,915
Coal Ash	Raw Material, Mixing Material	5,822
By-product Gypsum	Raw Material(Additive)	2,568
Low Quality Coal from Mine	Raw Material, Fuel	574
Non-iron Slag	Raw Material	1,236
Revolving Furnace Slag	Raw Material	935
Sludge etc.	Raw Material, Fuel	2,235
Soot & Dust	Raw Material, Fuel	943
Molding Sand	Raw Material	492
Used Tire	Fuel	284
Waste Oils	Fuel	353
Spent Activated Clay	Fuel	82
Waste Plastics	Fuel	171
Others	Raw Material, Fuel	450
Total		**28,061**

As can be seen, the AFR consist of among others municipal waste, industrial waste and hazardous waste.

If we look at the hazardous waste fraction it can also be seen that most of the fraction found in Table 24 can be treated as AFR. Here the unknown organic hazardous waste has been placed in waste group A.

Table 24: Waste groups versus AFR-types of waste

Possible Hazardous AFR-waste fuel	Waste Group	1997 study HW generation m^3/year	2007 study HW in tons/year
Solid waste & sludges	A	79,000	90,500
Solvents - halogenated	H	10,500	6,000
Agriculture and organic waste	P	19,500	1000
Solvents	S	26,500	3,500
Pre-treated chemicals in small packagings	V	2,500	4,500
Waste oil and oil waste	W	21,000	6,500
	Total	**159,000**	**112,000**

However, before the waste is used as AFR proper pre-treatment must be carried out at a blending platform.

Besides these types of hazardous waste that may be used as fuel in cement kiln, other types may be used as alternative raw materials.

Table 25: Waste that may be used as raw material AFR in cement kiln

Province	Waste stream	m^3/year	Class	Waste Group	Possible hazard-ous AFR raw material
KwaZulu-Natal	Steelmaking slags	725,000	9	L	Maybe as Fe-containing waste?
KwaZulu-Natal	Gypsum waste ex phosphoric acid manu-facturing.	700,000	9	I	Maybe as by product Gypsum
Mpumalanga	Gypsum waste ex phosphoric acid manu-facturing.	2,000,000	9	I	Maybe as by product Gypsum
Mpumalanga	Gypsum waste ex phosphoric acid manu-facturing.	1,000,000	9	I	Maybe as by product Gypsum
Gauteng	Gypsum waste	100	9	I	Maybe as by product Gypsum
Gauteng	Steelmaking slags	1,566,000	9	L	Maybe as Fe-containing waste?
Gauteng	Steelmaking dust and sludge (dry basis)	94,500	9	L	Maybe as Fe-containing waste?
KwaZulu-Natal	Steelmaking dust and sludge (dry basis)	42,900	9	L	Maybe as Fe-containing waste?
Mpumalanga	Steelmaking slags	300,000	9	L	Maybe as Fe-containing waste?
Mpumalanga	Steelmaking dust and sludge (dry basis)	85,800	9	L	Maybe as Fe-containing waste?
Western Cape	Steelmaking slags	150,000	9	L	Maybe as Fe-waste?
Western Cape	Steelmaking dust and sludge (dry basis)	42,900	9	L	Maybe as Fe-containing waste?
	Total	**6,707,200**			

Whether all these waste types can be used in cement kilns, is a question that has to be examined further.

7 Proposal to Hazardous Waste Classification of AFR in South Africa

Waste management in South Africa is based on the principles of the White Paper on Integrated Pollution and Waste Management and the National Waste Management Strategy (NWMS) published by the Department of Environmental Affairs and Tourism in 1999 and 2000. South Africa supports the waste hierarchy in its approach to waste management, by promoting cleaner production, waste minimisation, reuse, recycling and waste treatment with disposal and maybe high temperature treatment seen as a last resort in the management of waste.

The South African Waste Information System (SAWIS) developed by DEAT in 2005, is a system used by government and industry to capture routine data on the tonnages of waste generated, recycled and disposed of in South Africa on a monthly and annual basis. The system is though still in a trial period where 5 out of 11 provinces are covered by 2008. In 2006 the SAWIS was piloted in 2 provinces while in 2007/8 SAWIS is further rolled out to 3 provinces.

According to "Guideline on implementing the South African Waste Information System, 2006" /27/ data and information on waste are necessary to:

- assist government with the development of national policies and strategies on waste;
- assist with the identification of problem waste streams or waste streams that occur in large quantities, which may require the development of specific strategies to manage the waste streams and/or their impacts;
- develop capacity within government around integrated waste management;
- monitor the effectiveness of waste management policies and strategies;
- ensure the prioritisation of waste matters on the political agenda;
- support research regarding the most appropriate storage, collection, transport, treatment and
- disposal methods for each waste stream;
- support the diversion of waste from landfill thereby promoting waste reuse, recycling and waste exchange opportunities;
- capacitate stakeholders and communities through public access to information;
- support national and international reporting obligations of government; and
- in time, allow for all waste generated nationally to be traced to a treatment or disposal facility within the country;

If we look at the classification method related to how countries using waste as AFR classify their waste, then there is no general procedure. In EU the waste is classified according to the European Waste Catalogue. However, that is not a practical grouping of e.g. AFRs. In the Guidelines on Co-processing of Waste Materials in Cement Production /20/ are stated 21 principles to be followed when dealing with AFR. These guidelines are also presented in "Guidelines of co-processing of hazardous waste and AFRs in cement kilns" /21/.

The European Cement Industry uses the European Waste Catalogue codes when they label the waste - like the hazardous waste industry. In fact when handling and transporting hazardous waste in Europe, you need to operate with at least 3 sets of codes:

- ADR classes (like the South African SANS 10228 classification) and UN-number
- European Waste Code and possible
- A treatment classification code used by the treatment plant.

As the transport part is important for the handling of waste and the transportation is already following the existing South African SANS 10228: "The Identification and Classification of Dangerous Goods for Transport", this system might practically be part of a new system. Furthermore, as the UN-number also is necessary in order to transport the hazardous waste, that number might be a possibility for building up a new system especially if the classes and the numbers are combined.

A possibility could be to group the waste according to classes as in Table 27, and make one additional sub-class for hazardous waste that is not covered by the UN dangerous goods declaration. In this way a rather simple list of waste could be build up. The list may even be dynamic because if a new group of hazardous waste (and AFR) emerge, it shall just be included and supplied with the necessary treatment waste groups. The treatment waste groups can even be defined differently from the different treatment companies so that they classify the waste according to the way they want to treat it.

Such a system means that the overall classification as in Table 26 will be kept, and underneath at the next level it can be seen how the waste is treated and how much of the same kind of waste is given different treatment.

The handling and transport of waste must be followed by a manifest declaring the type and amount of hazardous/AFR waste (one type per manifest) and the necessary safety data sheets.

This system must be further developed in agreement with DEAT, in order to decide what information is necessary for DEAT, and what DEAT shall use the information for.

Statistic information shall be given about the amount, types and treatment of hazardous waste produced in order to:

- to secure enough capacity for waste treatment
- to secure the right waste treatment,
- to be able to follow the development in waste generation,
- to be able to suggest new waste management initiatives,
- to be able to benchmark the waste treatment with other countries.

As some companies only can treat certain types of hazardous waste, the permit to treat waste can be bound up to the UN-numbers, so that a special treatment company only are allowed to treat special UN-numbers.

7.1 Waste classification proposal

In South Africa waste is classified into two main categories: General Waste and Hazardous Waste /27/. The hazardous waste is then categorised according to Table 26.

Table 26 South African hazardous waste categorisation

Hazardous waste categorisation for SAWIS

Waste Level		
Level 1	**Level 2**	**Level 3**
Hazardous waste	H01 Explosives	
	H02 Gases	H02.01 Flammable gases H02.02 Non-flammable, non-toxic gases H02.03 Toxic gases
	H03 Flammable liquids	
	H04 Flammable solids and substances	H04.01 Flammable solids H04.02 Substances liable to spontaneous combustion H04.03 Substances that, on contact with water, emit flammable gases
	H05 Oxidising substances and organic peroxides	H05.01 Oxidizing substances H05.02 Organic peroxides
	H06 Toxic and infectious substances	H06.01 Toxic substances H06.02 Infectious substances
	H07 Radioactive substances	
	H08 Corrosives	
	H09 Miscellaneous dangerous substances and goods	

In order to register the treatment of the waste and thereby be able to see if the waste has been treated as AFR, dedicated waste or land filling, a level 4 in the above system could be introduced.

Explosives and radioactive waste is normally covered by special legislation, but hazardous waste and class 1 and 7 are kept in the system. Also class 6.2 infectious waste may only be used for certain part of clinical waste. As not all hazardous waste are dangerous goods (like Ni-Cd batteries, fluorescent tubes) and therefore outside the SANS 10228, a class 10 is defined for this purpose.

Table 27 Selected SANS 10228 - Classes including an additional class for hazardous wastes, which are not dangerous goods

Class	Description
Class 1	Explosives
Class 2	Gases: compressed, liquefied or dissolved under pressure
Class 2.1	Flammable gases
Class 2.2	Non-flammable, non-toxic gases
Class 2.3	Toxic gases
Class 3	Flammable liquids
Class 3.1	Low flashpoint group of liquids; flashpoint below – 18°C
Class 3.2	Intermediate flashpoint group of liquids; flashpoint of –18°C up to, but not including 23°C
Class 3.3	High flashpoint group of liquids flashpoint of 23°C up to, and including, 61°C
Class 4	Flammable solids or substances
Class 4.1	Flammable solids
Class 4.2	Flammable solids liable to spontaneous combustion
Class 4.3	Flammable solids which emit flammable gases when in contact with water
Class 5	Oxidising substances and organic peroxides
Class 5.1	Oxidising substances
Class 5.2	Organic peroxides
Class 6	Toxic and infectious substances
Class 6.1	Toxic substances
Class 6.2	Infectious material
Class 7	Radioactive materials
Class 8	Corrosive substances
Class 9	Other miscellaneous dangerous substances, that is any other substance which experience has shown, or may show, to be of such dangerous character that the provisions of this Section should apply to it.
Class 10	Hazardous waste but not dangerous goods

After having classified the waste according to Table 27 the treatment waste group shall be added according to Table 28. In order to use the waste group system in Table 28, one must start from above and then choose in which waste group the hazardous waste must be placed successively.

Table 28 Waste group system

Waste Groups		Description
O	Yes →	**O**rganic peroxides, strong oxidizing compounds forms part of the waste
No ↓		
R	Yes →	**R**eactive compounds that e.g. react with water generating burnable or acidic gases forms part of the waste
No ↓		
M	Yes →	**M**ercury is part of the waste e.g. mercury batteries, fluorescent lamps, thermometers, COD-liquids etc.
No ↓		
V	Yes →	**V**arious waste for sorting, e.g. waste in small packaging's from laboratories or households, empty packaging's for recycling, pressure bottles, spray cans, asbestos, medicine, iso-cyanates, batteries without mercury etc.
No ↓		
P	Yes →	**P**esticides are part of the waste e.g. empty pesticides packagings.
No ↓		
I	Yes →	**I**norganic waste is the only compounds (no organic waste), e.g. hydrochloric acid, sulphuric acid, nitric acid, sodium hydroxide, cyanide baths or metal salts etc.
No ↓		
W	Yes →	**W**aste oil without any emulsifying compounds as lubricating oil, heating oil, diesel oil perhaps mixed with water, soil or sand.
No ↓		
H	Yes →	**H**alogenated solvents and compounds with sulphur that by incineration generate acidic gasses e.g. compounds containing sulphur, chlorine, iodine, bromine or iodine e.g. trichlor-, Freon, carbon-disulfide, mercaptans, PCB etc.
No ↓		
S	Yes →	**S**olvents without halogens and sulphur - must be able to be pumped and have a heating value of more than minimum (12 MJ/kg (must be defined) and with less than 50 % water.
No ↓		
A	Yes →	**A**ll other hazardous chemical waste.

As an illustration of this principle a long row of waste is listed in Table 29 below, and each waste stream has been categorised according to this system. The list is not exhaustive, but should give an idea of how it may work.

In order to follow the SA - Categorisation system showed in **Error! Reference source not found.**, the figures H0 may be added in front of each class in the list (e.g. H04.01-A, or maybe to make it short just H4.1-A).

Table 29 Proposed Waste Classification Scheme

Origin	Waste type	Waste Group[2]*	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Cleaning of equipment used in connection with glue and plastic	Methylene chloride, perchloroethylene etc. mixed with flammable solvents.	H	1992	II	3+6.1		3	H03-H
Cleaning of equipment used in connection with rubber and glue	Solvents with organic bonded halogens.	H	2810	II	6.1		3	3-H
Cleaning of equipment used in connection with glue and plastic	Methylene chloride etc. and mixture of methylene chloride with non flammable solvents.	H	2810	II	6.1		3	3-H
Cliché manufacture including reminiscence from recycling of etching liquids	Perchloroethylene and buthanol.	H	1992	II	3		3	3-H
Cliché manufacture including reminiscence from recycling of etching liquids	Remains from quality control chlorinated hydrocarbons.	H	2810	II	6.1		3	3-H
Medical industry synthesis and cleaning	Chloroform, methylenechloride mixed with flammable solvents.	H	1992	II	3+6.1		3	3-H
Remains from PVC application on textiles	PVC-paste.	H	1993	II	3		3	3-H
Remains from plastic production	Printing ink and remains with more than 1% chlorine.	H	1992	II	3+6.1		3	3-H
Reminiscence from recycling of solvents.	Reminiscence from recycling of halogenated solvents.	H	1992	II	3+6.1		3	3-H
Stripping of printing ink, paint and lacquer	Halogen containing paint and solvents.	H	1992	II	3+6.1		3	3-H

[2] *In this table O=Oxidizing compounds, R=Reactive compounds; M=Mercury containing waste; V=Various waste for sorting, P=Pesticides; I=Inorganic waste; W=Waste oil; H=Halogenated solvents; S=Solvents; A=All other kinds of waste.*

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Stripping of printing ink, paint and lacquer	Trichloroethylene etc. mixed with flammable solvents.	H	1992	II	3+6.1		3	3-H
Cleaning of equipment used in connection with glue and plastic	Toluene, xylene etc.	S	1993	III	3		3	3-S
Cleaning of equipment used in connection with glue and plastic	Methyl meta-acrylate, ethyl acetate, ethyl alcohol, isopropanol.	S	1993	II	3		3	3-S
Cleaning of storage tanks	Toluene, Xylene etc. including mixtures of solvents without halogen/sulphur.	S	1993	II	3		3	3-S
Cleaning of equipment used in connection with rubber and glue	Xylene etc. including mixtures of solvents, without halogen and sulphur.	S	1993	II	3		3	3-S
Cleaning of equipment used in connection with glue and plastic	Styrene and acetone, styrene, xylene and ethylalcohol.	S	1993	II	3		3	3-S
Cliché manufacture including reminiscence from recycling of etching liquids	Ethanol, water, polyamide.	S	1993	II	3		3	3-S
Degreasing (Oil and fat)	Turpentine, kerosene etc.	S	1993	II	3		3	3-S
Degreasing (Oil and fat)	Stoddard solvent.	S	1993	II	3		3	3-S
Drying of natural gas	Discharged drying liquids, triethylene glycol.	S		No specific demands			3	3-S
Drying of gas pipelines	Discharged methanol.	S	1230	II	3+6.1		3	3-S
Film development and copying	Discharged solvents e.g. propanol	S	1993	II	3		3	3-S
Hospital and laboratory analysis	Toluene, xylene etc. and mixtures containing these compounds	S	1993	II	3		3	3-S
Medical industry synthesis and cleaning	Non chlorinated solvents containing medicine remains.	S	1993	II	3		3	3-S
Recycling of offset developers	Reminiscence.	S	1993	III	3		3	3-S

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Recycling of acetone used for cleaning	Styrene and acetone including unhardened polyester	S A	1993 3175	II III	3 4.1		3	3-S H04.01-A
Replacement of fuel	Gasoline, fuel.	S	1993	II	3		3	3-S
Servicing of oil traps or other types of traps	Jet fuel, turpentine.	S	1993	II	3		3	3-S
Servicing of oil traps or other types of traps	Mixed solvents free of halogen and sulphur.	S	1993	II	3		3	3-S
Spent cleaning liquid from dry cleaning	Turpentine	S	1300	II	3		3	3-S
Stripping of printing ink, paint and lacquer	Acetone, isopropanol, gasoline, MEK, ethyl acetate, pumpable.	S	1993	II	3		3	3-S
Stripping of printing ink, paint and lacquer	Toluene, xylene, thinner, turpentine etc. or mixtures containing these solvents.	S	1993	II	3		3	3-S
Stripping of printing ink, paint and lacquer	Ethyl acetate, ethanol, ketones etc.	S	1993	II	3		3	3-S
Washing and cleaning compounds/formulations for cleaning of machinery including off spec. products	Organic solvents without aromatics and without chlorine/sulphur.	S	1993	II	3		3	3-S
	Fuel oil	W	1202	III	3		3	3-W
	Diesel oil	W	1202	III	3		3	3-W
	Petrol	S	1203	II	3		3	3-S
Anti rust treatment of cars, removal of old anti rust waxes	Sludge from drainage system.	A	1993	III	3		3	3-A

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Cleaning of spray paint cabins/boxes	Paint sludge with organic solvents.	A	1993	III	3		3	3-A
Cleaning of equipment used in connection with glue and plastic	Old "base" compounds (hardener).	A	1133 3175	II III	3 4.1		3	3-A 4.1-A
Distillation of used dry cleaning liquid	Reminiscence from distillation of turpentine	A	1993 3175	III III	3 4.1		3	3-A 4.1-A
Distillation of ethyl alcohol	Reminiscence containing higher alcohols and ketones	A	1993	III	3		3	3-A
Distillation of used cleaning liquid	Reminiscence containing aliphatic hydrocarbons without chlorine, pumpable	A	1993	III	3		3	3-A
Distillation of gasoline	Reminiscence from gasoline manufacture	A	1993	III	3		3	3-A
Impregnation of textiles	Obsolete raw materials, tar containing products.	A	1993	III	3		3	3-A
Medical industry synthesis and cleaning	Pumpable organic distillation reminiscences without halogen and sulphur.	A	1993	III	3		3	3-A
Obsolete paint, printing ink and lacquer	Printing ink, paint and lacquer with solvents.	A	1993	II	3		3	3-A
Obsolete glue and off-spec. products	Glue waste, 2 component glue and/or glue containing organic solvents.	A	1993 3175	III III	3 4.1		3	3-A 4.1-A
Remains from latex application on textiles (carpets).	Latex and rubber sludge containing organic solvents.	A	1287 1287	II III	3		3	3-A
Remains from textile dying	Colour emulsion etc.	A	1993	II	3		3	3-A
Remains from gluing processes.	Glue, pumpable, not pumpable.	A	1133 3175	II III	3 4.1		3	3-A
Remains from plastic production.	Printing ink and remains of glue not con-	A	1993	II	3		3	3-A

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
	taining halogens pumpable and non pumpable.		3175		4.1			4.1-A
Reminiscences from recycling of solvents.	Paint waste with remains of solvents, without halogens.	A	1993 3175	II III	3 4.1		3	3-A 4.1-A
Servicing of oil traps or other types of traps	Anti rust compounds, kerosene etc.	A	1993	III	3		3	3-A
Stripping of printing ink, paint and lacquer	Printing ink, paint, lacquer, and toluene, xylene, thinner etc.	A	1993	II	3		3	3-A
Stripping of textile printing ink.	Turpentine, butyl acetate etc.	A	1993	II	3		3	3-A
Stripping of printing ink, paint and lacquer	Distillation reminiscence from recycling of solvent (toluene) from photo gravure printing.	A	1993	II	3		3	3-A
Tar distillation	Tar sludge.	A	1993	II	3		3	3-A
Water from jet fuel storage tanks	Ethylene glycol mono methyl ether.	A	1993	II	3		3	3-A
Cleaning of equipment used in connection with glue and fat	Methylene chloride and flammable solvents mixed with methylene chloride. Acetone and ethylene glycol.	H S	1992 1993	II II	3+6.1 3		3 3	3-H 3-S
Distillation of used dry cleaning liquid	Reminiscence with perchloroethylene from cleaning of working clothes, not pumpable	H	3175	III	4.1		4.1	4.1-H
Cliché manufacture including reminiscences from recycling of etching liquids	Ethanol, water, polyamide (non pumpable).	A	3175	III	4.1		4.1	4.1-A
Medical industry synthesis and cleaning	Solid organic reminiscences with halogen/sulphur.	A	3175	III	4.1		4.1	4.1-A

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Stripping of printing ink, paint and lacquer	Acetone, isopropanol, gasoline, turpentine, MEK, ethyl acetate, not pumpable.	A	3175	III	4.1		4.1	4.1-A
	Perchloric acid with more than 50 % acid	O	1873		5.1+8	558	5.1	5.1-O
	Hypochlorite inorganic	O	1470	I	5.1		5.1	5.1-O
Cleaning of equipment used in connection with glue and fat	Halogenated solvents, non flammable.	H	2810	II	6.1		6.1	6.1-H
Cleaning following steel hardening	Solutions containing potassium cyanide, sodium cyanide, barium cyanide, sodium nitrite, sodium carbonate.							
	<0,3% -³ 3% cyanide	I	1935	III	6.1		6.1	6.1-I
	> 3% cyanide	I	1935	I	6.1		6.1	6.1-I
Copper plating	Cupper cyanide, sodium cyanide Sodium hydroxide							
	<0,3 % - 3% cyanide	I	1935	III	6.1		6.1	6.1-I
	> 3 % cyanide	I	1935	I	6.1		6.1	6.1-I
Manufacture of phenol resin	Water containing phenol and formaldehyde remains including condensation products emulsions	A	2927	I	6.1+8		6.1	6.1-A
Off spec. pesticide, production	- Pesticides and their raw materials excluding mercury	P					6.1	6.1-P
	- Pesticides and their raw materials including mercury	M					6.1	6.1-M
Degreasing (Oil and fat)	Trichloroethylene, trichlororethane, perchloroethylene etc.	H	2810	II	6.1		6.1	6.1-H

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Hospital and laboratory analysis	Chloroform etc.	H	2810	II	6.1		6.1	6.1-H
Impregnation of textiles	Baths containing pentachlorophenol or derivatives from it, metals and/or solvents.	H	2810 1992	II III	6.1		6.1	6.1-H
Medical industry synthesis and cleaning	Mono chlorinated partly sulphonated hydrocarbons and sulphides of high molecular weight, water, remains of sodium hydroxide, approx. 8% chlorine and approx. 6% sulphur.	H	2810	II	6.1		6.1	6.1-H
Medical industry synthesis and cleaning	Heads and reminiscences containing halogens, toxic compounds and flammable solvents.	H	2929	I	6.1+3		6.1	6.1-H
Medical industry synthesis and cleaning	Chlorine and sulphur containing organic compounds of high molecular weight.	H	2810	I	6.1		6.1	6.1-H
Medical industry synthesis and cleaning	Organic distillation reminiscences dissolved in methylene chloride.	H	2810	I	6.1		6.1	6.1-H
Recycling of solvents	Methylene chloride, trichloroethylene, trichlororethane etc.	H	2810	II	6.1		6.1	6.1-H
Spent cleaning liquid from dry cleaning	Perchloroethylene	H	1897	III	6.1		6.1	6.1-H
Stripping of printing ink, paint and lacquer	Halogen containing hydrocarbons not flammable.	H	2810	II	6.1		6.1	6.1-H
Treatment of wastewater from manufacture of pesticides	Chlorophenols.	P	2810	I	6.1		6.1	6.1-P
Cleaning of gasoline tanks	Organic lead compounds.(fuel anti-knock mixture)	A	1649	I	6.1+3		6.1	6.1-A
Stripping of wood preservatives.	Organic tin-compounds.	A	3282	I	6.1		6.1	6.1-A
Wood Preservation, cleaning of	Wood preservatives and solvents.	A	2929	II	6.1+3		6.1	6.1-A

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
equipment								
Fat determination in animal feed stock	Mercury activator.	M	2024	II	6.1		6.1	6.1-M
Laboratories	COD - liquids.	M	2024	II	6.1		6.1	6.1-M
Degreasing (Oil and fat)	Sodium cyanide and sodium hydroxide (< 3% cyanide).	I	1935	III	6.1		6.1	6.1-I
Flue gas cleaning (wet scrubbers)	Sodium hydroxide, sodium sulphide.	I	3243	II	6.1		6.1	6.1-I
Hardening of steel	Potassium cyanide, sodium cyanide, barium cyanide, sodium nitrite and possibly sodium carbonate	I	1935	I	6.1		6.1	6.1-I
Metal foundry, grinding and blast cleaning	Filter dust, sand and slag containing heavy metals.	I	3243	II	6.1		6.1	6.1-I
Veterinarian blood test	Potassium cyanide	I	1680	I	6.1		6.1	6.1-I
Wood preservation deposits in storage tanks and dipping vessels	Chromic acid, arsenic acid copper and flour compounds.	I	3289	I	6.1+8		6.1	6.1-I
Air cleaning by manufacture of medicine	Filter dust containing medicine.	V	3249 3249	II III	6.1 6.1		6.1	6.1-V
Air cleaning by manufacture of pesticides	Filter dust containing pesticides.	P	2588 2588 2588	I II III	6.1 6.1 6.1		6.1 6.1 6.1	6.1-P
El zinc plating	Zinc cyanide, sodium cyanide $\frac{< 3\% \text{ cyanide}}{> 3\% \text{ cyanide}}$ 0	I	1935 1935	III I	6.1 6.1		6.1 6.1	6.1-I
Cliché manufacture including remi-	Nitric acid and etching oil.	A	1826	II	8		8	8-A

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
niscences from recycling of etching liquids	£ 50% nitric acid							
Degreasing (Oil and fat)	Sodium hydroxide and potassium hydroxide.	A	1719	II	8		8	8-A
Laboratories	Kjeldahl liquids containing no mercury.	A	3267	II	8		8	8-A
Recycling of drums	Sodium hydroxide, chemical residues, paint.	A	3264	II	8		8	8-A
Recycling of spent oil	Oil and sulphuric acid, acid sludge.	A	1760	II	8		8	8-A
Remains from bleaching of textiles	Waste containing hypochlorite and hydrogen peroxide.	A	3266	II	8		8	8-A
Remains from manufacture of acetylated starch.	Remains containing acetic acid.	A	3265	II	8		8	8-A
Stripping of paint from wood	Sodium hydroxide and paint	A	1719	II	8		8	8-A
Chromating	Chromic acid	I	2240	II	8		8	8-I
Chrome plating	Chromic acid solutions	I	1755	II	8		8	8-I
Cleaning of glass	Chromic acid.	I	1755	II	8		8	8-I
Cleaning of gas flasks	Acid.	I	3264	II	8		8	8-I
Cliché manufacture including reminiscences from recycling of etching liquids	Chromic acid in mixture with other acids.	I	3264	II	8		8	8-I
Cliché manufacture including reminiscences from recycling of etching liquids	Potassium permanganate and alkali.	I	1760	II	8		8	8-I
Copper plating	Copper sulphate, sulphuric acid	I	1760	II	8		8	8-I
Degreasing (Oil and fat)	Chromic acid.	I	1755	II	8		8	8-I

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Degreasing (Oil and fat)	Phosphoric acid.	I	1805	III	8		8	8-I
El zinc plating	- Zinc chloride, ammonium chloride - Zinc oxid, sodiumhydroxide	I I	2331 3266	III II	8 8		8 8	8-I
Electro polishing	Sulphuric acid, phosphoric acid	I	3264	II	8		8	8-I
Emptying of discharged car batteries	Lead contaminated sulphuric acid	I	2796	II	8		8	8-I
Etching	Chromic acid, hydrochloric acid Sulphuric acid, iron chloride, hydrochloric acid, iron chloride Copper chloride, ammonium hydroxide.	I I I	1755 1760 3266	II II II	8		8	8-I
Flushing	Zinc chloride, ammonium chloride	I	3264	II	8		8	8-I
Metal Removal	Chromium^{+3} salts, hydrochloric acid hydrochloric acid, iron^{+2} chloride sulphuric acid	I I I	1755 3264 3264	II II II	8		8	8-I
Nickel plating	Boric acid, nickel chloride, nickel sulphate	I	3264	II	8		8	8-I
Pickling	Sulphuric acid, Hydrochloric acid	I	3264	II	8		8	8-I
Pickling	Chromic acid, hydrochloric acid, sulphuric acid	I	1760	II	8		8	8-I
Pickling	Sodium hydroxide, sodium aluminate	I	1824	II	8		8	8-I
Pickling	Hydrochloric acid	I	1787	II	8		8	8-I
Pickling	Hydrochloric acid, nitric acid fluor boric acid, hydrochloric acid, sulphuric acid	I	1790	II	8+6.1		8	8-I
Recycling of catalysts from oil hard-	Nickel containing acid.	I	1760	II	8		8	8-I

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
ening								
Reminiscence from extraction of heavy metals from cliché etching baths.	Nitric acid.	I	2031	II	8		8	8-I
Descaling of boilers	Hydrochloric acid, formic acid etc.	I	1760	II	8		8	8-I
Car batteries, dry cells, discharged	Obsolete accumulators (car batteries) containing heavy metals and sulphuric acid	V	2796 2797	II II	8 8		8	8-V
Hydraulic oil from turbines transformer oil and oil impregnated capacitors	Oil containing PCB.	H	2315	II	9		9	9-H
Cleaning of brakes.	Dust from brake discs containing asbestos.	V	2212	II	9		9	9-V
Drying of natural gas	Discharged sulfinol.	H		-				
Medical industry synthesis and cleaning	Solid and liquid remains of finished medicine.	H						
Cleaning of spray paint cabins/boxes	Lacquer remains from wet boxes.	A		No specific demands				
Cleaning of spray paint cabins/boxes	Paint dust and sludge.	A		No specific demands				
Cleaning of storage tanks	Ethylene glycol.	A		No specific demands				
Colouring of leather goods	Water and colour reminiscences	A		No specific demands				
Film development and copying	Fixation baths	A		No specific demands				
Film development and copying	Used developer	A		No specific demands				

Origin	Waste type	Waste Group[2*]	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
Film development and copying	Chromium containing bleach baths chromium containing stop/hardening baths and chromium containing hardening baths	A H		No specific demands				
Glue stripping	Waste glue.	A		I/II				
Hospitals and laboratory analysis	Formaldehyde (4-10%)	A						
Manufacture of mineral wool	Remains from production of phenol resin for impregnation of mineral wool	A		No specific demands				
Obsolete printing ink, paint and lacquer	Printing ink and paint, water based.	A		No specific demands				
Remains from oxidized starch.	Remains containing sodium hypochlorite.	A						
Stripping of printing ink, paint and lacquer	Printing ink, paint and water, without solvents.	A		No specific demands				
X-ray film development	Developer.	A		No specific requirements				
X-ray film development	Fixation bath.	A		No specific requirements				
Dentists	Sludge containing mercury.	M		II				
Mercury batteries, discharged	Mercury batteries.	M						
Silver and gold plating	Alkaline cyanide containing bath with silver/gold	I	 1935 1935	 I III				
Medical industry synthesis and clean-	Solid and liquid remains of finished medi-	V						

Origin	Waste type	Waste Group[2]*	UN Number	UN Packing Group	Danger labels	Hazard identification number (ADR)	SANS Class	Proposed new Waste Class
ing	cine.							
Medicine waste	Obsolete medicine in "small" packs.	V		No specific demands				
Manufacture of polyurethane products	Isocyanates	V						
				-			10	

**In this table O=Oxidizing compounds, R=Reactive compounds; M=Mercury containing waste; V=Various waste fore sorting, P=Pesticides; I=Inorganic waste; W=Waste oil; H=Halogenated solvents; S=Solvents; A=All other kinds of waste.*

8 Waste Tyres

8.1 Tyres in general

Even though waste tyres are not hazardous waste, the waste tyres constitute a special problem in the society. Because the waste tyres problem partly may be solved by incineration as AFR, this is dealt with in a special chapter.

"The scrap tyre problem" has been discussed much the last years/ 5/6/.The problem has especially grown in Europe after the EU landfill directive from 1999, which bans the land filling of tyres from 2003 and bans shredded tyres in landfills from 2006. Also the European End-of-Life Vehicle (ELV) directive from 2002 requiring that 85 % of ELVs shall be reused or recycled by 2006 also enhances the tyre problem.

According to the "Technical Guidelines" from the Basel Convention /6/, leachate from whole tyres or granulated tyres shows no evidence of increasing levels of substances according to drinking water standards.

So what is the problem? Why is tyres difficult waste? According to the EU legislation tyres are not hazardous waste. Obviously tyres do not give rise to leaching problems.

However, when tyres are placed on a landfill:

- The rubber does not decompose.
- There is a rather high fire risk and in case of fire in tyres, potential hazardous levels of carbon monoxide and PAHs can be found in the plume. After open air burning, compounds like pyrolytic oils and other rests in the soil can cause environmental damage to the flora and fauna.
- The tyres contain a lot of air and therefore use a lot of space in the landfill.
- Another problem is that the amount is so huge, and the tyres are very visible in the nature.

Tyres may be looked upon as a valuable raw product for incineration:

Net calorific value of tyres is 30-35 GJ per ton. - Very high compared to other fuels. Black coal: 25-31 GJ per ton.

Table 30: Fuel Costs

Fuel Costs		
Fuel	Heating Value MJ/kg	Average Fuel Costs (€/GJ)
Heating oil	42	4-7
Natural gas	38 MJ/m3	2-6
Coal	25	0.5-1.2
Wood biomass	20	0-1.5
Mixed plastic waste	43	0
Tyres	33	0

Co-combustion where worn-out tyres are used as fuel in energy intensive processes as a replacement for fossil fuels and thus lowering the operating costs and the net greenhouse gas burden on the environment have shown to be a successful technology. The most important co-combustion application for tyres is their use in cement kilns as a replacement for coal.

Cement Kilns
Many of the leading cement companies around the world (Lafarge, Holcim, Cimpor, Heidelberg, Taiheiyo, Italcementi, Aalborg Portland, and Castle Cement) have plants around the world that are currently co-combusting tyres.

Tyres are typically injected directly into the rotary cement kiln where the clinker is produced at temperatures about 1500° C. The energy content of the tyres is utilized *in situ* as heat, and the incombustible parts of the tyre are incorporated into the cement clinker.

The benefit of utilizing the tyres in this way is that it displaces costly fossil fuels, reduces greenhouse gas emissions and leaves little or no residues that require disposal.

The advantages of this process for tyre treatment include high degree of mixing, and the absorption of acid gases by the alkaline environment within the kiln.

8.2 Discussion of Technology

The company Juniper /7/ have looked into the different treatment methodologies, incineration, pyrolysis, gasification, microwave, plasma, cement kilns, boilers and shredding and granulation, and the overall conclusion of these many methods is:

The use of scrap tyres in cement kilns is increasing and is by far the leading thermal technology used for scrap tyres management. The ability to use existing infrastructures and the reduction in the operating costs for the cement manufacturer, are the primary attractions of this "management "route". Stricter regulation of emission from these facilities, and growing political and public concerns over the "dilute and disperse" element of contaminants in cement, could negatively affect the current growth rate. However, the low commercial success rate of other thermal technologies and limited growth prospect for mechanical recyclers mean that cement kilns are likely to handle increasing volumes of tyres, particular in Europe.

A few dedicated grate based incineration facilities, which can handle whole and shredded scrap tyres, are in operation, but there is no indications of an appetite in the industry to develop new incineration plants, in light of the growing negative opinion, both publicly and politically, of this technology. While fluidized bed incineration is being further developed in Japan, the economic viability of this approach is uncertain.

Despite the very limited success of pyrolysis and gasification systems, development projects have continued at pace/8/, and a number of developers have indicated plans to build their first reference plant within the next year or so. However, because pyrolysis processes have been under development for the past 10 years or more, with several demonstration projects built or planned, but none so far being commercially successful. The success of pyrolysis clearly hinges upon the ability to find viable, value added outlets for the pyrolytic char, oil and the scrap steel, a challenge which as been underestimated by most developers of pyrolysis systems.

Incineration may in some respect be seen as misuse of a good raw material /9/ and /10/. There may be advantages of mechanical recycling to rubber granulates.

Mechanical recycling is a fully established business with a large number of dedicated process equipment suppliers. "Of-the shelf" equipment can be used to build a process, and therefore the time to start up is relatively short and the capital costs significantly lower than the thermal options. Environmentally sound, with little evidence of pollution from its use, the rubber granulate can be

- Inexpensive in comparison with many other materials.
- Light weight, providing advantages for applications on soft ground.
- Durable and resistant to a wide variety of chemicals.
- Available in substantial quantities.

Further high growth in this sector will hinge upon the development of large capacity applications for shreds and granulate which are currently linked to the use of shreds for recovering energy and granulate in road constructions.

8.3 South Africa

The tyre industry in South Africa is initiating a waste (scrap) tyre collection process to make the waste tyres available to private enterprises for recycling purposes. To this end they have formed a Section 21 Company (association not for gain) the South African Tyre Recycling Process Company (SATRP Co) to manage the process on the industry's behalf. The SATRP Co does not plan to be involved in the actual recycling process which is to be the role of private enterprise /14/.

The tyre industry in SA consists of the manufacturers, importers, dealers, retailers, recyclers and consumers.

Industry is endeavouring to solve the environmental problem of tyres being burned and waste (scrap) tyres being fitted to vehicles.

The funding of the process will be through an “Environmental levy” on each new tyre sold. The fee will be initiated by the tyre suppliers (manufacturers, importers and retailers), and passed on to the consumer through the tyre dealer.

A new industry of collecting and recycling waste rubber will be established. At present, there are approximately 12 plants in the country using waste tyres. Only one produces rubber crumb, with one other using the crumb in applications. The others are smaller entrepreneurs making mats, sandals, etc.

New investors are planning an additional 5 to 20 plants once the project is established.

Cement kilns and the like, once converted to accept waste rubber as part of their fuel source, would be a main constant consumer of waste tyres. All waste tyre users will have to comply with national environmental standards as per DEA&T requirements.

8.4 Flow of waste tyres in the proposed process

The Waste Tyre Regulation works on the premises that the majority of waste tyres occur at tyre dealerships or retailers. For the purpose of the Regulation, a Tyre Dealer is defined as:

“any person who imports, manufactures, distributes or otherwise deals in tyres”.

The SATRP Company will call for tenders for the collection, temporary storage and delivery of waste tyres in each province. The Collection Agent contracted in a province will be required to appoint or employ regional collectors who will be responsible for collecting tyres from dealerships in a defined area and transport them to the Agent's storage site. The SATRP Company will advise the Collection Agent where the waste tyres are to be delivered and if any pre-delivery processing has to take place.

8.5 Diagram of Flow of waste tyres

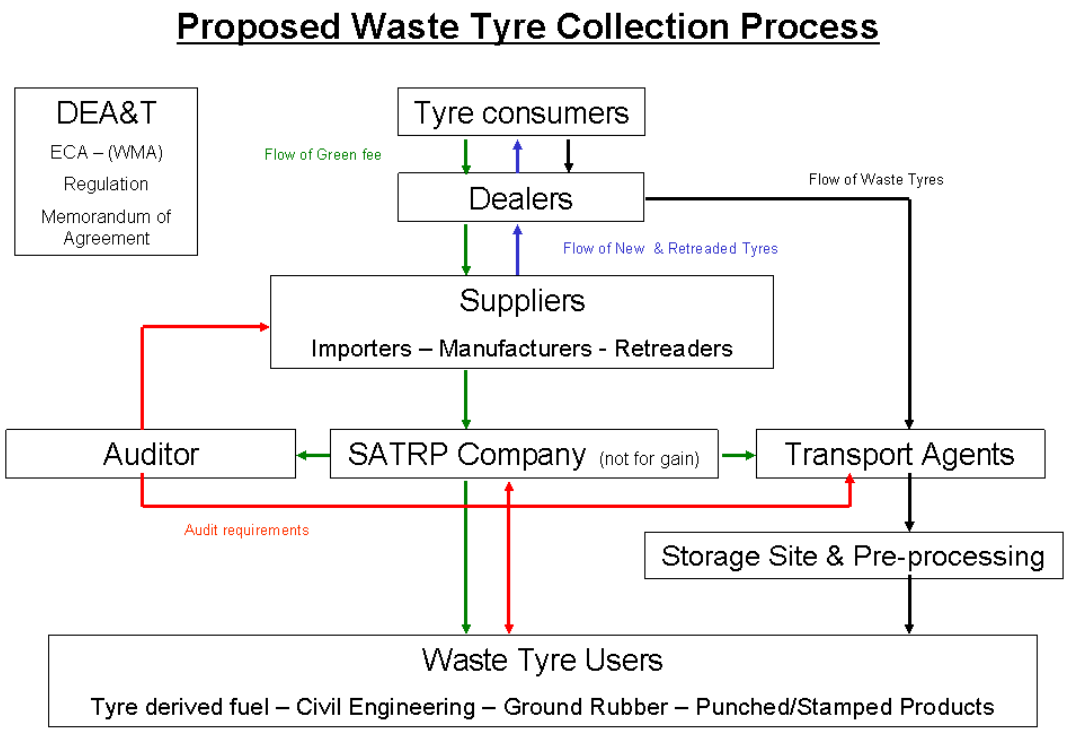

Figure 12: Flow of waste tyres, payment, audit and green fee

8.6 Funding the process

The suppliers will fund the process by raising the green fee on all sales to their customers, generally the dealer. The suppliers will pay the green fee to the auditor of the SATRP Company. This will be done in order to maintain the confidentiality of sales figures. The auditor will pay the total green fee collection to the SATRP Company.

The suppliers will recover the green fee from the dealer who in turn will recover it from the consumer. The green fee will be widely publicised by the SATRP Company in order to make the public aware of the rate at which it should be charged as well as how it is being utilised. The green fee will be charged as a separate line item and will therefore be transparent. No profit will be made on the green fee at any stage from supplier through to consumer.

As it will not be possible to arrange for the collection of all the different categories of tyres, they will be prioritised. The first category of tyres to be addressed will be passenger, and commercial tyres. The green fee will most probably be based on rim size. No green fee will be charged on resold tyres. If a retailer imports used casings, he will be obliged to pay the green fee on those casings and absorb it into the cost of the resold tyre. No green fee will be payable on tyres exported by suppliers where they are in possession of the export documentation.

8.7 Amount of waste tyres in South Africa

The following figures are related to passenger, light and heavy commercial tyres /15/.

Table 31: Amounts of passenger, light and heavy commercial tyres in SA

	Tyres - number per year	Kg per tyre	Total tons per year
Passenger tyres	5,600,000	6.77	37,912
Light commercial tyres	2,500,000	12.46	31,150
Heavy commercial tyres	1,000,000	54.55	54,550
Total	**9,100,000**		**123,612**

8.7.1 Stockpile

It is believed that the stockpile throughout the country must be between 1 to 2 years arising. A vast number of tyres are being burned in the open, by unemployed people in order to recover the steel content which is then sold to scrap metal dealers. The stockpile has therefore been somewhat depleted.

Vehicle Park

Table 32: Amount of vehicles in South Africa in 2006

Transport vehicles	Numbers in 2006
Passenger (includes passenger cars, caravans and light trailers)	5,310,259
Light commercial (includes taxis, light delivery vehicles and trailers)	2,268,500
Heavy commercial (includes buses, trucks and trailers)	437,422
Total amount of transport vehicles	**8,016,181**

Replacement rate

Passenger and light commercial vehicles replace approximately 1 tyre per vehicle per year.

Heavy commercial vehicles replace about 1.6 new tyres and about 0.6 re-traded tyres per year per vehicle.

The vehicle park has grown quite substantially in the past few years, but that is not anticipated to continue. It is estimated that the passenger park will grow 3 % in 2007 and 2 % in 2008. The light and heavy commercial parks will grow about 4 % in 2007 and 2008/15/.

9 Conclusion

9.1 Amount of Hazardous Waste

In this report no precise information of the total amount of hazardous waste generated in 2006 or 2007 in SA has been found. However, based on former surveys and the investigations made in this study, a picture of the amounts can be seen.

According to this study an amount of 710,000 tons of hazardous waste during 2007 has been reported disposed of from a few waste contractors, and the amount of waste that may be incinerated is at least 117,000 tons/year.

Furthermore, there is about 123,000 tons of waste tyres/year that may be incinerated. So considering that this study does not cover all waste sources, there is at least 240,000 tons of organic waste that with advantage may be incinerated in cement kilns each year.

Based on the information from the 1992 study (see chapter 3.3) there is about 300,000 to 400,000 tons of organic hazardous waste whereof an unknown amount with advantage can be incinerated each year, besides the waste tyres.

Based on the information from 1997 study (see

Table 12) around 160,000 m^3 out of about 7 million m^3 waste in 1997, seem to be waste types that may be incinerated, beside the waste tyres.

As can be seen, a precise amount of hazardous waste that may be incinerated is difficult to predict based on the existing information. However, this study indicates that there is at least 117,000 tons, whereas the two older - but more comprehensive studies - indicate that the amount is more in the magnitude of 160,000 m^3/year to 400,000 tons/year.

However, in connection to this investigation a local waste treatment company has stated that *"a tremendous amount of organic hazardous waste is being disposed of at small disposal sites. These waste streams can be delisted in South Africa to a GLB+ site and will not be reflected at the bigger hazardous landfill sites. The majority of all oil wastes (as example) will reflect as disposal at a lined General Landfill site due to the legislation"*.

As this study did not have the time to investigate this statement in details, the conclusion of this (small) investigation is that for certain there will be more organic hazardous waste generated than reported here, and in order to have the total amount registered, the enterprises must be compelled - with basis in the legislation - to report the amount of waste types generated to the new waste information system being build up in South Africa.

In order to be able to plan properly for how the generated hazardous waste (collection, transport, recycling, and treatment) shall be managed in the years to come, it is recommended that a proper hazardous waste inventory should be made.

9.2 Type of Hazardous Waste

The objective of this study is also to characterise the types of South African hazardous waste in an incineration context and more over compare the South African hazardous waste (types) with hazardous waste generated in Europe.

As can be seen from Appendix 2, the type of industries found in Europe may also be found in South Africa. Nearly all groups of industries in the European Waste Catalogue are covered with several comparable South African industries so there is no doubt that South Africa has the same polluting industries as in Europe. Therefore, it must also be anticipated that South Africa has the same hazardous waste problems as seen in Europe.

As can be seen from both the 1997 study and the present study, it is striking how much alike the South African hazardous waste profile in Figure 11 based on 198,000 tons from 2005-2007 is to the Danish waste profile in

Figure 10 based on about 84,000 tons from 1997. As can be seen in Figure 4, the waste in the 1997 study is distributed in all the waste groups with waste group A (other waste types) and I (inorganic waste) as far the biggest

groups. This picture resembles also very much to the picture of Danish waste in

Figure 10, except from the large amount of inorganic waste in the South African waste profile.

In the 1997 inventory investigation it is seen from Figure 1 that the biggest volume of waste is coming from Gauteng, KwaZulu Natal and Mpumalanga.

After having sorted all the waste streams out on waste groups it is seen that the biggest fraction of waste is waste for landfill (inert waste) and inorganic waste.

If we look at the waste streams it is obvious from the data that the gypsum production and the steelmaking slags are very big fractions as can be seen in Table 11.

The gypsum and the steelmaking slag makes up more than 6.7 million m^3. The rest is mostly ordinary oil and chemical waste and makes up about 295,000 m^3 in 1997.

Based on a division into waste groups of about 415,000 tons of hazardous waste consisting of about 50,000 different waste loads from 2006-2007 and based on analyses of the 1992 and 1997-studies, it is obvious that the types of hazardous waste in South Africa correspond very well to existing European waste streams.

The mining industry exists in both Europe and South Africa, and is particular because of the very large amounts of special waste types, and special efforts are needed to cope with this.

Also the waste types found in the European Waste catalogue can be matched by the RSA waste types as can be seen in Appendix 2.

Certain legacy waste like organic waste containing chloride and mixed with heavy metals, is very special waste and must be avoided in the future, because it is so expensive to treat the organics without spreading the heavy metals. The treatment of that kind of legacy waste will need to be investigated thoroughly to find out what will be the cleverest cleaning up solution.

A hazardous waste classification system has been attempted sketched in chapter 7 for use in the future development of the classification system, and it is suggested that the classification based on this report may be scrutinised by DEAT. The new proposed system is a further development of the existing classification system based on the UN classification system for transport of dangerous goods.

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Appendix 1: European Waste Catalogue

Office for Official Publications of the European Communities

This document is meant purely as a documentation tool and the institutions do not assume any liability for its contents

COMMISSION DECISION of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste
(notified under document number C(2000) 1147) **(Text with EEA relevance)**
(2000/532/EC) (OJ L 226, 6.9.2000, p. 3)

Amended by:

Official Journal
►**M1** Commission Decision 2001/118/EC of 16 January 2001 L 47 1 16.2.2001
►**M2** Commission Decision 2001/119/EC of 22 January 2001 L 47 32 16.2.2001
►**M3** Council Decision 2001/573/EC of 23 July 2001 L 203 18 28.7.2001

COMMISSION DECISION
of 3 May 2000 replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste
(notified under document number C(2000) 1147) **(Text with EEA relevance)**
(2000/532/EC)

THE COMMISSION OF THE EUROPEAN COMMUNITIES,
Having regard to the Treaty establishing the European Community, Having regard to Council Directive 5/442/EEC of 15 July 1975 on waste[3] , as amended by Directive 91/156/EEC[4], and in particular Article 1(a) thereof, Having regard to Council Directive 91/689/EEC of 12 December 1991 on hazardous waste[5], and in particular Article (4), second indent thereof, Whereas:

(1) Several Member States have notified a number of waste categories which they consider to display one or more of the properties listed in Annex III to Directive 91/689/EEC.

(2) Article 1(4) of Directive 91/689/EEC requires the Commission to examine notifications from Member States with a view to amending the list of hazardous wastes laid down in Council Decision 94/904/EC[6].

[3] OJ L 194, 25.7.1975, p. 47.

[4] OJ L 78, 26.3.1991, p. 32

[5] OJ L 377, 31.12.1991, p. 20.

[6] OJ L 356, 31.12.1994, p. 14.

(3) Any waste inserted in the list of hazardous wastes must also be included in the European Waste Catalogue laid down in Commission Decision 94/3/EC[7] . It is appropriate, in order to increase the transparency of the listing system and to simplify existing provisions, to establish one Community list which integrates the list of wastes laid down in Decision 94/3/EC and that of hazardous wastes laid down in Decision 94/904/EC.

(4) The Commission is assisted in this task by the Committee established by Article 18 of Directive 75/442/EEC.
(5) The measures laid down in this Decision are in accordance with the opinion expressed by the aforementioned Committee, HAS ADOPTED THIS DECISION:

Article 1
The list in the Annex to this Decision is adopted.
▼M1
Article 2
Wastes classified as hazardous are considered to display one or more of the properties listed in Annex III to Directive 91/689/EEC and, as regards H3 to H8, H10[8] and H11 of the said Annex, one or more of the following characteristics:

— flash point ≤ 55 ºC,
— one or more substances classified[9] (2) as very toxic at a total concentration ≥ 0,1 %,
— one or more substances classified as toxic at a total concentration ≥ 3 %,
— one or more substances classified as harmful at a total concentration ≥ 25 %,
— one or more corrosive substances classified as R35 at a total concentration ≥ 1 %,
— one or more corrosive substances classified as R34 at a total concentration ≥ 5 %,
— one or more irritant substances classified as R41 at a total concentration ≥ 10 %,
— one or more irritant substances classified as R36, R37, R38 at a total concentration ≥ 20 %,
— one substance known to be carcinogenic of category 1 or 2 at a concentration ≥ 0,1 %,
— one substance known to be carcinogenic of category 3 at a concentration ≥ 1 %
— one substance toxic for reproduction of category 1 or 2 classified as R60, R61 at a concentration ≥ 0,5 %,
— one substance toxic for reproduction of category 3 classified as R62, R63 at a concentration ≥ 5 %,

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[7] OJ L 5, 7.1.1994, p. 15

[8] In Directive 92/32/EEC amending for the seventh time Directive 67/548/EEC the term ‘toxic for reproduction’ was introduced. The term ‘teratogenic’ was replaced by a corresponding term ‘toxic for reproduction’. This term is considered to be in line with property H10 in Annex III to Directive 91/689/ EEC

[9] The classification as well as the R numbers refers to Directive 67/548/EEC on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (OJ L 196, 16.8.1967, p. 1.) and its subsequent amendments. The concentration limits refer to those laid down in Directive 88/379/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labelling of dangerous preparations (OJ L 187, 16.7.1988, p. 14.) and its subsequent amendments.

— one mutagenic substance of category 1 or 2 classified as R46 at a concentration ≥ 0,1 %,
— one mutagenic substance of category 3 classified as R40 at a concentration ≥ 1 %.

Annex III (DIR 91/689/EU)

PROPERTIES OF WASTES WHICH RENDER THEM HAZARDOUS

H1 'Explosive`: substances and preparations which may explode under the effect of flame or which are more sensitive to shocks or friction than dinitrobenzene.

H2 'Oxidizing`: substances and preparations which exhibit highly exothermic reactions when in contact with other substances, particularly flammable substances.

H3-A 'Highly flammable`: - liquid substances and preparations having a flash point below 21 °C (including extremely flammable liquids), or - substances and preparations which may become hot and finally catch fire in contact with air at ambient temperature without any application of energy, or - solid substances and preparations which may readily catch fire after brief contact with a source of ignition and which continue to burn or to be consumed after removal of the source of ignition, or - gaseous substances and preparations which are flammable in air at normal pressure, or - substances and preparations which, in contact with water or damp air, evolve highly flammable gases in dangerous quantities.

H3-B 'Flammable`: liquid substances and preparations having a flash point equal to or greater than 21 °C and less than or equal to 55 °C.

H4 'Irritant`: non-corrosive substances and preparations which, through immediate, prolonged or repeated contact with the skin or mucous membrane, can cause inflammation.

H5 'harmful`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may involve limited health risks.

H6 'Toxic`: substances and preparations (including very toxic substances and preparations) which, if they are inhaled or ingested or if they penetrate the skin, may involve serious, acute or chronic health risks and even death.

H7 'Carcinogenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce cancer or increase its incidence.

H8 'Corrosive`: substances and preparations which may destroy living tissue on contacts.

H9 'Infectious`: substances containing viable micro-organisms or their toxins which are known or reliably believed to cause disease in man or other living organisms.

H10 'Teratogenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce non-hereditary congenital malformations or increase their incidence.

H11 'Mutagenic`: substances and preparations which, if they are inhaled or ingested or if they penetrate the skin, may induce hereditary genetic defects or increase their incidence.

H12 Substances and preparations which release toxic or very toxic gases in contact with water, air or an acid.

H13 Substances and preparations capable by any means, after disposal, of yielding another substance, e.g. a leachate, which possesses any of the characteristics listed above.

H14 'Ecotoxic`: substances and preparations which present or may present immediate or delayed risks for one or more sectors of the environment.

Notes

1. Attribution of the hazard properties 'toxic` (and 'very toxic`), 'harmful`, 'corrosive` and 'irritant` is made on the basis of the criteria laid down by Annex VI, part I A and part II B, of Council Directive 67/548/EEC of 27 June 1967 of the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances (1), in the version as amended by Council Directive 79/831/EEC (2).

2. With regard to attribution of the properties 'carcinogenic`, 'teratogenic` and 'mutagenic`, and reflecting the most recent findings, additional criteria are contained in the Guide to the classification and labelling of dangerous substances and preparations of Annex VI (part II D) to Directive 67/548/EEC in the version as amended by Commission Directive 83/467/EEC (1).

3. In Wejding, H. /18/ we find that "the classification as well as the R-phrases refer to Council Directive 67/548/EEC and its subsequent amendments, cf. footnote 7. The concentration limits refer to those laid down in Council Directive 1999/45/EC which had repealed Council Directive 88/379/EEC and its subsequent amendments. With reference to this footnote 7, interlinking the hazardous waste and general classification legislation, various member states have recalled that all substances and preparations being waste, which are to be classified as dangerous according to the chemical legislation, should also be classified as hazardous waste – following the same procedures (including the use of specific concentration limits laid down for specific substances (and not only the generic ones mentioned above) as well as the procedures regarding additivity of hazards). The Commission agrees that at first sight, the Hazardous Waste Directive seems to define its own set of criteria for the classification of hazardous waste, i.e. the H -characteristics H1 -H14. But with regard to the health hazards underlying the criteria H4-H8 and H10-H11, it is clearly stated in paragraph 1 and 2 of the Notes of Annex III to Directive 91/689/EEC that the H -characteristics are to reflect the classifications Very Toxic, Toxic, Harmful, Corrosive, Irritant and CMR according to Directive 67/548/EEC and its amendments. Although a similar provision is not explicitly made for the physico -chemical hazards (H1, H2, H3A, H3B, H12) and for the environmental hazard (H14), the test methods to define these properties

shall be those as described in Annex V to Directive 67/548/EEC and its adaptations to technical progress, cf. the paragraph “Test Methods” in Annex III to Directive 91/689/EEC – which also shows clearly how the regulations are interlinked " /18/.

Test methods

The test methods serve to give specific meaning to the definitions given in Annex III. The methods to be used are those described in Annex V to Directive 67/548/EEC, in the version as amended by Commission Directive 84/449/EEC (2), or by subsequent Commission Directives adapting Directive

Article 3

Member States may decide, in exceptional cases, on the basis of documentary evidence provided in an appropriate way by the holder, that a specific waste indicated in the list as being hazardous does not display any of the properties listed in Annex III to Directive 91/689/ EEC. Without prejudice to Article 1(4), second indent, of Directive 91/689/EEC, Member States may decide, in exceptional cases, that a waste indicated in the list as being non-hazardous displays one or more of the properties listed in Annex III to Directive 91/689/EEC. All such decisions taken by Member States shall be communicated on a yearly basis to the Commission. The Commission shall collate these decisions and examine whether the Community list of wastes and hazardous wastes should be amended in the light of them.

Article 4

Member States shall take the measures necessary to comply with this Decision not later than 1 January 2002.

Article 5

Decision 94/3/EC and Decision 94/904/EC are repealed with effect from 1 January 2002.

Article 6

This Decision is addressed to the Member States.

▼M1

ANNEX

List of wastes pursuant to Article 1(a) of Directive 75/442/EEC on waste and Article 1(4) of Directive 91/689/EEC on hazardous waste.

Introduction

1. The present list is a harmonised list of wastes. It will be periodically reviewed on the basis of new knowledge and, in particular, of research results, and if necessary revised in accordance with Article 18 of Directive 75/442/EEC. However, the inclusion of a material in the list does not mean that the material is a waste in all circumstances. Materials are considered to be waste only where the definition of waste in Article 1(a) of Directive 75/ 442/EEC is met.

2. Wastes included in the list are subject to the provisions of Directive 75/442/EEC except where Article 2(1)(b) of this Directive applies.

3. The different types of wastes in the list are fully defined by the six-digit code for the waste and the respective two-digit and four-digit chapter headings. This implies that the following steps should be taken to identify a waste in the list.

3.1. Identify the source generating the waste in chapters 01 to 12 or 17 to 20 and identify the appropriate six-digit code of the waste (excluding codes ending with 99 of these chapters). A specific production unit may need to classify its activities in several chapters. For instance, a car manufacturer may find its wastes listed in chapters 12 (wastes from shaping and surface treatment
of metals), 11 (inorganic wastes containing metals from metal treatment and the coating of metals) and 08 (wastes from the use of coatings), depending on the different process steps.

Note: separately collected packaging waste (including mixtures of different packaging materials) shall be classified in 15 01, not in 20 01.

3.2. If no appropriate waste code can be found in chapters 01 to 12 or 17 to 20, the chapters 13, 14 and 15 must be examined to identify the waste.

3.3. If none of these waste codes apply, the waste must be identified according to chapter 16.

3.4. If the waste is not in chapter 16 either, the 99 code (wastes not otherwise specified) must be used in the section of the list corresponding to the activity identified in step one.

4. Any waste marked with an asterisk (*) is considered as a hazardous waste pursuant to Directive 91/689/EEC on hazardous waste, and subject to the provisions of that Directive unless Article 1(5) of that Directive applies.

5. For the purpose of this Decision, ‘dangerous substance’ means any substance that has been or will be classified as dangerous in Directive 67/548/EEC and its subsequent amendments; ‘heavy metal’ means any compound of antimony, arsenic, cadmium, chromium (VI), copper, lead, mercury, nickel, selenium, tellurium, thallium and tin, as well as these materials in metallic form, as far as these are classified as dangerous substances.

6. If a waste is identified as hazardous by a specific or general reference to dangerous substances, the waste is hazardous only if the concentrations of those substances are such (i.e. percentage by weight) that the waste presents one or more of the properties listed in Annex III to Council Directive 91/ 689/EEC. As regards H3 to H8, H10 and H11, Article 2 of this Decision shall apply. For the characteristics H1, H2, H9 and H12 to H14 Article 2 of the present Decision does not provide specifications at present.

7. In line with Directive 1999/45/EC, which states in its preamble that the case of alloys has been considered to need further assessment because the characteristics of alloys are such that it may not be possible accurately to determine their properties using currently available conventional methods, the provisions of Article 2 would not apply to pure metal alloys (not contaminated by dangerous substances). This will be so pending further work that the Commission and Member States have taken the commitment to undertake on the specific approach of the classification of alloys. The waste materials which are specifically enumerated in this list shall remain classified as at present.

8. The following rules for numbering of the items in the list have been used: For those wastes that were not changed, the code numbers from Commission Decision 94/3/EC have been used. The codes for wastes that were changed have been deleted and remain unused in order to avoid confusion after implementation of the new list. Wastes added have been given a code that has not been used in Commission Decision 94/3/EC and Commission Decision 2000/532/EC.

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07 03 07* halogenated still bottoms and reaction residues
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08 03 12* waste ink containing dangerous substances
08 03 13 waste ink other than those mentioned in 08 03 12
08 03 14* ink sludges containing dangerous substances
08 03 15 ink sludges other than those mentioned in 08 03 14
08 03 16* waste etching solutions
08 03 17* waste printing toner containing dangerous substances
08 03 18 waste printing toner other than those mentioned in 08 03 17
08 03 19* disperse oil
08 03 99 wastes not otherwise specified
08 04 wastes from MFSU of adhesives and sealants (including waterproofing products)
08 04 09* waste adhesives and sealants containing organic solvents or other dangerous substances
08 04 10 waste adhesives and sealants other than those mentioned in 08 04 09
08 04 11* adhesive and sealant sludges containing organic solvents or other dangerous substances
08 04 12 adhesive and sealant sludges other than those mentioned in 08 04 11
08 04 13* aqueous sludges containing adhesives or sealants containing organic solvents or other dangerous substances
08 04 14 aqueous sludges containing adhesives or sealants other than those mentioned in 08 04 13
08 04 15* aqueous liquid waste containing adhesives or sealants containing organic solvents or other dangerous substances
08 04 16 aqueous liquid waste containing adhesives or sealants other than those mentioned in 08 04 15
08 04 17* rosin oil
08 04 99 wastes not otherwise specified
08 05 wastes not otherwise specified in 08
08 05 01* waste isocyanates

09 WASTES FROM THE PHOTOGRAPHIC INDUSTRY
09 01 wastes from the photographic industry
09 01 01* water-based developer and activator solutions
09 01 02* water-based offset plate developer solutions
09 01 03* solvent-based developer solutions
09 01 04* fixer solutions
09 01 05* bleach solutions and bleach fixer solutions
09 01 06* wastes containing silver from on-site treatment of photographic wastes
09 01 07 photographic film and paper containing silver or silver compounds
09 01 08 photographic film and paper free of silver or silver compounds
09 01 10 single-use cameras without batteries
09 01 11* single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03
09 01 12 single-use cameras containing batteries other than those mentioned in 09 01 11

09 01 13* aqueous liquid waste from on-site reclamation of silver other than those mentioned in 09 01 06
09 01 99 wastes not otherwise specified

10 WASTES FROM THERMAL PROCESSES
10 01 wastes from power stations and other combustion plants (except 19)
10 01 01 bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)
10 01 02 coal fly ash
10 01 03 fly ash from peat and untreated wood
10 01 04* oil fly ash and boiler dust
10 01 05 calcium-based reaction wastes from flue-gas desulphurisation in solid form
10 01 07 calcium-based reaction wastes from flue-gas desulphurisation in sludge form
10 01 09* sulphuric acid
10 01 13* fly ash from emulsified hydrocarbons used as fuel
10 01 14* bottom ash, slag and boiler dust from co-incineration containing dangerous substances
10 01 15 bottom ash, slag and boiler dust from co-incineration other than those mentioned in 10 01 14
10 01 16* fly ash from co-incineration containing dangerous substances
10 01 17 fly ash from co-incineration other than those mentioned in 10 01 16
10 01 18* wastes from gas cleaning containing dangerous substances
10 01 19 wastes from gas cleaning other than those mentioned in 10 01 05, 10 01 07 and 10 01 18
10 01 20* sludges from on-site effluent treatment containing dangerous substances
10 01 21 sludges from on-site effluent treatment other than those mentioned in 10 01 20
10 01 22* aqueous sludges from boiler cleansing containing dangerous substances
10 01 23 aqueous sludges from boiler cleansing other than those mentioned in 10 01 22
10 01 24 sands from fluidised beds
10 01 25 wastes from fuel storage and preparation of coal-fired power plants
10 01 26 wastes from cooling-water treatment
10 01 99 wastes not otherwise specified
10 02 wastes from the iron and steel industry
10 02 01 wastes from the processing of slag
10 02 02 unprocessed slag
10 02 07* solid wastes from gas treatment containing dangerous substances
10 02 08 solid wastes from gas treatment other than those mentioned in 10 02 07
10 02 10 mill scales
10 02 11* wastes from cooling-water treatment containing oil
10 02 12 wastes from cooling-water treatment other than those mentioned in 10 02 11
10 02 13* sludges and filter cakes from gas treatment containing dangerous substances
10 02 14 sludges and filter cakes from gas treatment other than those mentioned in 10 02 13
10 02 15 other sludges and filter cakes
10 02 99 wastes not otherwise specified
10 03 wastes from aluminium thermal metallurgy
10 03 02 anode scraps
10 03 04* primary production slags
10 03 05 waste alumina
10 03 08* salt slags from secondary production
10 03 09* black drosses from secondary production

10 03 15* skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities
10 03 16 skimmings other than those mentioned in 10 03 15
10 03 17* tar-containing wastes from anode manufacture
10 03 18 carbon-containing wastes from anode manufacture other than those mentioned in 10 03 17
10 03 19* flue-gas dust containing dangerous substances
10 03 20 flue-gas dust other than those mentioned in 10 03 19
10 03 21* other particulates and dust (including ball-mill dust) containing dangerous substances
10 03 22 other particulates and dust (including ball-mill dust) other than those mentioned in 10 03 21
10 03 23* solid wastes from gas treatment containing dangerous substances
10 03 24 solid wastes from gas treatment other than those mentioned in 10 03 23
10 03 25* sludges and filter cakes from gas treatment containing dangerous substances
10 03 26 sludges and filter cakes from gas treatment other than those mentioned in 10 03 25
10 03 27* wastes from cooling-water treatment containing oil
10 03 28 wastes from cooling-water treatment other than those mentioned in 10 03 27
10 03 29* wastes from treatment of salt slags and black drosses containing dangerous substances
10 03 30 wastes from treatment of salt slags and black drosses other than those mentioned in 10 03 29
10 03 99 wastes not otherwise specified

10 04 wastes from lead thermal metallurgy

10 04 01* slags from primary and secondary production
10 04 02* dross and skimmings from primary and secondary production
10 04 03* calcium arsenate
10 04 04* flue-gas dust
10 04 05* other particulates and dust
10 04 06* solid wastes from gas treatment
10 04 07* sludges and filter cakes from gas treatment
10 04 09* wastes from cooling-water treatment containing oil
10 04 10 wastes from cooling-water treatment other than those mentioned in 10 04 09
10 04 99 wastes not otherwise specified

10 05 wastes from zinc thermal metallurgy

10 05 01 slags from primary and secondary production
10 05 03* flue-gas dust
10 05 04 other particulates and dust
10 05 05* solid waste from gas treatment
10 05 06* sludges and filter cakes from gas treatment
10 05 08* wastes from cooling-water treatment containing oil
10 05 09 wastes from cooling-water treatment other than those mentioned in 10 05 08
10 05 10* dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities
10 05 11 dross and skimmings other than those mentioned in 10 05 10
10 05 99 wastes not otherwise specified

10 06 wastes from copper thermal metallurgy

10 06 01 slags from primary and secondary production
10 06 02 dross and skimmings from primary and secondary production
10 06 03* flue-gas dust

10 06 04 other particulates and dust
10 06 06* solid wastes from gas treatment
10 06 07* sludges and filter cakes from gas treatment
10 06 09* wastes from cooling-water treatment containing oil
10 06 10 wastes from cooling-water treatment other than those mentioned in 10 06 09
10 06 99 wastes not otherwise specified
10 07 wastes from silver, gold and platinum thermal metallurgy
10 07 01 slags from primary and secondary production
10 07 02 dross and skimmings from primary and secondary production
10 07 03 solid wastes from gas treatment
10 07 04 other particulates and dust
10 07 05 sludges and filter cakes from gas treatment
10 07 07* wastes from cooling-water treatment containing oil
10 07 08 wastes from cooling-water treatment other than those mentioned in 10 07 07
10 07 99 wastes not otherwise specified
10 08 wastes from other non-ferrous thermal metallurgy
10 08 04 particulates and dust
10 08 08* salt slag from primary and secondary production
10 08 09 other slags
10 08 10* dross and skimmings that are flammable or emit, upon contact with water, flammable gases in dangerous quantities
10 08 11 dross and skimmings other than those mentioned in 10 08 10
10 08 12* tar-containing wastes from anode manufacture
10 08 13 carbon-containing wastes from anode manufacture other than those mentioned in 10 08 12
10 08 14 anode scrap
10 08 15* flue-gas dust containing dangerous substances
10 08 16 flue-gas dust other than those mentioned in 10 08 15
10 08 17* sludges and filter cakes from flue-gas treatment containing dangerous substances
10 08 18 sludges and filter cakes from flue-gas treatment other than those mentioned in 10 08 17
10 08 19* wastes from cooling-water treatment containing oil
10 08 20 wastes from cooling-water treatment other than those mentioned in 10 08 19
10 08 99 wastes not otherwise specified
10 09 wastes from casting of ferrous pieces
10 09 03 furnace slag
10 09 05* casting cores and moulds which have not undergone pouring containing dangerous substances
10 09 06 casting cores and moulds which have not undergone pouring other than those mentioned in 10 09 05
10 09 07* casting cores and moulds which have undergone pouring containing dangerous substances
10 09 08 casting cores and moulds which have undergone pouring other than those mentioned in 10 09 07
10 09 09* flue-gas dust containing dangerous substances
10 09 10 flue-gas dust other than those mentioned in 10 09 09
10 09 11* other particulates containing dangerous substances
10 09 12 other particulates other than those mentioned in 10 09 11
10 09 13* waste binders containing dangerous substances
10 09 14 waste binders other than those mentioned in 10 09 13

10 09 15* waste crack-indicating agent containing dangerous substances
10 09 16 waste crack-indicating agent other than those mentioned in 10 09 15
10 09 99 wastes not otherwise specified

10 10 wastes from casting of non-ferrous pieces

10 10 03 furnace slag
10 10 05* casting cores and moulds which have not undergone pouring, containing dangerous substances
10 10 06 casting cores and moulds which have not undergone pouring, other than those mentioned in 10 10 05
10 10 07* casting cores and moulds which have undergone pouring, containing dangerous substances
10 10 08 casting cores and moulds which have undergone pouring, other than those mentioned in 10 10 07
10 10 09* flue-gas dust containing dangerous substances
10 10 10 flue-gas dust other than those mentioned in 10 10 09
10 10 11* other particulates containing dangerous substances
10 10 12 other particulates other than those mentioned in 10 10 11
10 10 13* waste binders containing dangerous substances
10 10 14 waste binders other than those mentioned in 10 10 13
10 10 15* waste crack-indicating agent containing dangerous substances
10 10 16 waste crack-indicating agent other than those mentioned in 10 10 15
10 10 99 wastes not otherwise specified

10 11 wastes from manufacture of glass and glass products

10 11 03 waste glass-based fibrous materials
10 11 05 particulates and dust
10 11 09* waste preparation mixture before thermal processing, containing dangerous substances
10 11 10 waste preparation mixture before thermal processing, other than those mentioned in 10 11 09
10 11 11* waste glass in small particles and glass powder containing heavy metals (for example from cathode ray tubes)
10 11 12 waste glass other than those mentioned in 10 11 11
10 11 13* glass-polishing and -grinding sludge containing dangerous substances
10 11 14 glass-polishing and -grinding sludge other than those mentioned in 10 11 13
10 11 15* solid wastes from flue-gas treatment containing dangerous substances
10 11 16 solid wastes from flue-gas treatment other than those mentioned in 10 11 15
10 11 17* sludges and filter cakes from flue-gas treatment containing dangerous substances
10 11 18 sludges and filter cakes from flue-gas treatment other than those mentioned in 10 11 17
10 11 19* solid wastes from on-site effluent treatment containing dangerous substances
10 11 20 solid wastes from on-site effluent treatment other than those mentioned in 10 11 19
10 11 99 wastes not otherwise specified

10 12 wastes from manufacture of ceramic goods, bricks, tiles and construction products

10 12 01 waste preparation mixture before thermal processing
10 12 03 particulates and dust
10 12 05 sludges and filter cakes from gas treatment
10 12 06 discarded moulds
10 12 08 waste ceramics, bricks, tiles and construction products (after thermal processing)
10 12 09* solid wastes from gas treatment containing dangerous substances

10 12 10 solid wastes from gas treatment other than those mentioned in 10 12 09
10 12 11* wastes from glazing containing heavy metals
10 12 12 wastes from glazing other than those mentioned in 10 12 11
10 12 13 sludge from on-site effluent treatment
10 12 99 wastes not otherwise specified

10 13 wastes from manufacture of cement, lime and plaster and articles and products made from them

10 13 01 waste preparation mixture before thermal processing
10 13 04 wastes from calcinations and hydration of lime
10 13 06 particulates and dust (except 10 13 12 and 10 13 13)
10 13 07 sludges and filter cakes from gas treatment
10 13 09* wastes from asbestos-cement manufacture containing asbestos
10 13 10 wastes from asbestos-cement manufacture other than those mentioned in 10 13 09
10 13 11 wastes from cement-based composite materials other than those mentioned in 10 13 09 and 10 13 10
10 13 12* solid wastes from gas treatment containing dangerous substances
10 13 13 solid wastes from gas treatment other than those mentioned in 10 13 12
10 13 14 waste concrete and concrete sludge
10 13 99 wastes not otherwise specified

10 14 waste from crematoria

10 14 01* waste from gas cleaning containing mercury

11 WASTES FROM CHEMICAL SURFACE TREATMENT AND COATING OF METALS AND OTHER MATERIALS; NON-FERROUS HYDROMETALLURGY

11 01 wastes from chemical surface treatment and coating of metals and other materials (for example galvanic processes, zinc coating processes, pickling processes, etching, phosphating, alkaline degreasing, anodising)

11 01 05* pickling acids
11 01 06* acids not otherwise specified
11 01 07* pickling bases
11 01 08* phosphatising sludges
11 01 09* sludges and filter cakes containing dangerous substances
11 01 10 sludges and filter cakes other than those mentioned in 11 01 09
11 01 11* aqueous rinsing liquids containing dangerous substances
11 01 12 aqueous rinsing liquids other than those mentioned in 11 01 11
11 01 13* degreasing wastes containing dangerous substances
11 01 14 degreasing wastes other than those mentioned in 11 01 13
11 01 15* eluate and sludges from membrane systems or ion exchange systems containing dangerous substances
11 01 16* saturated or spent ion exchange resins
11 01 98* other wastes containing dangerous substances
11 01 99 wastes not otherwise specified

11 02 wastes from non-ferrous hydrometallurgical processes

11 02 02* sludges from zinc hydrometallurgy (including jarosite, goethite)
11 02 03 wastes from the production of anodes for aqueous electrolytical processes
11 02 05* wastes from copper hydrometallurgical processes containing dangerous substances
11 02 06 wastes from copper hydrometallurgical processes other than those mentioned in 11 02 05
11 02 07* other wastes containing dangerous substances

11 02 99 wastes not otherwise specified
11 03 sludges and solids from tempering processes
11 03 01* wastes containing cyanide
11 03 02* other wastes
11 05 wastes from hot galvanising processes
11 05 01 hard zinc
11 05 02 zinc ash
11 05 03* solid wastes from gas treatment
11 05 04* spent flux
11 05 99 wastes not otherwise specified

12 WASTES FROM SHAPING AND PHYSICAL AND MECHANICAL SURFACE TREATMENT OF METALS AND PLASTICS
12 01 wastes from shaping and physical and mechanical surface treatment of metals and plastics
12 01 01 ferrous metal filings and turnings
12 01 02 ferrous metal dust and particles
12 01 03 non-ferrous metal filings and turnings
12 01 04 non-ferrous metal dust and particles
12 01 05 plastics shavings and turnings
12 01 06* mineral-based machining oils containing halogens (except emulsions and solutions)
12 01 07* mineral-based machining oils free of halogens (except emulsions and solutions)
12 01 08* machining emulsions and solutions containing halogens
12 01 09* machining emulsions and solutions free of halogens
12 01 10* synthetic machining oils
12 01 12* spent waxes and fats
12 01 13 welding wastes
12 01 14* machining sludges containing dangerous substances
12 01 15 machining sludges other than those mentioned in 12 01 14
12 01 16* waste blasting material containing dangerous substances
12 01 17 waste blasting material other than those mentioned in 12 01 16
12 01 18* metal sludge (grinding, honing and lapping sludge) containing oil
12 01 19* readily biodegradable machining oil
12 01 20* spent grinding bodies and grinding materials containing dangerous substances
12 01 21 spent grinding bodies and grinding materials other than those mentioned in 12 01 20
12 01 99 wastes not otherwise specified
12 03 wastes from water and steam degreasing processes (except 11)
12 03 01* aqueous washing liquids
12 03 02* steam degreasing wastes

13 OIL WASTES AND WASTES OF LIQUID FUELS (except edible oils, and those in chapters 05, 12 and 19)
13 01 waste hydraulic oils
13 01 01* hydraulic oils, containing PCBs (1)
13 01 04* chlorinated emulsions
13 01 05* non-chlorinated emulsions
13 01 09* mineral-based chlorinated hydraulic oils
13 01 10* mineral based non-chlorinated hydraulic oils
13 01 11* synthetic hydraulic oils
13 01 12* readily biodegradable hydraulic oils

13 01 13* other hydraulic oils
13 02 waste engine, gear and lubricating oils
13 02 04* mineral-based chlorinated engine, gear and lubricating oils
13 02 05* mineral-based non-chlorinated engine, gear and lubricating oils
13 02 06* synthetic engine, gear and lubricating oils
13 02 07* readily biodegradable engine, gear and lubricating oils
13 02 08* other engine, gear and lubricating oils
13 03 waste insulating and heat transmission oils
13 03 01* insulating or heat transmission oils containing PCBs
13 03 06* mineral-based chlorinated insulating and heat transmission oils other than those mentioned in 13 03 01
13 03 07* mineral-based non-chlorinated insulating and heat transmission oils
13 03 08* synthetic insulating and heat transmission oils
13 03 09* readily biodegradable insulating and heat transmission oils
13 03 10* other insulating and heat transmission oils
13 04 bilge oils
13 04 01* bilge oils from inland navigation
13 04 02* bilge oils from jetty sewers
13 04 03* bilge oils from other navigation
13 05 oil/water separator contents
13 05 01* solids from grit chambers and oil/water separators
13 05 02* sludges from oil/water separators
13 05 03* interceptor sludges
13 05 06* oil from oil/water separators
13 05 07* oily water from oil/water separators
13 05 08* mixtures of wastes from grit chambers and oil/water separators
13 07 wastes of liquid fuels
13 07 01* fuel oil and diesel
13 07 02* petrol
13 07 03* other fuels (including mixtures)
13 08 oil wastes not otherwise specified
13 08 01* desalter sludges or emulsions
13 08 02* other emulsions
13 08 99* wastes not otherwise specified

14 WASTE ORGANIC SOLVENTS, REFRIGERANTS AND PROPELLANTS (except 07 and 08)
14 06 waste organic solvents, refrigerants and foam/aerosol propellants
14 06 01* chlorofluorocarbons, HCFC, HFC
14 06 02* other halogenated solvents and solvent mixtures
14 06 03* other solvents and solvent mixtures
14 06 04* sludges or solid wastes containing halogenated solvents
14 06 05* sludges or solid wastes containing other solvents

15 WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED
15 01 packaging (including separately collected municipal packaging waste)
15 01 01 paper and cardboard packaging
15 01 02 plastic packaging
15 01 03 wooden packaging

15 01 04 metallic packaging
15 01 05 composite packaging
15 01 06 mixed packaging
15 01 07 glass packaging
15 01 09 textile packaging
15 01 10* packaging containing residues of or contaminated by dangerous substances
15 01 11* metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers

15 02 absorbents, filter materials, wiping cloths and protective clothing

15 02 02* absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances
15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02

16 WASTES NOT OTHERWISE SPECIFIED IN THE LIST

16 01 end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)

16 01 03 end-of-life tyres 16 01 04* end-of-life vehicles ◄; NB: This entry is not part of the proposal submitted for opinion to the Committee. The necessary changes to this entry will be made on the basis of the outcome of the procedure in Council on the proposal included in document COM(2000) 546
16 01 06 end-of-life vehicles, containing neither liquids nor other hazardous components
16 01 07* oil filters
16 01 08* components containing mercury
16 01 09* components containing PCBs
16 01 10* explosive components (for example air bags)
16 01 11* brake pads containing asbestos
16 01 12 brake pads other than those mentioned in 16 01 11
16 01 13* brake fluids
16 01 14* antifreeze fluids containing dangerous substances
16 01 15 antifreeze fluids other than those mentioned in 16 01 14
16 01 16 tanks for liquefied gas
16 01 17 ferrous metal
16 01 18 non-ferrous metal
16 01 19 plastic
16 01 20 glass
16 01 21* hazardous components other than those mentioned in 16 01 07 to 16 01 11 and 16 01 13 and 16 01 14
16 01 22 components not otherwise specified
16 01 99 wastes not otherwise specified

16 02 wastes from electrical and electronic equipment

16 02 09* transformers and capacitors containing PCBs
16 02 10* discarded equipment containing or contaminated by PCBs other than those mentioned in 16 02 09
16 02 11* discarded equipment containing chlorofluorocarbons, HCFC, HFC
16 02 12* discarded equipment containing free asbestos
16 02 13* discarded equipment containing hazardous components (2) other than those mentioned in 16 02 09 to 16 02 12
16 02 14 discarded equipment other than those mentioned in 16 02 09 to 16 02 13

16 02 15* hazardous components removed from discarded equipment
16 02 16 components removed from discarded equipment other than those mentioned in 16 02 15
16 03 off-specification batches and unused products
16 03 03* inorganic wastes containing dangerous substances
16 03 04 inorganic wastes other than those mentioned in 16 03 03
16 03 05* organic wastes containing dangerous substances
16 03 06 organic wastes other than those mentioned in 16 03 05
16 04 waste explosives
16 04 01* waste ammunition
16 04 02* fireworks wastes
16 04 03* other waste explosives
16 05 gases in pressure containers and discarded chemicals
16 05 04* gases in pressure containers (including halons) containing dangerous substances
16 05 05 gases in pressure containers other than those mentioned in 16 05 04
16 05 06* laboratory chemicals, consisting of or containing dangerous substances, including mixtures of laboratory chemicals
16 05 07* discarded inorganic chemicals consisting of or containing dangerous substances
16 05 08* discarded organic chemicals consisting of or containing dangerous substances
16 05 09 discarded chemicals other than those mentioned in 16 05 06, 16 05 07 or 16 05 08
16 06 batteries and accumulators
16 06 01* lead batteries
16 06 02* Ni-Cd batteries
16 06 03* mercury-containing batteries
16 06 04 alkaline batteries (except 16 06 03)
16 06 05 other batteries and accumulators
16 06 06* separately collected electrolyte from batteries and accumulators
16 07 wastes from transport tank, storage tank and barrel cleaning (except 05 and 13)
16 07 08* wastes containing oil
16 07 09* wastes containing other dangerous substances
16 07 99 wastes not otherwise specified
16 08 spent catalysts
16 08 01 spent catalysts containing gold, silver, rhenium, rhodium, palladium, iridium or platinum (except 16 08 07)
16 08 02* spent catalysts containing dangerous transition metals ($_3$) or dangerous transition metal compounds
16 08 03 spent catalysts containing transition metals or transition metal compounds not otherwise specified
16 08 04 spent fluid catalytic cracking catalysts (except 16 08 07)
16 08 05* spent catalysts containing phosphoric acid
16 08 06* spent liquids used as catalysts
16 08 07* spent catalysts contaminated with dangerous substances
16 09 oxidising substances
16 09 01* permanganates, for example potassium permanganate
16 09 02* chromates, for example potassium chromate, potassium or sodium dichromate
16 09 03* peroxides, for example hydrogen peroxide
16 09 04* oxidising substances, not otherwise specified
16 10 aqueous liquid wastes destined for off-site treatment
16 10 01* aqueous liquid wastes containing dangerous substances
16 10 02 aqueous liquid wastes other than those mentioned in 16 10 01

16 10 03* aqueous concentrates containing dangerous substances
16 10 04 aqueous concentrates other than those mentioned in 16 10 03
16 11 waste linings and refractories
16 11 01* carbon-based linings and refractories from metallurgical processes containing dangerous substances
16 11 02 carbon-based linings and refractories from metallurgical processes others than those mentioned in 16 11 01
16 11 03* other linings and refractories from metallurgical processes containing dangerous substances
16 11 04 other linings and refractories from metallurgical processes other than those mentioned in 16 11 03
16 11 05* linings and refractories from non-metallurgical processes containing dangerous substances
16 11 06 linings and refractories from non-metallurgical processes others than those mentioned in 16 11 05

17 CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)
17 01 concrete, bricks, tiles and ceramics
17 01 01 concrete
17 01 02 bricks
17 01 03 tiles and ceramics
17 01 06* mixtures of, or separate fractions of concrete, bricks, tiles and ceramics containing dangerous substances
17 01 07 mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06
17 02 wood, glass and plastic
17 02 01 wood
17 02 02 glass
17 02 03 plastic
17 02 04* glass, plastic and wood containing or contaminated with dangerous substances
17 03 bituminous mixtures, coal tar and tarred products
17 03 01* bituminous mixtures containing coal tar
17 03 02 bituminous mixtures other than those mentioned in 17 03 01
17 03 03* coal tar and tarred products
17 04 metals (including their alloys)
17 04 01 copper, bronze, brass
17 04 02 aluminium
17 04 03 lead
17 04 04 zinc
17 04 05 iron and steel
17 04 06 tin
17 04 07 mixed metals
17 04 09* metal waste contaminated with dangerous substances
17 04 10* cables containing oil, coal tar and other dangerous substances
17 04 11 cables other than those mentioned in 17 04 10
17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil
17 05 03* soil and stones containing dangerous substances
17 05 04 soil and stones other than those mentioned in 17 05 03

17 05 05* dredging spoil containing dangerous substances
17 05 06 dredging spoil other than those mentioned in 17 05 05
17 05 07* track ballast containing dangerous substances
17 05 08 track ballast other than those mentioned in 17 05 07
17 06 insulation materials and asbestos-containing construction materials
17 06 01* insulation materials containing asbestos
17 06 03* other insulation materials consisting of or containing dangerous substances
17 06 04 insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 06 05* construction materials containing asbestos (7)
17 08 gypsum-based construction material
17 08 01* gypsum-based construction materials contaminated with dangerous substances
17 08 02 gypsum-based construction materials other than those mentioned in 17 08 01
17 09 other construction and demolition wastes
17 09 01* construction and demolition wastes containing mercury
17 09 02* construction and demolition wastes containing PCB (for example PCB containing sealants, PCB-containing resin-based floorings, PCB-containing sealed glazing units, PCB-containing capacitors)
17 09 03* other construction and demolition wastes (including mixed wastes) containing dangerous substances
17 09 04 mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03

18 WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (except kitchen and restaurant wastes not arising from immediate health care)
18 01 wastes from natal care, diagnosis, treatment or prevention of disease in humans
18 01 01 sharps (except 18 01 03)
18 01 02 body parts and organs including blood bags and blood preserves (except 18 0103)
18 01 03* wastes whose collection and disposal is subject to special requirements in order to prevent infection
18 01 04 wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
18 01 06* chemicals consisting of or containing dangerous substances
18 01 07 chemicals other than those mentioned in 18 01 06
18 01 08* cytotoxic and cytostatic medicines
18 01 09 medicines other than those mentioned in 18 01 08
18 01 10* amalgam waste from dental care
18 02 wastes from research, diagnosis, treatment or prevention of disease involvinganimals
18 02 01 sharps (except 18 02 02)
18 02 02* wastes whose collection and disposal is subject to special requirements in order to prevent infection
18 02 03 wastes whose collection and disposal is not subject to special requirements in order to prevent infection
18 02 05* chemicals consisting of or containing dangerous substances
18 02 06 chemicals other than those mentioned in 18 02 05
18 02 07* cytotoxic and cytostatic medicines
18 02 08 medicines other than those mentioned in 18 02 07

19 WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTEWATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE

19 01 wastes from incineration or pyrolysis of waste

19 01 02 ferrous materials removed from bottom ash
19 01 05* filter cake from gas treatment
19 01 06* aqueous liquid wastes from gas treatment and other aqueous liquid wastes
19 01 07* solid wastes from gas treatment
19 01 10* spent activated carbon from flue-gas treatment
19 01 11* bottom ash and slag containing dangerous substances
19 01 12 bottom ash and slag other than those mentioned in 19 01 11
19 01 13* fly ash containing dangerous substances
19 01 14 fly ash other than those mentioned in 19 01 13
19 01 15* boiler dust containing dangerous substances
19 01 16 boiler dust other than those mentioned in 19 01 15
19 01 17* pyrolysis wastes containing dangerous substances
19 01 18 pyrolysis wastes other than those mentioned in 19 01 17
19 01 19 sands from fluidised beds
19 01 99 wastes not otherwise specified

19 02 wastes from physico/chemical treatments of waste (includingdechromatation, decyanidation, neutralisation)

19 02 03 premixed wastes composed only of non-hazardous wastes
19 02 04* premixed wastes composed of at least one hazardous waste
19 02 05* sludges from physico/chemical treatment containing dangerous substances
19 02 06 sludges from physico/chemical treatment other than those mentioned in 19 02 05
19 02 07* oil and concentrates from separation
19 02 08* liquid combustible wastes containing dangerous substances
19 02 09* solid combustible wastes containing dangerous substances
19 02 10 combustible wastes other than those mentioned in 19 02 08 and 19 02 09
19 02 11* other wastes containing dangerous substances
19 02 99 wastes not otherwise specified

19 03 stabilised/solidified wastes (4)

19 03 04* wastes marked as hazardous, partly (5) stabilised
19 03 05 stabilised wastes other than those mentioned in 19 03 04
19 03 06* wastes marked as hazardous, solidified
19 03 07 solidified wastes other than those mentioned in 19 03 06

19 04 vitrified waste and wastes from vitrification

19 04 01 vitrified waste
19 04 02* fly ash and other flue-gas treatment wastes
19 04 03* non-vitrified solid phase
19 04 04 aqueous liquid wastes from vitrified waste tempering

19 05 wastes from aerobic treatment of solid wastes

19 05 01 non-composted fraction of municipal and similar wastes
19 05 02 non-composted fraction of animal and vegetable waste
19 05 03 off-specification compost
19 05 99 wastes not otherwise specified

19 06 wastes from anaerobic treatment of waste

19 06 03 liquor from anaerobic treatment of municipal waste
19 06 04 digestate from anaerobic treatment of municipal waste
19 06 05 liquor from anaerobic treatment of animal and vegetable waste

19 06 06 digestate from anaerobic treatment of animal and vegetable waste
19 06 99 wastes not otherwise specified
19 07 landfill leachate
19 07 02* landfill leachate containing dangerous substances
19 07 03 landfill leachate other than those mentioned in 19 07 02
19 08 wastes from wastewater treatment plants not otherwise specified
19 08 01 screenings
19 08 02 waste from desanding
19 08 05 sludges from treatment of urban wastewater
19 08 06* saturated or spent ion exchange resins
19 08 07* solutions and sludges from regeneration of ion exchangers
19 08 08* membrane system waste containing heavy metals
19 08 09 grease and oil mixture from oil/water separation containing only edible oil and fats
19 08 10* grease and oil mixture from oil/water separation other than those mentioned in 19 08 09
19 08 11* sludges containing dangerous substances from biological treatment of industrial wastewater
19 08 12 sludges from biological treatment of industrial wastewater other than those mentioned in 19 08 11
19 08 13* sludges containing dangerous substances from other treatment of industrial wastewater
19 08 14 sludges from other treatment of industrial wastewater other than those mentioned in 19 08 13
19 08 99 wastes not otherwise specified
19 09 wastes from the preparation of water intended for human consumption or water for industrial use
19 09 01 solid waste from primary filtration and screenings
19 09 02 sludges from water clarification
19 09 03 sludges from decarbonation
19 09 04 spent activated carbon
19 09 05 saturated or spent ion exchange resins
19 09 06 solutions and sludges from regeneration of ion exchangers
19 09 99 wastes not otherwise specified
19 10 wastes from shredding of metal-containing wastes
19 10 01 iron and steel waste
19 10 02 non-ferrous waste
19 10 03* fluff-light fraction and dust containing dangerous substances
19 10 04 fluff-light fraction and dust other than those mentioned in 19 10 03
19 10 05* other fractions containing dangerous substances
19 10 06 other fractions other than those mentioned in 19 10 05
19 11 wastes from oil regeneration
19 11 01* spent filter clays
19 11 02* acid tars
19 11 03* aqueous liquid wastes
19 11 04* wastes from cleaning of fuel with bases
19 11 05* sludges from on-site effluent treatment containing dangerous substances
19 11 06 sludges from on-site effluent treatment other than those mentioned in 19 11 05
19 11 07* wastes from flue-gas cleaning
19 11 99 wastes not otherwise specified

19 12 wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified

19 12 01 paper and cardboard
19 12 02 ferrous metal
19 12 03 non-ferrous metal
19 12 04 plastic and rubber
19 12 05 glass
19 12 06* wood containing dangerous substances
19 12 07 wood other than that mentioned in 19 12 06
19 12 08 textiles
19 12 09 minerals (for example sand, stones)
19 12 10 combustible waste (refuse derived fuel)
19 12 11* other wastes (including mixtures of materials) from mechanical treatment of waste containing dangerous substances
19 12 12 other wastes (including mixtures of materials) from mechanical treatment of wastes other than mentioned in 19 12 11

19 13 wastes from soil and groundwater remediation

19 13 01* solid wastes from soil remediation containing dangerous substances
19 13 02 solid wastes from soil remediation other than those mentioned in 19 13 01
19 13 03* sludges from soil remediation containing dangerous substances
19 13 04 sludges from soil remediation other than those mentioned in 19 13 03
19 13 05* sludges from groundwater remediation containing dangerous substances
19 13 06 sludges from groundwater remediation other than those mentioned in 19 13 05
19 13 07* aqueous liquid wastes and aqueous concentrates from groundwater remediation containing dangerous substances
19 13 08 aqueous liquid wastes and aqueous concentrates from groundwater remediation other than mentioned in 19 13 07

20 MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS

20 01 separately collected fractions (except 15 01)

20 01 01 paper and cardboard
20 01 02 glass
20 01 08 biodegradable kitchen and canteen waste
20 01 10 clothes
20 01 11 textiles
20 01 13* solvents
20 01 14* acids
20 01 15* alkalines
20 01 17* photochemicals
20 01 19* pesticides
20 01 21* fluorescent tubes and other mercury-containing waste
20 01 23* discarded equipment containing chlorofluorocarbons
20 01 25 edible oil and fat
20 01 26* oil and fat other than those mentioned in 20 01 25
20 01 27* paint, inks, adhesives and resins containing dangerous substances
20 01 28 paint, inks, adhesives and resins other than those mentioned in 20 01 27
20 01 29* detergents containing dangerous substances
20 01 30 detergents other than those mentioned in 20 01 29

20 01 31* cytotoxic and cytostatic medicines
20 01 32 medicines other than those mentioned in 20 01 31
20 01 33* batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries
20 01 34 batteries and accumulators other than those mentioned in 20 01 33
20 01 35* discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components (6)
20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35
20 01 37* wood containing dangerous substances
20 01 38 wood other than that mentioned in 20 01 37
20 01 39 plastics
20 01 40 metals
20 01 41 wastes from chimney sweeping
20 01 99 other fractions not otherwise specified
20 02 garden and park wastes (including cemetery waste)
20 02 01 biodegradable waste
20 02 02 soil and stones
20 02 03 other non-biodegradable wastes
20 03 other municipal wastes
20 03 01 mixed municipal waste
20 03 02 waste from markets
20 03 03 street-cleaning residues
20 03 04 septic tank sludge
20 03 06 waste from sewage cleaning
20 03 07 bulky waste
20 03 99 municipal wastes not otherwise specified

(1) For the purpose of this list of wastes, PCBs will be defined as in Directive 96/59/EC.
(2) Hazardous components from electrical and electronic equipment may include accumulators and batteries mentioned in 16 06 and marked as hazardous; mercury switches, glass from cathode ray tubes and other activated glass, etc.
(3) For the purpose of this entry, transition metals are: scandium, vanadium, manganese, cobalt, copper, yttrium, niobium, hafnium, tungsten, titanium, chromium, iron, nickel, zinc, zirconium, molybdenum and tantalum. These metals or their compounds are dangerous if they are classified as dangerous substances. The classification of dangerous substances shall determine which among those transition metals and which transition metal compounds are hazardous.
(4) Stabilisation processes change the dangerousness of the constituents in the waste and thus transform hazardous waste into non-hazardous waste. Solidification processes only change the physical state of the waste (e.g. liquid into solid) by using additives without changing the chemical properties of the waste. (5) A waste is considered as partly stabilised if, after the stabilisation process, dangerous constituents which have not been changed completely into non-dangerous constituents could be released into the environment in the short, middle or long term.
(6) Hazardous components from electrical and electronic equipment may include accumulators and batteries mentioned in 16 06 and marked as hazardous; mercury switches, glass from cathode ray tubes and other activated glass etc.
►**M3** (7) As far as the landfilling of waste is concerned, Member States may decide to postpone the entry into force of this entry until the establishment of appropriate measures for the treatment and disposal of waste from construction material containing asbestos. These measures are to be established according to

the procedure referred to in Article 17 of Council Directive 1999/31/EC on the landfill of waste (OJ L 182, 16.7.1999, p. 1) and shall be adopted by 16 July 2002 at the latest. ◄

Appendix 2: Type of industries in South Africa

One of the questions in the objectives of this report has been: "Is the industry in South Africa much different from the industry in the rest of the world e.g. Europe?"

In order partly to answer this question types of industries in SA are here compared with the types of industries found in Europe. In this table the left column corresponds to the list of industries found in the European Waste Catalogue. In the right column is then mentioned industries in SA that matches the European industries. In this table neither the amounts nor the type of wastes produced by the industries have been considered. The table just shows that comparable industries exist in EU and South Africa.

Table 33: Comparison of waste producing trade industries in Europe and SA

European Waste Producers	South African Trade industries
01 Wastes resulting from exploration, mining, quarrying, physical and chemical treatment of minerals	Anglo American plc Anglo Platinum De Beers Goldfields Harmony Gold Kumba Resources
02 Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food reparation and processing	Agricultural activities range from intensive crop production and mixed farming in winter rainfall and high summer rainfall areas to cattle ranching in the bushveld and sheep farming in the arid regions. Maize is most widely grown, followed by wheat, oats, sugar cane and sunflowers. Almost 50% of South Africa's water is used for agriculture, with about 1.3-million hectares under irrigation. Ag-Chem Africa (Pty) Ltd. - Ag-Chem Africa (Pty) Ltd. is a South African based company specialising in liquid fertilizers, adjuvant and pesticides. Various suspension concentrate fertilizer and copper fungicide formulations are produced at our warehouse in Pretoria. A range of amino acid chelated products in a liquid formula.
03 Wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard	Sonae is the largest producer of wood based panel products in the world. Sonae Novobord is the leading manufacturer of particleboard and medium density fibreboard (mdf) products in South Africa. http://www.kellysearch.com/za-product-608.html
04 Wastes from the leather, fur and textile industries	Leather making is a source of significant income in most African countries. It is also, both in Africa and elsewhere, a major cause of industrial pollution and has been a prime target of public scrutiny and government regulation. In Eastern and Southern Africa, where the leather sector is a key area of industrial development, most tanneries have effluent treatment plants and some are experimenting with various means of reducing the volume of solid waste. The leading leather manufacturers have come to realize that fighting pollution at the source, at all stages of production can yield substantial benefits in addition to considerable reduction in effluent and solid waste volume. http://www.unido.org/doc/4580 Witon Chemicals Pty., Ltd - South Africa. Custom formulating of water based polymer composites, resins, compounds and binders for the textile,

European Waste Producers	South African Trade industries
	non-wovens, adhesives, waterproofing, laminating and coatings industries. Part of the Industrial Latex Compounds Group.
05 Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal	South Africa is ranked among the top 25 chemical producing countries in the world, and is a world leader in coal-based synthesis and gas-to-liquids technologies. South Africa's chemicals exports have been growing at an annual average rate of around 19% since 1999, on the back of new trade agreements and heightened competitiveness as a result of low manufacturing costs and plentiful mineral and organic supplies for manufacturing. In addition to low energy costs, the sector benefits from efficient, cost-effective access to water and steam. SA's chemicals industry is dominated by the basic chemicals sector, with major production of liquid fuels, olefins, organic solvents and industrial mineral derivatives. Primary, secondary and tertiary products are divided into: petroleum refineries and products (44%); basic chemicals (16%); fertilizers and pesticides (7%); synthetic resins and plastic materials (8%); paints, varnishes and lacquers (4%); medicinal and pharmaceutical preparations (6%); and cleaning, toilet preparations and cosmetics (7%). The Chemical and Allied Industries' Association (CAIA) was established in 1993, though its origins can be traced back to the Transvaal Chemical Manufacturers' Association (TCMA), which was formed over 50 years ago. CAIA has 182 company members composed of manufacturers, distributors, warehousing, hauliers, spill response companies and consultants. Of these 131 are signatories to Responsible Care. http://www.southafrica.info/doing_business/economy/key_sectors/chemical-sector.htm
06 Wastes from inorganic chemical processes	**Feedstock - inorganic** South Africa has abundant mineral feedstock for chemical manufacturing. The country is ranked internationally among the top five producers of several major industrial chemicals. Phosphate rock is benchmarked as the highest quality available for processing. http://www.southafrica.info/doing_business/economy/key_sectors/chemical-sector.htm
07 Wastes from organic chemical processes	South Africa's chemical industry is of substantial economic significance to the country, contributing around 5% to GDP and approximately 25% of its manufacturing sales. The industry is the largest of its kind in Africa. It is highly complex and widely diversified, with end products often being composed of a number of chemicals which have been combined in some way to provide the required properties and characteristics. It can be divided into four broad categories: Base chemicals Intermediate chemicals Chemical end-products Speciality end-products **Base chemicals** including the petrochemical building blocks, ethylene, propylene, butadiene, benzene, toluene, xylenes, and methanol, which are all important chemical building blocks sourced from the petrochemical industry. Inorganic chemicals such as ammonia, caustic soda, sulphuric acid,

European Waste Producers	South African Trade industries
	chlorine, sulphur, soda ash, bromine, fluorine and phosphorus, to name but a few, are also base chemicals. Petrochemicals production in South Africa is largely centred around the Sasol II and Sasol III plants at Secunda and the Natref refinery at Sasolburg where Sasol generates various feedstocks and olefins which facilitate the downstream manufacture of polymers and other products. Using the Fischer Tropsch process, Sasol produces about two million tonnes per annum of a range of various olefins for the petrochemical industry. About 0.6 million tonnes of olefins are used by the chemical industry and the remaining 1.4 million tonnes is used in fuels. A small proportion (about 25,000 tons) is recovered from crude oil refineries. When compared with international petrochemicals plants based on natural gas or ethane, the local synfuels plants tend to be less competitive and reinvestment in the synthetic coal- based technologies would currently be difficult to justify. As a result Sasol has looked to Mozambique and its gas fields for readily available feed-stock. In consequence a gas pipe-line has just been completed and natural gas is now piped through to the Secunda site. Some benzene and other aromatics are produced by the Engen refinery in Durban. A modest amount of propylene is produced at the Sapref refinery in Durban where a splitter owned by Safripol is in operation. The Mosref plant generates mixed alcohol and ketone streams which are currently exported. Phosphoric acid is sourced from phosphate rock mined at Phalaborwa by Foskor. **Intermediate chemicals** is a term which can be used to describe a plethora of products such as ammonia, waxes, solvents, phenols, tars, plastics, and rubbers. **Chemical end-products** include processible plastics, paints, explosives, and fertilisers. **Speciality chemical end-products** tend to be lower volume, higher added-value chemical products. Many pharmaceuticals, agro-chemicals, bio-chemicals, food-, fuel- and plastics - additives fall into this category. The base, intermediate chemicals and chemical end products are produced by the larger companies such as Sasol, Omnia, African Explosives Ltd., Chemical Services, NCP Chlorchem, Dow Agrosciences and Dow Polymers. Other players which are active in these categories include Hoechst SA, Afrox, Bayer, Shell Chemicals, BASF, African Products, Engen Petroleum, Ineos Silicas SA (Pty) Ltd, ICI, Rohm and Haas, Air Products and Lanxess. Traders and agents are also active in this market. There are a number of companies involved in local production or import of speciality and performance chemicals. Included are Chemserve, Fine Chemicals Corp (S.A. Druggists), Noriscel, Henkel, Revertex, CH Chemicals and various companies in Protea Chemicals which is now part of the Omnia Group. There is an active trading sector comprising traders and agents who handle the import and marketing of speciality and fine chemicals. Included are Saarchem, Protea Chemicals, Crest Chemicals, Carst & Walker, Lewis & Everitt and T&C Chemicals. **Organisations (650)** Added Value Engineering Consultants (Pty) Limited, Chemical and Allied Industries' Association, MBT South Africa (Pty) Limited, Protea Speciality Chemicals, Chemimpo South Africa (Pty) Ltd, Safripol (Pty) Ltd, Samchem Drilling Fluids & Chemicals, South African Chemical Technology Incubator, 24-Hour Spill Response, 3M Occupational Health & Environment Safety Division, 3M South Africa (Pty) Ltd, Active Chemicals (Pty) Ltd, AECI Coatings, AECI Ltd, African Explosives Limited, Air Products SA (Pty) Ltd, Akulu

European Waste Producers	South African Trade industries
	Marchon (Pty) Ltd, Alpine Injection Moulding, Always 4 Africa, Anchor Glass **Facilities (8)** Calref, Caltex Refinery, Engen Refinery, Natref, Sapref, Sasol I, Sasol II, Sasol III. http://www.mbendi.co.za/indy/chem/af/sa/p0005.htm
08 Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks	Dekro Paints in South Africa is a leading producer and distributor of paint, coatings and resins for any circumstance - decorative, industrial or marine http://www.kellysearch.com/za-product-608.html
09 Wastes from the photographic industry	-
10 Wastes from thermal processes	-
11 Wastes from Chemical surface treatment and coating of metals and other materials; non-ferrous hydro-metallurgy	**Metalquip** is a supplier to the plating and metal finishing industries in the Western Cape, South Africa. The company supplies chemicals and finishing materials and is a reliable source of quality products. **Phoenix Galvanizing** is a hot dip galvanizing company that has been operational since September 1996. Hot Dip Galvanizing is one of the most widely used methods of protecting steel from corrosion. Although Isinyithi is a new company, its principals have been active in the South African and International Corrosion industry for many years and represent some of the most experienced corrosion practitioners in South Africa in private industry. **Electroplating** South Africa Rack and barrel plating on steel, brass, zinc diecast. http://www.kellysearch.com/za-product-608.html.
12 Wastes from shaping and physical and mechanical surface treatment of metals and plastics	FELPRO TRADING CC - an importer of plastic raw materials and chemicals and purchase FCL lots of polystyrene, ABS, Nylons, chemicals etc. and sell to customers in RSA and other African countries Chemplast - The best Plastics in Africa. The leading PTFE site. Terbo Plastics - South African company manufacturing various types of plastic media for packaging and wastewater applications. http://dir.chemnet.com/Regional/South_Africa/
13 Oil wastes and wastes of liquid fuels (except edible oils, and those in chapters 05, 12 and 19)	
14 Waste organic solvents, refrigerants and propellants (except 07 and 08)	Afrox - African Oxygen Limited (Afrox) is in the business of gases, welding products and healthcare. Afrox is the largest producer of gases in sub-Saharan Africa.
15 Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not other wise specified	

European Waste Producers	South African Trade industries
16 Wastes not otherwise specified on the list	Bromine Africa - Importers of bromine-based compounds and solvents to the South African market.
17 Construction and demolition wastes (including excavated soil from contaminated sites)	
18 Wastes from human or animal health care and/or related research (except kitchen and restaurant wastes not arising from immediate health care)	Dynachem - Specialty manufacturer of detergent, construction chemicals, marine chemicals, Sanitisers, dairy cleaners, laundry detergents, floor care chemicals, marble polishes, automotive chemicals, oil spill absorbants, etc.
19 Wastes from waste management facilities, off-site wastewater treatment plants and the preparation of water intended for human consumption and water for industrial use	True Water Solutions - True Water Solutions supplies the world' s most modern water treatment equipment - Reverse Osmosis Water Purification System - for industrial use. Bio-Systems SA - South Africa. Scientific services and products for the biological treatment and bio-augmentation of liquid effluents, technology for the re-use of wastewater and absorbents, and bio-remediation of oil contaminated soils.
20 Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions.	

As it can be seen, South Africa matches most of the European industry.

Nearly all groups in the European Waste Catalogue may be matched with several comparable South African industries so there is no doubt that South Africa has the same polluting industries as in Europe. Therefore it must also be anticipated that South Africa also has the same hazardous waste problems as are seen in Europe.

Appendix 3: Toxicity and Hazard Criteria

Appendix 8.1

TOXICITY AND HAZARD CRITERIA (LD_{50}, LC_{50}, Koc, Pow, DOC, COD) AND EEC) (Section 8)

It has definite regulatory and economic advantages to rank or classify waste in accordance with criteria for example toxicity, hazard and exposure. These criteria are defined in the Glossary of this document and also briefly discussed hereunder:

1. Acute Mammalian Toxicity (LD_{50})

Acute mammalian toxicity is expressed as LD_{50} (mg/kg). This indicates the dosage that statistically will kill 50% of the test organisms concerned. LD_{50} values are expressed per kg body mass.

Toxicity category	LD_{50} (Oral) mg/kg	LD_{50} (Dermal) mg/kg	LC_{50} (Inhalation) mg/λ
Extreme	< 5	< 40	< 0.5
High	5 to < 50	40 to < 200	0,5 – 2
Moderate	50 to < 500	200 to < 2 000	2 – 10
Low	500 to < 5 000	> 2 000	> 10

2. Acute Ecotoxicity (LC_{50})

Ecotoxicity is the potential to harm animals and plants, but more specifically ecosystems, constituted by a community with its habitat. It is based on the LC_{50} of specific warm and cold-water fish or aquatic invertebrate species.

Toxicity category	LC_{50} (96 hr) mg/λ
Extreme	< 1
High	1 to <10
Moderate	10 to < 100
Low	100 to < 1 000

3. Persistence Potential (K_{oc})

Soil adsorption (K_{oc}) is an important phenomenon, which tends to restrict the movement of both organic and inorganic chemicals from the landfill site. The soil adsorption coefficient of a chemical describes its potential for chemically binding with soil particles. A compound with a low soil adsorption coefficient will generally tend to migrate from the landfill site. For example, phenol is not only highly water soluble, but also has a low soil adsorption coefficient. Rapid leaching of phenol in many landfill sites reflects these characteristics.

K_{oc} is therefore related to mobility:

A	B	C
Slightly adsorbed = high leachability = K_{OC} <50	**Moderately adsorbed** = moderate leachability = K_{OC} 50 – 200	**Strongly adsorbed** = slight leachability = K_{OC} >200

4. Accumulation Potential (P_{ow})

The octanol/water partition coefficient (P_{ow}) is often used as an index of the bio-accumulation potential for a chemical in the aquatic environment. It is environmentally of extreme importance in that it indicates migration into biota. As such, accumulation is not only an integral component describing exposure, but also describes a potential for being persistent in the environment. It normally correlates to soil sorption, making it possible to estimate soil sorption from accumulation potential.

The K_{oc} and the P_{ow} may be estimated by regression models, if these data are not available.

These simplified models are:

$\text{Log } K_{oc} = 3.6 - (0.55 \times \log S)$
$\text{Log } P_{ow} = 4.50 - (0.75 \times \log S)$
Where S = solubility in parts per million (ppm)

5. Biodegradation of compounds (COD and DOC)

Biodegradation is quantified by simple laboratory tests which, , do not accurately simulate aerobic and anaerobic processes in a landfill site, but acts as an indicator.

	Test	Parameter measured	Duration of test	Readily biodegradable
BIO-DEGRADATION	Modified OEDC Screening (EEC = C3) (OECD = 301E)	Dissolved Organic Carbon (DOC)	28 days	70% loss of DOC
	Modified AFNOR test (EEC = C4) (OECD = 301A)	DOC	28 days	70% loss of DOC
	Closed bottle test (EEC = C6) (OECD = 301D)	Oxygen consumption (COD)	28 days	60% of COD
	Modified MITI test (EEC = C&) (OECD = 301C)	COD	28 days	60% of COD

6. Estimated Environmental Concentration (EEC) and Acceptable Exposure (AE)

6.1 Estimated Environmental Concentration (EEC)

The EEC (also referred to as the estimated exposure concentration in some scientific literature) reflects the concentration of the substance that is available to humans and the environment (considering groundwater as a route) and hence the potential exposure and risk. The EEC could either be based on calculations derived from assumptions related to a fixed scenario or from site specific data and conditions.

It is important to determine EEC, as it indicates exposure, which together with the potential effects of the substance of concern, determines the degree of the hazard posed. Therefore, when the level of an adverse effect and the amount of a substance available (exposure) is known, the likelihood of an adverse effect can be determined. This is a critical aspect in managing hazardous waste to ensure that both humans and the environment are protected.

EEC is also used as a criterion to determine whether a substance, which has already been hazard rated, would, if it migrates from a disposal site, enter the environment at concentrations that do not exceed the Acceptable Exposure for that substance. In this instance, the waste containing this substance, could be "delisted" which means that it may be disposed of on an approved and authorised General disposal site equipped with an appropriate leachate management system. In such a case, the Total Load for a specific substance must be determined for that site and will not be allowed to be exceeded.

Many **pathways** of exposure exist, being instrumental in an effect being caused to a receptor. The pathway is the transport medium by which a contaminant will migrate from a source to a receptor. A **receptor** could either be a plant, animal, human being or ecosystem exposed to the substance. Once the substance reaches a point of contact with the receptor, the compound could be absorbed through different **routes of exposure**. For animals and human health, three basic routes of exposure exist namely, ingestion, inhalation and dermal absorption. For aquatic animals, direct contact with the gills or integument is regarded the route of exposure.

With regard to the environment and waste disposal in the environment, extensive groundwater contamination is a well-known and well-documented fact worldwide. Not only is the contamination or pollution of waters a pathway ultimately reaching man, animals or plants, but is it firstly of consequence to the aquatic environment, the sensitivity of which is not under dispute. Risk (measure of the probability and severity of adverse effects and thus a function of hazard, exposure and preventative measures) to the aquatic environment is defined as the likelihood that the aquatic environment will suffer harm, directly or indirectly, from the introduction of chemicals as a result of human activity. The key to aquatic hazard analysis involves the determination of environmental concentrations (exposure) of substances, and the effect they produce.

For the calcualtion of EEC, in terms of the fixed scenarion approach, groundwater is the pathway of exposure to humans and the environment. However, in the instance of site specific risk assessment, substance transport and fate could be determined for various media, for example, air, soil, ground- and surface water.

The calcualtion of an EEC (fixed scenario) is based on the assumption that the total amount of the most hazardous substance in the waste stream, disposed by landfill, will be introduced into a one hectare water body of 15cm depth.

This simplified model presents a ***worst case scenario.*** The calculation based on this approach for EEC is done in accordance with the following simplified formula:

EEC, parts per billion (ppb) = dose (g/ha) x 0.66

Based on thhe above formula, one gram of a specific substance landfilled will give rise to 0,66 ppb of the same substance in one hectare of groundwater of 15 cm depth.

6.2 Acceptable Exposure (AE)

As described in paragraph 6.1 of this appendix, exposure, which is to be quantified by calculating an environmental concentration, requires a source, a transport medium and a point of contact with a receptor.

The aquatic environment is extremely sensitive to contamination and pollution. It is therefore possible to prove for many substances that if the aquatic environment is not at risk (being within acceptable exposure), that humans and other mammals, avian and plant-life, should also not be exposed to unacceptable risk. There are, however, instances where human health is more sensitive to specific substances than the aquatic environment.

Acceptable Exposure is calculated based on:

- acceptable exposure to the environment, which is 0.1 x LC_{50} of the contaminant, and which will result in a concentration that would cause a mortality incidence of one in three hundred thousand[145] in the aquatic environment;
- a systemic acceptable exposure for human health, which is the concentration of a contaminant in water, calculated from a reference dose or Tolerance Daily Intake as derived from chronic toxicity studies and a person of 70kg mass drinking two litres of water per day, and
- an acceptable exposure to human health for carcinogenic substances and which refers to a concentration which would result in an estimated excess probability in human health to develop cancer. It is calculated from a slope factor derived from chronic toxicity studies, a 70kg person and the consumption of 2 litres of water per day, and is expressed corresponding to an excess lifetime cancer risk of 1 in 10 000.

When the EEC is higher than any one of the three exposure levels, the waste stream remains in the hazard rating. When it is lower, the waste stream can delist to be disposed of on an authorised General Waste landfill. The Permit Holder of such a General Waste landfill equipped with a leachate management system must apply and obtain approval for accepting delisted wastes from the Competent Authority.

The acceptable exposure level applicable to a specific contaminant is the **lowest of the three levels** calculated, and is the acceptable exposure level to be adhered to (refer to the Hazardous Waste Classification Tables in Appendix 9.4).

Any deviation from the approach on selecting the strictest of either the human or eco-toxicity in terms of calculating acceptable exposure levels must demonstrate that, by not selecting the lowest of the three calculated exposure levels, the principles of anthropocentrism and sustainable development in no way have been violated.

It can statistically be proven that one tenth of the LC_{50} of all substances with similar dose/response slopes will result in a mortality incidence of one in three hundred thousand in the aquatic environment. The mortality incidence of one in three hundred thousand in the aquatic environment has adopted as an Acceptable Exposure. It may be argued that this figure may be somewhat liberal with regard to very endangered species.

APPENDIX 8.1: TOXICITY AND HAZARD CRITERIA

Potential risk to the **environment** is assessed by using the aquatic environment as the receptor. The environment is regarded as being immediately below the liner of a disposal site unless otherwise motivated to and approved by the Competent Authority.

Regarding the aquatic environment, fish and crustacea are used as surrogates in the calculation of LC_{50} values, and interpreted to cover a wide range of trophic levels and taxa.

Acute experimental toxicity data (LC_{50}) is much more common in the international literature than chronic data, i.e., no-observed-effect levels (NOEL). Therefore, acute data is accepted as a valid criterion for acceptable exposure assessment purposes. In calculating a mean acute value, data from different species is not combined within a taxa group, but is calculated separately. The lowest LC_{50} value (most sensitive species) is then accepted for calculation of the Acceptable Exposure (AE). Species mostly used were *inter alia* Fathead minnow, Rainbow trout, Bluegill sunfish, Sheephead minnow and Daphnia magna. Using the data from the most sensitive species tested gives a cautious but acceptable definition of hazard. Since chronic toxicity data (with regard to ecotoxicity) is less common than acute data, a practice of calculating chronic data by incorporating K_{ow} correlations has internationally been applied. This should, however, not be allowed to overrule experimental acute toxicity data, since it could lead to errors by orders of magnitude. Chronic toxicity data has therefore not been used in the Minimum Requirements.

The endpoint is a measurable ecological consequence and a measure and expression of mortality incidence. The point of departure in deriving an acceptable exposure limit or exposure to the environment is thus based on acute toxicity from which LC_{50} values are the most abundant in the international literature.

Contrary to the Acceptable Exposure (AE) for the environment as based and derived from mortality incidences, the AE for **human health** is based on the acceptable chronic daily intake of a substance, and is referred to as the Acceptable Daily Intake (ADI, WHO), or Reference Dose (RfD, EPA). It refers to the daily exposure to a contaminant during an entire lifetime, without appreciable risk to human health, and is expressed in units of mg/kg body weight/day.

The adverse effect to human health by substances can, very basically, be described as those substances, which would cause an adverse effect when a certain amount of the substance reaches a particular target organ or target tissue. These substances are referred to as non-carcinogens for which threshold or sub-threshold levels for adverse effects are established by dose-response studies. Dose response studies endeavour to estimate the relationship between dose levels and magnitude of effect. The adverse effect is systemic (non-carcinogenic), and results in a threshold value, which is termed TDI, ADI or RfD, i.e., an estimated daily exposure which could be tolerated during a lifetime, without appreciable risk to human health. Although body weight and water ingestion criteria vary widely among individuals, the criteria by which TDI, ADI or RfD are calculated is based on an adult of 70kg body weight who consumes 2 litres of water per day. (The mean body weight in the South African population, fifteen to ninety five years of age for both sexes, is 68 kg[*]). It is also assumed that the bioavailability of chemicals in drinking water, via the groundwater pathway, is 100%, which in most cases adds conservatism into an assessment.

Causation of malignant or benign neoplasms – new and/or abnormal growth such as a tumour – due to exposure to chemicals, are termed chemical carcinogenesis, i.e., the induction of cancer. It is normally estimated as the excess probability in human health to develop cancer according to exposure by a specific pathway, the excess risk being linearly related to dose.

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Thus for carcinogens, the risk diminishes with dose, and will only approach zero when dose becomes zero. It therefore differs from non-carcinogenic compounds in that a threshold dose is not applicable. However it is[*] to be noted that chemicals with inadequate data could be assessed by either threshold or non-threshold, or both methods, which also holds for chemicals with an epi-genetic mechanism of tumour development. The "Acceptable Exposure" for a carcinogen is expressed in the international literature by a Slope Factor (SF), defined as the probability of a response per unit exposure over a lifetime, being the upper-bound estimate of the slope of a dose-response curve, and is expressed in terms of risk/dose, where dose is expressed as mg/kg/day, and SF in $(mg/kg/day)^{-1}$.[*]

Slope Factors (SF), i.e., the potency estimate of a potentially carcinogenic chemical, and referred to by the Minimum Requirements, are those calculated by the USEPA according to a weight of evidence regarded to be of sufficient evidence to be classified as carcinogenic.[*]

Slope Factors are therefore to be used to calculate the AE to human health for chemicals regarded to be potentially carcinogenic. However, due to the absence of a threshold for carcinogens, different concentrations of a chemical in drinking water could be calculated, which will respond to different risk levels of excess cancer risk to human health.

The Department of Water Affairs and Forestry and the Department of Environmental Affairs and Tourism accept, similar to the USEPA, that a concentration (AE) which may result in an additional cancer event in an exposed 10 000 individuals should be considered significant. It is important to note that such risk levels may be altered in accordance with policy changes.

The Acceptable Exposure (AE) in drinking water for a chemical compound regarded to be of a potentially carcinogenic nature, could therefore be calculated as follows:

$$AE\ (mg/\lambda) = \frac{\left(\frac{10^{-4}\ x\ 70Kg}{SF(mg/Kg/day)^{-1}}\right)}{2\lambda}$$

For the Hazardous Waste Classification Tables (Appendix 9.4), AE's for the environment, human health (non-carcinogenic) and human health (carcinogenic) are calculated for every compound listed. The most conservative calculated AE is then applied to calculate disposal allowed in g/ha/m. Examples of calculations are included in Section 8.

[*] Thandi Puoane et al, Obesity Research, Vol 10, No. 10, October 2002
[*] Development of Risk Assessment Methodology for Municipal Sludge Landfilling, EPA 600-690-008
[*] USEPA. 1986a. Guidelines for Carcinogenic Risk Assessment. Federal Register 51 (185) : 33992 - 34003