

**Critical perspectives on the definition of waste in  
South Africa – experiences within the steelmaking  
industry**

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# ABSTRACT

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During the past few decades the focus of waste management in South Africa has been emphasised, especially in view of the increase in economic development which has resulted in an increase in commercial, industrial, hazardous, mining, power generation as well as radioactive waste. The iron and steel making industry in South Africa provides for a vast amount of recycling opportunities of various materials resulting from the iron and steelmaking process. The regulation of waste management in South Africa may have some significant implications on this particular industry.

In this dissertation the history of waste management legislation in South Africa is researched. It is found that initially only waste disposal was regulated, but over time, in addition to disposal, other aspects were also regulated in terms of other pieces of environmental legislation, such as the recycling, recovery and storage of waste. In an attempt to provide for uniform waste management regulation in South Africa, and in order to achieve sustainable development by the provision of a new waste hierarchy, the National Environmental Management: Waste Act was introduced.

As part of this legislation, a new definition of waste was also introduced. It is indicated as part of this dissertation that various interpretations of the definition of 'waste' are possible. It is also indicated that these various interpretations may not only have some significant implications for the iron and steelmaking industry in South Africa, but may also have significant implications for the implementation of the waste hierarchy, as envisaged in terms of current waste management legislation.

In the light of the above, and after taking comments by the members of the South African Iron and Steel Institute into consideration, recommendations are made for an improved legislative framework for waste management in South Africa. It is recommended that there should be a trade-off between the protection of the environment and the re-use, recovery and recycling opportunities of materials available to industry in the short-term as well as the long-term.

In order to achieve such a trade-off, it is suggested that the 'End-of Waste' criteria in South Africa be reconsidered and re-evaluated to ensure more legal certainty with regard as to exactly constitutes waste and to provide for a definition of 'waste' which is clearly defined.

**Key words:**

Waste management, disposal, recovery, re-use, recycling, waste hierarchy, iron and steelmaking, National Environmental Management: Waste Act, national legislation, waste hierarchy, sustainable development.

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Finally, I dedicate this dissertation to my grandparents, Martin and Cecile Dewet. I know that this piece of work would have made them proud.

## LIST OF ACRONYMS

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ANC	African National Congress
APPA	Atmospheric Pollution Prevention Act, 1965
BFGAS	Blast Furnace Gas
BOF	Basic Oxygen Furnace
CE	Council for the Environment
COG	Coke Oven Gas
CONNEP	Consultative National Environmental Policy Initiative
COSATU	Congress of South African Trade Unions
DANCED	Danish Cooperation for Environment and Development
DEA	Department of Environmental Affairs
DR	Direct Reduction
DRI	Direct Reduction Iron
DWAF	Department of Water Affairs and Forestry
EAF	Electric Arc Furnace
ECA OF 1982	Environment Conservation Act, 1982
ECA	Environment Conservation Act, 1989
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EPA	Environmental Protection Agency
EPPIC	Environmental Planning Professions Interdisciplinary Committee
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HSA	Hazardous Substances Act, 1973
HC	Habitat Council
IDRC	Canadian International Development Research Centre
IEM	Integrated Environmental Management
NWA	National Water Act, 1998
NEMA	National Environmental Management Act, 1998
NEMAQA	National Environmental Management: Air Quality Act, 2004
NEMWA	National Environmental Management: Waste Act, 2008
NGOS	Non-Governmental Organisations
OECD	Organisation for Economic Cooperation and Development

ROD	Record of Decision
SACP	South African Communist Party
SAISI	South African Iron and Steel Institute
SANCO	South African National Civic Organisation
SANS	South African National Standards
VOC	Volatile Organic Compounds
WA	Water Act, 1956
WML	Waste Management License

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# CHAPTER 1. INTRODUCTION

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This chapter starts by providing the background to the research and introducing the problem statement (section 1.1), after which the research objective and questions are described (section 1.2). To assist the reader to navigate within the text, the final section presents an outline of the dissertation, clearly linking the research questions and methods to the various chapters (section 1.3).

## 1.1. BACKGROUND AND PROBLEM STATEMENT

Over the past decade, waste management in South Africa has been prioritised within environmental management, as well as within the various governmental departments that have regulated these functions. Globally, waste has also become a prominent issue, as highlighted by discussions held at the World Summit on Sustainable Development in Johannesburg in 2002. The Summit promotes development which takes into account strategies which are socially, environmentally and economically sustainable.

During the past decade, the focus on service delivery has been emphasised within South Africa, together with local economic development programmes and poverty alleviation projects. Local municipalities have also become more accountable to their communities, ensuring that they have an integrated waste management plan in place to adequately provide an equitable service to all. With the increase in economic development came an increase in commercial, industrial, hazardous, mining, power generation waste and radioactive waste; all which have to be regulated in terms of legislation.

Within both the public and the private sector, waste needs to be managed according to the following principles – accountability, affordability, ‘cradle to grave’ management, polluter pays, equity, sustainable development, integration, open information,

subsidiarity, waste avoidance and minimisation, co-operative governance, and environmental protection and justice (Fiehn & Ball, 2005:2).

Key issues which face South Africa with regard to waste management include the lack of available or current waste information from all sectors, illegal dumping and illegal dumping sites, salvaging at waste disposal facilities, use of unpermitted landfills by municipalities, limited environmentally accepted landfill airspace, large portions of the population not receiving a weekly or adequate waste collection service, recycling not generally undertaken or encouraged by municipalities, waste minimisation which is almost exclusively industry driven, government departments' lack of waste databases, lack of regulation and enforcement of legislation and limited waste legislation (Fiehn & Ball, 2005:2).

One of the key issues identified above as a challenge that South Africa faces, is the fact that waste minimisation is almost exclusively industry driven. The reason why waste minimisation is to a large extent industry driven is because of the nature of activities driven by industries. The steel making industry for example is faced with some significant challenges pertaining to the recycling of waste materials. Due to the nature of the industry, a lot of different types of waste materials are generated on a big scale and the challenge faced by the steel making industry is to find some alternative uses or recycling methods in order to avoid disposal of the material as an alternative which is not only very expensive but is also not a very environmentally sound alternative.

In light of the aforementioned challenges, various pieces of legislation were put into place over the past decades in order to try and regulate waste management in South Africa, for example the Environment Conservation Act, 1989 (Act No. 73 of 1998) – the ECA, the National Environmental Management Act, 1998 (Act No. 107 of 1998) – the NEMA, and the National Water Act, 1998 (Act No. 36 of 2008) – the NWA.

The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) – the NEMWA, fundamentally reformed the law regulating waste management in South Africa, and for the first time provided a coherent and integrated legislative framework for addressing all the steps in the waste management hierarchy. The NEMWA repealed the ECA to a large extent, as well as the NEMA as far as it related to waste management issues.

The NEMWA was promulgated and took effect on the 1<sup>st</sup> of July 2009 (SA, 2010(a):8).

With the promulgation of the NEMWA, a new emphasis was put on waste management in South Africa. One of the most significant principles that NEMWA is giving effect to is sustainable development which requires that the generation of waste is avoided, or where it cannot be avoided, that it is reduced, re-used, recycled or recovered, and only as a last resort treated and safely disposed of. This is also referred to as the classical waste hierarchy model (SA, 2010(a):27):



**Figure 1-1 Waste Management Hierarchy in terms of NEMWA**

In order to give effect to the aforementioned principle of sustainable development, a new definition of 'waste' was introduced as part of the waste hierarchy model.

Therefore, in order to be able to determine what substances will be regarded as waste streams and regulated as such, the new definition of waste and what it means for waste management is the focus of this research.

Unfortunately, the definition of 'waste' as contained in the NEMWA is very broad and open to different interpretations. Different interpretations sometimes result in conflicting situations between industry(s) and government.

Industries in general, and more specifically the iron and steel industry, favour a wider interpretation of the definition of 'waste' than what is currently supported by government. Government tends to favour a more restrictive approach with regard to the interpretation of the definition of 'waste'.

Since waste management was regulated to a limited extent in the past, government wants to regulate all aspects of waste management and include the whole life cycle of industry processes in this regulation process. However, a more restrictive approach to the interpretation of the definition of 'waste' may have some significant implications for the implementation of the waste hierarchy, as envisaged by the NEMWA.

The regulation of most substances as waste materials will make the implementation of the waste hierarchy very difficult, if not impossible, since most recycling and re-use opportunities may prove not to be viable in the light of overregulation and the issuing of waste management licenses. As a result, significant volumes of certain substances will be disposed of instead of being re-used, recycled or recovered; which is contrary to the waste management hierarchy.

A wider interpretation of the definition of 'waste', as proposed by the South African Iron and Steel Institute (SAISI), may prove to be the more viable option in achieving the principles as envisaged by the aforementioned waste management hierarchy by providing for viable short-term recycle and re-usable opportunities. Furthermore, a wider interpretation may also assist in the creation of job opportunities nationwide,

instead of the restriction of job creation, which will be one of the consequences of a strict interpretation.

This dissertation will explore and evaluate the implications of the specific definition of waste towards achieving the objectives of the NEMWA. It is questioned whether expanded regulation of substances is necessarily the correct way to achieve these objectives. This will be done by assessing the steelmaking process, since this process provides extensive recovery, re-use and recycle opportunities as part of the internal as well as external processes.

## **1.2. RESEARCH OBJECTIVE AND SUB-RESEARCH QUESTIONS**

In view of the problem statement described in the previous section the main objective of the research is:

To critically review the definition of '*waste*' as contained in the NEMWA and the possible implications of such interpretation(s) on the iron and steel making industry in South Africa and to make certain recommendations with regard to future regulation of waste.

In order to achieve the above-mentioned research objective, the following sub-research objectives/questions need to be considered:

1. What aspects with regard to waste management are currently being regulated in terms of the NEMWA in comparison with previous environmental legislation?
2. What is the life cycle of the iron and steel making process and what are the recycling and recovering opportunities as part of this process?



3. What are the different possible interpretations of the definition of '*waste*' as contained in the NEMWA by both the regulating authorities as well as industries?
4. What are the implications of each of the aforementioned interpretations on the iron and steel making industry?
5. What should the correct interpretation of the definition of '*waste*' be in terms of the South African waste management legislation in order to give effect to the waste hierarchy in South Africa?

### **1.3. STRUCTURE OF THE RESEARCH**

To allow for easy interpretation of the results, the research aimed to provide a clear linkage between the set research questions, the methodology applied to address the questions, the phases in the research process, and ultimately the chapters relating to each research question – as illustrated in Table 1 and described below:

In order to achieve the research objective (defined in section 1.2) the following research process, consisting of four phases, was followed:

#### **1. Phase 1: Introduction and Methodology**

Phase 1 deals with the introduction and research methodology, which are described in the following chapters:

- Chapter 1: Introduction

The research is introduced by providing background and the problem statement, followed by the research questions. It concludes by explaining the outline and structure of the mini-dissertation.

- Chapter 2: Methodology

This chapter describes the research methodology applied to address the research objective and questions introduced in Chapter 1.

#### **2. Phase 2: Define and Prepare**

Phase 2 of the research addresses sub-research questions 1 and 2 (outlined in

Chapter 1, section 1.2), and aims to define the research by setting the history of the legislation of waste management of South Africa.

This phase also explores the reasons why the iron and steel making industry is used as an example. Phase 2 includes the following chapters:

- Chapter 3: Legislative Framework

This chapter will establish the history of the legislation of waste management of South Africa and determine which waste management aspects were previously legislated, which waste management aspects are currently being legislated, what the main differences are with regard to the legislation of waste management in South Africa in terms of the new NEMWA, and the reasons for changing the legislation with regard to waste management in South Africa.

This chapter will distinguish between environmental legislation prior to and post 1970.

- Chapter 4: Case Study Review – The iron and steelmaking industry

The research focuses on the iron and steel making industry as an example of how important the correct interpretation of the definition of waste is in terms of NEMWA, and what the consequences may be should the incorrect interpretation be followed. This chapter will establish the process of the iron and steel making industry with an emphasis on the life cycle of the iron and steel making process. This chapter also focuses on the possible recycling and recovering opportunities as part of this process.

### **3. Phase 3: Collect and Analyse**

Phase 3 of the research addresses sub-research questions 3 to 5 (outlined in section 1.3). During this phase data is collected via a documentation review and interviews

(outlined in section 2.2), and analysed. It includes the following chapters:

- Chapter 5: Literature Review and Data Analysis

This chapter explores the various possible interpretations of the definition of waste as contained in the new NEMWA by the regulating authorities as well as industries, and the implications of each of these interpretations for the iron and steel making industry. This chapter also establishes what the correct interpretation of the definition of 'waste' (in terms of the South African waste management legislation) should be in order to give effect to the waste hierarchy in South Africa. This chapter also gauges the views of the iron and steel making industry and regulating authorities on the current legislative framework.

#### **4. Phase 4: Conclude and Recommend**

In the final phase, conclusions and recommendations are made in Chapter 6 for an improved understanding of the definition of waste in order to be able to improve waste management in South Africa.

**Table 1-1 The structure of the mini-dissertation**

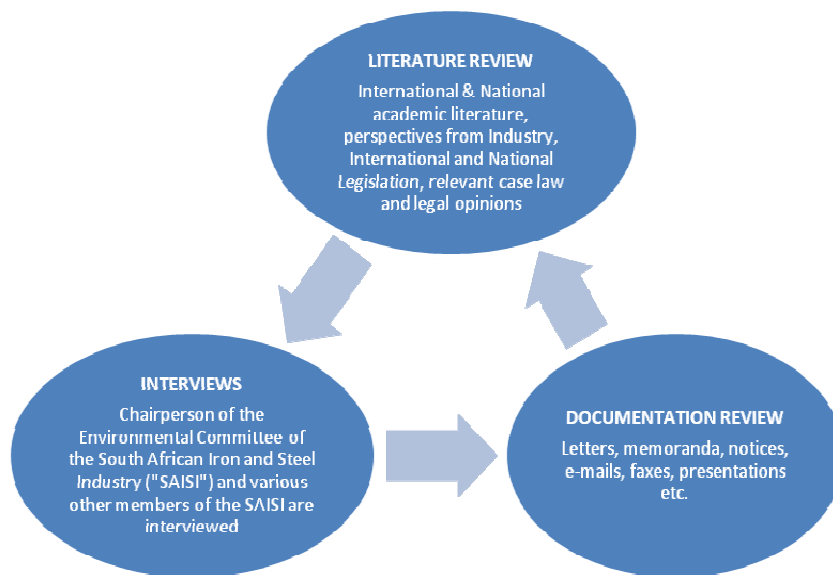
RESEARCH OBJECTIVES / QUESTIONS (See Chapter 1, section 1.3)	METHODS (See Chapter 2)	PHASES	CHAPTERS (See Chapter 1, section 1.4)	Phase 1 Introduction and Research Methodology
1. Which aspects with regard to waste management are currently being regulated in terms of the NEMWVA in comparison with previous environmental legislation?	Legislative Review (See Chapter 2, section 2.2.1)	Phase 2 Define and Prepare	Chapter 3 Legislative Framework: Waste Management in South Africa	Chapter 4 The Iron and Steelmaking Process
2. What is the life cycle of the iron and steelmaking process and what are the recycling and recovering opportunities as part of this process?	Literature Review (See Chapter 2, section 2.2.1)			
3. What are the different possible interpretations of the definition of waste as contained in the new NEMWVA by both the regulating authorities as well as industries?	Documentation Review (See Chapter 2, section 2.2.1)	Phase 3 Collect and Analyse	Chapter 5 The Interpretation of the definition of Waste	
4. What are the implications of each of the aforementioned interpretations on the iron and steelmaking industry?	Case Studies and Documentation Review (See Chapter 2, sections 2.2.1 & 2.2.2)			
5. What should the correct interpretation of the definition of waste be in terms of the South African waste management legislation in order to give effect to the waste hierarchy in South Africa?	Case Studies, Documentation, Review, Case law review as well as the assessment of various legal opinions. (See Chapter 2, sections 2.2.1 & 2.2.2)			
6. What are the views of the steel industry and regulating authorities on the current legislative framework?	Interviews (See Chapter 2, section 2.2.1)			
<b>RESEARCH OBJECTIVE</b> (See Chapter 1, section 1.3) To critically review the definition of waste as contained in the NEMWVA and the possible implications of such interpretation(s) on the steel industry in South Africa and to make certain recommendations with regard to future regulation of waste.		Phase 4 Conclude and Recommend	Chapter 6 Conclusion and Recommendations	

## CHAPTER 2. METHODOLOGY

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### 2.1. RESEARCH METHODS

This section describes the research methods used as illustrated in Figure 2.



**Figure 2-1 Research methods**

#### 2.1.1 *Literature and documentation review*

The literature review was conducted by utilising electronic, Internet and library sources, with specific reference to international and national legislation, policy documents, academic sources and articles, aimed to answer sub-research questions 1 - 3:

1. What aspects with regard to waste management are currently being regulated in terms of the NEMWA in comparison with previous environmental legislation?

2. What is the life cycle of the iron and steel making process, and what are the recycling and recovering opportunities as part of this process?
3. What are the different possible interpretations of the definition of 'waste' as contained in the new NEMWA, by both the regulating authorities and industry?

A review of local academic literature was conducted to gain an overview of the legislative history pertaining to the regulation of waste management in South Africa. International and local academic literature was consulted to obtain a broad overview of international as well as the national definition of waste and possible interpretation thereof. The perspectives of numerous legal practitioners, as well as representatives of industries, were also considered in order to explore the various debates related to the interpretation of the definition of waste. A basic literature study was performed in terms of:

- The current legal framework for waste management regulation in South Africa.
- The historical legal framework for waste management regulation in South Africa.
- The life cycle of the iron and steel making process.
- Compliance with the waste hierarchy as part of the iron and steel making process.
- Possible interpretations of the definition of 'waste' as contained in NEMWA.

The documentation review aimed to collect the different perspectives on the interpretation of the definition of 'waste', as well as the challenges associated with the different interpretations. The types of documents covered a wide spectrum; for example: presentations, letters, memoranda, notices, articles, presentations, relevant case law and legal opinions. These documents were obtained through administrative records of the representatives of the iron and steel making industry. In some instances documentation was supplemented and confirmed via interviews.

### 2.1.2 Interviews

A semi-structured interview was used to answer sub-research questions 4 and 5. A semi-structured interview has predetermined questions, but the order, question wording and explanations given can be modified based upon the interviewer's perception of what seems most appropriate. The wording of the question can be changed and explanations given, particularly questions which seem inappropriate with a particular interviewee can be omitted, and/or additional ones included (Robson, 2002:270):

4. What are the implications of each of the aforementioned interpretations on the iron and steel making industry?
5. What should the correct interpretation of the definition of 'waste' be in terms of the South African waste management legislation in order to give effect to the waste hierarchy in South Africa?

The main interviewee was Mr S Spanig in his capacity as chairperson of the Environmental Committee of the SAISI. SAISI is a non-profit, pro-competition and non-governmental representative organisation serving the collective interests of the primary steel industry in South Africa. One of these interests is compliance with environmental legislation, together with the adherence to internationally accepted sound environmental management principles. SAISI's membership includes four primary carbon steel producers and South Africa's only primary stainless steel producer: ArcelorMittal South Africa Ltd, Cape Gate (Pty) Ltd, Columbus Stainless (Pty) Ltd, Evraz Highveld Steel and Vanadium (Pty) Ltd and Scaw Metals Group.

The said individual was selected because he was one of the key stakeholders involved with obtaining relevant legal opinions with regard to the interpretation of the definition of waste as contained in NEMWA, and he was also one of the key stakeholders liaising with the relevant government departments regarding possible challenges as a result of the new definition of waste.



Eight other environmental managers representing the main steel producers within the industry were also interviewed. The aim of the interviews was to obtain the view of SAISI and environmental managers in the steel industry with regard to the challenges faced by the industry as a result of the new definition of waste introduced in NEMWA. The eight additional interviewees were given the opportunity to state whether they agree with the main interviewee's views and suggestions, and they were also given the opportunity to make recommendations with regard to the interpretation of the definition of waste in order to achieve the principles as stated as part of the waste hierarchy envisaged by the NEMWA.

The interviews covered the following broad lines of enquiry:

- What does the iron and steel making process entail and what recycling opportunities are there as part of this process?
- What are the differences between the current regulation of waste in terms of NEMWA and the previous regulation of waste management in terms of previous environmental legislation?
- What are the problems/challenges associated with the current legislative regime pertaining to waste management in comparison with challenges associated with the previous legislative regime?
- What are the possible solutions to the aforementioned problems / challenges?

A complete list of the questions asked and interviewees is contained as part of Annexure 2.

## **2.2. CHALLENGES FOR THE RESEARCH**

In order to inform the research design of possible future research the following main challenges are highlighted:

Access to interviewees: The accessibility of governmental officials remains a challenge. It is extremely difficult to arrange interviews with government officials.

Identifying the relevant interviewees from governmental departments was also surprisingly difficult.

In order to solve this problem, a written interpretation document was obtained from the department in order to be able to determine the department's interpretation of the definition of waste. However, for the purpose of future research, it may be important to acknowledge these challenges as a contribution to future research methodological design.

## **CHAPTER 3. LEGISLATIVE FRAMEWORK: WASTE MANAGEMENT IN SOUTH AFRICA**

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As discussed in Chapter 2, part of the research aim is to determine the current legal framework with regard to waste management in South Africa, and compare that with the historical legal framework. In order to achieve this research aim, a discussion will follow with regard to the pre 1970s environmental legislation, the post 1970s environmental legislation, as well as a discussion with regard to the current legal environmental framework:

### **3.1. PRE 1970 ENVIRONMENTAL LEGISLATION**

South Africa's first legislation to manage natural resources was probably the 1888 Forest Act of the Cape Colony with the purpose to protect and manage the Knysna and Tsitsikamma forests. Areas to protect wild game were set aside soon after. The establishment of the Pongola (1894) and Sabie (1898) game reserves in the Transvaal Republic, the Hluhluwe, Umfolozi and St. Lucia game reserves in Zululand in 1895, and the Giant's Castle Reserve in the Colony of Natal in 1903 (Fuggle, 2008:2) followed.

Thereafter, following the establishment of the Union of South Africa in 1910, legislation to protect and manage various components of the environment was promulgated: water (1912), forests (1913), pollution and public health (1919) as well as relics and antiques (1934). From 1940 until 1969, legislation was promulgated by government to protect marine resources (1940), soil (1946), water (1956), air (1965), as well as legislation to regulate pesticides (1947), atomic energy (1967), and the physical planning and utilization of resources (1967).

These pieces of legislation were promulgated independently of each other, did not provide an integrated framework for the management of the country's natural resources, and made little attempt to draw civil society into either the formulation of the

laws or their implementation. With a few exceptions, this legislation is not known for its rigorous enforcement (Fuggle, 2008:3).

From the above it is clear that, up until at least the 1970s, there was no integrated framework legislation for environmental management with specific reference to waste management in South Africa. Although not specifically legislated, the following pieces of national legislation are examples whereby waste management aspects were regulated to some extent prior to the 1970s:

### *3.1.1 The Water Act, 1956 (Act No. 54 OF 1956) - WA*

The WA did not specifically regulate waste management, but provided for the regulation of waste-related aspects as far as it related to the disposal / treatment of effluent. The WA was the first piece of legislation that was aimed at the control of the industrial use of water and the treatment and the disposal of effluent.

One of the most significant pieces of legislation which regulated waste management aspects pertaining to water use in the 50s was the WA. The purpose of the WA, as contained as part of the long title of the WA, was

*'to consolidate and amend the laws in force in the then Union of South Africa relating to the control, conservation and use of water for domestic, agricultural, urban and industrial purposes'.*

In moving from the pre-1950s to the post-1950s era, South Africa underwent a change from an agriculturally-based economy to one in which industry and mining played a major role. These changes coincided with the evolution from its early beginnings as the Department of Irrigation to the Department of Water Affairs and Forestry; today known as the Department of Water and Environmental Affairs. As a result, the WA was aimed at the control of the industrial use of water and the treatment and disposal of effluent.

By 1956 it was becoming apparent that reconciling water supply with water demand would be increasingly difficult, and that the re-use of effluent would have to play a major role in the management of the country's scarce water resources. After 1956, the earlier requirement of the health authorities that prohibited the disposal of effluent to natural water courses had to fall away.

The WA required that all effluent be returned to the water body from which the water was originally drawn. Later amendments in terms of the Water Amendment Act, 1984 (Act No. 96 of 1984) broadened water quality management in the form of uniform effluent standards. The WA was repealed by the National Water Act, 1998 (Act No. 36 of 1998) (SA, 2011:3).

### *3.1.2 Atmospheric Pollution Prevention Act, 1965 (Act No. 45 of 1965) – APPA*

The APPA did not specifically provide for waste management regulation, but certain waste management aspects were regulated as far as they related to air quality emissions by means of the licensing of scheduled processes or specific conditions contained as part of registration certificates.

The APPA came into effect on 21 April 1965. The purpose of the APPA is part of the long title as contained in the APPA, being

*'... to provide for the prevention of the pollution of the atmosphere, for the establishment of a National Air Pollution Advisory Committee, and for matters incidental thereto'.*

The APPA combined features of a framework umbrella act, with the control of scheduled industrial processes pertaining to noxious and offensive gases, regulated by the national department; while the control of smoke, dust and vehicular emissions was carried out at local authority level.

With respect to noxious and offensive gases, the APPA made provision for the so-called '*Schedule 2*' processes. In terms of section 9(1)(a)(i), as contained in the APPA,

*'no person could within a controlled area carry on a scheduled process in or on any premises unless he was the holder of a registration certificate authorising him to carry on that process in or on those premises'.*

Furthermore, in terms of section 9(1) (b),

*'no person could erect or cause to be erected any building or plant, or alter or extend or cause to be altered or extended any existing building or plant, which was intended to be used for the purpose of carrying on any scheduled process in or on any premises, unless he was the holder of a provisional registration certificate authorising the erection, alteration or extension of that plant or building for that purpose'.*

Section 9(1)(c) also made provision for the fact that,

*'no person was allowed to alter or extend or cause to be altered or extended an existing building or plant in respect of which a current registration certificate had been issued unless he had, before taking steps to bring about the proposed alteration or extension, applied to the chief officer for provisional registration of the proposed alteration or extension or unless such alteration or extension would not have affected the escape into the atmosphere of noxious or offensive gases produced by the scheduled process in question'.*

The following scheduled processes were cited as part of Schedule 2, as contained in the APPA, relevant to waste management:

- **'Schedule process 9:** Alkali waste processes: That is to say, processes in which alkali waste or the drainage there from is subjected to any chemical process for the

recovery of sulphur or for the utilisation of any constituent of such waste or drainage’;

- ‘**Schedule process 25:** Acid sludge processes: That is to say, processes in which acid sludge produced in the refining of coal tar, petroleum or other hydrocarbon derivatives, is treated in such a manner as to cause the evolution of noxious or offensive gases’;
- ‘**Schedule process 39:** Waste incineration processes: That is to say, processes for the destruction by incineration of waste that contains chemically bonded halogens, nitrogen, phosphorus, sulphur or metal, or any other waste that can give rise to noxious or offensive gases’;
- ‘**Schedule process 54:** Metal recovery processes: That is to say, processes in which metal is recovered from any form of scrap material containing combustible components’.

In addition, Sections 11 and 12 respectively, regulated the conditions of both the provisional and the final registration certificate. In terms of Section 11(2), every provisional registration certificate had to specify the following:

- The situation and extent of the proposed building or plant to which the certificate relates;
- The nature of the scheduled process intended to be carried on;
- The raw materials intended to be used, the nature of the operations intended to be carried out and the products intended to be produced;
- The appliances intended to be installed and any other measures intended to be taken with a view to preventing or reducing to a minimum the escape into the atmosphere of any noxious or offensive gases likely to be produced by the operations intended to be carried on; and

- The proposed measures for the purification of the effluents discharged from the appliances installed for preventing or reducing to a minimum the escape onto the atmosphere of any noxious or offensive gases from the processes that will be in operation, and for the prevention of the release of noxious or offensive constituents from such effluents when they come into contact with other effluents in drains or drainage canals.

Furthermore, in terms of Section 12, it was compulsory for a registration certificate to contain the following condition:

*‘that all plant and apparatus used for the purpose of carrying on the scheduled process in question and all appliances for preventing or reducing to a minimum the escape into the atmosphere of noxious or offensive gases, shall at all times be properly maintained and operated and that the holder of the certificate shall ensure that all other necessary measures are taken to prevent the escape into the atmosphere of noxious or offensive gases’.*

Therefore, as a result of the aforementioned, the conditions as contained in provisional/final registration certificates often contained provisions with regard to waste management, even though the scheduled process triggered did not pertain to waste management.

From the above it is clear that although waste management was not specifically defined and regulated in terms of the APPA, waste materials were regulated as part of the APPA by listed schedule processes that regulated waste related activities that could have had an impact on the environment with specific reference to atmospheric emissions, or as part of conditions contained in provisional/final registration certificates dealing with other aspects, such as the disposal of certain waste streams connected with scheduled processes.



The APPA was repealed in its entirety by the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) – the NEMAQA, on the 1<sup>st</sup> of April 2010.

## **3.2. POST 1970 ENVIRONMENTAL LEGISLATION**

Environmental governance during the 1970s and 1980s was characterised by a linkage between environmental management and physical planning, as well as by an atmosphere of co-operation and trust between the national government departments responsible for the environment and environmental non-governmental organisations - 'NGOs'.

During these decades, both senior civil servants and politicians recognised that there was more environmental expertise in the private sector and civil society than in South African government departments. They consequently created both the atmosphere and opportunities to harness this expertise and energy, and as a result, the following legislation was implemented with regard to waste management (Fuggle, 2008:4):

### *3.2.1 Environment Conservation Act, 1982 (Act No. 100 OF 1982) – the ECA of 1982*

The ECA of 1982 did not specifically provide for waste management regulation, but this piece of legislation was the first step towards the regulation of environmental impact assessments, and by implication, waste management aspects would form part of environmental impact assessment regulation.

The 1970s saw an explosion of environmental concern in South Africa as in most of the world. A non-statutory Cabinet Committee on Environmental Conservation was established in 1972 (and renamed the Council for the Environment in 1975). Encouraged by this committee, civil society formed the Habitat Council (HC) and the Environmental Planning Professions Interdisciplinary Committee (EPPIC) in 1974 to act

as channels of responsible communication between the national government and civil society on environmental issues.

With the active involvement of the HC and EPPIC, a White Paper was published in 1980. This White Paper led, after extensive deliberation and public input, to The Environment Conservation Act, 1982 (Act No. 100 of 1982) – the ECA of 1982, and the statutory Council for the Environment in 1983 (Fuggle, 2008:3).

Although the ECA of 1982 did not specifically provide for the regulation of waste management *per se*, the ECA of 1982 and its subsequent amendments introduced three important elements into South African environmental legislation, which was the first step in the future regulation of all waste related impacts on the environment:

- It mandated public participation in the development of environmental policy and regulations and allowed for public comment on Environmental Impact Reports (EIRs);
- It required that EIRs be prepared for such activities and areas as the Minister would determine;
- It established a statutory Council for the Environment (comprised of persons from the civil society appointed on account of their environmental expertise) to advise the Minister on environmental policies. It also established a Committee on Environmental Conservation (comprised of representatives from government departments) to advise the Director-General of Environmental Affairs on how best to co-ordinate and promote provisions of the ECA of 1982 (Fuggle, 2008:4).

Although waste management was not specifically regulated in the ECA of 1982, this piece of legislation was a step towards the regulation of Environmental Impact Assessments (EIAs) in South Africa, of which waste management would form part as an impact on the environment.

Following promulgation of this enabling legislation, the Council for the Environment (CE) was charged with initiating research and conducting public consultations to develop a South African process to regulate activities likely to result in unacceptable environmental effects. The CE established an interim committee on Environmental Evaluation to give effect to the Minister's request. In support of this initiative, the Department of Environment Affairs seconded a junior member of its staff to work in an academic institution under the direction of the Chair of the Committee.

This flexible arrangement allowed the initiative to proceed with a minimum of red tape, to engage openly with civil society, and to harness the intellectual energy of the university community. In May 1985, the initiative produced a 660-page compilation and analysis of the experiences of different countries - both developed and developing - that had adopted environmental impact assessment procedures. This document was widely circulated before a three-day workshop of interested parties to formulate a South African procedure for Environmental Assessment.

This workshop recommended that South Africa adopt Integrated Environmental Management (IEM) as a regulatory framework for the country. More consultation with stakeholders followed - professional institutions, environmental NGOs, National and Provincial Government Departments, political parties - and in 1989 the Council for the Environment published the '*Integrated Environmental Management in South Africa* (IEM Guideline)' (Fuggle, 2008:4).

### *3.2.2 Environment Conservation Act, 1989 (Act No. 73 of 1989) – the ECA*

The ECA was the first piece of legislation formally regulating waste management in South Africa. The ECA provided for a definition of 'waste' and regulated mainly the disposal of waste.

Following the publication of the IEM Guideline, the 1989 amendment to the ECA contained provisions to give the IEM Guideline the force of law: However, eight years

were to elapse before this was done. During this time IEM Guideline documents were issued and numerous environmental assessments were conducted on a voluntary basis (Fuggle, 2008:4).

One example of such a voluntary EIA conducted prior to the formal regulation of EIAs was the establishment of the steel plant at Saldanha situated in the Western Cape by Saldanha Steel (Pty) Ltd during 1994 (Spanig, 2011(a)).

Not only were the provisions in the ECA a first step towards EIAs, but it was also the first significant piece of legislation regulating effective protection and controlled utilisation of the environment with specific reference to waste management in South Africa. The ECA did not only define waste, but also regulated the disposal of waste at disposal sites.

The ECA came into operation on 9 June 1989 and underwent many amendments, and was recently repealed in its entirety, save for a few provisions, by NEMWA. The ECA regulated waste management only as far as it related to waste disposal.

One challenge that the government departments were faced with regarding the ECA was the fact that associated aspects of waste management were not regulated in terms of the ECA, although elements such as recycling were defined in the definition as contained in the ECA.

In terms of the ECA, waste was *initially* defined as follows:

*'Any matter whether gaseous, liquid or solid or any combination thereof, originating from any residential, commercial or industrial area or agricultural area identified by the Minister as an undesirable or superfluous by-product, emission, residue or remainder of any process or activity'.*

The definition of waste as described above required the Minister to 'identify' certain matter as waste. The Minister of Water Affairs only identified certain matter as 'waste' in Government Notice Regulation 1986 of 24 August 1990 (GNR1986) on 24 August 1990. In GNR 1986 the definition of waste was amplified as certain matter that was identified and related to -

*'An undesirable or superfluous by-product, emission or residue or remainder of any process or activity any matter, gaseous, liquid or solid or any combination thereof, originating from any residential, commercial or industrial area, which -*

*Is discarded by any person;*

*Is accumulated and stored by any person with the purpose of eventually discarding it with or without prior treatment connected with the discarding thereof; or*

*Building rubble used for filling or levelling purposes;*

*Is stored by any person with the purpose of recycling, re-using or extracting a usable product from such matter'.*

The aforementioned definition of waste was only functional in relation to the operation of a waste disposal site. In terms of Section 20(1) of the ECA – *'no person may establish, provide or operate a disposal site without a permit'.*

Furthermore, section 20(9) of the ECA reads as follows:

*'(9) Subject to the provisions of any other law, no person shall discard waste or dispose of it in any other manner, except –*

- (a) *at a disposal site for which a permit has been issued in terms of this section; or*
- (b) *in a manner or by means of a facility or method and subject to such conditions as the Minister may prescribe.'*

In terms of section 1 of the ECA, 'prescribe' means to 'prescribe by regulation or notice in the Gazette'. Section 20(8) provides that the Minister may, by notice, issue directions with regard to the matters mentioned in section 20(8) (a) - (c), whilst sections 24 to 28 deal with the regulations that the Minister may promulgate in respect of waste management, littering, products, noise vibration, environmental impact reports, limited development areas and general regulatory powers.

The only direction issued is GN 91 of 1 February 2002, dealing with the control and management of general communal and general small waste disposal sites, whilst the only regulations promulgated, which were not repealed, are GN R154 of 10 January 1992 (noise control), GN 292 of 28 February 2003 mentioned above, GN R1196 of 8 July 1994 (application for disposal site permit), and GN R625 of 9 May 2003 (plastic bags). In view of the aforesaid, it follows that no regulation(s) was promulgated in respect of the '*manner or by means of a facility or method*' for the discarding or disposal of waste as referred to in section 20(9)(b) above (Griffiths, 2008:2).

A disposal site was defined in terms of the ECA as, '*a site used for the accumulation of waste with the purpose of disposing or treatment of such waste*'. In order to fall within the ambit of the said definition, the site must be used for the accumulation of waste for the purpose of –

- a) disposing of such waste; or
- b) treatment of such waste (Griffiths, 2008:1).

The words 'disposal', 'disposing of' and 'treatment' are not defined in the ECA. The meaning of 'disposal' and 'dispose of' in the Oxford Dictionary are as follows:

*'Disposal – the action of disposing of, settling, or definitely dealing with; alienation, making over, or parting with, by the sale or the like'*

*'Dispose of - to make a disposition, ordering, or arrangement of, ... to get rid of, to get done with, settle, furnish .... to make over or part with by way of sale, bargain, sell' (Griffiths, 2008:2).*

Therefore, the act of disposing involves some measure of permanence and a disposal site means the ultimate destination of such waste. This will also be applicable to treatment of waste for the purpose of final disposal of such waste. As a result, temporary storage areas of waste for other purposes than treatment of waste for final disposal were not included in the definition/interpretation of disposal. A disposal site only referred to the permanent disposal of waste (Griffiths, 2008:2).

'Store' is not defined in terms of the ECA, and is defined in terms of the Oxford Dictionary as follows:

*'Store - ... stock of something ready to be drawn upon, ... articles of particular kind or for special purpose accumulated for use, supply of things needed, ... deposit (furniture, etc) in a warehouse for temporary keeping ...'*

Neither the ECA nor the regulations promulgated, except GN 292 of 28 February 2003 pertaining to the identification of matters of a waste, make any reference whatsoever to 'store' or 'the storage of waste' and are silent on this subject. In view of the aforesaid, it speaks for itself that storage cannot be construed as disposal, and therefore a site which is utilised for the storage of waste cannot be construed as a disposal site within the meaning of the ECA (Griffiths, 2008:2).

As a result of the above, it is clear that the ECA (in terms whereof only waste disposal was regulated), did not make provision for the temporary storage of waste and other waste management related aspects. Only the National Environmental Management Act, 1998 (Act No. 107 of 1998) (the NEMA) made provision for the temporary storage and other waste related aspects after 1997, but only as far as it related to EIA activities, not the section 20 ECA permits.

This created problems for government departments since various waste management issues were not regulated in terms of the ECA and the need arose, for waste storage areas to be regulated, especially temporary ones. In order to overcome this problem, the department issued an interpretation guideline entitled the '*Interpretation of the definition a waste disposal site with regard to the issuing of permits for waste incinerators, waste management facilities and other alternative waste disposal technologies and related guidelines*'.

According to this interpretation, waste had to be disposed of at a disposal site which was defined as a site used for the disposing and treatment of such waste. According to the department, the land on which an incinerator/transfer station/waste recycling plant/treatment facility/waste storage was established/installed, could thus be regarded as a disposal site, for which a permit should be issued in terms of the ECA because of the continuous storage of waste on the premises of these plants or sites before the disposal, removal or handling thereof (SA, 2000:1).

In order to give effect to the aforementioned interpretation, the then Department of Water Affairs and Forestry issued the Waste Management Series during 1998 (The Minimum Requirements). This series comprised of following three documents:



**Table 3-1 Minimum Requirements, 1998 (SA, 1998(c))**

Doc:	Name:	Description:
1.	The Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste	<p>This document sets out the waste classification system. In this document wastes are placed in two classes, General or Hazardous waste, according to their inherent toxicological properties.</p> <p>Hazardous wastes are further subdivided, according to the risk that they may pose at disposal, using a hazard rating. In this way, a less hazardous waste is distinguished from an extremely hazardous waste.</p> <p>Wastes with a hazard rating of 1 or 2 are very or extremely hazardous, while wastes with a hazard rating of 3 or 4 are of moderate or low hazard. The requirements for pre-treatment and disposal are appropriately set in accordance with the waste classification.</p> <p>Hazardous waste prevention and minimisation are briefly addressed, because of their importance, as is handling, transportation and storage.</p>
2.	The Minimum Requirements for Waste Disposal by Landfill	<p>This document addresses landfill classification, and the siting, investigation, design, operation and monitoring of landfill sites.</p> <p>In the landfill classification system, a landfill is classified in terms of waste class, size of operation, and potential for significant leachate generation, all of which influence the risk it poses to the environment.</p> <p>Graded requirements are then set for all aspects of land filling, including public participation.</p>
3.	The Minimum Requirements for the Monitoring of Water Quality at Waste Management Facilities.	<p>This document addresses the monitoring of water quality at and around waste disposal facilities.</p>

The Minimum Requirements Series was intended to enforce the permit system as prescribed in terms of section 20 of the ECA, and also to enforce the acceptable disposal of waste. This series was also intended to raise waste management standards in South Africa and to facilitate conformance with the international standards required by future trading partners and the Basel Convention.

Furthermore, the Minimum Requirements Series was also used to classify waste as general or hazardous. In terms of the new NEMWA, a new waste classification system will be promulgated (see section 3.3.3).

The approach adopted by this series was the Integrated Waste Management Approach. The aim was to curtail the risk associated with the handling and disposal of waste to the point where they are acceptable to man and the environment. Waste management must therefore be carefully planned in advance and take place in the following order:

- **Waste prevention:** the prevention and avoidance of the production of a waste, perhaps by regulation;
- **Waste minimisation:** the reduction of the volume of waste during production by means of different processes or clean technology;
- **Resource recovery:** recycling of waste or the recovery of energy through incineration and biodegradation;
- **Treatment:** the treatment of waste to reduce volume or hazardousness;
- **Disposal:** the safe disposal of waste so that it will not pollute the environment or cause health hazards (SA, 1998(d):V).

This principle is based on the classical waste hierarchy principle which forms the basis of NEMWA, which was promulgated in 2009 (refer to section 3.3.3). Although the Minimum Requirements Series provided for the waste hierarchy, this was never enforced in terms of the ECA or the series itself, and only waste disposal as such was regulated. Therefore, in order to try and solve the government's dilemma with regard to the regulation of temporary storage sites/facilities of waste, the Minimum Requirements Series also tried to regulate the temporary storage of waste prior to disposal; for example waste transfer stations.

The Minimum Requirements only made provision for temporary storage as far as it related to hazardous waste, stored for a continuous period of more than 90 days (SA, 1998(d):10-3).

As discussed above, the temporary storage areas of waste for purposes other than treatment of waste for final disposal were not included in the definition/interpretation of disposal. A disposal site only referred to the permanent disposal of waste.

The ECA only regulated waste disposal and made provision for the fact that one may only dispose of waste at a waste site issued with a section 20 permit, or in a manner or by means of a facility prescribed by the Minister.

The Minimum Requirements were not issued as directions as provided for in section 20(8) of the ECA. With regard to the legal status of the said requirements, reference to the following court decisions can be made:

- BPSA (Pty) Ltd v MEC, Ace and Land Affairs 2004 (5) SA 124 (WLD) at 153 C – D  
Claassen J remarked as follows:

*'The department is vested with the statutory duty to authorize the establishment of new filling stations pursuant to ss 21 and 22 of the ECA. In order to exercise these functions, it adopted the aforesaid guideline regarding the establishment of new filling stations. There are clearly circumstances in which a state organ, such as the department in the present case, would wish to formulate a particular policy to guide the exercise of its discretionary powers, provided it is not implemented in a rigid and inflexible manner. The adoption of a guiding policy is not only legally permissible but in certain circumstances may be both practical and desirable.'*

- The MEC For Agriculture, ETC v Sasol Oil 2006 (5) SA 481 (SCA) at 491 B – C  
Cackalia AJA stated as follows:

*'The adoption of policy guidelines by state organs to assist decision-makers in the exercise of their discretionary powers has long been accepted as legally permissible and eminently sensible. This is particularly so where the decision is a complex one, requiring the balancing of a range of competing interests or considerations, as well as specific expertise on the part of a decision-maker. As explained in Bato Star Fishing (Pty) Ltd v Minister of Environmental Affairs, a court should in these circumstances give due weight to the policy decisions and findings of fact of such a decision-maker. Once it is established that the policy is compatible with the enabling legislation, as here, the only limitation to its application in a particular case is that it must not be applied rigidly and inflexibly, and that those affected by it should be aware of it.'*

*An affected party would then have to demonstrate that there is something exceptional in his or her case that warrants a departure from the policy.'*

- Sasol Oil (Pty) Ltd and Another v Metcalfe NO 2004 (5) SA 161 (WLD) at 170 C – D  
Wills J said:

*'... Clearly, these guidelines do not constitute subordinate legislation in the sense that regulations, for example, are so considered. Mr Freund has, in my view correctly, taken the point that the guidelines do not, constitute 'administrative action' as defined in s 1 of PAJA. The guidelines do not constitute' a decision taken ... which adversely affects the rights of any person and which has a direct, external legal effect ...' (Griffiths, 2008:3).*

In view of the aforesaid, it is clear that the adoption of policy guidelines is legally permissible but must be compatible with the enabling legislation, *in casu*, with the provisions of the ECA. In order for the minimum requirements to be legally enforceable, they must be included as part of an authorisation. Therefore, the Minimum Requirements Series will not be enforceable if not adopted as a condition in an authorisation granted by an authority (Griffiths, 2008:3).

In view of the aforementioned interpretation of a disposal site, no section 20 ECA permits were required for the following types of activities, even though the material could fall within the ambit of the waste definition:

- Scrap yards – although scrap could be regarded as a waste in terms of the definition as envisaged by the ECA, the site used for the storage of waste does not fall within the ambit of a disposal site;
- Temporary storage areas for waste for the purpose of disposing waste at a permanent disposal site;
- Temporary storage areas for waste/by-products for the purpose of processing/treatment of such waste/by-products for the purpose of re-using it or selling it.

Even though the selling of waste could be included in the definition of the disposal of waste, the temporary storage area is not meant for the ultimate destination of such waste.

- Storage areas for the sole purpose of treatment of waste for final disposal of such waste must obtain a section 20 ECA permit. This does not include temporary storage areas for the treatment of waste for purpose of reusing or selling of the product and where the remainder of the treated product goes to a disposal site.

As a result of the above, it is clear that during the late 80s and early 90s up until 1997, the ECA only regulated the disposal of waste at disposals sites and associated treatment of such waste. The ECA did not focus on other waste-related aspects such as the re-use, recovery or recycling of waste in South Africa, although the definition of waste defined in terms of the ECA made provision for such waste related aspects.

As a result, most materials that were not regarded as superfluous or undesirable by-products, but were still recovered or recycled, were regarded as a product and regulated in terms of other pieces of legislation such as the Hazardous Substances Act, 1973 (Act No. 15 of 1973) – (the HSA). A major advantage in terms of the ECA was the fact that overregulation and duplication of authorisations were prevented (Spanig, 2011(a)).

In 1993 the African National Congress (ANC), the Congress of South African Trade Unions (COSATU), the South African Communist Party (SACO), and the South African National Civic Association (SANCO) requested the Canadian International Development Research Centre (IDRC) to review apartheid era environmental policies and make recommendations. A mission team consisting of both international and local members consulted widely and compiled a report to the sponsoring organisations entitled *'Environment, Reconstruction and Development, A Report from the International Mission on Environmental Policy'*. This served as the background document for a nationwide consultation on environmental policy in South Africa. The 'main messages' from the report were:

- The natural environment is the source of renewable and non-renewable natural resources on which South Africa's prosperity has depended in the past and will continue to depend in the future;
- South African's need to find a new and shared vision of their national future in which environmental justice and pride in their natural patrimony is central;
- Development in South Africa will not be economically sustainable unless the environmental 'bottom line' is written clearly into economic and social policy;
- Current structures and processes in government and civil society are inadequate for the task (Fuggle, 2008:5).

The report also specifically recommended,

*'that the restructuring of central government departments should explicitly address the need to have an integrated and consistent approach to natural resources and environmental management' (Fuggle, 2008:5).*

During April 1995, the then Deputy Minister of Environmental Affairs, Bantu Holomisa, launched the Consultative National Environmental Policy initiative (CONNEP). In August, with financial and intellectual support from the Canadian International Development Research Centre (IDRC) and the Danish Cooperation for Environment and Development (DANCED), some 500 persons gathered in Johannesburg for three days of deliberations to initiate the formulation of a National Environmental Policy. Participants represented a wide array of stakeholders; environmental NGOs, community based organisations, the environmental professions, commerce and industry, trade unions, political parties, as well as provincial and national government representatives (Fuggle, 2008:6).

This process led to a discussion document entitled, *'Towards a New Environmental Policy for South Africa'* during April 1996. After further consultation with stakeholders a Green Paper on a National Environmental Policy was issued and widely circulated in October 1996 (Fuggle, 2008:6).

### *3.2.3 The Constitution of the Republic of South Africa Act, 1996 (Act No. 108 of 1996) – The Constitution*

The promulgation of the Constitution was the first step towards the provision of an integrated framework legislation for the management of the country's natural resources and other environmental-related issues.

Concurrent with the circulation of the Green Paper on a National Environmental Policy, the Constitution was promulgated on 18 December 1996 and took effect on 4 February 1997.

The promulgation of the Constitution had major implications for environmental management in South Africa. The main effects are the protection of environmental and property rights, the drastic change brought about by the sections dealing with administrative law such as access to information, just administrative action and broadening of the *locus standi* of litigants. These aspects provide general and overarching support, and are of major assistance in the effective implementation of the environmental management principles and structures of the NEMA. Section 24 in the Bill of Rights of the Constitution specifically states:

*'24. Environment*

*Everyone has the right -*

- (a) to an environment that is not harmful to their health or well-being;  
and*
- (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –*
  - (i) prevent pollution and ecological degradation;*
  - (ii) promote conservation; and*
  - (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social*



*development'*

A second CONNEP gathering to discuss the Green Paper took place in January 1997. A Draft White Paper on Environmental Management Policy flowed from this, and was gazetted for comment in July 1997.

The final White Paper was gazetted on 15 May 1998 and a draft National Environmental Management Bill was gazetted on 1 July 1998. This Bill was passed in November and became the National Environmental Management Act, 1998 (Act No. 107 of 1998) – the NEMA, when it came into force during January 1999. The NEMA was regarded as the enabling framework legislation for future environmental legislative provisions. Various pieces of legislation would follow the NEMA principles in an attempt to regulate different impacts on the environment, for example air and waste (Fuggle, 2008:6).

#### *3.2.4 Environmental impact assessment regulations in terms of the ECA (the EIA regulations)*

The first EIA regulations were promulgated in terms of the ECA. With regard to waste management, these regulations provided for EIAs with regard to waste disposal.

Concurrent with the promulgation of the Constitution and the NEMA, the first EIA regulations were also promulgated in terms of the ECA. Section 21 of the ECA provided that the Minister of Water Affairs had the authority to identify activities which may have a substantial detrimental effect on the environment. Section 21(2) of the ECA listed the various categories that such listed activities may fall under, for example waste disposal. The undertaking of an activity identified in section 21 of the ECA was prohibited in terms of section 22 of the ECA. In order to undertake such an activity, a written authorisation was required from the Minister of Water Affairs or local authority or other officer designated by the Minister by regulation in terms of section 22.

The list of activities, as required by section 21 of the ECA, only came into operation upon the commencement of the regulations published in the Government Gazette. Government Notice Regulation 1182 of 5 September 1997 (GNR 1182) contained such listed activities. However, the application of the various items came into operation at different specified dates, as set out in Schedule 2 of the GNR 1182. As a result, an authorisation for a listed activity could not be applied for prior to 1997 since the activities were only identified, at the earliest, on 5 September 1997.

The following activities were identified in GNR 1182, being activities that may be relevant to waste management-related aspects which required an environmental authorisation:

- **Item 1 (c)(ii)** referred to 'the construction, erection or upgrading of facilities for the manufacturing, storage, handling, treatment or processing of any dangerous or hazardous substance that is controlled by national legislation'. This item came into operation on the 2<sup>nd</sup> of March 1998. This activity may have been applicable to waste management activities.

In this regard it is important to take cognisance of the HSA. This act specifically deals with dangerous or hazardous substances. The HSA classifies the various hazardous substances into Group I, Group II, Group III and Group IV according to the definitions in section 1 which draws reference to section 2 of the HSA. Section 2 states that the Minister of Health may publish regulations in order to classify hazardous substances into the various Groups.

In terms of the regulations under HSA, specifically Government Notice Regulation 1382 of 12 August 1994, all substances and goods specified in the South African Bureau of Standards 1995 Code of Practice 0228, are part of Group II hazardous substances. However, the latter standards have been updated and replaced by the South African National Standards 2006 – Identification and Classification of Dangerous Goods and Transport, Code of Practice 10228 Edition 4 (SANS 10228).

The SANS 10228 classifies the varying substances and goods in Classes 1-9. Although the SANS 10228 does not regulate waste *per se*, certain waste streams could have fallen into one of the nine classes as prescribed in terms of the SANS 10228;

- **Item 8** referred to 'the disposal of waste as defined in section 20 of the ECA, excluding domestic waste, but including the expansion, upgrading or closure of facilities for all waste, ashes and building rubble';
- **Item 9** referred to '*scheduled processes listed in the Second Schedule to the APPA*'. Therefore, waste management activities listed in terms of APPA will also trigger an EIA.

It is clear from the above listed items that these EIA regulations only regulated to a large extent the disposal of waste. Any other alternative uses of waste, for example the re-use, recovery and recycling of waste, were not regulated in terms of these EIA regulations.

### *3.2.5 The National Environmental Management Act, 1998 (Act No. 107 of 1998) – the NEMA*

The NEMA did not *per se* regulate waste management as part of the Act, but regulated waste management-related aspects as part of the EIA listed activities, promulgated in terms of the NEMA. The NEMA therefore did not only regulate the disposal of waste but also other waste management-related aspects, such as the recycling and recovery of waste. The NEMA does not provide for a separate definition of waste and as a result, reference was still made to the definition of waste as envisaged in terms of the ECA, and therefore many recycling and recovery activities were not regulated.

The previous listed EIA activities, in terms of GNR 1182 and 1183, were ultimately repealed on 3 July 2006 by the listed activities and the EIA process promulgated in terms of the NEMA as contained in Government Notice Regulation 385, 386 and 387 of

21 April 2006 (GNR 385, 386 and 387) which came into operation on 3 July 2006.

The following activities were identified in GNR 386 as waste-related activities that needed authorisation by means of a basic assessment process, prior to the commencement of an activity:

- **Activity 1(o):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the recycling, re-use, handling, temporary storage or treatment of general waste with a throughput capacity of 20 cubic metres or more daily average measured over a period of 30 days, but less than 50 tons daily average measured over a period of 30 days';
- **Activity 1(p):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the temporary storage of hazardous waste';
- **Activity 7:** 'The above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic metres but less than 1000 cubic metres at any one location or site'. Dangerous goods are defined in the NEMA as 'goods that are capable of posing a significant risk to the health and safety of people or the environment and which are listed in South African National Standard No. 10228 designated 'The identification and classification of dangerous goods for transport', SANS 10228:2003, edition 3, published by Standards South Africa, ISBN 0-626-14417-5, as may be amended from time to time'. This may include waste, specifically with reference to hazardous waste;
- **Activity 23:** 'The decommissioning of existing facilities or infrastructure, other than facilities or infrastructure that commenced under an environmental authorisation issued in terms of the Environmental Impact Assessment Regulations, 2006 made under section 24(5) of the Act and published in Government Notice No R 385 of 2006, for –

- (d) the disposal of waste
  - (f) the recycling, handling, temporary storage or treatment of general waste with a daily throughput capacity of 20 cubic metres or more; or
  - (g) the recycling, handling, temporary storage or treatment of hazardous waste’;
- **Activity 24:** ‘The recommissioning or use of any facility or infrastructure, excluding any facility or infrastructure that commenced under an environmental authorisation issued in terms of the Environmental Impact Assessment Regulations, 2006 made under section 24(5) of the Act and published in Government Notice No. R385 of 2006, after a period of two years from closure or temporary closure, for –
    - (c) facilities for any process or activity, which require permission, authorisation, or further authorisation, in terms of legislation governing the release of emissions, pollution, effluent or waste prior to the facility being recommissioned’;
  - **Activity 25:** ‘The expansion of or changes to existing facilities for any process or activity, which requires an amendment of an existing permit or license or a new permit or license in terms of legislation governing the release of emissions, pollution or effluent’.

The following activities were identified in GNR 387 as waste-related activities that needed authorisation, by means of a full scoping process, prior to the commencement of an activity:

- **Activity 1(c):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the above ground storage of a dangerous good, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of 1000 cubic metres or more at any one location or site including the storage of one or more dangerous, in a tank farm'. Once again, dangerous goods are defined in terms of the NEMA as 'goods that are capable of posing a significant risk to the health and safety of people or the environment and which are listed in South African National Standard No. 10228 designated 'The identification and classification of dangerous goods for transport', SANS 10228:2003, edition 3, published by Standards South Africa, ISBN 0-626-14417-5, as may be amended from time to time'.

This may include waste, specifically with reference to hazardous waste;

- **Activity 1(e):** 'The construction of facilities or infrastructure, including associated structures or infrastructure for any process or activity which requires a permit or license in terms of legislation governing the generation or release of emissions, pollution, effluent or waste and which is not identified in GNR 386';
- **Activity 1(f):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the recycling, re-use, handling, temporary storage or treatment of general waste with a throughput capacity of 50 tons or more daily average measured over a period of 30 days';
- **Activity 1(g):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the use, recycling, handling, treatment, storage or final disposal of hazardous waste';
- **Activity 1(o):** 'The construction of facilities or infrastructure, including associated structures or infrastructure, for the final disposal of general waste covering an area of 100 square metres or more or 200 cubic metres or more of airspace';

- **Activity 1(q):** ‘The construction of facilities or infrastructure, including associated structures or infrastructure, for the incineration, burning, evaporation, thermal treatment, roasting or heat sterilisation of waste or effluent, including the cremation of human or animal tissue’;

The term ‘waste’ was never defined in terms of the NEMA, and as a result, reference was made to the definition of ‘waste’ as defined in terms of the ECA. The terms ‘recycling’ and ‘re-use’ were also not defined in terms of the ECA, and as a result, these terms remained opened for interpretation. This situation was, however, rectified by the NEMWA.

### **3.3. CURRENT WASTE MANAGEMENT ENVIRONMENTAL LEGISLATION**

#### *3.3.1 The National Water Act, 1998 (Act No. 36 of 1998) – NWA*

Waste management regulated in terms of the NWA pertains to discharging, disposal and certain controlled activities of waste.

Only discharging and disposal, as far as it relates to waste management pertaining to water resources, are being regulated in terms of the NWA.

Waste is defined in terms of the NWA to regulate activities and processes that involve:

- **Section 21(e)** water use: ‘engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1)’. These activities may include the following in terms of section 37(1) as contained in the NWA:
  - Engaging in the irrigation of land with waste or water containing waste generated through any industrial activity or by a waterworks;

- Engaging in the intentional recharging of an aquifer with waste or water containing waste;
  - Engaging in an activity that is declared under section 38(1) as a controlled activity if the relevant authority is satisfied that the activity in question is likely to impact detrimentally on a water resource
- **Section 21(f)** water use: ‘discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit’;
  - **Section 21(g)** water use: ‘disposing of waste in a manner which may detrimentally impact on a water resource’;
  - **Section 21(h)** water use: ‘disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power-generation process’.

Waste, in terms of the NWA, is defined as,

*‘any solid material or material that is suspended, dissolved or transported in water (including sediment) and which is spilled or deposited on land or into a water resource in such volume, composition or manner as to cause, or to be reasonably likely to cause the water resource to be polluted’.*

In terms of the NWA, a water resource is defined as follows:

A watercourse, which includes the following:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and



- Any collection of water which the Minister may, by notice in the *Gazette*, declare to be a watercourse,
- And a reference to a watercourse includes, where relevant, its bed and banks;
- Surface water;
- Estuary – partially or fully enclosed body of water –
  - Which is open to the sea permanently or periodically;
  - Within which the sea water can be diluted, to an extent that it is measurable, with fresh water drained from land.
- Aquifer – a geological formation which has structures or textures that hold water or permit appreciable water movement through them;

**‘Pollution’** is defined as the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it -

- (a) less fit for any beneficial purpose for which it may reasonably be expected to be used; or
- (b) harmful or potentially harmful -
  - (aa) to the welfare, health or safety of human beings;
  - (bb) to any aquatic or nonaquatic organisms;
  - (cc) to the resource quality; or
  - (dd) to property;

**‘Resource quality’** means the quality of all the aspects of a water resource including -

- (a) the quantity, pattern, timing, water level and assurance of instream flow;
- (b) the water quality, including the physical, chemical and biological characteristics of the water;
- (c) the character and condition of the instream and riparian habitat; and
- (e) the characteristics, condition and distribution of the aquatic biota;

Although ‘pollution’ is a very broad concept in terms of the NWA, if the material is discharged or disposed of on land or into a water resource, or used in a controlled activity in such a volume, composition, or manner that it will not cause or is not likely to cause a physical, chemical or biological property of the water resource to be altered, the material cannot be regarded as a waste.

Therefore, if the activity pertaining to waste falls within the ambit of the above listed water uses (discharging or disposal) or controlled activities, the activity must be authorised in terms of section 40 of the NWA (water use license), unless it is covered in Schedule 1 of the NWA or if it falls within the ambit of a general authorisation.

The activities pertaining to waste contained in Schedule 1 can be summarised as follows:

*‘A person may, subject to the conditions as contained in the NWA –*

*Discharge –*

*Waste or water containing waste;*

*Run-off water, including storm water from any residential, recreational, commercial or industrial site, into a canal, sea outfall or other conduit controlled by another person authorised to undertake the purification, treatment or disposal of waste or water containing waste, subject to the approval of the person controlling the canal, sea outfall or other conduit'.*

There are currently two general authorisations applicable.

It is important to take cognisance of the fact that a water use license had to be obtained separately from a section 20 ECA permit, and EIAs in terms of the ECA and all other relevant authorisations in terms of the current NEMA and the NEMWA. Therefore, the WA is still applicable, and a water use license must be obtained in addition to a waste management license in terms of the current waste management legislation, i.e. NEMWA.

### *3.3.2 The National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) – the NEMAQA*

The NEMAQA replaced the APPA and fundamentally reformed the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation, and for securing ecologically sustainable development while promoting justifiable economic and social development.

The NEMAQA was promulgated on 24 February 2005 and came into effect on the 11<sup>th</sup> of September 2005, except for sections 21,22,36, to 49, 51(1)(e) and (f), 51(3), 60 and 61, which came into operation on the 1<sup>st</sup> of April 2010, and as a result, the APPA was repealed in its entirety.

As in the case with the APPA, no specific provisions are made with regard to waste management regulation in terms of the NEMAQA. However, in terms of Section 21 of the NEMAQA, provision is made for the,

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

Such a list has been published and took effect on the 1<sup>st</sup> of April 2010. In terms of the listed activities, the following activities may have an impact on waste management in terms of the NEMAQA, which is listed in detail in Annexure 1:

- **Subcategory 2.3:** Industrial fuel oil recyclers;
- **Subcategory 4.20:** Slag processes;
- **Subcategory 4.21:** Metal recovery;
- **Subcategory 8:** Disposal of hazardous and general waste;
- **Subcategory 9.1:** Pulp and Paper Manufacturing Activities, including By-Products Recovery;
- **Subcategory 9.1:** Lime recovery kiln;
- **Subcategory 9.2:** Alkali waste chemical recovery furnaces;
- **Subcategory 9.3:** Copeland alkali waste chemical recovery process;
- **Subcategory 10:** Animal matter processing.

The aforementioned list of activities that may have an impact on waste management is based on the definition of waste, to include recovery, re-use and recycling of materials as envisaged in terms of NEMWA. Since the NEMAQA does not provide for a definition of waste, there is now often referral to the definition of waste as contained in NEMWA, since NEMWA was promulgated in 2009.

This poses some problematic conclusions/repercussions for industry, especially the steelmaking industry, which will be discussed in Chapter 5.

In addition to the regulation of waste management aspects by the listed activities which may be connected to waste management, the following requirements must be included in an air quality license, as contained in section 43 of the NEMAQA:

*‘43. Contents of provisional atmospheric emission licences and atmospheric emission licences*

*(1) A provisional atmospheric emission licence and an atmospheric emission licence must specify -*

- (a) the activity in respect of which it is issued;*
- (b) the premises in respect of which it is issued;*
- (c) the person to whom it is issued;*
- (d) the period for which the licence is issued;*
- (e) the name of the licensing authority;*
- (f) the periods at which the licence may be reviewed;*
- (g) the maximum allowed amount, volume, emission rate or concentration of pollutants that may be discharged in the atmosphere -*
- (i) under normal working conditions; and*

- (ii) under normal start-up, maintenance and shut-down conditions;*
- (h) any other operating requirements relating to atmospheric discharges, including non-point source or fugitive emissions;*
- (i) point source emission measurement and reporting requirements;*
- (j) on-site ambient air quality measurement and reporting requirements;*
- (k) penalties for non-compliance;*
- (l) greenhouse gas emission measurement and reporting requirements;  
and*
- (m) any other matters which are necessary for the protection or enforcement of air quality'.*

As a result of the contents of Section 43 as contained in the NEMAQA, it is clear that additional waste management measures may be implemented as part of air quality licenses; even in instances where the listed activity is not connected to waste management, for example the correct disposal of dusts as collected as part of dust extraction systems.

### *3.3.3 The National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) – NEMWA*

The NEMWA fundamentally reformed the law regulating waste management in South Africa, and for the first time provided a coherent and integrated legislative framework for addressing all the steps in the waste management hierarchy by providing a new definition of waste, as well as definitions for the recovery, re-use and recycling of waste

(SA, 2010(a):8).

The most significant piece of legislation regulating all waste management aspects within South Africa, falling under the framework legislation of the NEMA, is the NEMWA which was promulgated and took effect on 1 July 2009. One of the most important objectives of the NEMWA, which is significantly different from previous waste management legislation, is the fact that NEMWA wants to achieve compliance with regard to the waste hierarchy principles. One of the most significant objectives as contained in the preamble of NEMWA states that,

*'sustainable development requires that the generation of waste is avoided, or where it cannot be avoided, that it is reduced, re-used, recycled or recovered and only as last resort treated and safely disposed of'.*

The NEMWA thus ultimately seeks, *inter alia*, to encourage the prevention and reduction / minimisation of waste generation through legislated '*command & control*' mechanisms, whilst promoting the justifiable re-use and re-cycling of the waste, and only considers disposal of waste, as well as the remediation of land affected by poor waste management practices, as a last resort. The conceptual approach to waste management is underpinned by the waste hierarchy.

The essence of the approach is to group waste management measures across the entire value chain in a series of steps, which are applied in descending order of priority.

The foundation of the hierarchy, and the first choice of measures in the management of waste, is waste avoidance and reduction. Where waste cannot be avoided, it should be recovered, reused, recycled and treated. Waste should only be disposed of as a last resort.

NEMWA, in addition, addresses those situations in which the waste hierarchy is not implemented successfully, through providing additional measures for the remediation of contaminated land to protect human health and secure the well-being of the environment in terms of section 35-41 as contained in the NEMWA (SA, 2010(a):27).

In order to achieve compliance with the waste hierarchy, the NEMWA changed the definition of waste significantly and for the first time in waste management legislation in South Africa, NEMWA provides for definitions for the re-use, recovery and recycling of materials and also provides for a definition for a by-product since these concepts are now also regulated in terms of the NEMWA.

**Waste** in terms of the NEMWA is now defined as:

*‘Any substance, whether or not that substance can be reduced, re-used, recycled and recovered-*

- (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;*
- (b) which the generator has no further use of for the purposes of production;*
- (c) that must be treated or disposed of; or*
- (d) that is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but -*
  - (i) a by-product is not considered waste; and*
  - (ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste.’*



Recovery, recycle and re-use in terms of the NEMWA is defined as follows:

- **‘Recovery’** means ‘the controlled extraction of a material or the retrieval of energy from waste to produce a product’.
- **‘Recycle’** means ‘a process where waste is reclaimed for further use, which process involves the separation of waste from a waste stream for further use and the processing of that separated material as a product or raw material’.
- **‘Re-use’** means ‘to utilise articles from the waste stream again for a similar or different purpose without changing the form or properties of the articles’.
- **By-product** in terms of the NEMWA is also defined as:

*‘A substance that is produced as part of a process that is primarily intended to produce another substance or product and that has the characteristics of an equivalent virgin product or material;*

The definition of waste can be divided into two parts as follows:

**Table 2 The definition of waste (SA, 2008).**

What is ***included*** as a ‘waste’?

Currently a waste as defined in terms of NEMWA is any substance, whether or not that substance can be reduced, re-used, recycled and recovered-

- (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;
- (b) which the generator has no further use of for the purposes of production;
- (c) that must be treated or disposed of and includes waste generated by the mining and medical

What is ***excluded*** as a waste?

A by-product is not considered waste; and

any portion of waste, once re-used, recycled and recovered, ceases to be waste’

Problems with regard to the interpretation of this definition of waste, as well as the implication thereof for the steel industry, will be discussed in Chapter 5.

In terms of section 19(1) as contained in the NEMWA, the Minister may by notice in the Gazette publish a list of waste management activities that have, or are likely to have, a detrimental effect on the environment and which may not commence without a waste management license in terms of section 20 (b) of NEMWA. The Minister published such a list under Government Notice 718 in Government Gazette 32368 of 3 July 2009. The significance of this list pertaining to waste management in South Africa is that all the recovery, recycling and re-use activities in South Africa are regulated within the ambit of this list of waste management activities.

Furthermore, the NEMWA also makes provision for the classification of waste and will introduce a new classification system, hopefully during 2012. Drafts of the Waste Classification and Management Regulations have already been circulated for public comment and the final publication for comment is planned for early 2012. The aforementioned regulations will introduce the new classification system in terms of the 'SANS 10234' standard.

This standard includes the latest edition of the South African National Standard: Globally Harmonized System of Classification and Labelling of Chemicals – GHS, and supplementary List of Classification and Labelling of Chemicals in accordance with the GHS. These Regulations will supersede the Minimum Requirements Series, with specific reference to the classification of waste, landfill classes, design of landfill lining, leachate collection, and leakage detection systems and disposal of specific wastes to particular classes of landfill. It is also planned by government to publish, together with the aforementioned regulations, regulations with regard to a Standard for Assessment of Waste for Landfill Disposal.

The aforementioned regulations will change the current waste classification and disposal system in terms of the Minimum Requirements significantly. However, for purposes of this dissertation, it will not be necessary to have a detailed discussion in this regard.

As indicated above, the purpose of the new waste management legislation was to provide a coherent and integrated legislative frame work for addressing all the relevant steps as part of the waste hierarchy. However, interviews with SAISI members have indicated that industry feels that this was not achieved by the incorporation of the definition of waste as currently contained in the NEMWA, and as a result, overregulation and duplication are the order of the day.

# CHAPTER 4. THE IRON AND STEELMAKING PROCESS

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## 4.1. INTRODUCTION

As discussed in Chapter 2, part of the research aim is to determine the life cycle of the iron and steel making process, and determine possible alternative uses for the materials resulting from secondary production processes. In order to achieve this research aim, a discussion will follow with regard to primary steelmaking, secondary steelmaking, and alternative techniques, together with a discussion of the possible uses of by-products forming part of the secondary production processes.

The iron and steel making process is often associated with operations that are detrimental to the environmental, especially with regard to air emissions and waste management related aspects. However, the iron and steel making process also presents important opportunities that are in line with the waste hierarchy, as envisaged in terms of the NEMWA. Materials are recycled and materials that do not have an alternative use outside the ambit of the iron and steel operations are often used as part of the internal processes in order to avoid waste disposal. Thus, the iron and steel process provides significant opportunities to give effect to the waste hierarchy.

Steel is manufactured by the chemical reduction of iron ore, using an integrated steel manufacturing process or a direct reduction process. In the conventional integrated steel manufacturing process (also referred to as primary steelmaking), the iron from the blast furnace is converted to steel in a basic oxygen furnace (BOF). Steel can also be made in an electric arc furnace (EAF) from scrap steel and, in some cases, from direct reduced iron. BOF is typically used for high-tonnage production of carbon steels, while the EAF is used to produce carbon steels and low-tonnage speciality steels. An emerging technology, i.e. direct steel manufacturing, produces steel directly from iron ore.

In the BOF process, coke making and iron making precede steel making. These steps are not necessary with an EAF. Pig iron is manufactured from sintered, pelletized or lump iron ores using coke and limestone in a blast furnace.

It is then fed to a BOF in molten form, along with scrap metal, fluxes, alloys and high-purity oxygen to manufacture steel. In some integrated mills, sintering (heating without melting) is used to agglomerate fines and thus recycle iron-rich material such as mill scale.

In view of the aforementioned, it is clear that modern steelmaking processes can be divided into the following three categories:

- Primary steelmaking - a combination of iron as well as steel making. Pig iron is produced from the blast furnace and used as the feedstock into the BOF to produce steel;
- Secondary steelmaking - uses scrap steel as the feedstock into the EAF to produce steel. Iron making does not form part of this process;
- New/alternative iron making techniques - smelting reduction and direct reduction (EC, 2001: 16).

The main upstream operations covered by the descriptions are:

- Loading, unloading and handling of bulk raw materials;
- Blending and mixing of raw materials;
- Coke production;
- Sintering and pelletisation of iron ore;

- The production of molten iron by the blast furnace route, including slag processing;
- The production and refining of steel using the basic oxygen process, including upstream ladle desulphurisation, downstream ladle metallurgy and slag processing;
- The production of steel by electric arc furnaces, including downstream ladle metallurgy and slag processing;
- Continuous casting
- Smelting reduction and direct reduction

With regard to the associated processes (for example reheat or heat treatment furnaces, power plants, oxygen plants), as well as all other steel related downstream processes, (for example rolling, pickling, coating, etc.) they are not included as part of this dissertation (EC, 2001: xxv).

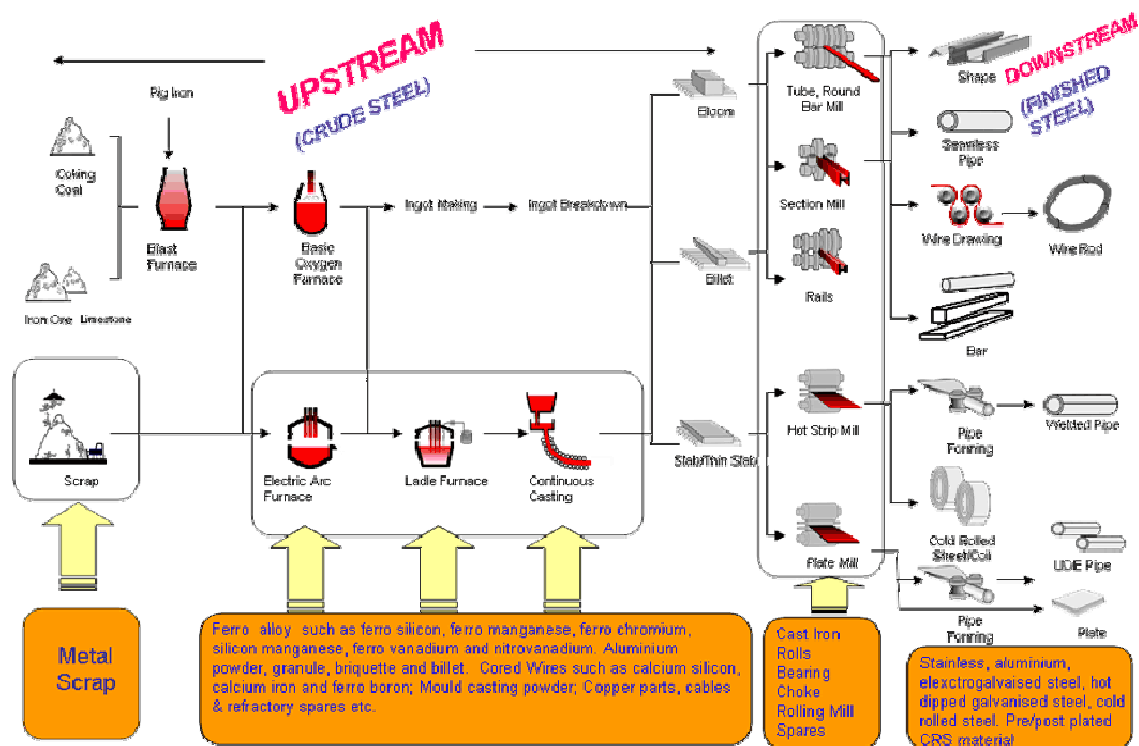


Figure 2 Process flow of Primary and Secondary Steelmaking

## 4.2. PRIMARY STEELMAKING

Of the abovementioned three steel-making routes, primary steelmaking (i.e. the classic blast furnace/basic oxygen furnace route) is by far the most complex; taking place in large industrial complexes known as integrated steelworks, covering areas up to several square kilometres.

Integrated steel works are characterized by networks of interdependent material and energy flows between the various production units, for example sinter plants, coke oven plants, blast furnaces and basic oxygen steel-making plants with subsequent castings. Before describing these individual types of plants in detail, an overview of the interdependencies mentioned will be given (EC, 2001: 17).

In an integrated steelworks the blast furnace is the main operational unit where the primary reduction of oxide ores takes place leading to liquid iron, also known as pig iron. Modern high-performance blast furnaces require physical and metallurgical preparation of the burden. The two types of iron ore preparation plants are the sinter plants and the pellet plants. Pellets are nearly always made from one well-defined iron ore or concentrate at the mine and are transported in this form. Sinter is generally produced at the ironworks from pre-designed mixtures of fine ores, residues and additives. The sinter option is the preferred option in South African steel-making (EC, 2001: 17).

The main reducing agents in a blast furnace are coke and powdered coal forming carbon monoxide and hydrogen which reduce the iron oxides. Coke and coal also partly act as a fuel. Coke is produced from coal by means of dry distillation in a coke oven and has better physical and chemical characteristics than coal. In many cases, additional reducing agents / fuel are supplied by injection of oil, natural gas and (in a few cases) plastics. A hot blast provides the necessary oxygen to form the carbon monoxide (CO), which is the basic reducing agent for the iron oxides (EC, 2001: 19).

The blast furnace is charged at the top with burden consisting of alternate layers of coke and a mixture of sinter and/or pellets, lump ores and fluxes. In the furnace the iron ore is increasingly reduced and liquid iron and slag are collected in the bottom of the furnace, from where they are tapped. The slag from the blast furnace is granulated, pelletised, or tapped into slag pits. The slag granules or pellets are usually sold to third parties for alternative uses in road construction and for agricultural purposes (EC, 2001: 19).

The liquid iron from the blast furnace (pig iron) is transported to a basic oxygen furnace, where the carbon content (approximately 4%) is lowered to less than 1%, thereby resulting in steel. Upstream ladle desulphurization of the pig iron and downstream ladle metallurgy of the steel are generally applied in order to produce steel of the required quality. On leaving the basic oxygen furnace the liquid steel is cast, either into ingots or by means of continuous casting.





#### *4.2.1 Interdependency of the different production processes / units in terms of energy, by-products / residues, air and water*

The individual units, as discussed above, are connected both in terms of product flows and internal flows of residues (mill scale, filter dusts, sludges from scrubbing blast furnace gas or basic oxygen furnace gas, etc), water (common treatment of various wastewater streams, cascade usage of cooling water, etc) and energy (COG, blast furnace gas, basic oxygen furnace gas, steam from the blast furnace top pressure turbines or basic oxygen furnaces, etc).

The following interdependencies have been installed in order both to minimize emissions and to optimize productivity and reduce costs (EC, 2001: 19):

##### 4.2.1.1 Energy

Energy interdependency is the most complex of these interdependencies. The dominant energy inputs are coal and, if bought from an external supply, coke. Also electricity, natural gas, oil and (in a few cases) plastics represent the energy inputs. Coke oven gas (COG), Blast furnace gas (BFgas) and basic oxygen furnace gas (BOF gas) are used for many purposes (heating coke oven batteries, provision of hot blast, ignition of the sinter feed, heating furnaces for hot rolling, etc.). Steam from top pressure turbines of the blast furnaces or from basic oxygen furnaces is also used for various processes (EC, 2001: 19).

COG and BFgas are recovered and used at all integrated steelworks. However, this is not the case for BOF gas or for steam recovery using blast furnace top pressure turbines. Steam recovery is dependent on top pressure of the blast furnace, on the operation condition of the BOF, and the usability of BOF gas (EC, 2001: 19).

#### 4.2.1.2 Solid residues / by-products

The management of residues in an integrated steelworks is characterized by advanced techniques for extracting value from the various types of slag and by recycling most of the residues in the sinter plant, which can be considered the 'digester of an integrated steelworks'.

Beside the sintering process itself, the sinter plant plays this important role of recycling residues for which no adequate alternatives exists. Only small parts of the overall quantity of residues are landfilled. This often consists of fine dusts from BFGas cleaning, rubble, fine dust from BOF gas scrubbing (if wet cleaning is used), and in some cases, the high alkali chlorides and heavy metal chlorides from the last field of electrostatic precipitators treating the off-gas from sinter strands (EC, 2001: 22).

#### 4.2.1.3 Water

The water management in an integrated steelworks primarily depends on the local conditions, and above all, on the availability of fresh water and legal requirements. Legal restraints tend to focus on minimizing discharges of cooling water and materially polluted wastewater, but there are also cases where the authorities demand the avoidance of plumes from re-cooling towers, which prevents further cooling water recycling (EC, 2001: 23).

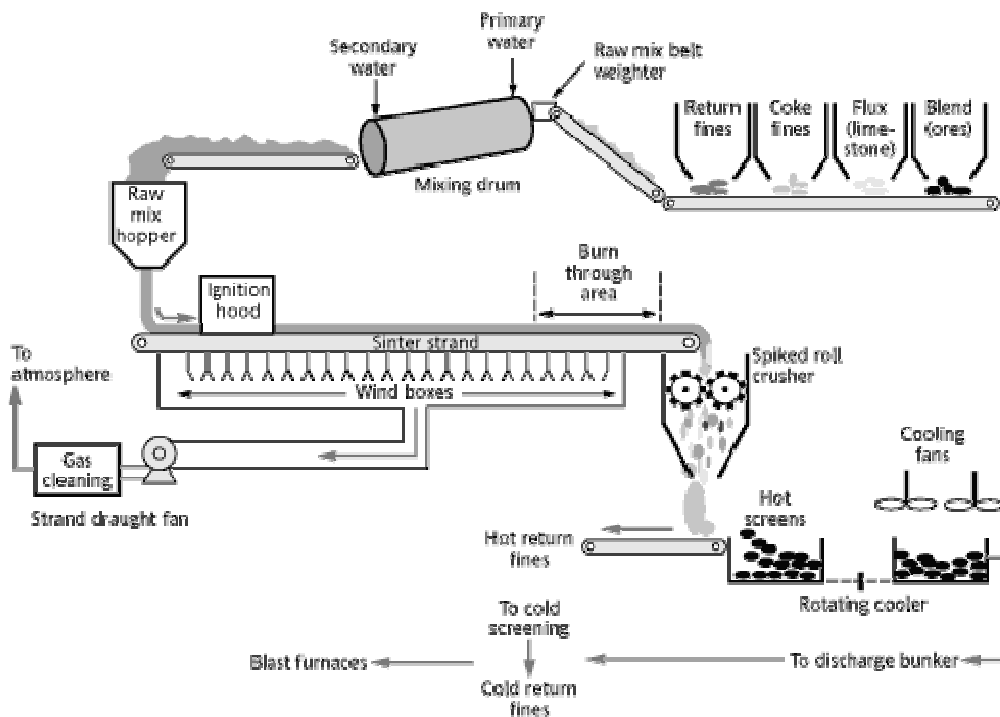
The following processes form an integral part of the primary steel making process:

#### 4.2.2 *Sinter plants*

The sinter process forms part of primary steelmaking. The function of the sinter plant is to supply the blast furnace with a raw material referred to as 'sinter'; a combination of blended ores, fluxes and coke which is partially 'cooked' or sintered.

#### 4.2.2.1 Purpose of the sinter process

Modern high-performance blast furnaces achieve improved performance by prior physical and metallurgical preparation of the burden, which improves permeability and reducibility. This preparation entails agglomerating the furnace charge by sintering. The charge consists of a mixture of fine ores, additives, iron-bearing recycled materials from downstream operations such as coarse dust and sludge from BFGas cleaning, mill scale casting scale, etc to which coke breeze is added enabling the ignition of it (EC, 2001: 24).



**Figure 4** Flow process of a sinter plant

#### 4.2.2.2 Sinter Process

##### 4.2.2.2.1 Blending and mixing of raw materials

Raw materials require blending prior to the sintering operation. This generally involves layering the materials on prepared areas in the precise quantities required by the sintering operation. Some flux material may also be added at this stage, as can recycled materials from the downstream operations mentioned above.

The ore beds are usually finished by covering with a layer of coarse material to prevent wind whipping. At the start of the sintering operation, the ore blend is transferred from the beds to storage bunkers at the start of the sinter plant (EC, 2001: 24).

Other additives, such as lime, olivine, collected dust and mill scale, dusts (and to a much lower extent sludges) from gas cleaning in blast furnaces and recycled sinter (particles in the range of < 5mm) from sinter screening, may be added to the ore blend at the mixing stage (EC, 2001: 25).

Coke breeze (small-grade coke with particle sizes of < 5mm) is the most commonly used fuel for the sintering process. It is usually produced directly by an on-site coke oven plant and stored in hoppers for later use. Alternatively, breeze may be obtained by crushing coke. In some cases anthracite is used as a fuel. Integrated steelworks with insufficient coke capacity to meet the needs of their sinter plant rely on external coke breeze suppliers (EC, 2001: 25).

The ore blend and the coke breeze are weighed on conveyor belts and loaded into a mixing drum. Here, they are blended completely and the mixture is dampened to enhance the formation of micro pellets, which improves the permeability of the sinter bed.

Where bunker blending and mixing are employed the emissions are abated by evacuation of particulate matter and subsequent purification of the collected gas (EC, 2001: 25).

#### 4.2.2.2.2 Sinter strand operation

The sinter plant essentially consists of a large travelling grate of heat resistant cast iron. The material to be sintered is placed on top of a 30-50mm deep layer of recycled sinter. This bottom layer prevents the mixture from passing through the slots of the grate and protects the grate from direct heat of the burning mixture (EC, 2001: 25).

In modern sinter plants, the layer of materials to be sintered is approximately 400-600mm deep, but shallower beds are common in older plants. At the start of the grate a canopy of gas burners ignites the coke breeze in the mixture. In the down-draft process, a powerful fan draws process air through the entire length of the sinter bed into distribution chambers located underneath the grate known as wind-boxes. The waste gas flow from a sinter plant varies from 350000 to 1600000 Nm<sup>3</sup>/hour, depending on the plant size and operating conditions. Typically the specific waste gas flow is between 1500 and 2500 Nm<sup>3</sup>/t graded sinter.

Most sinter plants with large suction areas have two off-gas collecting mains with separate fans and de-dusting devices, which could be suitable for advanced emission reduction measures (EC, 2001: 26).

As the sinter mixture proceeds along the grate, the combustion front is drawn downwards through the mixture. This creates sufficient heat (1300-1480°C) to sinter the fine particles together into porous clinker, referred to as sinter (EC, 2001: 26).

A number of chemical and metallurgical reactions take place during the sintering process. These produce both the sinter itself, and also dust and gaseous emissions.

The reactions overlap and influence each other, occurring as solid-state and heterogeneous reactions between the melt, solids and gaseous phases which are present in the sintering zone (EC, 2001: 26).

The number and variety of pollutants are present in the off-gas from the sinter strand, as is the case for most of the combustion processes. The gas contains particulate matter (heavy metals, mainly iron compounds, but also other ones, especially lead compounds), alkalichlorides, sulphur oxides, nitrogen oxides, hydrogen chloride, hydrogen fluoride, hydrocarbons, carbon monoxide, and also significant trace amounts of PAH and aromatic organo-halogen compounds such as PCDD/F and PCB. The gaseous emissions from the sinter plant dominate overall emissions from integrated steelworks (EC, 2001: 26).

The coke breeze is fully combusted before reaching the end of the grate, and the last one or two wind-boxes are used to begin the cooling process. The cooler can be integrated into the sinter strand, but it is the most common for it to be separate. As it is produced, sinter falls off the end of the grate in the form of a cake, which is broken up on a crash deck and by a crusher. In many plants the sinter then goes through a hot screening process, in which fines measuring less than around 5mm are separated and recycled to the feed mixture (EC, 2001: 27).

#### 4.2.2.2.3 Hot sinter screening and cooling

When the cooling is not integrated into the strand, the sintered material proceeds to a cooler after coming off the strand. The cooler is typically a rotating structure, some 20-30m in diameter, in which the sinter is placed in a layer more than 1m thick. The sinter is cooled by air, which is forced upwards through the layer. Sinter cooling gas flow is high and depends on the kind and age of the system used. Sometimes, the sensible heat in the sinter cooling waste gas is used in a waste-heat boiler, in the sinter grate ignition hoods, or to preheat the green feed. Other designs of cooler are also known to exist (EC, 2001: 27).

Cooled sinter is transferred to screens that separate the pieces to be used in the blast furnace (4-10mm and 20-50mm) from the pieces to be returned to the sinter process (0-5mm as 'returnfines', 10-20mm as 'hearth layer'), (EC, 2001: 27).

#### 4.2.3 *Coke oven plants*

Coke is one of the reducing agents used as part of the blast furnace iron making process to form carbon monoxide and hydrogen, which reduce the iron oxides. Coke also partly acts as a fuel. Coke is produced from coal by means of dry distillation in a coke oven and has better physical and chemical characteristics than coal (EC, 2001: 109).

Coal pyrolysis means the heating of coal in an oxidation free atmosphere to produce gases, liquids and a solid residue (coke). Coal pyrolysis at high temperature is called carbonisation. In this process the temperature of the flue gases is usually 1150-1350°C, indirectly heating the coal up to 1000-1100°C for 14-24 hours. This produces blast furnace and foundry cokes. Coke is the primary reducing agent in blast furnaces and cannot be wholly replaced by other fuels such as coal. Coke functions both as support material and as a matrix through which gas circulates in the stock column (EC, 2001: 109).

##### 4.2.3.1 Applied processes and techniques

By the 1940s the basic design of modern coke ovens had been developed. The ovens were about 12m long, 4m high and 0.5m wide, and were equipped with doors on both sides. The air supply was preheated by the hot exit gas; waste heat recovery enabled higher temperatures and increased coke rates. Since the 1940s, the process has been mechanised and the constructing materials have been improved without significant design modifications. Current assemblies may contain up to 60 ovens as large as 14m long and 6m high. Because of heat transfer considerations, widths have remained 0.3-0.6m. Each oven in the battery holds up to 30 tonnes of coal.



Some recently constructed coke oven plants have increased dimensions yet further (EC, 2001: 109).

Developments in recent years have also been particularly aimed at minimising emissions from the processes and at improving working conditions for operators. The coke making process can be subdivided into the following processes:

- Coke handling.
- Battery operation (coke charging, heating/firing, coking, coke pushing, coke quenching).
- Coking.
- Collection and treatment of COG with recovery of by-products (EC, 2001: 110).

These processes will now be discussed individually:

#### 4.2.3.2 Coke handling

Coal handling comprises the following steps:

- Discharge of coal – the coal is discharged from ships or trains onto transportation system or for storage. Usually large cranes with grabs are used. Wind may cause coal dust emissions.
- Coal storage – coke oven plants are normally associated with large coal stocking areas. Wind may cause coal dust emissions. Attention has to be paid to proper treatment (sedimentation) of run-off water.
- Coal transport – coal transport by conveyor, possible transfer points outside buildings and transportation by road has to be taken into consideration.

- Coal preparation – coal preparation comprises bed blending, bunker blending and crushing which may lead to dust emissions. During blending recycled substances such as tar may be added which may lead to emissions of volatile compounds,
- Charging of the coal tower (coal dust emissions may occur),
- Charging of the charging car (coal dust emissions may occur), (EC, 2001: 111).

#### 4.2.3.3 Coke oven battery operations

The operation of a coke oven battery comprises of the following processes:

- **Coal charging:**

There are a number of techniques for charging coke ovens with pulverised coal (70-85% is < 3mm) through the charging holes. The most common technique is gravity charging by charging cars. This can be simultaneous, sequential or stage charging by speed controlled horizontal screw feeders or turntables. Other systems are also possible. Regardless of the system the flow of the coal must be kept under control. General measures are given for all these systems. The aim of these measures is to achieve 'smokeless' charging (charging with reduced emissions), (EC, 2001: 112).

Within the process a distinction can be made between the following:

- Emissions during the charging process itself;
- Evacuation and cleaning of the charging gases;
- Leveller door emissions during levelling the coal with the levelling bar;

- Fugitive emissions from material spilled on the oven deck (EC, 2001: 112).

- **Heating / firing of the chambers**

The individual coke oven chambers are separated by heating walls. These consist of a certain number of heating flues with nozzles for fuel supply and with one or more air inlet boxes, depending on the height of the coke oven wall. The average nozzle-brick temperature, characterising heating flue operation, is usually set between 1150 and 1350°C. Usually, cleaned coke oven gas is used as a fuel, but other gases such as (enriched) blast furnace gas can be used as well (EC, 2001: 113).

In order to improve energy efficiency, regenerators are located right under the ovens, exchanging heat from flue gases with combustion air or blast furnace gas. If the heating walls are not completely gas-tight because of cracks (which is very often the case), coke oven gas will reach the flue gas and will be emitted with it via the stack (EC, 2001: 113).

#### 4.2.3.4 Coking

The carbonisation process starts immediately after coal charging. The gas and moisture driven off accounts for about 8-11% of the charged coal. This crude COG is exhausted via ascension pipes into the collecting main. The high calorific content of this gas means that after purification it can be used as a fuel (e.g. for battery heating). The coal is heated by the heating/firing system described above, and remains in the coke oven until the centre of the coal has reached a temperature of 1000-1100°C (EC, 2001: 114).

Depending on oven width and heating conditions the coking process takes around 14-24 hours to complete (EC, 2001: 114).

- **Coke pushing and quenching:**

Fully carbonised coke is pushed out of the oven into a container by the ram of the pusher machine. Contact with atmospheric oxygen causes the coke to start burning instantaneously. The container used is generally a coke quenching car which transports the hot coke to a quenching tower. Here the coke is quenched directly by large volumes of water. The water fraction that does not evaporate can be collected and used in the next batch, thus preventing wastewater emissions (EC, 2001: 114).

In an alternative system, known as dry quenching, the quenching car takes the hot coke to a vertical quenching chamber. Inert quenching gas circulates around the chamber, which is isolated from the atmosphere, thus preventing combustion whilst cooking coke. The gas is cooled by a heat exchanger in order to recover thermal energy (EC, 2001: 115).

#### 4.2.3.5 Collection and treatment of COG with recovery of by-products

Raw COG has a relatively high calorific content due to the presence of hydrogen, methane, carbon monoxide and hydrocarbons. Furthermore, the raw coke oven gas contains valuable products such as tar, light oil, sulphur and ammonia (EC, 2001: 115).

Tar and naphthalene in the raw gas may clog the piping and equipment, and should be removed first. For each tonne of coke produced, approximately 35 to 45kg of tar may be recovered. Several products can be recovered from the tar such as pitch, anthracene oil, wash oil, naphthalene oil, carbolic oil (phenol) and light oil (EC, 2001: 116)..

Sulphur compounds and ammonia cause corrosion of piping and the sulphur compounds cause emissions of SO<sub>2</sub> when the coke oven gas is used as a fuel. For each tonne of coke produced, approximately 3kg of ammonia and 2.5 kg of H<sub>2</sub>S are generated (EC, 2001: 116).

In some cases light oil, especially BTX, is recovered from the raw coke oven gas as a valuable by-product. Up to 15kg of light oil may be recovered per tonne of coke produced. This oil contains benzene, toluene, xylenes, non-aromatics, homologous aromatics, phenol, pyridine bases, and other organic compounds such as polycyclic aromatic hydrocarbons (PAH), (EC, 2001: 116).

- **Gas cooling:**

Hot crude oven gas enters the ascension pipes at a temperature of approximately 899°C. In the goose neck it is directly cooled by an ammonia liquor spray to a steam saturation temperature of around 80°C. This requires 2-4m<sup>3</sup> of ammonia liquor for each tonne of coal carbonised (EC, 2001: 117).

The liquid phase, i.e. the condensate, is fed to the tar/water separator, whilst the gas phase is led to the primary coolers. It used to be common for primary coolers to be operated as open systems. Nowadays indirect cooling with closed cooling systems is more frequent. When sufficient cooling water of the right temperature is reached, the gas can be cooled to below 20°C, given a moderate ambient temperature. Under these conditions most of the higher boiling point compounds and the water from the steam fraction of the gas will condense (EC, 2001: 117).

Droplets and particles are precipitated in the down-stream electrostatic tar precipitators before the gas is drawn into the washing facilities by exhausters (suction fans). Occasionally electrostatic tar precipitators are installed down-stream of the exhausters. The precipitate from the electrostatic precipitator is also led to the tar/water separator (EC, 2001: 117).

The suction fans cause compression of the gas, and even if the fans are such that this is only slight, the attendant temperature increase cannot be tolerated in view of the down-stream processing conditions. This makes it essential to use so-called final coolers (EC, 2001: 117).

Final coolers may be indirect or direct, in which case the cooling water of which is used to absorb the impurities from the COG.

Consequently, at the end of the cooling cycle, during return-flow cooling using natural draft or fan coolers, emissions are inevitably generated. Closed systems are therefore usually preferred for final cooling, though open cycles are still operated at some plants (EC, 2001: 117).

- **Tar recovery from the coke oven gas:**

Most of the water and the high boiling point hydrocarbons are condensed during coke oven gas cooling. The condensate from the pipes and the electrostatic tar precipitator is led to the tar/water separator, where the tar is recovered. The water phase is separated off as so called 'coal water', and led through the ammonia stripper/still prior to further treatment (EC, 2001: 117). Sometimes scrapers are installed to remove tar from the condensate. These chunks are usually fed back to the coal feed (EC, 2001: 117).

- **Desulphurisation of coke oven gas:**

Coke oven gas contains hydrogen sulphide (H<sub>2</sub>S) and various organosulphur compounds, carbon oxisulphide, mercaptans, etc. All desulphurisation techniques currently in use are highly efficient at removing H<sub>2</sub>S. They are less efficient at removing organosulphur compounds (EC, 2001: 117).

Commercial coke oven gas desulphurisation processes can be divided into two categories:

- Processes using wet oxidation to produce elemental sulphur;

- Processes which absorb and strip H<sub>2</sub>S for subsequent conversion into sulphuric acid or elemental sulphur (EC, 2001: 117).

All wet oxidation processes utilise a reduction-oxidation catalyst to facilitate the wet oxidation of hydrogen sulphide to elemental sulphur or sulphate. All these processes are characterised by very efficient removal of hydrogen sulphide, but have the disadvantage of producing highly contaminated wastewater and/or air, which make elaborate treatment facilities a necessary part of the process.

Absorption/stripping processes are characterised by generally lower H<sub>2</sub>S removal, but since air is not included in the regenerating system and no toxic catalysts are used, emissions to air and water of process-related chemicals are minimised or eliminated. The processes can be operated to produce sulphuric acid, or a very high-purity elemental sulphur (EC, 2001: 118).

A common process combination is NH<sub>3</sub>/H<sub>2</sub>S circuit scrubbing in the low pressure stage, and potassium carbonate scrubbing in the high pressure stage, combined with a BTX washer either at low or at enhanced pressure. Potassium scrubbing at both the pressure stages, combined with a BTX washer, is also common (EC, 2001: 118).

- **Recovery of ammonia from the coke oven gas:**

The ammonia formed during coking appears in both the coke oven gas and the condensate (weak liquor) from the gas. Typically 20-30% of the ammonia is found in the weak liquor (EC, 2001: 118).

Three techniques are applied commercially to remove ammonia from the coke oven gas:

- NH<sub>3</sub>/H<sub>2</sub>S scrubbing circuit. In this process, the ammonia is scrubbed from the

coke oven gas in an ammonia scrubber using water or dilute liquor wash as a scrubbing liquid. The effluent from the ammonia scrubber is used as a scrubbing liquor in the H<sub>2</sub>S scrubber. The effluent from the H<sub>2</sub>S scrubber contains H<sub>2</sub>S and NH<sub>3</sub> and is led to the ammonia stripper and the still. This process is also known as the CarL Still, Diamex or Ammoniumsulphide Kreislaufwascher process (EC, 2001: 118);

- Direct recovery as ammonium sulphate. Two processes can be used: The Otto-type absorber and the Wilputte low differential controlled crystallisation process. In both systems the COG is sprayed with a diluted sulphuric acid solution and ammonium sulphate is yielded (EC, 2001: 118);
- Direct recovery as anhydrous ammonia (NH<sub>3</sub>). The recovery of ammonia from the gas as anhydrous ammonia has been developed by the United States Steel Corporation under the name USS PHOSAM. In this process, ammonia is scrubbed from the coke oven gas by counter-current contact with an ammonia-lean phosphate solution (EC, 2001: 118).

- **Recovery of light oil from coke oven gas:**

The gas leaving the ammonia absorbers contains light oil; a clear yellow-brown oil with a specific gravity of 0.88. It is a mixture of the products of COG with boiling points mostly between 0 and 200 °C, containing well over a hundred constituents. Most of these are present in such low concentrations that their recovery is seldom practicable. The light oil is usually referred to as BTX. The principal usable constituents are benzene, toluene, xylene and solvent naphtha (EC, 2001: 118).

Three main methods are used for the recovery of light oil:

- Refrigeration and compression to temperature below -70 °C and pressures of 10 bar (EC, 2001: 118);



- Absorption by solid absorbents, in which the light oil is removed from the gas by passing the latter through a bed of activated carbon and recovering the light oil from the carbon by heating with indirect or direct steam (EC, 2001: 118);
- Absorption by solvents, consisting of washing the COG with a petroleum wash oil, a coal tar fraction or other absorbent, followed by steam distillation of the enriched absorbent to recover the light oil (EC, 2001: 118).
- **Coke oven water flows:**

A number of water flows are generated during the coking process and coke oven gas cleaning. Some of these flows are related to coking operations themselves and others are related to coke oven gas treatment (EC, 2001: 119).

The water vapour present in the collecting main originates from several sources: coal moisture, 'chemical water', and steam or ammonia liquor used in the goose necks for the suction of the charging gases (EC, 2001: 119). The crude coke oven gas is led through the primary cooler and the electrostatic precipitator, during which the water vapour and the tar are mostly condensed. The condensed water and tar from the collecting main, the coolers and the electrostatic precipitator, are led to the tar/water separator (EC, 2001: 119).

The water from the tar/water separator contains high concentrations of ammonia and is led to the ammonia liquor storage tank (EC, 2001: 119). The ammonia liquor storage tank provides water for the goose neck spray equipment. The ascension pipe lids are sealed. The surplus water in the ammonia liquor storage tank is led to the ammonia stripper/still (EC, 2001: 120).

It should be noted that usually all water flows, except for water from closed cooling systems and wet oxidative desulphurisation systems, are eventually drained from the ammonia still and led to a wastewater treatment plant (EC, 2001: 120). High concentrations of NH<sub>3</sub> are present in the ammonia still.

There are several reasons for decreasing the ammonia concentrations before discharging the water to a wastewater treatment plant or to the environment:

- The ammonia can be recovered as a valuable energy source (in a sulphuric acid plant) or as a valuable by-product (as ammonium sulphate or anhydrous ammonia).
- Free ammonia is highly toxic for aquatic ecosystems (including biological wastewater treatment plants).
- Ammonia has a very high specific oxygen demand. Thus, there is a risk for oxygen depletion of the wastewater treatment plant or the recipient water (EC, 2001: 120).

This has led to ammonia strippers being installed in virtually all coke oven plants. This device strips H<sub>2</sub>S and NH<sub>3</sub> from the liquid by steam and alkaline additives.

The vapours are subsequently led to the crude gas or to the NH<sub>3</sub>/H<sub>2</sub>S scrubbing circuit or to a sulphuric acid plant, where NH<sub>3</sub> and H<sub>2</sub>S are incinerated together. Sometimes the NH<sub>3</sub> is removed from these vapours in saturators, producing ammonium sulphate (EC, 2001: 120).

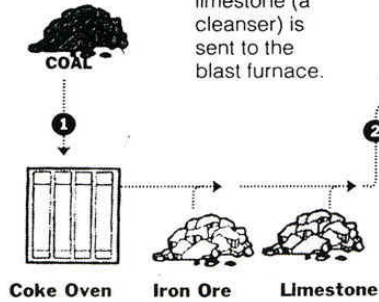
#### *4.2.4 Blast furnace*

The first true coke-based blast furnace was introduced in 1735. The blast furnace remains by far the most important process for the production of pig iron. The technique is likely to continue to dominate pig iron production for at least the next 20 years (EC, 2001: 172).

### THE INGREDIENTS ...

1. Coal is dumped into large ovens where it is heated to up to 2,400 degrees Fahrenheit, which removes most of coal's gases and converts it to coke. Coke is used because it burns with intense heat and little smoke.

2. The coke, along with iron ore and limestone (a cleanser) is sent to the blast furnace.



### ... HELP MELT THE ORE ...

3. The elements are hoisted to the top of the furnace and sprinkled, in layers, into the stove.

4. Hot blasts of air rising melt the falling ore.

5. The molten iron collects at the bottom and is drained.

### ... AND REMOVE IMPURITIES.

6. Impurities rise to the top of the ore and are skimmed off.

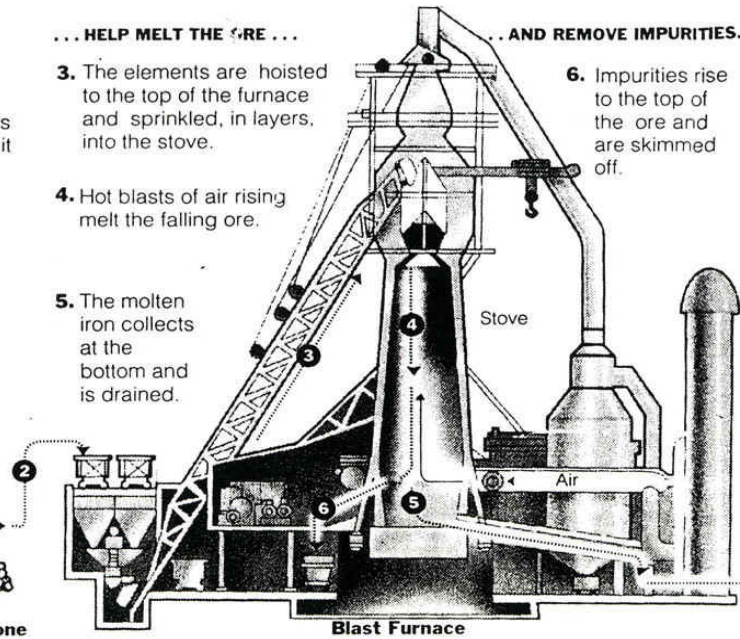


Figure 5 Blast Furnace Process Description

#### 4.2.4.1 Applied processes

A blast furnace is a closed system into which iron bearing materials (iron ore lump, sinter and/or pellets), additives (slag formers such as limestone) and reducing agents (coke) are continuously fed from the top of the furnace shaft through a charging system that prevents the escape of blast furnace gas (EC, 2001: 172).

A hot air blast, enriched with oxygen and auxiliary reducing agents (coal powder, oil, natural gas and in a few cases plastics) is injected on the tuyere level providing a counter-current of reducing gases. The air blast reacts with the reducing agents to produce mainly carbon monoxide (CO), which in turn reduces iron oxides to metal iron. The liquid iron is collected in the hearth along with the slag, and both are cast on a regular basis. The liquid iron is transported in torpedo vessels to the steel plant and the slag is processed to produce aggregate, granulate or pellet for road construction and cement manufacture.

The blast furnace gas is collected at the top of the furnace. It is treated and distributed around the works to be used as a fuel for heating or for electricity production (EC, 2001: 173).

Various reducing agents are available. Carbon/hydrocarbons in the form of coke, coal, oil, natural gas, or nowadays in some cases also plastics, are generally available in sufficient quantities at reasonable cost. However, the choice between several reducing agents is not determined by costs alone. Apart from being a reducing agent, coke also serves as a carrier of the bulk column in the blast furnace. Without this carrying capacity, blast furnace operation would not be possible (EC, 2001: 172).

Iron ore processed nowadays contains a large content of hematite ( $\text{Fe}_2\text{O}_3$ ) and sometimes small amounts of magnetite ( $\text{Fe}_3\text{O}_4$ ). In the blast furnace, these components become increasingly reduced, producing iron oxide ( $\text{FeO}$ ) then a partially reduced and carburised form of solid iron. Finally, the iron charge melts, the reactions are completed, and liquid hot metal and slag are collected in the bottom. The reducing carbons react to form  $\text{CO}$  and  $\text{CO}_2$ . Fluxes and additives are added to lower the melting point of the gangue, improve sulphur uptake by slag, provide the required liquid pig iron quality and allow for further processing of the slag (EC, 2001: 172).

As the blast furnace burden moves down, its temperature increases, thus facilitating oxide reduction reactions and slag formation. The burden undergoes a series of composition changes as this happens:

- The iron oxide in the burden becomes increasingly reduced (forming sponge iron and finally molten pig iron).
- The oxygen from the iron ore reacts with the coke or the carbon monoxide, thus forming carbon monoxide or carbon dioxide, which is collected at the top.
- The gangue components combine with the fluxes to form slag. This slag is a complex mix of silicates of a lower density than the molten iron.

- The coke primarily serves as a reducing agent, but also as a fuel. It leaves the furnace as carbon monoxide, carbon dioxide or carbon in the pig iron.
- Any hydrogen present also acts as a reducing agent by reacting with oxygen to form water (EC, 2001: 174).

The main operations that form part of the blast furnace process are as follows:

#### 4.2.4.2 Charging

The mixture of iron bearing materials (iron ore rubble, sinter and/or pellets) and additives (flux material) are known collectively called the 'burden'. The burden and the accompanying coke are charged into the top of the furnace, either via skips or mechanical conveyor belts. It enters into the furnace via a sealed charging system which isolates the furnace gases from the atmosphere.

This system is necessary because blast furnace pressure exceeds atmospheric pressure (0.25-2.5 bar gauge). Whilst many new large blast furnaces have high top pressures (up to 2.5 bar gauge) there are modern furnaces operating at pressures much lower than this. These pressures can be as low as 0.25 bar gauge, depending on the age of the furnace and other constraints such as available blast pressure and limitations due to the gas treatment plant construction (EC, 2001: 174).

The sealed charging system can be a bell charging system or a bell-less charging system. Some particulate matter and BFGas emissions may arise during charging. The evacuation of gas at the top of the furnace and connection to the BFGas treatment system can be used to control emissions at this stage of the process (EC, 2001: 174).

#### 4.2.4.3 Hot stoves

The hot blast for the blast furnace operation is provided by the hot stoves (sometimes referred to as the 'blast furnace cowpers'). Stoves are auxiliary installations used to heat the blast. Increased blast temperature results in reduction of carbon requirement. A hot blast is needed to transfer heat to the solid burden in order to raise the temperature for reaction. The blast also helps to provide the oxygen necessary for coke gasification, and transport the gas that, on contact with the burden, reduces iron oxides (EC, 2001: 174).

The stoves operate on a cyclical basis. They are heated up by burning gases (usually enriched BFGas) until the dome is at the correct temperature (approximately 1100-1500°C). Combustion gas is then cut off and cold ambient air is forced through the stoves in the reverse direction. The cold air is heated by the hot bricks and thus forms the hot blast (900-1350°C), which is fed to the blast furnace. The process continues until the stove can no longer generate the proper blast gas temperature, after which the initial heating cycle is started again. The duration of each cycle depends on individual site conditions such as energy source, system characteristics and conservation measures (EC, 2001: 174).

In principal hot stoves can be classified as being of either the internal or external combustion chamber type. This distinction is important for CO emissions (EC, 2001: 175). Three or four hot stoves are necessary for each blast furnace. Emissions to air occur during the heating phase of the stove (EC, 2001: 175).

#### 4.2.4.4 Blast furnace process

##### 4.2.4.4.1 General process description

In a blast furnace, the raw materials enter at the top, while the products (molten iron and slag) are tapped from the bottom (the hearth).

The solid burden moves downwards, meeting a rising stream of hot reducing gas. BFGas with residual calorific value is collected from the top of the furnace for treatment (EC, 2001: 176).

A blast furnace can be divided into six temperature zones:

**Table 3 Blast Furnace Temperature Zone (EC, 2001: 176)**

<b>ZONE:</b>	<b>DESCRIPTION:</b>
THE TOP:	At the top, charging of the burden and evacuation of BFgas occurs
THE SHAFT:	In the shaft, the hot BFgas gives its heat to the solid burden. The temperature of the burden rises from ambient temperature to approximately 950°C and the iron oxide becomes partially reduced in this zone.
THE BELLY:	The belly links the shaft to the bosh. In this section the temperature rises further from 950°C to approximately 1 250°C. Further reduction of the iron oxide takes place and coke reaction begins
THE BOSH:	Coke reactions continue to take place in this zone. The iron melts and slag is formed.
THE TUYERES:	In this zone the hot blast is introduced into the furnace by means of a series of tuyeres (up to 42). The tuyeres are located around the upper perimeter of the hearth and are fed by a large pipe (bustle pipe), circling the furnace at the height of the bosh. Temperatures here can exceed 2000°C and the oxides are completely reduced.
THE HEARTH:	The hearth collects the molten pig iron and slag. One to four tapholes are located around the hearth, with one or two in operation at any time.

The shaft, belly, bosh and tuyere belt are typically water-cooled with the hearth water, oil or air cooled. The furnace is lined with refractory material (EC, 2001: 176).

Pig iron production ranges from approximately 0.5 Mt/a for small blast furnaces to nearly 4 Mt/a for large blast furnace (EC, 2001: 176).

#### 4.2.4.4.2 Blast furnace top gas (BFgas)

BFgas contains about 20-28% CO, 1-5% H<sub>2</sub>, inert compounds (50-5% N<sub>2</sub>, 17-25% CO<sub>2</sub>), some sulphur and cyanide compounds, and large amounts of dust from the burden.



The amount of cyanide may be especially high during blow down operations of the blast furnace, but this only occurs occasionally and then additions are made to the system to minimise cyanide formation. The heating value of BFGas is approximately 2.7 to 4.0 MJ/Nm<sup>3</sup>. The production of BFGas is approximately 1200 to 2000 Nm<sup>3</sup>/t pig iron (EC, 2001: 176).

After cleaning, the BFGas is often used as a fuel after enriching with coke oven gas or natural gas, which have a higher heating value. BFGas can also be used without upgrading, e.g. in the hot stoves, if modern burners and/or combustion air preheating are applied. BFGas can also be used without enrichment or modern burners/preheating if appropriate safety precautions are taken (EC, 2001: 176).

#### 4.2.4.4.3 Zinc and lead

Blast furnace technology uses high-grade ore. Any elements accompanying the iron are distributed between the hot metal phase and slag. Those passing into the hot metal include phosphorous, sulphur, manganese and silicon. Titanium, aluminium, calcium, magnesium and the bulk of silicon and sulphur pass into the slag as oxides or metalloids. It is also possible for a variety of elements to volatilise and deposit on different parts of the blast furnace. This is especially the case for zinc (Zn) and lead (Pb) which reach the blast furnace via iron ores and recycled by-products via the sinter plant (EC, 2001: 177).

The total zinc in the charge generally varies from 100 to 250 g/t of pig iron produced. As a rule of thumb, most modern plants restrict zinc to 100-150 g/t pig iron. Recycled materials with a high zinc or lead content are usually not accepted, or only used in limited amounts (EC, 2001: 177).

Removal of Zn and Pb from the furnace is done by operating the blast furnace in such a way that the temperature in the centre of the furnace is kept above 400°C.

The zinc is then more likely to be removed with the top gas as fine ZnO particles, which are almost completely retained in the BFGas treatment (EC, 2001: 177).

#### 4.2.4.4.4 Direct injection of reducing agents

Most blast furnace installations inject reducing agents into the furnace at the tuyere level. This partially replaces coke in the top charge. This practice enables the operator to optimise the use of reducing agents. Other advantages are increased output and a reduction in the coke-making requirements, thereby decreasing the specific coke oven emissions per tonne of steel produced. Many plants inject powdered coal, oil or natural gas (EC, 2001: 177).

#### 4.2.4.4.5 Casting

The blast furnace is periodically cast to remove the molten pig iron and slag from the hearth. For this purpose one of the tapholes is opened in the side wall of the hearth by means of a taphole drill or soaking bar. In some cases, an oxygen lance is used to open the taphole. Usually, a blast furnace has one to four tapholes. The number of tapholes is determined by the capacity of the blast furnace. In modern blast furnaces, pig iron and slag are tapped together (typically slag starting to run after the hot metal). The slag and pig iron are subsequently separated at the skimmer in the cast house, after which each continues in a separate runner (EC, 2001: 177).

Molten pig iron tapped from the blast furnace flows along refractory or low cement covered runners, lined with a heat resistant alumina-carbon or silica-carbide mixtures, and is poured into ladles (directly or via tilted runners). These ladles can be open or closed top types, or torpedo cars. In this molten state, the metal has a temperature of approximately 1440-1500°C. Slag tapped from the furnace flows in runners to a granulation plant, to slag ladles or to an open pit. At the end of the casting cycle, the tap-hole is closed mechanically by injecting a specific heat resistant tap hole clay mixture, using a so-called 'mudgun' (EC, 2001: 177).

#### 4.2.4.5 Slag processing

The amount of slag produced is determined by the iron ore used and the amount of flux required to achieve the necessary pig iron quality. Slag can be put to a variety of uses including material for road building, concrete aggregate, thermal insulation (mineral wool) and as a cement replacement. Total utilisation of blast furnace slag is a target which has already been met in many cases (EC, 2001: 178)

Currently there are three processes available to treat blast furnace slag:

**Table 4 Slag Processes (EC, 2001: 178)**

<b>PROCESS:</b>	<b>DESCRIPTION:</b>
<p><b>SLAG GRANULATION PROCESS:</b></p>	<p>Granulation is the most common process currently used to treat blast furnace slag. The process involves pouring the molten slag through a high-pressure water spray in a granulation head, located in close proximity to the blast furnace.</p> <p>After granulation, the slag/water slurry is typically transported to a drainage system, consisting of horizontal filtering basin (especially the OCP process), a vertical filtering hopper or a rotating de-watering drum (especially the INBA process). In several cases, the slag/water slurry is transported to a separation tank prior to water drainage. Here, water vapours are collected and condensed, or emitted via a stack.</p> <p>After de-watering the residual moisture of the slag sand is generally around 10%. The filter bed is periodically back-washed with water and air to remove the fine particles (EC, 2001: 178)</p>
<p><b>SLAG PIT PROCESS:</b></p>	<p>The slag pit process involves pouring thin layers of molten slag directly into slag pits adjacent to the furnaces. Alternatively, after collection of slag in ladles the molten slag is slowly cooled and crystallised in open air. The pits are alternately filled and excavated, and lump slag is broken up and crushed for use as coarse aggregate. In practice, cooling time can be reduced by spraying the hot slag with a controlled amount of water, although this increases the potential for odour emissions. When properly applied, the cooling water is totally consumed by evaporation.</p> <p>The slag pit process produces lump slag that is a desirable raw material for road construction. The cooling time has a strong influence on the quality of lump slag produced. Water cooling also improves the micro-structure, achieving better mechanical properties (EC, 2001: 179).</p>
<p><b>SLAG PELLETIZING PROCESS:</b></p>	<p>The pelletizing process is only in use in a few plants worldwide. The molten slag is spread in a layer on a plate, which acts as a deflector. The sheet of slag is sheared by controlled water jets which initiate the swelling and cooling of the slag. The slag is then projected centrifugally into the air on a rotating drum to complete the blowing-up and cooling. The slag particles follow different trajectories according to their size, which ranges from granulated sand to expand pellets.</p> <p>When properly applied, process water is totally consumed by evaporation and as moisture in the product. Specific water consumption is less than that required for wet granulation (EC, 2001: 180)</p>

#### 4.2.5 Basic oxygen steelmaking and casting

The replacement of air with oxygen in steelmaking was originally suggested by Henry Bessemer. Since 1950, oxygen has been used in steelmaking, irrespective of the specific production method. A prerequisite for the cost-effective use of the basic oxygen furnace (BOF) process on an industrial scale was the availability of the required tonnage of technically pure oxygen, as well as the water-cooled lance technology necessary for introducing the oxygen into the converter. The first production-scale BOF was erected at Linz in 1953 (EC, 2001: 216).

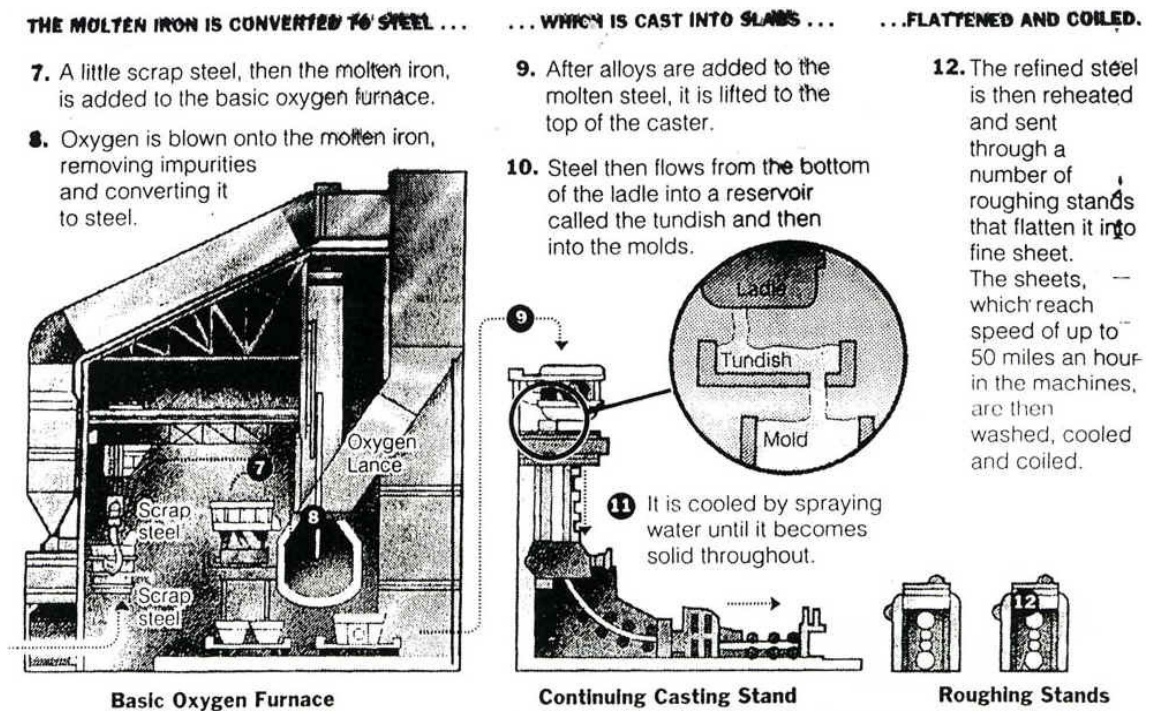


Figure 6 Basic Oxygen Furnace Process Description

#### 4.2.5.1 Applied processes and techniques

The objective in oxygen steelmaking is to burn (i.e. oxidise) the undesirable impurities contained in the metallic feedstock.

The main elements thus converted into oxides are carbon, silicon, manganese, phosphorus and sulphur.

The purpose of this oxidation process, therefore is:

- To reduce the carbon content to a specified level (from approximately 4% to less than 1%, but often lower);
- To adjust the contents of desirable foreign elements;
- To remove undesirable impurities to the greatest possible extent (EC, 2001: 217)

The production of steel by the BOF process is a discontinuous process which involves the following steps:

#### 4.2.5.2 Transfer and storage of hot metal

Hot metal is supplied from the blast furnace to the steelmaking plant using transfer cars or torpedo ladles. The ladles are lined with corundum, mullite, bauxite or dolomite brick with an additional insulating layer between the steel and the refractory material. The torpedo ladle, a form of hot metal mixer travelling on rails, has become the predominant system. The mixing vessel is supported on either side and can be rotated to discharge its contents.

Torpedo ladles are commonly designed with capacities between 100 and 300 tonnes, with the largest units holding up to 400 tonnes. The design of the torpedo ladle

minimise heat loss. The fact that the torpedo ladle doubles as a hot metal mixer eliminates the need for a separate hot metal storage system (EC, 2001: 218). The service life of torpedo ladles in normal use varies between 150000 and 400000 tonnes.

Desulphurisation in the torpedo ladle shortens its potential utilisation cycle between relinings and requires special care in the selection of the refractory materials (EC, 2001: 218).

While transporting in an open-top ladle, hot metal is in some cases stored in mixers. These are rotatable horizontal steel containers lined with refractory brick. They serve to compensate for production fluctuations of the blast furnace and the steelmaking plant, to equalise the chemical composition of individual blast furnace heats, and to ensure homogeneous temperatures. Modern hot metal mixers have capacities of up to 2000 tonnes (EC, 2001: 218).

#### 4.2.5.3 Pre-treatment of hot metal

Classic hot metal pre-treatment comprises the following steps:

- Desulphurisation
- Dephosphorisation
- Desiliconisation

The most commonly process used worldwide is the desulphurisation process. Improved blast furnace metallurgy and a reduction in the amount of sulphur introduced via the reducing agents have resulted in lower hot metal sulphur levels. Today specified sulphur concentrations (between 0.001 and 0.020%) for charging in the converter are commonly adjusted in a hot metal desulphurisation facility located away from the blast furnace.

External desulphurisation also implies benefits in terms of environmental protection. With an upstream blast-furnace process, these generally include reduced consumption of coke and sinter, decreased output of hot metal and steelmaking slag, improved quality of the metallurgical slag, prolonged service life of the refractory linings, and reduced oxygen consumption (EC, 2001: 218).

Known desulphurisation agents include calcium carbide, caustic soda, soda ash, lime and magnesium impregnated materials. Soda desulphurisation is a straightforward process due to the low melting temperature and the resulting easy miscibility of the product with the hot metal. Its drawbacks include the low specificity and the need to find a disposal route for the soda slag produced. The sulphur content of these slags varies between 1 and 15% and their Na<sub>2</sub>O content between 5 and 40%, depending on the process employed. Recycling soda slag within the plant is an impractical proposition because of its high alkalinity. A cost-efficient alternative recycling method has not been devised to date. When dumped, sodium sulphite decomposes into sodium hydroxide solution and hydrogen sulphide due to the presence of water.

The use of soda ash is restricted. Small amounts of soda ash may be utilised to a limited extent during the skimming process (EC, 2001: 218).

The most widespread hot metal desulphurisation method used today is that based on calcium carbide, which has superseded the previous soda process for waste disposal and air management reasons. The use of a mixture of calcium carbide, magnesium and lime allows the hot metal to be desulphurised to final levels below 0.001%, regardless of the initial sulphur content. Disadvantages lie in the fairly low exhaustion of the desulphurising agent and the need for intense mixing of the desulphurising agent with the hot metal. One specific benefit is that the process gives rise to a crumbly slag which can be easily removed. The use of magnesium in addition to calcium carbide is approximately just as common as the use of calcium carbide alone. Other desulphurising agents include lime powder, lime in conjunction with natural gas, and magnesium (EC, 2001: 218).



The desulphurisation process is carried out by a number of different methods and systems. In the more common variants, desulphurisation takes place:

- In the blast furnace launder.
- In the pouring stream.
- In the transfer ladle, or
- In purpose designed metallurgical vessels.

Known desulphurisation equipment includes the immersion lance, the siphon ladle, rotating and oscillating vessels, and agitating equipment for use in the ladle. Calcium carbide is most commonly used in conjunction with the immersion lance and the stirring method. Magnesium is added in powdered form in a carrier gas via an immersed lance. The desulphurisation process is performed at separate treatment stations (EC, 2001: 218).

An example of practice is as follows: A desulphurising agent is blown through a lance into the hot metal with the aid of nitrogen.

The sulphur is bound in the slag, which floats to the top of the hot metal. The slag is then removed in the slag separation unit and the liquid iron is fed from the ladle into the weighing pit. If necessary, process agents are added in these pits. In some cases, a second slag removal is performed here using slag scrapers. After weighing, the pig iron is charged into the converter (EC, 2001: 219).

#### 4.2.5.4 Oxidation in the BOF

In order to meet the objectives mentioned above, undesired impurities are oxidised with subsequent removal with the off-gas or slag. Undesirable impurities are removed with the off-gas or the liquid slag.

The energy required to raise the temperature and melt the input materials is supplied by the exothermic oxidation reactions, so that no additional heat input is required, on the one hand, and scrap or ore have to be added to balance heat on the other hand. In some BOF and combined blowing processes gaseous hydrocarbons (e.g. natural gas) are injected as tuyere coolant (EC, 2001: 219).

The operation of a BOF is semi-continuous. A complete cycle consists of the following phases: charging scrap and molten pig iron, oxygen blowing, sampling and temperature recording and tapping. In a modern steelworks, approximately 300 tonnes of steel are produced in a 30-40 minute cycle. During the process a number of additives are used to adapt the steel quality and to form slag. During charging and tapping, the converter is tilted. During oxygen blowing, the converter is placed in the upright position (EC, 2001: 220).

There are several types of reactors used for the basic oxygen steel making process. The most commonly used type is the LD converter applied for pig iron with low phosphorous content. In the case of high phosphorous content a modified process is used. The converter is a pear-shaped, refractory-lined reactor into which a water-cooled oxygen lance is lowered. Through this lance pure oxygen (>99%) from an air separation plant is blown onto the liquid pig iron (EC, 2001: 220).

Other types of steel making reactors are the OBM (Oxygen-Bottom-Maxhuette process) or Q-BOP process and the LWS process (Loire-Wendel-Sprunch process). These processes differ from the LD-converter in that instead of top-blowing oxygen through a retractable lance, oxygen and fluxes are blown through submerged tuyeres in the furnace bottom (EC, 2001: 221).

In these converters oxygen is injected from the bottom, through tuyeres cooled by hydrocarbons blown into the melt. Combined blowing techniques have also been developed. Where necessary, the process can be enhanced by 'bottom stirring' with argon gas (Ar) or nitrogen (N<sub>2</sub>) through porous bricks in the bottom lining in certain

phases of the process. Alternatively, bottom tuyeres may be used to inject pure oxygen or other gases during the blowing process. This produces a more intensive circulation of the molten steel and improves the reaction between the oxygen and the molten metal. The most frequent types are the LBE process (Lance-Bubbling-Equilibrium process) and the TBM process (Thyssen-Blowing-Metallurgy process). A special version is the KMS process (Klockner-Maxhutte-Steel Making process) in which oxygen is injected from the bottom together with lime and coal (EC, 2001: 222).

The amount of oxygen consumed depends on the composition of the hot metal. Progress of the steel making process is measured by taking samples of the molten metal. In modern plants sampling is performed without interrupting the oxygen blowing, using a sub-lance. The same result is obtained by standardising the process procedures and/or by using adequate dynamic modelling and monitoring. Those practices sustain quality, productivity and reduce the fume emissions during former converter tilting. When the steel quality meets the demands, the oxygen blowing is stopped and the crude steel is tapped from the converter into a ladle. The molten steel is then transported, after secondary metallurgy, to the casting machine (EC, 2001: 223).

The oxidising reactions are exothermic, thus increasing the temperature of the molten iron. Scrap, iron ore or other coolants are added to cool down the reaction and maintain the temperature at approximately 1600-1650°C. Usually, approximately 10-20% of the converter charge is scrap, but values up to 40% are sometimes used.

The amount of scrap charged depends on the pre-treatment given to the pig iron and the required liquid steel tapping temperature. Variations in the market value of scrap and the required steel specifications also have an influence (EC, 2001: 223).

The gases produced during oxygen blowing (converter gas) contain large amounts of carbon monoxide. In many steelmaking plants, measures have been taken to recover the converter gas and use it as an energy source.

Both 'open combustion' and 'suppressed combustion' systems are in use. Open combustion systems introduce air into the converter flue gas duct, thus combusting the carbon monoxide. The heat generated is later recovered in a waste heat boiler. In suppressed combustion, a skirt is lowered over the converter mouth during oxygen blowing. Thus, ambient oxygen cannot enter the flue gas duct and the combustion of carbon monoxide is prevented. The CO-rich flue gas can be collected, cleaned and stored for subsequent use as fuel.

A main advantage of suppressed combustion is the smaller flue gas flow since no combustion occurs and no additional air-nitrogen is introduced. This results in higher productivity since oxygen blowing speed can be increased (EC, 2001: 223). The oxygen steelmaking process also generates considerable quantities of particulate matter, during charging of scrap and hot metal, blowing and during tapping of slag and liquid steel (EC, 2001: 223).

During the steelmaking process, slag is formed. Slag control is intended to effectively reduce the amount of undesirable substances contained in the hot metal and to generate slag of high quality that will be suitable for subsequent processing and usage (EC, 2001: 223). Usually, the slag is cooled and crushed, after which metallic iron is recovered by magnetic separation. The technical properties of the slag make it suitable for many kinds of application in civil and hydraulic engineering (EC, 2001: 223). Because of its structure, LD slag has high abrasion resistance and is therefore often used for road construction. It is also put to other uses or disposed of in landfills (EC, 2001: 223).

#### 4.2.5.5 Secondary metallurgy

The oxidizing process in the converter is usually followed by post-treatment comprising a number of diverse metallurgical operations. Referred to as 'secondary metallurgy', this treatment was developed in response to ever increasing quality requirements and has led to substantial productivity increases by shifting the burden of metallurgical

refining processes away from the converter.

The main objectives of secondary metallurgy are:

- Mixing and homogenising.
- Adjustment of chemical compositions to close analysis tolerances.
- Temperature adjustment in time for the downstream casting process.
- Deoxidation.
- Removal of undesirable gases such as hydrogen and nitrogen.
- Improvement of the oxidic purity by separating non-metallic inclusions (EC, 2001: 223).

An important step in secondary metallurgy is vacuum treatment. This mainly serves to remove gaseous hydrogen, oxygen, nitrogen or residual carbon concentrations from the steel at a vacuum of up to 50 Pa. The purpose of this operation is decarburisation and to free the molten steel from gases dissolved in the heat during the blowing cycle. Thus, the mass content of oxygen and nitrogen can be lowered to 0.0002% and 0.005%, respectively, by reducing pressure to 10 mbar.

Today, vacuum treatment operations include the precision decarburization and deoxidation of unalloyed steels, the decarburisation of chromium-alloyed grades, the removal of sulphur and inclusions, as well as various alloying, homogenisation, temperature management and reoxidation prevention steps.

Vacuum metallurgy has given us steels of improved purity, lower gas content, and tighter alloying tolerances (EC, 2001: 225).

The following vacuum treatment methods are used:

- Ladle stand or degassing.
- Recirculating degassing.

Of these, recirculating degassing is the most common process today, although ladle stand degassing is coming back into widespread use (EC, 2001: 225).

In ladle degassing, the ladle containing the oxidised metal is placed in a vacuumised container. An input of additional energy ensures higher reaction speeds and reduces the final concentration of undesirable bath constituents. This agitation may be accomplished by injecting argon through one or more porous plugs in the ladle bottom, by homogenising the melt via a lance, or by an inductive stirring process (EC, 2001: 225).

Depending on individual requirements, it is possible to add high-purity scrap (cooling scrap) to adjust the temperature of melts or to introduce alloying agents to obtain a precision adjustment of the steel composition. Alloying agents are added to the melt in solid form, or enclosed in a hollow wire which is unwound from a reel system, or else by powder injection via lances. Before the end of the stirring cycle, the oxygen level may be determined with the aid of a special probe and adjusted by adding deoxidants. Throughout the stirring process, the dust/gas mixture rising up from the ladle is drawn off by a movable fume hood (EC, 2001: 225).

In recirculating degassing, the molten metal is vacuum treated continuously or in separate portions. Depending on the process design, a distinction is made between vacuum lift degassing (DH) and vacuum recirculating degassing (RH) (EC, 2001: 225).

The vacuum treatment is a key consideration in plant water management, since the vacuum is generated by a steam and water based process.

Smaller systems use water ring pumps for this purpose, whereas larger facilities rely on multi-stage steam jet vacuum pumps. Gas from the vacuum treatment chamber is drawn into the water by an under-pressure generated on the water jet pump principle. The water flow rates necessary for this evacuation process are considerable and may reach approximately 5m<sup>3</sup>/t LS (EC, 2001: 225).

#### 4.2.5.6 Casting

Once the final steel quality has been achieved the steel is conveyed in a casting ladle to the casting machines. Until a few years ago, the standard method was to pour the molten steel into permanent moulds (permanent mould or ingot casting) by a discontinuous process. Today, the method of choice is continuous casting, whereby the steel is cast in a continuous strand (EC, 2001: 225).

Continuous casting offers several important benefits:

- Energy savings, reduced emissions and reduced water utilisation due to the elimination of slabbing mills and billet mills.
- Improved working conditions.
- High yield rates, in excess of 95%.
- High productivity (EC, 2001: 226).

Since continuous casting was first introduced on an industrial scale in the late 60s, its share in overall EU steel output has risen to approximately 95.4%. Worldwide, about 75% of all steel is now cast by the continuous method. Apart from the traditional ingot casting process, continuous casters have also replaced the blooming-slabbing and semi-finishing operations of conventional hot-rolling mills.

Today, almost all steel grades for rolled products can be handled by the continuous casting route, since the necessary preconditions such as deoxidation and degassing are provided by modern secondary metallurgy (EC, 2001: 226).

There exist various types of continuous casters referred to as vertical type, bending-and-straightening type, bow type and oval bow type machines, depending on their configuration (EC, 2001: 226).

The liquid steel is poured from the converter into a ladle, which transports the steel after secondary metallurgy to the so called tundish of the continuous casting machine (CCM). This is an intermediate ladle with controllable outlet. The ladles are preheated prior to accepting a liquid steel charge in order to avoid temperature stratification in the tundish (EC, 2001: 226).

When the liquid steel has reached the desired temperature, it is poured into the tundish. From here it passes to a short water-cooled copper mould in which no air is present and which performs oscillating up and down movements to prevent the steel from sticking. The mould gives the metal the desired shape. When the metal leaves the casting mould, a 'skin' of solidified steel has formed, and a large number of trundles (the 'pinch-roll') guide the cast steel with a gentle curve toward a horizontal position. Here, the endless casting is cut in pieces with a torch cutter. Slabs, blooms and billets are cast in this way (EC, 2001: 226).

In the case of non-self-supporting sections, the red-hot strand, with its solidified surface zone, moves through a number of driven and un-driven roll pairs which support its shell against ferrostatic pressure. As the core is still liquid it is sprayed carefully with water and cooled until fully solidified (secondary cooling). This process prevents cracks in the strand surface zone, which is still fairly thin, and also protects the rolls from overheating (EC, 2001: 227).



The supporting, conveying and drive elements are commonly rolls equipped with interior and exterior cooling. In the secondary cooling zone, interior roll cooling becomes dispensable as soon as the temperature is reduced sufficiently by the water spray. A number of bearings are connected to an automatic grease lubricating system. Once the strand has fully solidified, it can be cut to size by cutting torches moving with the strand or by shears. The rapid cooling process gives the steel a uniform solidification microstructure with favourable technological properties. The solidification microstructure of the strand can be influenced by downstream air or water cooling (EC, 2001: 227).

The shape of the strand is determined by the mould geometry. Current mould types include rectangular, square, round or polygonal sections. For the production of steel shapes, it is possible to use moulds resembling the approximate cross section of the intended product. Typical strand dimensions in continuous casting vary between 80x80mm and about 310x310mm, 600mm (round) in billet, and 450x650mm in bloom systems, while slab casters produce sizes of up to 350mm in thickness and up to 2720mm in width.

Billet casters can handle several (currently up to eight) strands at the same time, while the number of strands in slab casting is limited to two (EC, 2001: 22).

In ingot casting, the liquid steel is cast into casting moulds. Depending on the desired surface quality, degassing agents (such as NaF) can be added during casting in the ingot mould. After cooling the ingots are taken out of the casting mould and transported to the rolling mills. Subsequently, after pre-heating the ingots are rolled into slabs, blooms or billets. In many places, ingot casting has been replaced by continuous casting. It is expected that ingot casting will eventually be almost completely replaced by continuous casting, except in the case of those products which require ingot casting to achieve the necessary quality, such as producing heavy weights for forging (EC, 2001: 227).

### 4.3. SECONDARY STEELMAKING

Secondary steelmaking consists of electric steelmaking and casting. The electric steelmaking process consists largely of the electric arc furnaces which use ferrous scrap material as input material, as opposed to pig iron, as part of the basic oxygen furnace process (primary steelmaking).

#### 4.3.1 *Applied processes and techniques*

The direct smelting of iron-containing materials, such as scrap, is usually performed in electric arc furnaces (EAF) which play an important and increasing role in modern steel works concepts (EC, 2001: 274).

The major feed stock for the EAF is ferrous scrap, which may comprise of scrap from inside the steelworks (e.g. off cuts), cut-offs from steel product manufactures (e.g. vehicle builders) and capital or post-consumer scrap (e.g end of life products). Direct-reduced iron (DRI) is also increasingly being used as a feedstock, due both to its low gangue content and variable scrap prices. As in the BOF, a slag is formed from lime to collect undesirable components in the steel (EC, 2001: 274).

With respect to the end-products, a distinction has to be made between production of ordinary, so-called carbon steel as well as low alloyed steel, and high alloyed steel/stainless steels (EC, 2001: 276).

For the production of carbon steel and low alloyed steels, the following main operations are performed:

- Raw material handling and storage.
- Furnace charging with/without scrap preheating.

- EAF scrap melting.
- Steel and slag tapping.
- Ladle furnace treatments for quality adjustment.
- Slag handling.
- Continuous casting (EC, 2001: 276).

For high alloyed and special steels, the operation sequence is more complex and tailor-made for the end-products. In addition to the mentioned operations for carbon steels, various ladle treatments (secondary metallurgy) are carried out, such as:

- Desulphurisation.
- Degassing for the elimination of dissolved gases like nitrogen and hydrogen.
- Decarburisation (EC, 2001: 276).

The main operations for the production of carbon steel and low alloyed steels will now be discussed individually:

#### *4.3.2 Raw materials handling and storage*

The main scrap storage areas are usually outside in large uncovered and unpaved scrap yards which may lead to soil pollution but there are also certain plants having covered and paved scrap-yards. Depending on weather conditions, volatile inorganic and organic compounds may be emitted (EC, 2001: 276). Some scrap sorting is carried out to reduce the risk of hazardous contaminants. In-house generated scrap can be cut into manageable sizes using oxygen lancing. The scrap may be loaded into charging baskets in the scrap-yard or may be transferred to temporary scrap bays inside the melting shop.

In some cases the scrap is preheated in a shaft or on a conveyor (EC, 2001: 277).

Other raw materials include fluxes in lump and powder, powdered lime and carbon, alloying additions, deoxidants and refractories are normally stored under cover. Following delivery, handling is kept to a minimum and where appropriate, dust extraction equipment may be used. Powdered materials can be stored in sealed silos (lime should be kept dry) and conveyed pneumatically or kept and handled in sealed bags (EC, 2001: 277).

#### *4.3.3 Scrap preheating*

In the past years more and more new, as well as existing, EAF have been equipped with a system for preheating the scrap by the off gas in order to recover energy. The shaft technology and the Consteel Process are the two proven systems which have been successfully introduced into practice (EC, 2001: 277).

The shaft technology has been developed in steps. With the single shaft furnace normally only about half of the charged scrap can be preheated, but with the finger shaft furnace (which means a shaft having a scrap retaining system) 100% of scrap can be preheated. The first basket is preheated during refining of the previous heat and the second during melt down of the first one. A further modification is the double shaft furnace which consists of two identical shaft furnaces (twin shell arrangement) positioned next to each other and serviced by a single set of electrode arms. The scrap is partly preheated by off gas and partly by side wall burners (EC, 2001: 277).

Scrap preheating may result in higher emissions of aromatic organohalogen compounds such as polychlorinated dibenzo-p-dioxins and -furans (PCDD/F), chlorobenzenes, polychlorinated biphenyls (PCB) as well as polycyclic aromatic hydrocarbons (PAH) and other partial combustion products from scrap which is contaminated with paints, plastics, lubricants or other organic compounds.

This formation can be minimised by post-combustion within the furnace by additional oxygen burners.

They have been developed in order to (post)-combust CO (and hydrocarbons). Thus, the chemical heat from this combustion can also be used for scrap preheating. But such a post-combustion is different from a post-combustion after the EAF in order to reduce emissions of organic compounds like PCDD/F, etc. Such a post-combustion requires considerable quantity of energy (EC, 2001: 277).

#### *4.3.4 Charging*

The scrap is usually loaded into baskets together with lime or dololime which is used as a flux for the slag formation. Lump coal is also charged at some plants with the result of relevant benzene (as well as toluene and xylenes) emissions. The furnace electrodes are raised in the top position, and the roof is then swung away from the furnace for charging.

It is normal to charge about 50-60% of the scrap with the first scrap basket, the roof is then closed, and the electrodes lowered to the scrap. Within 20-30mm above the scrap strike an arc. After the first charge has been melted the remainder of the scrap is added from a second or third basket (EC, 2001: 277).

A proprietary available system is known as the shaft furnace which allows part of the scrap to be preheated by charging it through a vertical shaft integrated in the furnace roof. Another new charging system has been developed. In the Consteel Process the scrap is continuously fed via a horizontal conveyor system into the arc furnace. But this system is not generally considered as a proven technique (EC, 2001: 278).

#### 4.3.5 *Arc furnace melting and refining*

During the initial period of melting, the applied power is kept low to prevent damage to the furnace walls and roof from radiation whilst allowing the electrodes to bore into the scrap. Once the arcs have become shielded by the surrounding scrap the power can be increased to complete melting. Oxygen lances and/or oxy-fuel burners are more and more used to assist in the early stages of melting. Fuels include natural gas and oil. Furthermore oxygen may be brought to the liquid steel by specific nozzles in the bottom or side wall of the EAF. Oxygen in electric furnace steelmaking has found increasing considerations within the last 30 years, not only for metallurgical reasons but also for increasing productivity requirements.

The increase of oxygen usage can be attributed to today's availability of liquid oxygen and on-site oxygen plants (EC, 2001: 278).

Oxygen for metallurgical reasons is used for decarburisation of the melt and removal of other undesired elements such as phosphorous, manganese, silicon and sulphur. In addition, it reacts with hydrocarbons forming exothermic reactions. Oxygen injection results in a marked increase in gas and fume generation from the furnace. CO and CO<sub>2</sub> gases, extremely fine iron oxide particles, and other product fumes are formed. In the case of post-combustion, the CO content is below 0.5 vol%. Argon or other inert gases may be injected into the melt to provide bath agitation and temperature balancing. The slag-metal equilibrium is also improved by this technique (EC, 2001: 278).

#### 4.3.6 *Steel and slag tapping*

In plants without separate secondary metallurgy facilities, alloying elements and other additions are often given to the steel ladle before or during tapping. Such additions can noticeably increase the fume arising during tapping. Slag may need to be removed during heating and oxidising at the end of the heat prior to tapping.

The furnace is tilted backwards towards the slagging door and the slag run off, or raked into a pot or on the ground below the furnace, resulting in dust and fume generation. Today the steel is normally tapped through a bottom tapping system with minimum slag carry over into the ladle (EC, 2001: 278).

#### *4.3.7 Secondary metallurgy*

Secondary metallurgy which is carried out in ladles covers the processes and treatment of molten steel after the tapping of the primary steel making furnace up to the point of casting. It is typically carried out at ladle treatment stations.

These stations in bulk steel production plants are usually located around a vacuum generation system or arc heating unit. Other minor stations are based on inert gas or powder injection equipment. In the case of production of leaded steel, off gases containing lead have to undergo special treatment (EC, 2001: 278).

#### *4.3.8 Slag handling*

Besides slag tapping, further dust and fumes are created during retrieval of the slag which may still be hot, using excavators. Outside the furnace building the slag may be cooled by water spraying before it is crushed and screened to allow metal recovery. In the case of slag with free lime-alkaline, fumes may be emitted. Slag breaking (or in some cases cutting with oxygen lances) and metal recovery can create dust emissions (EC, 2001: 279).

#### *4.3.9 Continuous casting*

The liquid steel is usually cast continuously. Ingot casting is also still applied for some grades and applications. Continuous casting is a process which enables the casting of one, or a sequence of, ladles of liquid steel into a continuous strand of billet, bloom,

slab, beam blank or strip.

Steel is tapped from the ladle into a tundish from which it is distributed at a controlled rate into water-cooled copper moulds of appropriate dimensions (EC, 2001: 279).

To prevent the solidified shell from sticking, the mould is oscillated in the direction of casting at speed greater than the casting speed, and a mould lubricant is added in powder form or vegetable oil. The strand is continuously withdrawn and is further cooled using direct water sprays. At a point where solidification is complete, the strand is cut to required lengths using automatic oxygas cutters.

In the case of oxygen cutting or hydraulic shears of stainless steel, iron powder injection is employed (EC, 2001: 279).

#### **4.4. NEW / ALTERNATIVE IRON MAKING TECHNIQUES**

Iron has been made in blast furnaces for more than 500 years. During that time, the blast furnaces have evolved into highly efficient reactors. However, other techniques are now available which present a challenge to the blast furnace route for pig iron production (EC, 2001: 319).

Blast furnaces require coke, and coke plants are expensive and have many environmental problems associated with their operation. Thus, it would be beneficial from an economical and environmental point of view to produce iron ore without the use of coke. Nearly all blast furnaces reduce their coke consumption significantly by means of reductant injection at tuyeres. However, coke can never be fully replaced in a blast furnace because of its burden supporting function. The minimum blast furnace coke rate is approximately 200 kg/t pig iron (EC, 2001: 319).



In order to achieve an efficient operation from an energetic and economic point of view, large blast furnaces are needed. These blast furnaces have a large and constant output. Thus, the capital costs are high and the flexibility is low. There is in some cases a requirement for a more flexible production in smaller production units in order to meet the requirements of the clients (EC, 2001: 319).

There is also an increasing production in steel from scrap in electric arc furnaces. Production of steel from scrap consumes considerably less energy compared with the production of steel from iron ores. The problems with the quality of scrap-based steel introduces restraints and the use of direct reduced iron (DRI) as feedstock enlarges the possibilities of the EAF-steelmaking route (EC, 2001: 319).

In summary, the following aspects put pressure on the blast furnace production route of steel:

- Environmental aspects of sinter plants.
- Environmental and economical aspects of the coke oven plant.
- Relative inflexibility and scale of the pig iron production.
- Increasing competition by the scrap based-and DRI-EAF steelmaking route (EC, 2001: 319).

But the advantages of the blast furnace route with regard to the recycling capability and economical investment should be recognised. This has triggered the improved environmental and economical operation of the blast furnace route and the development of alternatives routes for iron making. Two main types of alternative iron making which can be considered as proven types of alternative iron making are the following:

- **Direct reduction (DR):** Direct reduction involves the production of solid primary iron from iron ores and a reducing agent (e.g. natural gas). The solid product is called Direct Reduced Iron (DRI) and is mainly applied as feedstock in electric arc furnaces. The direct reduction process has been commercialised since the 1970's and a variety of processes have been developed.
- **Smelting reduction (SR):** This involves combining iron ore reduction with smelting (blast furnace) in a reactor, without the use of coke. The product is liquid pig iron, which can be treated and refined in the same way as pig iron from the blast furnace.

Today, only one variant of SR is commercially proven, but a number of variants are in advanced stages of development (EC, 2001: 319).

Next to the developments in iron making, there is a tendency towards continuous processes instead of batch processes. The shift from ingot casting to continuous casting in the 1980s is a representative example of this. In future, batch steelmaking (electric arc furnaces) will probably be replaced by continuous steelmaking processes (EC, 2001: 319).

#### 4.4.1 *Direct Reduction (DR)*

The concept of direct iron reduction is more than 45 years old, but the first commercial plants were built in the late 1960s. Because the leading direct reduction processes require a cheap source of natural gas, most of the plants are situated in oil-and gas-rich belts. To date, direct reduction has not made a significant breakthrough. In 1996/97, approximately 36.5 million tonnes of direct reduced iron were produced. That is 4.4% of the world pig iron production (EC, 2001: 321).

Direct reduction involves the reduction of iron ore to metallic iron in the solid state. Thus process temperatures are less than 1000°C. A solid product called 'direct

reduced iron' (DRI), is produced. DRI has a metallization rate of >92% and a carbon content of <2%. The direct reduced iron is normally used as feedstock for electric arc furnaces. A drawback of DRI is that it can pose a fire hazard. Therefore, DRI can be melted into briquettes, so called 'hot briquetted iron' (HBI) when the product has to be stored or transported over some distance (EC, 2001: 321).

The main benefit of a direct reduction unit compared with a blast furnace is that the direct reduction unit uses natural gas or coal as a fuel. Therefore, a coke oven plant is no longer needed; significantly reducing the emissions. The impact on the environment of a direct reduction unit itself is very limited. There is a little dust emission, which is easy to collect. The water need is low and water can be recycled to a large extent. Furthermore, a methane-based direct reduction unit produces much less CO<sub>2</sub> than a coal based unit (EC, 2001: 322).

However, DRI contains some gangue (3-6%) and this leads to an increased power consumption of the electric arc furnace with increasing DRI input (EC, 2001: 322).

#### 4.4.2 *Smelting Reduction (SR)*

In the smelting reduction process, the product is liquid pig iron or (in some cases) liquid steel. More than the direct reduction process, the smelting reduction process can be seen as a direct competitor of the traditional blast furnace.

The smelting reduction process has several advantages compared with the blast furnace process, which may in future lead to the adoption of smelting reduction as the main process for pig iron production. The following advantages can be mentioned:

- Smaller units, allowing a more flexible production.
- Few restrictions as to the raw materials used.

- Uses coal as fuel and omits operation of coke oven plant.
- Lower capital costs (EC, 2001: 323).

The disadvantages of SR can be summarised as follows:

- SR cannot utilise fine ores.
- Energy requirements and CO<sub>2</sub> emissions greater than blast furnace route.
- Economics very dependent on use of exported energy (EC, 2001: 323).

Several smelting reduction processes are in development and the most commonly known process is the Corex. The Corex is a two stage process: In the first step, iron ore is reduced to sponge iron in a shaft furnace by means of reducing gas. In the second step, the reduced iron is melted in the melter-gasifier vessel. Reducing gas (CO and H<sub>2</sub>) which is used in the reduction shaft is supplied by gasification of coal by means of oxygen, forming a fixed / fluidised bed in the melter-gasifier.

The partial combustion of the coal in the melter-gasifier generates the heat to melt the reduced iron. Liquid iron and slag are discharged at the bottom, by a conventional tapping procedure similar to that used in blast furnace operations (EC, 2001: 323).

Because of the separation of iron reduction and iron melting / coal gasifying in two steps, a high degree of flexibility is achieved and a wide variety of coals can be used. The process is designed to perform at elevated pressure, up to 5 bar. Charging of coal and iron ore is performed through a lock hopper system (EC, 2001: 323).

The reducing gas contains some 65-70% CO, 20-25% H<sub>2</sub> and 2-4% CO<sub>2</sub>. After leaving the melter-gasifier, the hot gas is mixed with cooling gas to adjust the temperature to approximately 850 °C. The gas is then cleaned in hot cyclones and fed into the shaft furnace as a reducing gas.

When the gas leaves the shaft furnace, it still has a relatively high calorific value of the gas is estimated at 7.5 MJ/Nm<sup>3</sup> in case of the use of a typical steam coal (28.5% volatile matter), but other coal types may result in other heating values of the export gas (EC, 2001: 323).

The Corex process uses coal as an energy source. Therefore, emissions from the coke oven are avoided. All the higher hydrocarbons that are liberated from the coal are cracked into CO and H<sub>2</sub> in the melter-gasifier. As a result, no by-products like tar, phenol, BTX, PAH, etc. are generated. The sulphur charged with the coal into the process is to a large extent picked up in the shaft furnace by DRI and calcined additives and is subsequently fed to the melter-gasifier.

Here, most of the sulphur is transferred to the liquid slag, as in the blast furnace route, and becomes harmless to the environment. The amount of sulphur discharged from the Corex process by gas and water (2-3% of the total sulphur input) is much lower than from the traditional coke oven / sinter plant / blast furnace route (20-30%). The export gas contains 10-70 ppmv H<sub>2</sub>S, depending on the type of coal used and the operational conditions. As oxygen (O<sub>2</sub>) instead of air is used for the gasification of char, no significant NO<sub>x</sub> and cyanide (CN) formation occurs. The required use of oxygen results in significant additional overall energy demands (EC, 2001: 324).

Dust emissions from the Corex plant are significantly less than in the traditional production route. All dust emissions at the coke oven are avoided. The dust content of the export gas is less than 5mg/Nm<sup>3</sup>. Most of the dust which is captured in the gas cleaning system is recycled to the process (EC, 2001: 324).

The primary benefit environmental benefit claimed for alternative iron making processes is that they can operate without coke or sinter. This prospect might avoid the necessity for coking plants and sinter machines that potentially have significant environmental impacts (EC, 2001: 329).

DRI processes have an active, installed production capacity of around 33 million t/a worldwide, although this still contributes less than 5% of world raw steel production during 1995. DRI processes have relatively low throughputs compared with the blast furnace and have generally been installed to take advantage of local factors such as very low cost energy and/or iron ore feed (EC, 2001: 329).

Dispensing with coking plants avoids emissions to air of dust and VOCs from the ovens and a variety of organic chemicals to air and water from by-products plants. Emissions from refiners processing the residual coke making oils and tars from the coke ovens will also be eliminated. In addition, the large quantities of water used in the process will be saved. Removing sinter plants reduces releases to the atmosphere of metallic / non-metallic dust and gaseous pollutants, such as sulphur dioxide. The majority of blast furnaces now have casthouse fume arrestment and bell-less charging systems installed, and their environmental performance will therefore be comparable with releases from reduction plants with equivalent systems (EC, 2001: 329).

It is important to remember that the traditional iron making route provides many recycling and disposal opportunities for ferruginous arisings, filter cakes and oils from downstream steel production that may not be available in many reduction processes. The traditional route also has the ability to use a wide range of feedstocks and reductants of varying quality. In order for the new technology to achieve an equivalent performance with the integrated steelmaking route, the means for treating fine ores and other arisings at site would need to be provided (EC, 2001: 329).

Emissions from reduction plants are generally low, with particulate releases to air after abatement of the order of 10 mg/Nm<sup>3</sup>. Abatement tends to be based on wet technology, leading to an aqueous waste stream, although this may be capable of being addressed by recycling the water or by dry cleaning. If DR or SR processes use iron pellets or sinter, then the emissions associated with the processing of these materials must be considered when comparing environmental performances of the various iron making routes (EC, 2001: 329).

As DR produces no physical change of state or separation of chemical impurities, product quality is wholly dependent on the quality of feedstocks. The DRI produced may not be of equivalent quality with that of iron from blast furnaces if low quality feedstocks are used. For environmental accounting purposes, DRI needs to be in molten form to be directly comparable with blast furnace iron. The additional energy requirements and emissions connected with this physical change of state need to be considered (EC, 2001:329).

Considering smelting reduction processes, large volumes of top gases are produced by Corex and energy efficiency will be poor unless the gases are utilised for power generation or used to produce more sponge iron. Coal consumption and oxygen requirements are higher than the blast furnace route and carbon dioxide emissions are significantly greater. Oxides of nitrogen from gas reforming have to be taken into consideration in both SR and DR operations (EC, 2001: 329).

#### **4.5. THE IRON AND STEELMAKING PROCESS AND THE WASTE HIERARCHY**

The reason why the iron and steel making industry was chosen as an example to illustrate the challenges associated with the implementation of the new definition of waste as contained in NEMWA is because a lot of the processes that form part of the iron and steel making process contributes to the successful implementation of the waste hierarchy by preventing, as far as possible, final disposal as a last resort.

In summary, a list of examples as part of the iron and steel making industry is given, indicating compliance with the classical waste hierarchy, as contained as part of the NEMWA.

**Table 5 Recovery, Recycling and Re-uses for Materials (Spanig, 2011(a))**

NR:	MATERIAL:	PROCESS:	USE:
1.	Ironmaking Slag	Ironmaking	<p>Ironmaking slags forms part of the blast furnace process where the steelmaking slags forms part of the electric arc furnace or basic oxygen furnace process.</p> <p>Ironmaking slags consist of air cooled slags and well as granulated slags.</p> <p>Air cooled slags are used as an aggregate.</p> <p>Granulated slag is not used as an aggregate but are send to the cement industry due to the favourable crystallized structures of calcium silicates which enhance the cementitious properties of OPC (ordinary Portland cement) when added.</p>
2.	Steelmaking Slag	Steelmaking	<p>Steelmaking slag can be used as an aggregate but there are certain restrictions due to the free lime content which may result in expansive reactions. Therefore, in order to be able to use the steelmaking slag as an aggregate, the free lime content should be limited.</p>
3.	Dusts	EAF / BOF	<p>Dusts are generated in material handling systems from cast house applications and from the furnaces itself. This will include both the electric arc furnace as well as the basic oxygen furnace.</p> <p>The dusts can be re-used in the sinter process and can also be sold in limited amounts as Iron oxide. The rest of the dusts are disposed of.</p> <p>Within the electric arc furnace processes, the dust could be recycled into the furnace till optimal levels of Zinc are obtained (20%) where after the dust could be sold to the Zinc recycling industry. ArcelorMittal South Africa (Pty) Ltd is currently investigating this option for its electric arc furnace processes.</p>
4.	Dolochar	Direct Reduction	<p>Dolochar is another important material generated at coal based direct reduction facilities. This material contains relatively high levels of Carbon (40%) and such carbon is current separated from the dolochar stream for internal re-use in the electric arc furnaces. Dolochar is also very suitable as a raw material for brick making.</p>



			However, despite the fact that there are a few alternative uses for the Dolochar, approximately 300 000 tons are produced per year and a lot of this material is still disposed of.
5.	Mill Scale	Rolling	<p>Mill scale is produced as part of the rolling processes. Although the rolling facilities do not form part of the discussion, it is worth mentioning the alternative uses for the Mill Scale. Mill Scale is a very pure form of Iron Oxide and is sold mainly to the Petro Chemical Industry where it is used to produce catalysts for Fisher Tropsch Synthieses.</p> <p>Any surplus mill scale is recycled into the internal process as a high quality Iron Ore replacement or scrap supplement.</p>
6.	Tar	Coke Making	<p>Tar is produced as part of the coke making process. Raw tar distilled into a pure form of tar can be used for road building purposes. It can also be used as a fuel.</p> <p>Because of its high Carbon content, tar can also be sold to Carbon electrode producers.</p>
7.	Ammonium Sulphate	Coke Making	Ammonium Sulphate is usually sold to the fertilizer industry.
8.	Naphthalene	Coke Making	Naphthalene is sold to the chemical industry for different uses such as the making of moth balls.
9.	Sulphur	Coke Making	Pure sulphur is produced as part of the coke making processes via 'Claus' processes by newly installed off gas treatment system to recover the sulphur. Such recovered sulphur is also sold to the chemical industry.
10.	Sludges	Coke Making	Sludges generated as part of water treatment processes are rich in Iron Oxide and are recycled via the sinter processes.
11.	Salts	Water Treatment	Salts can be recovered via desalination plants but it is a very expensive process to clean the salts. Most of it is being disposed of but future re-use options of future use of salts are investigated especially where Gypsum and/or Sodium Chloride is required.

From the above it is clear that the iron and steel making industry provides many opportunities to recover, re-use and recycle different waste streams in order to avoid disposal – using disposal only as a last resort. The next chapter will discuss the challenges faced by the industry with regard to the interpretation of the definition of waste, especially with regard to the question as to when exactly does waste cease to be a waste for purposes of regulation by the NEMWA.

# CHAPTER 5. THE INTERPRETATION OF THE DEFINITION OF WASTE

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## 5.1. INTRODUCTION

The internationally accepted waste hierarchy, as first accepted into policy by the European Community in the Framework Directive of 1975, is aimed at preventing waste where possible, re-using, recovering and recycling waste to reduce volumes, treating the waste to render it less hazardous or harmful to the environment, and disposing of unavoidable waste to landfill as a last resort (Oelofse & Godfrey, 2008:2):

**Table 6 Waste Management Hierarchy**

<b>Cleaner Production:</b>	Prevention
	Minimisation
<b>Recycling</b>	Re-use
	Recovery / Reclamation
	Composting
<b>Treatment</b>	Physical
	Chemical
	Biological
<b>Disposal</b>	Landfill

The successful implementation of the waste hierarchy largely depends on its translation into policy, strategy and legislation. However, one of the main obstacles to successful implementation appears to be the mere definition of waste and its legal interpretation by both government and industry.

As discussed in Chapter 3, the waste management hierarchy was first recognised as part of the Minimum Requirements and was formally adopted as part of the NEMWA (Oelofse & Godfrey, 2008:2).

A new definition of 'waste' was also introduced in order to give effect to the waste hierarchy. As will be indicated during later discussions, industry is of the opinion that this new definition will restrain the effective implementation of the waste hierarchy

Defining waste has its origins in the management of unwanted and discarded material, where waste historically was disposed of without consideration for the resultant environmental consequences or the re-use or recycling potential. The management of waste, both locally and internationally, has been incorporated into environmental legislation to protect both the environment and human health from any adverse effects of disposal. As discussed previously, waste disposal was regulated and managed in accordance with the principles as laid down by the ECA in South Africa (Oelofse & Godfrey, 2008:2).

While there are certainly some cases where it is clear that material is waste and re-use/recycling/recovery should not be considered, for example medical waste, resource recovery at landfill sites and waste dumps are clear indications of the existing re-use potential of waste being disposed of. There are also a vast number of 'difficult' or 'borderline' residues and by-products (mostly industrial waste) that are not being disposed of, but are consistently and profitably re-used, both locally and internationally.

Defining something as a waste therefore involves treading a very thin line between 'resource' and 'waste'. In addition, the classification of a material as 'waste' has fundamentally important commercial consequences; for instance, disposal requirements, and transportation of hazardous substances (Oelofse & Godfrey, 2008:2).

To promote waste re-use, there is a need for a clear definition of waste, and perhaps more importantly, clarity on when a substance will cease to be a waste. This dissertation provides a brief overview of different legal definitions of waste adopted abroad and a detailed discussion of the possible different interpretations of the definition of waste as contained in South African legislation.

## **5.2. INTERNATIONAL DEFINITIONS OF WASTE**

A review of the literature reveals an on-going international debate on the definition of waste. Countries and regions where this definition is currently in the spotlight include the European Union, Singapore, New Zealand, Taiwan, and the United States. The discussions in each of these countries are briefly highlighted in the following section.

### *5.2.1 European Union*

The Waste Framework Directive defines waste as ‘any substance or object in the categories set out in Annex I [of the Directive] which the holder discards or intends or is required to discard’. While simple, this definition is problematic in its interpretation and inconsistent in its enforcement. There is no consensus about when material is discarded or intended to be discarded. This uncertainty in the definition of waste has been argued to have implications for human rights (Oelofse & Godfrey, 2008:3).

Within the European Union, many of the cases dealing with, or testing the definition of, waste arise out of criminal prosecutions for violations of waste management regulations, where criminal liability depends on whether the substance or material concerned falls within the legal definition of waste. As a result, the UK government has acknowledged the need for a full debate on the interpretation of the definition of waste to provide industry and competent authorities with increased clarity in this regard. The European Community’s Sixth Environment Action Programme called for the ‘*clarification of the distinction between waste and non-waste*’ and this issue seems set to remain topical for some time to come (Oelofse & Godfrey, 2008:3).

Industry and government need to have the same understanding as to what is waste and what is a by-product (material with the potential for re-use, whether a re-use market currently exists or not). The definition of waste should allow for responsible waste recovery, recycling and re-use without creating a threat of criminal liability in terms of waste legislation, while at the same time, not ignoring the potential environmental and human health impacts associated with these activities. European case law gives a legal resolve on when waste is no longer considered waste.

If material can be re-used without further processing and if there is financial advantage to be gained from the re-use, the substance in question should not be regarded as waste, but as a legitimate product. The reasoning applicable to by-products should be confined to situations in which the re-use of the goods, materials or raw materials is not a mere possibility but a certainty (Oelofse & Godfrey, 2008:2).

As a result of the above, together with years of consultation with all stakeholders across the EU, the European Parliament and the Council of Ministers decided, amongst other key revisions, the need for '*End-of-Waste*' criteria in their recast Framework Directive on Waste in 2008 under the leadership of Dr. Caroline Jackson. The Directive's '*End-of-Waste*' article needed a separate Regulation to make it real, so after extensive stakeholder discussion and technical studies by the Commission's Joint Research Centre in Seville, Spain, the Commission made a legislative proposal for '*End-of-Waste*' criteria with regard to Iron, Steel and Aluminium to the Technical Adaptation Committee (TAC).

The Qualified Majority Vote missed by 1 vote in September 2010 (254 votes instead of 255) in the TAC, so proposed legislative text had to go the Council of the European Union. Council agreed in December to a new process requiring European Parliament scrutiny. European Parliament scrutiny ended in February 2011 and the draft Regulation was sent back to Council. The Council received the document back and sent it to the Official Journal for printing.

The Council Regulation (EU) No 333/2011 was published in the Official Journal of the European Union L 94 of 8.4.2011 – ‘The Regulation’. The Regulation comes into force after 20 days and is applicable from 9<sup>th</sup> October 2011 as scrap yards have to prepare themselves to meet the quality criteria (Johnson, 2011).

The objectives of the ‘End-of-Waste’ Criteria are summarised as follows as part of the Regulation:

1. *‘It results from an evaluation of several waste streams that recycling markets for scrap metal would benefit from the development of specific criteria determining when scrap metal obtained from waste ceases to be waste.*

*Those criteria should ensure a high level of environmental protection. They should be without prejudice to the classification of scrap metal as waste by third countries.*

2. *Reports of the Joint Research Centre of the European Commission have shown that a market and demand exist for iron, steel and aluminium scrap to be used as feedstock in steel works, foundries, aluminium refiners and remelters for the production of metals. Iron, steel and aluminium scrap should therefore be sufficiently pure and meet the relevant scrap standards or specifications required by the metal producing industry.*
3. *The criteria determining when iron, steel and aluminium scrap cease to be waste should ensure that iron, steel and aluminium scrap resulting from a recovery operation meet the technical requirements of the metal producing industry, comply with existing legislation and standards applicable to products and do not lead to overall adverse environmental or human health impacts. Reports of the Joint Research Centre of the European Commission have shown that the proposed criteria on the waste used as input in the recovery operation, on the treatment processes and techniques, as well as on the scrap metal*

*resulting from the recovery operation, fulfil those objectives since they should result in the production of iron, steel and aluminium scrap devoid of hazardous properties and sufficiently free of non-metallic compounds.*

- 4. In order to ensure compliance with the criteria, it is appropriate to provide that information on scrap metal which has ceased to be waste is issued and that a quality management system is implemented.*
- 5. A review of the criteria may prove necessary if, on the basis of a monitoring of the development of market conditions for iron and steel scrap and aluminium scrap, adverse effects on recycling markets for iron and steel scrap and aluminium scrap are noted, in particular with regard to the availability of, and access to, such scrap.*
- 6. In order to allow operators to adapt to the criteria determining when scrap metal ceases to be waste, it is appropriate to provide for a reasonable period to elapse before this Regulation applies.*
- 7. The Committee established by Article 39(1) of Directive 2008/98/EC has not delivered an opinion on the measures provided for in this Regulation and the Commission therefore submitted to the Council a proposal relating to the measures and forwarded it to the European Parliament.*
- 8. The European Parliament has not opposed the proposed measures' (Johnson, 2011).*

As a result of the aforementioned, the European Commission objectives for 'End-of-Waste' criteria can be summarised as objectives to:



- Set a high environmental standard.
- Distinguish between clean and dirty recycled products.
- Provides regulatory relief for low risk products.
- Facilitate the internal market (Johnson, 2011).

With the implementation of the new 'End-of-Waste' criteria, it is envisaged that the following key factors will be achieved:

- Low environmental risk.
- Potential environmental benefit.
- Facing a genuine barrier within the waste regime.
- Having a solid market for recycled product (Johnson, 2011).

The 'End-of-Waste' criteria trade off an improvement in quality of recycling scrap with regulatory relief for scrap yards and metal works. The regulatory relief is intended to remove the costs and administrative burden of the waste regime, for example in shipping iron & steel or aluminium scrap from the scrap yards to the metal works.

With the coming into effect of these new 'End-of-Waste' criteria, more companies can be recyclers under the law, and these criteria helps towards an inclusive EU recycling society. The new criteria recognise at last the value add of the sorting and mechanical processing of waste into non-waste scrap; i.e. making a waste into a product (Johnson, 2011).

It is perceived that this Regulatory relief will have the following advantages:

- Besides that setting high environmental, health safety and quality criteria for recycled materials will increase public confidence in recycled materials and should reinforce the public acceptance of recyclers in their communities.
- The image of the scrap processor will be improved by recognitions as a manufacturer of a product.
- The Regulation which has to be applied in the same way in each Member State should ensure a consistent approach by competent authorities towards companies that wish to take advantage of this regulatory relief.
- There may be knock-on effects too, of increasing interest in quality management tools and in machinery and equipment that can improve environmentally sound management (Johnson, 2011).

The revised Waste Framework Directive proposed more recyclables to be considered for criteria setting, amongst which are construction and demolition waste, some ashes and slags, other scrap metals, aggregates, tyres, textiles, compost, waste paper and glass. Work is progressing well on proposing criteria for copper scrap and waste paper.

Whilst this European 'End-of-waste' initiative will be working within Europe for the benefit of European metals recycling, it has the potential to also provide a template for other countries and regions to adopt, should they already have well-functioning waste management laws in place but have not yet determined environmental, health safety and quality criteria for recycled materials (Johnson, 2011).

From the above it is clear that there is a move, at least in the EU, towards a scenario where certain materials that are reusable and recyclable are taken out of the legislative system, subject to the implementation of sound environmental management systems.

### 5.2.2 Singapore

The Environmental Public Health Act, 1987 (Act No. 14 of 1987) defines waste as,

*'any substance which constitutes a scrap material or an effluent or other unwanted surplus substance arising from the application of any process; and any substance or article which requires to be disposed of as being broken, worn out, contaminated or otherwise dealt with as if it were waste shall be presumed to be waste unless the contrary is proved'.*

The definition of disposal facility, similar to the definition as contained in the ECA, also includes a recycling facility, subjecting recycling facilities to the same controls as disposal facilities (Oelofse & Godfrey, 2008:4).

This definition of waste therefore assumes just about everything to be waste, unless the producer or generator can prove that it is not. By subjecting recycling facilities to waste disposal controls, they are also subject to the bureaucratic process of applying for a waste disposal facility license. These definitions leave Singapore in the same situation as South Africa, where there is ambiguity as to what exactly can be defined as 'waste' and where waste legislation could be seen as a burden to waste re-use and implementation of the waste hierarchy(Oelofse & Godfrey, 2008:4).

### 5.2.3 New Zealand

Unlike a number of other OECD (Organisation for Economic Cooperation and Development) countries, New Zealand does not have comprehensive legislation dedicated to the management and minimisation of wastes.

Analysis of the waste minimisation and management provisions in OECD countries indicates that legislation is required to support waste management programmes and targets (Oelofse & Godfrey, 2008:2).

The New Zealand Waste Strategy defines waste as *'any material, solid, liquid or gas that is unwanted and/or unvalued and discarded or discharged'*. This definition recognises that, in fact, 'waste' is not necessarily a useless material but rather a renewable resource. This definition emphasises material being unwanted and/or unvalued. Availability of economically viable markets for these materials is therefore key in interpreting this definition (Oelofse & Godfrey, 2008:4).

The current New Zealand legislation does not provide sufficient direction and focus in the field of waste management and pollution prevention. Compared with programmes in the United Kingdom and Pennsylvania, the New Zealand waste management and pollution prevention programme is vague, lacking in direction and funding, and fails in reducing waste production or effectively managing waste. The broad definition of waste should be identified, at least in part, for this situation (Oelofse & Godfrey, 2008:4).

At the time of writing this article, the New Zealand Ministry for Environment has been developing a new Waste Minimisation (Solids) Bill. The new Waste Bill does not specifically define the term 'waste' but does define certain types of waste; namely organic waste, medical waste, and construction and demolition waste. According to Oelofse and Godfrey, this may be an attempt to avoid the confusion experienced internationally in legislating a too broad definition of waste (2008:4).

The international experiences of a broad legal definition of waste should guide new developments on the legislation front. It is, however, also possible that a too narrow definition of waste may result in increased adverse environmental consequences (Oelofse & Godfrey, 2008:5).

The New Zealand approach to defining specific waste-streams with specific controls may serve the purpose of reducing the impacts of problem waste-streams, through strict controls, while supporting the re-use of other waste streams with a high re-use potential. The added advantage of this approach is that re-use can be promoted and controlled in a specific manner to a waste- stream (Oelofse & Godfrey, 2008:5).

#### 5.2.4 Taiwan

The Waste Disposal Act of Taiwan, as amended in October 2001, does not specifically define 'waste'. Instead, the act classifies waste into two broad types: general wastes and industrial wastes. Industrial wastes are further broken down into hazardous industrial waste that contains toxic or dangerous substances in a sufficient concentration or quantity to endanger human health or pollute the environment, and general industrial waste that includes materials other than hazardous industrial waste (Oelofse & Godfrey, 2008:5).

According to Tsai and Chou (as cited by Oelofse & Godfrey, 2008:5), industrial wastes may still possess some economic value, depending on the quality and the ready accessibility of a market for it, and should not necessarily be considered a waste. As a result, a new paradigm was established, aiming at minimisation of the generation of industrial wastes and the use of virgin resources by the manufacturing industry. This new paradigm is evident in the promulgation, by the Environmental Protection Administration (EPA) of Taiwan, of the Resource Recycling Act (Oelofse & Godfrey, 2008:5).

The purpose of the Resource Recycling Act is to,

*'conserve natural resources, reduce waste, promote recycling and reuse of materials, mitigate environmental loading, and [build] a society in which resources are used in a sustainable manner'.*

The act defines renewable resources as,

*'substances that have lost their original usefulness, are economically and technologically feasible to recycle and may be recycled or reused as announced or approved by the Act'.*

Defining a material as a renewable resource, therefore, aims at protecting non-renewable resources through the re-use of 'waste' streams (Oelofse & Godfrey, 2008:5).

The Taiwanese government has further supported this new paradigm, with the promulgation of supporting regulations aimed at promoting recycling such as the Renewable Resource Recovery Regulations, Preferential Procurement Regulations and the Management Regulations for the Restriction or Prohibition of the Import or Export of Renewable Resources (Oelofse & Godfrey, 2008:5).

A key factor in the re-use of industrial waste in Taiwan is the Industrial Waste Exchange Information Service Centre, established by the Industrial Technology Research Institute (ITRI) with the assistance of the Taiwan EPA and the Ministry of Economic Affairs. This centre has, since 1987, actively assisted in coordinating with factories that intend to re-use industrial wastes (Oelofse & Godfrey, 2008:5).

To support resource re-use/recycling, the Waste Disposal Act has incorporated financial incentives such as tax deductions for investment, accelerated depreciation, and low-interest loans. The Waste Disposal Act has therefore provided both a regulatory framework for implementation as well as an economic framework that promotes re-use.

Although industrial waste re-use/recycling has benefited from this new paradigm and supporting legislation, it is not without its problems. Key factors that stand out in the Taiwanese case is the absence of a clear definition of waste, while at the same time

providing for the definition of a 'renewable resource', indicating a shift in mindset towards materials re-use and recycling(Oelofse & Godfrey, 2008:6).

Again, whether or not material is viewed as waste depends on the available market for it. The definition is not clear on where the distinction between waste and renewable resources should be made. The approach towards renewable resources is, however, a significant change in thinking from the historical, conservative, protection-based legal definition (Oelofse & Godfrey, 2008:6).

### 5.2.5 *United States of America*

According to Lown (as cited by Oelofse & Godfrey, 2008:6).the statutory definition of solid waste differs from the regulatory definition in the United States. Congress defined solid waste as,

*'any garbage, refuse, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semi-solid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities'.*

By contrast, the Environmental Protection Agency's (EPA) regulatory definition of 'solid waste' is 'any discarded material that is not excluded' under 40 Code of Federal Regulations [sec] 261.4(a), or by variance. If a material is discarded, it is solid waste, unless the EPA specifically removes it from the solid waste category (Oelofse & Godfrey, 2008:6).

The US EPA approach to defining solid waste is thus to spread its regulatory authority widely, and then to remove from the solid waste category anything that it deems to be legitimately recycled, or actually needed to make a product (Oelofse & Godfrey, 2008:6).

Many of the significant decisions that attempt to distinguish regulated discarded materials from non-regulated products have emanated from the US Court of Appeals for the District of Columbia. The court limited the EPA's authority under the Resource Conservation and Recovery Act (RCRA) to those materials that were actually part of the 'waste disposal problem' and not those which are 'destined for beneficial reuse or recycling in a continuous process by the generating industry itself'.

Thus, if a material was still part of the 'ongoing manufacturing or industrial process', it was outside the EPA's jurisdiction. In another court ruling, the EPA's jurisdiction was expanded to include materials recycled outside the generating facility, even if they were later sold as a product (Oelofse & Godfrey, 2008:6).

It has been argued, usually by the regulated community, that environmental regulations create unnecessary impediments to creative solutions like eco-industrial developments. The RCRA regulations are often cited as the most obstructing (Oelofse & Godfrey, 2008:6).

The American example once again points to the fact that defining material as waste has the consequence of subjecting that material to waste regulations. Waste regulations are primarily aimed at the protection of the environment against the possible harmful effects of waste material, if not managed properly. It is not geared towards providing an enabling legal environment for re-use or recycling of that material. Protection of the environment by applying the precautionary approach, and therefore a broad (catch-all) definition of waste, is therefore in direct conflict with the creation of an enabling environment for the re-use of waste material (Oelofse & Godfrey, 2008:6).

### **5.3. INTERPRETATION OF THE DEFINITION OF 'WASTE' IN SOUTH AFRICA**

A common question that arises within industry is whether a material, suitable for re-use or further processing (whether a market currently exists for it or not) should be



regarded as a waste or a by-product, and whether it should be regulated as such.

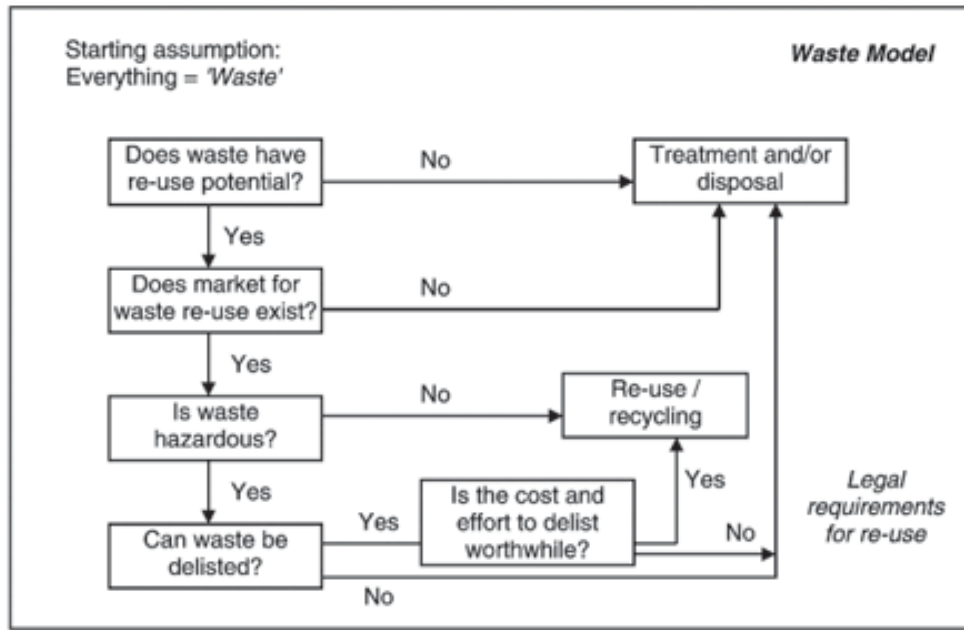
In South Africa, current waste re-use and recovery is subject to waste management regulations (as contained in the NEMWA) and controls in order to regulate the full life cycle of the waste (Oelofse & Godfrey, 2008:8).

Internationally, a serious emerging terminological and regulatory problem is being raised by increased controversy regarding potentially recyclable waste. In most existing legal definitions, the term 'waste' includes material that is technically suitable for recovery, recycling and re-use. By including these waste-streams in the definition of waste, the material becomes subject to the same regulations as other waste-streams that are not (or currently not) suitable for recovery. This creates a lot of problems for industries worldwide since recoverable, recyclable or re-usable materials will in most instances be subject to overregulation and duplication since these materials may also be regulated by different pieces of legislation pertaining to product handling and management in some jurisdictions (Oelofse & Godfrey, 2008:8).

Therefore, the implementation of the waste hierarchy through reduction and recycling targets requires clarity on what can be reduced or recycled. Unclear or ambiguous waste definitions are a common phenomenon throughout the world, leading to courts of justice having to resolve waste governance issues. Leaving it up to the judicial system to try and resolve the challenges faced by relevant stakeholders is not ideal. Since environmental legislation is a fairly new phenomenon in South Africa, judges often do not have the necessary practical experience and sound understanding of the different industry processes to try and resolve waste governance issues effectively (Oelofse & Godfrey, 2008:8).

Defining waste is imperative for the regulation of waste and the control of possible negative impacts of waste on the environment and human health if not properly managed. It is therefore important to define waste in a way that will support the regulation of environmental impacts, as well as support the principles of integrated

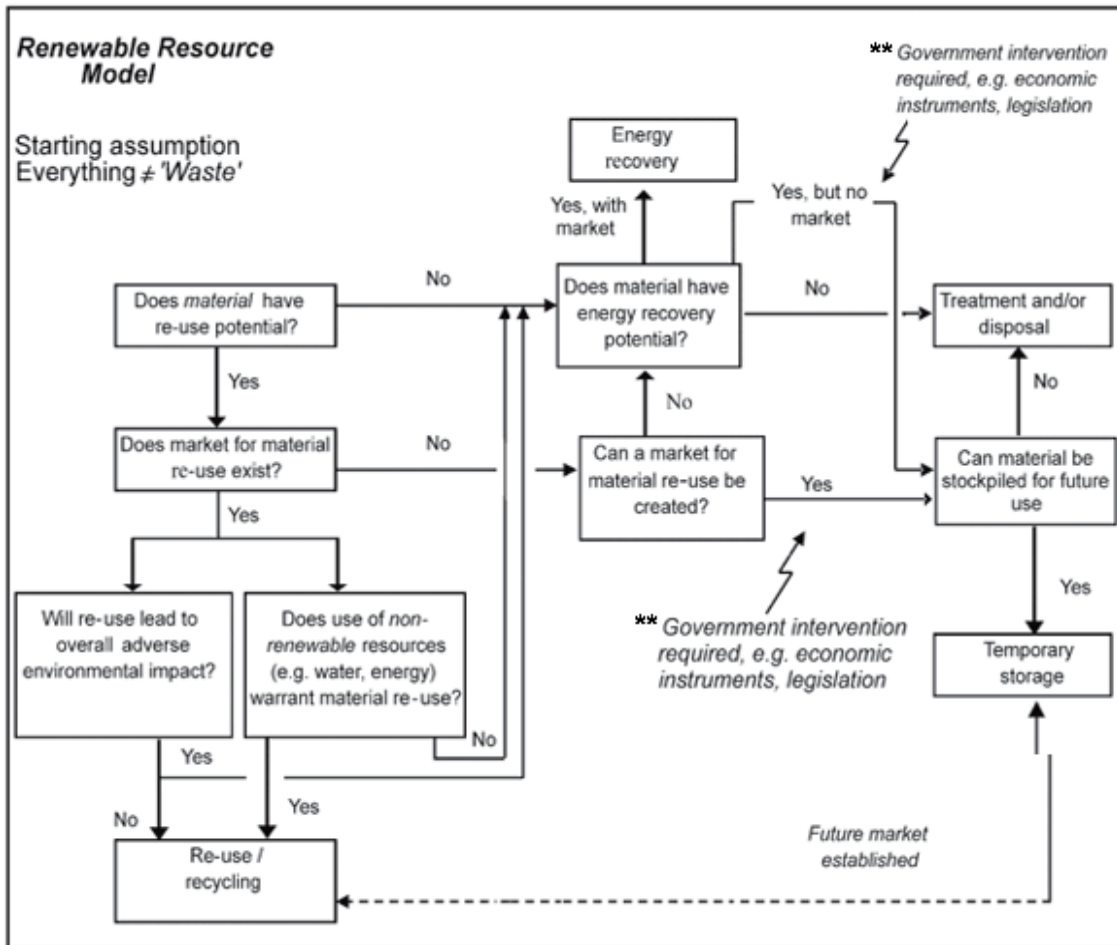
waste management, as defined through the waste hierarchy. Adopting a broad, all-encompassing definition of waste will promote environmental protection with the possibility of discouraging the implementation of the waste hierarchy, because of the bureaucratic processes involved (Oelofse & Godfrey, 2008:9):



**Figure 7 Waste Model**

On the other hand, adoption of a narrow definition of waste will support implementation of the waste hierarchy, but may undermine environmental protection. Irrespective of the definition adopted, some trade-off between protection and re-use is envisaged (Oelofse & Godfrey, 2008:9).

The result has been a paradigm shift towards waste as resource, and a resultant change in the governance of waste from protection to re-use (Oelofse & Godfrey, 2008:9):



**Figure 8 Renewable Resource Model**

The Taiwanese legal definition of industrial waste is an example where industrial waste may not necessarily be classified as waste if it still possesses some economic value.

The classification, however, depends on the quality of the material and the availability and accessibility of potential markets for its re-use. Furthermore, internationally, a typical approach to promote waste recovery through legislation is directed at specific waste-streams, as opposed to using a broad legal framework (Oelofse & Godfrey, 2008:9).

Reclaimed and recycled material needs to be controlled in order to limit the risks to the environment and to ensure that principles such as the '*polluter-pays-principle*', the '*cradle-to-grave principle*', as well as the '*duty-to-care principle*' as envisaged in the NEMA continues to apply, irrespective of the after-use of the material. The concept of '*Extended Producer Responsibility*' (EPR) provides one way of addressing this problem. EPR is also acknowledged and regulated in terms of the NEMWA under Part 3, section 18. A good example of EPR is where producers of certain waste streams are obliged to take a product back (such as electronic waste).

However, there are limits to this approach in terms of waste streams to which it can be applied, as well as the extent to which it is applied (such as, when the producer is released of responsibility). An argument can be made that the initial producer of the waste remains responsible for the waste until it is reworked into a secondary product, and that the producer of the secondary item then becomes the producer with extended responsibility. Although there is merit in the application of this approach, it can be applied irrespective of the definition of waste by linking it to pollution potential (Oelofse & Godfrey, 2008:10).

In certain cases, this concept may act as a disincentive for re-use and recycling, especially in the South African situation, where small, medium and micro enterprises with limited capital resources are the likely sector to become involved in recycling and re-use initiatives. It also needs to be recognised that reclamation and recycling is to a large degree dependent on fluctuations in the market and availability and cost of technology. In the absence of economic incentives, there is thus always the potential that certain material will be disposed of, irrespective of their potential to be re-used, or by the definition of '*waste*' (Oelofse & Godfrey, 2008:10).

In view of the aforementioned, the difficulties pertaining to the definition of '*waste*' in South Africa as contained in the NEMWA will now be assessed:

As discussed in paragraph 3.3.3 above, waste is defined in terms of NEMWA as:

*'Any substance, whether or not that substance can be reduced, re-used, recycled and recovered-*

- (a) that is surplus, unwanted, rejected, discarded, abandoned or disposed of;*
- (b) which the generator has no further use of for the purposes of production;*
- (c) that must be treated or disposed of; or*
- (d) that is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but -*
  - (i) a by-product is not considered waste; and*
  - (ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste'*

The problem is the question when does a waste ceases to be waste? Thus, to what extent should material that can be re-used, recovered or recycled be regulated in terms of NEMWA?

To illustrate the problem, the iron and steel making process, as discussed in Chapter 4, is taken as an example. Two examples of uses of materials as part of the iron and steel making process will be discussed: This embraces firstly, a process where scrap metal can be used as a raw material and put through a process up to the point where products are produced by means of the use of oxygen steelmaking furnaces and electric arc furnaces.

Secondly, the iron and steel making process relates to the utilisation of slag for different purposes. The slag is produced as a material resulting from the steelmaking process. The question then is whether the scrap metal that is purchased from dealers and used in the steelmaking process (whether in the process called basic oxygen steelmaking or electric steelmaking), is to be considered waste and secondly, whether the slag produced as part of the steelmaking process (from both the BOF process and the EAF process) is to be considered a waste as defined in terms of NEMWA. As mentioned in Chapter 4, more specifically section 4.5, slags can be utilised for different purposes such as road aggregate and agricultural purposes after they have first been processed to render them fit to be utilised for alternative uses.

To be able to address the aforementioned challenges, it is quite obvious that the possible answers to these challenges will depend on the interpretation of the definition of waste. In this regard it is important to take cognisance of the fact that there are (up to the date of this dissertation) four distinct possible interpretations of the definition of waste; each of which will be discussed individually:

### *5.3.1 Official government interpretation*

The Department of Environmental Affairs (the DEA) issued an interpretation of the definition of waste, which can be summarised as follows:

The DEA starts by looking at which materials are excluded as part of the definition of waste and as a result, which materials are therefore included as part of the definition of waste and regulated as such. According to the DEA, the following is not regarded as waste for purposes of NEMWA (SA, 2010(b):1):

- (a) A by-product as defined in the NEMWA is not a waste;
- (b) Any portion of waste, once re-used, recycled or recovered.

The DEA then goes further as to quote the definition of a by-product as contained in the NEMWA (SA, 2010(b):1):

*‘A substance that is produced as part of a process that is primarily intended to produce another substance or product and that has the characteristics of an equivalent virgin product or material;’*

According to the DEA, a by-product must fulfil the following conditions:

- The substance produced must be produced as part of a process that is primarily intended to produce another substance or product.
- The substance must demonstrate the equivalent **chemical** and physical characteristic of an equivalent virgin product or material.
- The substance or object can be used directly without any further processing (SA, 2010(b):1).

The DEA then goes on to try and answer the question as to exactly what constitutes a waste by quoting the definition of waste as contained in NEMWA. According to the DEA, the words *‘surplus’*, *‘unwanted’*, *‘rejected’*, *‘discarded’*, *‘abandoned’*, or *‘disposed of’* are not defined and the ordinary dictionary meaning should be used. *‘Surplus’* should be interpreted in the context of *‘unwanted’*, *‘rejected’*, *‘discarded’*, *‘abandoned’* or *‘disposed of’*. The fact that waste can be reduced, re-used, recovered and recycled is irrelevant for the purpose of determining whether it is ‘waste’ or not. The usage of the terms *‘unwanted’*, *‘rejected’*, *‘discarded’*, *‘abandoned’* does not mean that ‘waste’ that could have a value is not waste. (SA, 2010(b):2).

If the generator does not need a substance that originated from his/her production process, further for the purposes of production in his/her own processes, that substance becomes waste. If the substance that is generated in a process or production requires treatment before it could be re-used or is to be disposed of, it is

waste. Only once waste is re-used, recycled or recovered does it stop being waste. In other words, waste that can further be used in another process by means of re-use, recycling or recovery is **still** waste in the hands of the person acquiring that substance for the purpose of re-use, recycling or recovery **until** it has undergone the re-use, recycling and the recovery process (SA, 2010(b):2).

Therefore, if we look at the aforementioned restrictive interpretation by the DEA, the scrap metal used as part of the input material in the steelmaking process will only cease to be a waste once the material is put into either the basic oxygen furnace or the electric arc furnace. The different slags produced as part of the steelmaking process cannot be regarded as by-product since the slags do not have the exact same chemical and physical characteristics as the same virgin material. The slags will therefore be regarded as waste in terms of the NEMWA, and will only cease to be waste once they have been used as part of the road making process or when they have been used for agricultural purposes.

The question then arises as to whether the farmland on which the slags are being used should be considered as a waste management facility in terms of NEMWA. In terms of the NEMWA, a '*waste management facility*' is defined as:

*'the generation of waste, including the undertaking of any activity or process that is likely to result in a generation of waste'*.

From the above it is clear that this interpretation may have ridiculous consequences which could not have been the intention of the legislator. Such restrictive interpretation may also restrict the implementation of the waste hierarchy as envisaged in the NEMWA.



### 5.3.2 *Legal opinion: Adv. L Vorster, SC*

As a result of the aforementioned restrictive interpretation by the DEA, industries were forced to look at the possibilities of different legal interpretations. As a result, the following legal opinion was obtained from Adv. Louis Vorster, SC:

It is clear that the DEA's interpretation is focussed on the end-use of a recovered or recycled product, while industries were looking towards an interpretation that is focussed on the process of the recovery or the recycling for any recovery/recycling processes to be more viable. In this regard, the crisp issue point at issue between the two interpretations centres around the correct meaning to be ascribed to the provisions in paragraph (d)(ii) of the definition of waste as contained in NEMWA, being:

‘(ii) any portion of waste, once re-used, recycled and recovered, ceases to be waste’ (Vorster, 2009:3).

According to an external legal opinion that was obtained, if the literal wording of the subparagraph is taken, it would mean that waste only ceases to be waste once it is re-used, recycled or recovered. If, as industry would have it, material that would otherwise qualify as waste ceases to be waste if it is used in a process where it is either re-used or recycled or recovered.

The answer to this problem lies in the interpretation of the legislation taking into account the purpose of the legislation and the particular section which is at stake in the context of the whole Act. The principle that an ambiguity in the wording of legislation can be interpreted in the light of the purpose as it appears from the legislation is well-established in the South African law. This principle was formulated in the following cases (Vorster, 2009:3):

- *Public Carriers Association v Toll Road Concessionaries (Pty) Ltd* 1990(1) SA 925 (A),

- Nuwe SA Prinsipale Beleggings (Edms) Bpk v Saambou Holdings Ltd 1992(4) SA 696 (W).

There can be no doubt that the purpose of the NEMWA is to protect the environment for the benefit of present and future generations by providing for proper waste management practices which are necessary for sustainable development which requires that the generation of waste is avoided or reduced, re-used, recycled or recovered and only as a last resort treated and safely disposed of. That much is clear from the preamble to the NEMWA. It is from this perspective that the definition of 'waste' in the NEMWA must be interpreted having regard to the practical situations to which it finds application on the literal wording of the definition. In this regard, it is important to take cognisance of the following (Vorster, 2009:4):

*'It is clear from the wording of the definition of 'waste' that it refers to any substance irrespective of the question whether it can be reduced, re-used, recycled and recovered and which is surplus, unwanted, rejected, discarded, abandoned or disposed of.*

*It clearly refers to a substance for which there is no further use whether for the purpose of production of something else or at all. It clearly refers to a substance for which there is no other use either to the producers thereof or anybody else, and which has to be treated or disposed of' (Vorster, 2009:5)*

In short, it is a substance that, but for the possibility that it is recycled or treated or recovered to be put to some use, is regarded as of no use to anybody and something which should finally be disposed of in a waste treatment facility as defined in the NEMWA (Vorster, 2009:5).

It is for this reason that a by-product is not considered to be waste and any portion of waste which is re-used, recycled, or recovered is not considered to be a waste (Vorster, 2009:5).

An interpretation of the concept of 'waste' in the light of the purpose of the legislation, leads to the conclusion that any substance that can be reduced, used, recycled or recovered and which is not surplus, unwanted, rejected, discarded, abandoned or which the generator has no further use of, is not to be regarded as waste for the simple reason that it is of some economical use to somebody, whether that usefulness is attained by the manufacturing of a by-product or by the process of recycling or recovery or re-use (Vorster, 2009:5).

It follows from the foregoing that a purposive interpretation of the provisions of the NEMWA, and particularly the interpretation of the definition of 'waste' leads to the conclusion that:

*Waste is a substance that has no other use to the producer thereof or anybody else and is destined to be disposed of finally to a waste treatment facility (Vorster, 2009:6);*

A substance which is produced or manufactured by whatever means that can further be used in a process by means of re-use, recycling or recovery is not waste in the hands of the person acquiring that substance for the purpose of re-use, recycling or recovery.

It is a raw material in the hands of the person involved in the process to produce a useful end-product and not waste destined to be dumped on a waste disposal facility (Vorster, 2009:6).

It therefore follows that:

- Scrap metal used as input material for the production of steel will not classify as 'waste' defined in terms of the NEMWA (Vorster, 2009:6);

- Slags produced as part of the steelmaking process is not to be regarded as ‘waste’ as defined in terms of the NEMWA (Vorster, 2009:7).

### 5.3.3 *Legal opinion: Adv. W Trengove, SC*

Due to the uncertainties with regard to the interpretation of the definition of waste, the scrap industry also proceeded with an additional legal opinion from Adv. W Trengove, SC and Adv. T Dalrymple. This opinion can be summarised as follows:

The question as to whether scrap material for example constitute a ‘waste’ in terms of NEMWA, basically revolves around the question as to whether scrap metal will fall within any of the categories described in paragraphs (a)-(d) of the definition of ‘waste’ – if it does, it constitutes ‘waste’ and should be regulated as such. The Minister has not identified the scrap metal as ‘waste’ in terms of paragraph (d) of the definition and thus what remains is whether the scrap metal falls under paragraphs (a)-(c) (Trengove & Dalrymple, 2010 (b):2).

Scrap metal primarily comprises of the following:

- Off-cuts from the manufacturing processes which take the form of trimmings, cuttings, shavings, rod ends or stampings; and
- Obsolete materials consisting of industrial and consumer goods containing metal which are beyond their useful lives such as cars, appliances, machinery and equipment or which come from buildings and other structure demolition projects, salvage operations, replacement and reconstruction of worn out or obsolete industrial plants and facilities (Trengove & Dalrymple, 2010 (b):3).

In terms of the opinion, such unprocessed scrap metal is surplus, unwanted, rejected, discarded, abandoned or disposed of within the meaning of paragraph (a) (read with the definition of disposal).

It is also a substance which the original generator of the scrap metal has no further use for it for purposes of production as contemplated in paragraph (b). The scrap material may be acquired by a subsequent processor but that does not change character merely because it has done so. It changes character and ceases to be waste only once the material has been processed. Furthermore, it may require to be '*treated*' or '*disposed of*' within the meaning of paragraph (c) (read with the definitions of '*treatment*' and '*disposal*') (Trengove & Dalrymple, 2010 (b):3).

However, it is important to take cognisance of the fact that processed scrap metal that is bought by the members of SAISI as a raw material, does not constitute 'waste' for two reasons. The first is that it no longer constitutes a substance of the kind described in paragraphs (a)-(d) of the definition of 'waste' as contained in the NEMWA:

- It is no longer surplus, unwanted, rejected, discarded, abandoned or disposed of;
- It is not a substance of the kind described in paragraph (b). It does not make sense to ask whether the original generator of the scrap metal has any further use for it for purposes of production. The original generator has disposed of it and no longer has any intention in relation to it;
- The scrap metal no longer needs to be 'treated' or 'disposed of' within the meaning of paragraph (c);
- The Minister has not identified the scrap metal as waste in terms of paragraph (d) (Trengove & Dalrymple, 2010 (a):11).

As a result, it is clear from the above that the processing of the scrap metal will be regulated in terms of the NEMWA but the processed scrap metal that is sold to the steel producing industry will not be regarded as a 'waste' in terms of the NEMWA and will not be regulated as such (Trengove & Dalrymple, 2010 (a):11).

#### 5.3.4 Legal opinion: Adv. SJ Maritz, SC

Because the interpretation of the definition of 'waste' as contained in the NEMWA may have some significant financial and legal implications for the steel industry, the steel industry obtained a further legal opinion from Adv. SJ Maritz, SC. In terms of this opinion, the following questions were posed to the legal counsel:

- The legal position of the members of the SAISI is in regard to by-products produced as part of the steel producing processes, which respectively have an economic value in the open market to a greater or lesser extent with reference to the NEMWA;
- Members of the SAISI also buy steel and metal products, which have been recovered from the waste stream, in the open market. Members of the SAIS also seek an opinion as to the position in respect of those products in terms of the provisions of the NEMWA (Maritz, 2011:1).

The first part of the definition of waste as contained in the NEMWA which requires attention in order to be able to address the first question, is the meaning of '*which the generator has no further use of for the purposes of production*' in sub-clause (b) of the definition. The interpretation of the DEA of this sub-clause of the definition is as follows:

*'If the generator does not need a substance that originated from his/her production process, further for the purposes of production in his or her own processes, that substance becomes waste' (Maritz, 2011:3).*

It is the opinion of legal counsel that such a meaning cannot be read into the definition of waste since there is nothing in the definition which limits a substance which may be further used for the purposes of production to any act of primary production (Maritz, 2011:3).

In the Concise Oxford Dictionary (1990) *'product'* is defined as follows: *'A thing or substance produced by natural process or manufacture';* and *'production'* is defined as: *'The act or an instance of producing; the process of being produced'*.

According to legal counsel, there is nothing to prevent the members of the SAISI from producing more than one product. After all, the definition explicitly contemplates a substance for which the generator has no further use of for the purposes of production. There is also nothing to suggest that the members of the SAISI may not retain ownership and possession of a substance to be used in the production of any other product. In view of the aforesaid, the question then arises as how the exclusion of a by-product affects the aforementioned interpretation (Maritz, 2011:4).

To begin with, it is clear that a by-product is not waste. That term is defined as follows in section 1 of the NEMWA:

*“**by-product**’ means a substance that is produced as part of a process that is primarily intended to produce another substance or product and that has the characteristics of an equivalent virgin product or material’;*

It would appear that the meaning of this definition is that a by-product must have the characteristics of an equivalent virgin product or material, without the need to change such characteristics in some way or another. Therefore, if the chemical structure of the substance is to be changed, or some element thereof must be removed, or some other element must be added thereto, it can hardly be said that the substance would qualify as a by-product.

Having said that, it is at least notionally possible that an equivalent virgin product or material would require treatment to obtain a product which may be commercially exploited. If that is so, there is no reason why a by-product cannot be subjected to the same treatment. These issues are primarily questions of fact, which have to be established objectively.

Cases in point would be the slag produced by steel producers in the initial processes of steel production. That slag is sold in large quantities for example to cement producers exactly as it comes out of the oven.

It is true that the slag is treated with water to obtain the desired crystallisation, but the form is changed and not the substance. That being the case, it must of necessity be a by-product (Maritz, 2011:5).

Legal counsel was instructed that there are other by-products which require crushing or sifting to render it saleable. It is the view of legal counsel that these processes do not make any difference at all, because the form is changed without altering the characteristics thereof. It follows that, in dealing with by-products, the legislator had something different in mind as opposed to a substance which is fit for purposes of production, whatever the product may be. After all, the fact remains that in both cases the substance in question does not become part of the waste stream (Maritz, 2011:6).

It is trite that, in ascertaining the true intention of the legislator, it is presumed that existing rights are not affected other than expressly stated, or to be inferred by necessary implication (Maritz, 2011:6):

See: *Pretorius v Transnet Beperk* 1995 (2) SA 309 (AD).

Another way of putting it is that if legislation is capable of a restrictive interpretation upholding existing rights, an extended interpretation defeating such rights will not be followed. To illustrate this concept, the following example may be used: In the production of furniture a cabinetmaker produces a large quantity of off-cuts, chips and sawdust. Instead of disposing of the waste, the cabinetmaker then employs the waste to manufacture chipboard, which is sold in the open market.

There is absolutely nothing in the NEMWA which would prevent the cabinetmaker to manufacture the primary and secondary products.



In my view the same situation applies *in casu*. Another example could be the production of phosphates by a copper mine in as far as it is not regulated by the Mineral and Petroleum Resources Development Act, Act No 28 of 2002 (see clause 4(1)(b) of the Act). It is well-known that in the production of copper phosphates are produced as well. These phosphates are recovered and used extensively in the production of fertilizers. Here too, there is nothing to suggest that only one line of production may be employed to the exclusion of all others (Maritz, 2011:7).

Legal counsel was further instructed that the DEA holds the following view in respect of a by-product:

*'The substance produced must be produced as part of a process that is primarily intended to produce another substance or product. The substance must demonstrate the equivalent chemical and physical characteristic of an equivalent virgin product or material. The substance or object can be used directly without any further processing.'* (Maritz, 2011:8).

It is the view of legal counsel that this statement is untenable. The definition of a by-product quoted above refers to *'...the characteristics of an equivalent virgin product or material'*. The Concise Oxford Dictionary (*supra*) defines *'characteristic'* as *'typical, distinctive; a characteristic feature or quality'*. If the legislator had in mind that the by-product has to be identical to a virgin product or material, it would have said so. It is the view of legal counsel that the added qualifications are untenable. It has already been pointed out that a virgin product or material could require processing to produce a desired product. If that is so, the by-product should also be capable of equivalent treatment (Maritz, 2011:8).

With regard to the second question posed to Counsel, the following is important to take cognisance of the following:

Steel producing members of the SAISI do not engage any recovery activity. Recovered metal is bought by such members in the open market and is then employed as a raw material in the production of steel. In other words, the recovered metal goes into the oven in the form in which it is delivered. Steel producers do use their own off-cuts, but this does not qualify as recovery in terms of the NEMWA (Maritz, 2011:9).

Legal counsel finds the suggestion that such use constitutes waste management, for which a licence is required, supercilious. The reason for the aforementioned conclusion is obvious. Once the metal is recovered by a person licensed to do so in terms of the provisions of the NEMWA (see Chapter 5) the recovered metal ceases to be waste, and no further act of management is required. It remains a raw material which is used as such in steel manufacturing processes (Maritz, 2011:11).

From the abovementioned legal interpretations, it is clear that most are in favour of an interpretation based on the fact that the scrap metals used as part of the steelmaking process and the slags produced as part of the steelmaking process and used for different purposes, cannot be regarded as a 'waste' in terms of the NEMWA and should not be regulated as such. A summary of the legal opinions and subsequent outcomes are included as part of Annexure 3:

### *5.3.5 Industry perspective: comments on the way ahead*

After having had the opportunity to liaise with the governmental department in order to understand the department's interpretation of the definition of waste and obtain the various external legal opinions with regard to the interpretation of the definition of 'waste' as contained in the NEMWA, the chairperson of the SAISI, together with individual environmental managers within the industry, summarised the problems with regard to the different environmental legislation and suggested the following:

For a long time, only section 20 disposal site permits were applicable with regard to the management of waste in terms of the ECA. Although storage areas and transfer

stations were not included within the ambit of section 20 permits (see discussion in paragraph 3.2.2 above), industry has in some occasions applied for section 20 permits for these storage areas/transfer stations. The ECA defined 'waste' but only regulated the disposal of waste even though recycling was also mentioned as part of the definition. The regulation of by-products in terms of the ECA was therefore never an issue. The ECA was also never clear on 'End-of- Waste' criteria (Fuggle, 2008:4).

From 1997, waste-related activities had to be authorised in terms of the ECA EIA Regulations which often resulted in the duplication because the authorities wrongfully insisted that most of these activities also required Section 20 ECA permits (see discussion in section 3.2.2). Furthermore, the commencement of the NEMA limited the re-use, recycling and recovery of by-products/ waste as authorisations were restricted to certain or specified uses and new opportunities, especially short term opportunities could not be pursued. For example, a Record of Decision ('ROD') usually made provision for the specific use of certain waste streams.

As a result, a ROD usually contained a provision that slags and dusts had to be disposed of. Such provisions restricted the recovery and re-use of materials to the extent that, should an alternative use become possible (especially short-term uses), industry would not have been able to make use of such an opportunity since the ROD would have to be amended. And even if such processes did not require an ROD, the storage areas required RODs because the old ECA definition of waste still applied as it was also problematic (Spanig, 2011(a)).

In terms of the ECA, waste was defined as follows:

*'An undesirable or **superfluous** by-product, emission or residue or remainder of any process or activity any matter, gaseous, liquid or solid or any combination thereof, originating from any residential, commercial or industrial area, which -*

*Is discarded by any person;*

*Is accumulated and stored by any person with the purpose of eventually discarding it with or without prior treatment connected with the discarding thereof; or*

*Building rubble used for filling or levelling purposes;*

*Is stored by any person with the purpose of recycling, re-using or extracting a usable product from such matter' (see section 3.2.2).*

With the inclusion of the word 'superfluous' as part of the definition, a lot of by-products were excluded from the definition and were regulated as a part product instead of a waste, but with the promulgation of the NEMWA, there was a major change in the regulation of waste. There is now a greater focus by government authorities to regulate by-products applications, even though such materials do not comply with the definition of waste any longer according to the interpretations obtained by industry (Spanig, 2011(a)).

It is clear from the above that, with the promulgation of the NEMWA, there are great uncertainties due to the definition of waste that are difficult to interpret. Due to the tendency of the authorities to attempt to regulate most by-product applications, it results in absurdities which totally inhibit the further use of by-product applications and which are contrary to the purpose of the NEMWA (see discussion in section 3.3.3).

Previous drafts of the NEMWA Bill indicated that 'by-products' will not be regarded and regulated as waste. Therefore, even though there is not a current use for the by-product, you would not need to apply for an authorisation. As a result, the current definition of 'by-product' as contained in the NEMWA is different than originally indicated in the drafts.

This is also the reason why industries did not initially have a problem with the proposed definition of 'waste' since many materials would have been excluded from the definition if it fell into the ambit of the definition of a 'by-product'. However, the strict interpretation of the definition of the 'by-product', as currently contained in the NEMWA, excludes most materials from the definition. The implications if a product that is currently regarded as a waste can be summarised as follows (Spanig, 2011(a)):

- **Firstly**, by-products that are currently being sold and regarded as waste by the department must comply with waste related regulations, as well as other regulations with regard to dangerous goods and other product-related regulations. What industry would want is for materials to be regulated as a by-product and excluded from the definition of 'waste' in order to avoid duplication (Spanig, 2011(a)).
- **Secondly**, there is a certain stigma associated with a product that is regarded as waste, and as a result, certain restrictions with regard to opportunities may arise. For example, with the recent floods in China, there was a need for iron resources that needed to be supplied within three months. South Africa will therefore not be able to assist in such need since the materials may be regarded as waste in South Africa and will have to comply with both national and international waste management legislation. This means that the export of materials on short notice will not be possible since it will take approximately a year to get the necessary national authorisations in place and maybe another year to get onerous conditions sorted out with the government.

It was previously indicated by the department that the establishment of norms and standards in terms of NEMWA may be the solution to the problem. This will, however, not solve the problem with regard to short-term, once-off opportunities. This is clearly against the purpose of the waste hierarchy, as envisaged in the NEMWA (Spanig, 2011 (a)).

- **Thirdly**, if you use a material as part of an internal process that may be regarded as a waste, you run the risk that your process may be regarded as a waste incineration process and as a result, you may need a waste management license in terms of NEMWA, as well as an amended permit in terms of the NEMAQA, with very strict emission standards which in some instances it may not be viable to use such a product as part of the process (Spanig, 2011 (a)).
- **Fourthly**, the interpretation of the definition of waste may also have a significant impact on job creation in the industry in the following ways:
  - Various well established markets exist for secondary products or by-products from the iron and steel sector. Typical secondary products currently being sold are chemicals (for example tar, sulphur, ammonium sulphate, etc.), granulated blast furnace slag used as a cement extender to enhance the properties of cement, processed iron and steel slags used as aggregate to the civil industry (for example roads, bricks and concrete), processed steel slags as liming agents or products, low carbon by-products competing with low grade coals and mill scale used in catalyst for synfuels (Spanig, 2011(b): 3);
  - Internal recycling/re-use/recovery opportunities are being utilised and further optimisation is possible but requires investment. Rising costs of raw materials are a main driver to seek further opportunities. Approximately 40% of by-products generated are currently still being disposed of (Spanig, 2011(b):3);
  - The biggest challenges are posed by steel slags where free lime content is a limitation and obviously volumes and huge stock volumes of steel slags are available on disposal sites. These slags are also the preferred option to cap these disposal sites (Spanig, 2011(b):3);
  - It should be realised that the iron and steel sector may compete with other suppliers of materials and opportunities found may impact negatively on other industries. 'Renewable' materials may for instance

compete with quarries. A high economic growth rate may obviously create room for all potential suppliers of materials (Spanig, 2011(b):3);

- According to a study done by SAISI, the following opportunities may arise within industry:

**Table 7 Job Creation Opportunities (Spanig, 2011(b):4)**

<b>NR:</b>	<b>ACTIVITY:</b>	<b>JOBS:</b>
1.	Processing of slags and recovery of metal (2014)	120
2.	Carbon separation from Dolochar (2011)	10
3.	Recycling of secondary products into Sinter 2012	5
4.	Clay brick manufacturing using low carbon materials (2012)	100
5.	Clay brick manufacturing phase 2 (2015)	100
6.	Briquetting of carbon and iron containing materials (2014)	15
7.	Further opportunities regarding sale of carbon and iron containing materials (next 3 years)	20
8.	Rehabilitation projects over the next 5 years (not necessarily permanent)	50-100
9.	Waste sorting opportunities including refractories (next 5 years)	30
	<b>Total</b>	<b>450</b>

- The NEMWA is regarded as a stumbling block with regard to job creation firstly because of the challenges the industry are faced with regarding the different possible interpretations of the definition of waste as contained in the NEMWA. Secondly, potential onerous conditions as part of the waste management licenses (WML) may restrict certain recovery, recycling and re-use opportunities and may also scare off potential small business enterprises. Furthermore, opportunities may be lost due to long timelines involved to acquire WMLs and a more relaxed approach towards trials / pilot projects is required. There is also a huge risk of being regarded as an incineration facility if material that has a waste connotation

attached to it is used. The NEMAQA has strict emission limits for such incineration facilities (Spanig, 2011(b):6);

- Waste exchange programs are being launched at municipal level but the NEMWA is not considered, posing legal risks (Spanig, 2011(b):6);
- Infrastructure spending by government and construction activities in general are decreasing but this will hopefully only be a short term phenomenon(Spanig, 2011(b):6);
- ‘*Renewable*’ materials are not yet preferred materials in the construction industry often due to cost. It is still too easy to open a quarry next to a road building project. In urban areas a turnaround is being witnessed (Spanig, 2011(b):6).

What is needed is legislation that only provides for the disposal of waste. Recycling, re-using and recovery are already regulated in other ways, for example:

- Products are being regulated in terms of the Consumer Protection Act, 2000 (Act No. 68 of 2000) – the CPA. According to the Act, the purpose of the CPA is to *inter alia* promote a fair, accessible and sustainable marketplace for consumer products and services and for that purpose to establish national norms and standards relating to consumer protection, to provide for improved standards of consumer information, to prohibit certain unfair marketing and business practices, to promote responsible consumer behaviour, to promote a consistent legislative and enforcement framework relating to consumer transactions and agreements (Spanig, 2011(a));
- Products are also regulated by various other product related legislation such as the National Road Traffic Act, 1996 (Act No. 93 of 1996) – the NRTA. The NRTA regulates, *inter alia*, the transportation of dangerous goods in terms of South African Bureau of Standards SABS 0228, ‘*The identification and classification of dangerous substances and goods*’. In terms of these regulations, the safe transport of dangerous and hazardous substances is regulated (Spanig, 2011(a));



- Environmental specific related issues are regulated in terms of section 28 as contained in the NEMA. This section is commonly referred to as the '*Duty to Care*'. Section 28(1) reads as follows:

*'(1) Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment'*

This section is very wide and non-compliance with the '*duty of care*' may result in subsequent directives being issued against companies and criminal prosecution (Spanig, 2011(a));

- By-products are also being regulated through the NEMAQA where the major impacts are being regulated as air emissions (Spanig, 2011(a));
- Government should focus on material that are being discarded or disposed of which do not have any value whatsoever. Industry will therefore prefer regulation, as it was in terms of the previous ECA. Although the definition of waste in terms of the ECA was in some ways problematic, the ECA only regulated the disposal of waste (Spanig, 2011(a)).

## **CHAPTER 6. RECOMMENDATIONS AND CONCLUSIONS**

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The aim of this chapter is firstly to demonstrate that the main objective of the research has been achieved and that the sub-research questions presented in Chapter 1 have been answered. The main objective of the research was:

To critically review the definition of 'waste' as contained in the NEMWA and the possible implications of such interpretation(s) on the iron and steel making industry in South Africa and to make certain recommendations with regard to future regulation of waste.

### **6.1. INTRODUCTION**

The chapter starts by summarising the research results in relation to the different sub-research questions (section 6.2). This provides an easy reference to the outcomes of the research. In section 6.3 an overall conclusion and recommendations are made on how to regulate South African waste management in the future. These recommendations are based on a reflection on the existing knowledge, mainly from the literature review (see Chapters 3 and 4) as well as the research results emanating from the interviews (see Chapter 5). The chapter concludes with recommendations for further research in section 6.4.

### **6.2. SUMMARY OF RESULTS**

In order to achieve the overall research objective presented in Chapter 1, a number of sub-research questions were answered. Table 9 presents a summary of the outcome of the research results in relation to these sub-research questions:

**Table 8 Summary of research results in relation to sub-research questions**

**Sub-research question 1:**

What aspects with regard to waste management are currently being regulated in terms of the NEMWA in comparison with previous environmental legislation?

In Chapter 3, the current legal framework with regard to waste management in South Africa was determined and compared with the historical legal framework with regard to waste management in South Africa. The discussion was divided into three subsections namely:

- Firstly, environmental legislation pre-70s was discussed, and the only applicable legislation at the time was highlighted; namely the WA and APPA. With regard to waste management, the WA only regulated the management of effluent in that the WA required that all effluent be returned to the water body from which the water was originally abstracted and uniform effluent standards were established in order to be able manage effluent discharge effectively. In terms of APPA, waste management was not specifically defined and regulated but waste materials were regulated as part of the APPA by listed schedule processes that regulated waste related activities that may have had an impact on the environment with specific reference to atmospheric emissions or as part of conditions contained in provisional/final registration certificates dealing with other aspects such as the disposal of certain waste streams connected with scheduled processes;
- Secondly, environmental legislation that was promulgated after the 70s, but before the current waste management legislation, was highlighted. The following legislation was applicable during this time period: the ECA of 1982, the ECA, the Constitution, and EIA Regulations in terms of the ECA and the NEMA. Although

waste management was not specifically regulated in the ECA of 1982, this piece of legislation was a step towards the regulation of EIAs in South Africa, of which waste management would form part as an impact on the environment. In terms of the subsequent ECA that was promulgated during 1989, not only were the provisions in the ECA a first step towards EIAs, but it was also the first significant piece of legislation regulating effective protection and controlled utilisation of the environment with specific reference to waste management in South Africa. The ECA did not only define waste but also regulated the disposal of waste at disposal sites. It is also stated as part of this subsection that government authorities tried to regulate more than only waste disposal and tried to widen the ambit of disposal sites by means of the classification system, the Minimum Requirements. Arguments are provided in this regard as to why only waste disposal was regulated as part of the ECA.

The promulgation of the Constitution was the first step towards the provision for integrated framework legislation for the management of the country's natural resources and other environmental related issues; one of which includes waste management within South Africa. Concurrent with the promulgation of the Constitution, the first EIA Regulations were promulgated in terms of the ECA. It was concluded that these EIA Regulations only regulated the disposal of waste to a large extent, and any other alternative uses of waste, for example the re-use, recovery and recycling of waste, were not regulated in terms of these EIA regulations.

The NEMA did not *per se* regulate waste management as part of the act but regulated waste management-related aspects as part of the EIA listed activities that were promulgated in terms of the NEMA. The NEMA therefore did not only regulate the disposal of waste but also other waste management-related aspects, such as the recycling and recovery of waste. The NEMA did not provide for a separate definition of waste, and as a result, reference was still made to the definition of waste as provided for in terms of the ECA. Furthermore, the terms 'recycling' and 're-use' were never defined in terms of the NEMA, and were open

to interpretation. This situation was, however, rectified by the NEMWA;

- Thirdly, waste management legislation that is currently applicable was highlighted, namely the NWA, the NEMAQA and the NEMWA. Waste management regulated in terms of the NWA pertains to the discharging, disposal, and certain controlled activities of waste. Only discharging and disposal, as far as they relate to waste management pertaining to water resources, are being regulated in terms of the NWA.

No specific provision is made with regard to waste management regulation in terms of the NEMAQA. However, this piece of legislation also provides for a list of activities that have emissions and may have a detrimental effect to the environment. Some of these activities, although not waste-specific activities, may have an impact on waste management and may include recovery, re-use and the recycling of waste. These terms are not defined in terms of the NEMAQA, and waste is also not defined in terms of this piece of legislation. As a result, there is often referral to the definitions as provided for in the NEMWA.

The NEMWA fundamentally reformed the law regulating waste management and for the first time provided for a coherent and integrated legislative framework for all addressing all the steps in the waste management hierarchy by providing for a new definition of waste as well as definition for recovery, re-use and recycling of waste. A list of waste management activities was also promulgated, identifying activities that need a waste management license before the commencement of such activity and recovery, recycling and the re-use of waste is currently being regulated in terms of these listed activities.

### **Sub-research question 2:**

What is the life cycle of the iron and steel making process and what are the recycling and recovering opportunities as part of this process?

In Chapter 4, the Iron and Steel making process is described, together with possible recycling, recovery and re-use opportunities that may present themselves as part of this intricate process. The process is divided into primary and secondary steelmaking and alternative iron making techniques. The discussion is divided into four subsections as follows:

- Firstly, the primary steelmaking process is discussed in detail. Primary steelmaking consists of the classic blast furnace or basic oxygen furnace route, and is by far the most complex process of iron and steelmaking. This process also includes the discussion of the sinter plant which provides the blast furnace with sinter (raw materials); a combination of blended ores, fluxes and coke which is partially cooked or sintered and the coke making process;
- Secondly, the secondary steelmaking process is discussed in detail. This process consist of the electric arc furnace which use ferrous scrap material as input material;
- Thirdly, new/alternative iron making techniques are discussed with specific reference to direct reduction and smelting reduction. Direct reduction involves the production of solid primary iron from iron ores and a reducing agent (e.g. natural gas). The solid product is called 'direct reduced iron' and is mainly applied as feedstock in electric arc furnaces. Smelting reduction involves combining iron ore reduction with smelting (blast furnace) in a reactor, without the use of coke. The product is liquid pig iron, which can be treated and refined in the same way as pig

iron from the blast furnace;

- Fourthly, the steelmaking process and the waste hierarchy is discussed. In summary, iron making slag, steelmaking slag, various forms of dusts, dolochar, mill scale, tar ammonium sulphate, naphthalene, sulphur, sludges and salts are identified as materials/by-products that can be re-used, recovered, and recycled as part of the waste hierarchy process, as described as part of the NEMWA.

### **Sub-research question 3:**

What are the different possible interpretations of the definition of 'waste' as contained in the NEMWA by both the regulating authorities as well as industries?

Chapter 5 is divided into the following subsections:

- Firstly, the different international definitions of 'waste' are discussed, including those of the European Union, Singapore, New Zealand, Taiwan and the USA. It is indicated as part of this discussion that the definitions of 'waste' and the 'end-of-waste' criteria, as established in the European Union, are an inclination towards a scenario where certain materials that are re-usable and recyclable are taken out of the legislative system, subject to the implementation of sound environmental management systems. This way of thinking is more in line with industry's thinking, as later revealed as part of this chapter;
- Secondly, the different interpretations of the definition of 'waste' in South Africa, as contained in the NEMWA, are identified and discussed. The official government interpretation is the more restrictive interpretation, which means that if the generator does not need a substance that originated from his/her production process, further for the purposes of production in his/her own processes, that

substance becomes waste.

If the substance that is generated in a process or production requires treatment before it could be re-used or is to be disposed of, it is waste. Only once waste is re-used, recycled or recovered does it stop being waste. In other words, waste that can further be used in another process by means of re-use, recycling or recovery is **still** waste in the hands of the person acquiring that substance for the purpose of re-use, recycling or recovery **until** it has undergone the re-use, recycling and the recovery process.

As a result, the scrap metal used as part of the input material in the steelmaking process will only cease to be a waste once the material is put into either the basic oxygen furnace or the electric arc furnace. The different slags produced as part of the steelmaking process cannot be regarded as by-products since the slags do not have the exact same chemical and physical characteristics as the same virgin material.

The slags will therefore be regarded as waste in terms of the NEMWA, and will only cease to be a waste once they have been used as part of the road-making process, or when they have been used for agricultural purposes.

The first interpretation obtained by industry was that of Adv. L Vorster, SC. This opinion indicated that waste is a substance that has no other use to the producer thereof or anybody else, and is destined to be disposed of finally to a waste treatment facility. Furthermore, a substance which is produced or manufactured by whatever means that can further be used in a process by means of re-use, recycling or recovery, is not waste in the hands of the person acquiring that substance for the purpose of re-use, recycling or recovery. It is a raw material in the hands of the person involved in the process to produce a useful end-product and not waste destined to be dumped on a waste disposal facility.



According to this opinion, it follows that scrap metal used as input material for the production of steel will not classify as 'waste' as defined in terms of the NEMWA, and slags produced as part of the steelmaking process will also not be regarded as 'waste', as defined in terms of the NEMWA.

The second opinion obtained was from Adv. W Trengove, SC. This opinion concluded that the processing of the scrap metal will be regulated in terms of the NEMWA but the processed scrap metal that is sold to the steel producing industry will not be regarded as a 'waste' in terms of the NEMWA and therefore will not be regulated as such.

The third opinion obtained from Adv. SJ Maritz, SC focused on the processing of slags and how that would affect the interpretation of the definition of waste. This opinion concluded that if the form of the slag is changed, but not the substance of the material (for example the crushing and screening of the slag); the material is a by-product and excluded from the definition of waste. Furthermore, if the substance of the material is changed, the process can be regarded as a secondary production process and as a result, the slag will be regarded as a product and not a waste, as defined in terms of the NEMWA.

**Sub-research question 4:**

What are the implications of each of the aforementioned interpretations on the iron and steel making industry?

As part of Chapter 5, the following implications were identified by SAISI:

- Firstly, by-products that are currently being sold and regarded as a waste by the

department must comply with waste-related regulations, as well as other regulations with regard to dangerous goods and other product-related regulations. What industry wants is for materials to be regulated as a by-product and excluded from the definition of 'waste' in order to avoid duplication;

- Secondly, there is a certain stigma associated with a product that is regarded as waste, and as a result, certain restrictions with regard to opportunities may arise. For example, with the recent floods in China, there was a need for iron resources that needed to be supplied within three months. South Africa will therefore not be able to assist in such needs since the materials may be regarded as waste in South Africa and will have to comply with both national and international waste management legislation. This means that the export of materials at short notice will not be possible, since it will take approximately a year to get the necessary national authorisations in place, and it maybe another year to get onerous conditions sorted out with the government.

It was previously indicated by the department that the establishment of norms and standards in terms of NEMWA may be the solution to the problem. This will, however, not solve the problem with regard to short-term, once-off opportunities. This is clearly against the purpose of the waste hierarchy as envisaged in the NEMWA.

- Thirdly, if you use a material as part of an internal process that may be regarded as a waste, you run the risk that your process may be regarded as a waste incineration process. As a result, you may need a waste management license in terms of the NEMWA, as well as an amended permit in terms of the NEMAQA with very strict emission standards. In some instances it may not be viable to use such a product as part of the process;
- Fourthly, the interpretation of the definition of waste may also have significant impacts on job creation in the industry, which are discussed in more detail in

**Sub-research question 5:**

What should the correct interpretation of the definition of 'waste' be in terms of the South African waste management legislation in order to give effect to the waste hierarchy in South Africa?

As part of Chapter 5, the following suggestions are made by SAISI in order to address the problems associated with the interpretation of the definition of waste:

- According to SAISI, what is needed is legislation that only provides for the disposal of waste. Recycling, re-using and recovery are already regulated in other ways, for example products are being regulated in terms of the CPA. According to the Act, the purpose of the CPA is to *inter alia* promote a fair, accessible and sustainable marketplace for consumer products and services and for that purpose to establish national norms and standards relating to consumer protection, to provide for improved standards of consumer information, to prohibit certain unfair marketing and business practices, to promote responsible consumer behaviour, to promote a consistent legislative and enforcement framework relating to consumer transactions and agreements.

Products are also regulated by various other product-related legislation, such as the NRTA. The NRTA regulates, *inter alia*, the transportation of dangerous goods in terms of South African Bureau of Standards SABS 0228 '*The identification and classification of dangerous substances and goods*'. In terms of these regulations, the safe transports of dangerous and hazardous substances are regulated;

- Environmental-specific related issues are regulated in terms of section 28 as contained in the NEMA. This section is commonly referred to as the '*Duty to Care*'. This section is very wide, and non-compliance with the '*duty of care*' may result in subsequent directives being issued against companies and criminal prosecution;
- By-products are also being regulated through the NEMAQA where the major impacts are being regulated as air emissions;
- Government should focus on material that is being discarded or disposed of, and that does not have any value whatsoever. Industry will therefore prefer regulation, as it was in terms of the previous ECA. Although the definition of waste in terms of the ECA was in some ways problematic, the ECA only regulated the disposal of waste.

### **6.3. OVERALL CONCLUSION**

The iron and steelmaking industry is a very intricate, diverse and dynamic industry which provides for many possible recycling, recovering and re-use opportunities for various materials produced as part of the iron and steelmaking process, as illustrated in Chapter 4. The current interpretation of the definition of waste by the DEA is simply not viable in achieving the principles as envisaged in terms of the waste hierarchy, which forms part of section 2 as contained in the NEMWA.

The restrictive interpretation by the DEA entails that materials only cease to be a waste once they have been used as part of a production or subsequent process. The DEA therefore does not make provision for secondary production processes and also does not make provision for materials as by-products which do not have the exact same physical and chemical characteristics.

It was illustrated as part of the research that this interpretation is not feasible and will restrict recycling and recovery possibilities, especially opportunities that will only be viable for a short period of time. As part of the research it was indicated by industry that the implications (if a product is regarded as a waste) can be quite significant; not only for industry but also in terms of the economic and social impacts in South Africa as a whole.

It was also illustrated as part of the research that there is more than one possible interpretation for the current definition of waste as contained in the NEMWA. The other opinions (apart from the opinion obtained from the DEA) that were research focused on the possibility of materials, with specific reference to the use of slags, being regarded as by-products or secondary production products. The implication of these wider opinions is that the materials will not be regarded as a waste in terms of the NEMWA, and as a result will not be regulated as such.

However, cognisance should be taken of the fact that industry, by accepting the wider interpretation, is not suggesting that the use of the materials should not be regulated at all. It is understood by industry that government needs to regulate the use of these materials to make sure that the use of the materials complies with sound environmental principles. However, slags that are currently being regarded as a waste by the DEA must comply with waste-related regulations, as well as other regulations with regard to dangerous goods and other product-related legislation.

What industry is suggesting is for materials to be regulated as a by-product, and thus excluded from the definition of 'waste' in order to avoid duplication of regulation. In this regard it was also illustrated as part of the research that the use of the materials are already regulated; not only as part of various other pieces of legislation which are applicable to products, but also in terms of environmental legislation with specific reference to the '*Duty of Care*' principle as envisaged in terms of section 28 as contained in the NEMA.

In terms of this principle, a user of any product is responsible for ensuring that sound environmental management principles are applicable to the use of any product to make sure that the use of such a material is not detrimental to the environment.

Therefore, it is suggested that an alternative interpretation of the definition of waste as currently contained in the NEMWA should be followed by the DEA as a short-term solution. This interpretation need not be the same as the interpretations suggested by industry, but should ensure effective implementation of the waste hierarchy as prescribed by the NEMWA. It should also be remembered that the main purpose of the waste hierarchy is to make provision for sustainable development by providing for disposal as a last resort. With an ineffective implementation of the waste hierarchy, this will mean more disposal of waste at disposal sites. It is currently doubtful whether government has sufficient disposal facilities for such additional loads of waste disposal.

#### **6.4. RECOMMENDATIONS FOR FUTURE RESEARCH**

From the aforementioned it is clear that there is a conflict of interest between certain stakeholders involved with the interpretation of the definition of waste as contained in the NEMWA. Should the interpretation of the DEA be followed (as a long-term solution), which includes an all-encompassing definition of waste, such interpretation will promote environmental protection but at the same time discourage the implementation of the waste hierarchy as determined in the NEMWA. On the other hand, should the other interpretations as suggested by industry be followed as a long-term solution, such interpretations will support the implementation of the waste hierarchy but may undermine environmental protection.

It is therefore clear that there should be a trade-off between the protection of the environment and the re-use, recovery and recycling opportunities of materials available to industry on the short-term as well as the long-term.

In order to achieve such a trade-off, it is suggested that the 'End-of Waste' criteria in South Africa be reconsidered and re-evaluated to ensure more legal certainty with regard as to exactly constitutes waste and to provide for a definition of 'waste' which is clearly defined. This re-evaluation process should be done in the form of a public participation process by all the relevant stakeholders.

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# ANNEXURES

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## Annexure 1: Interview Questionnaire conducted as part of the research

The following specific questions were asked to the main interviewee, Mr S Spanig, chairperson of SAISI, and all other interviewees were asked whether they agree with his opinion or if not, the reasons as to why they disagree:

### List of Interview Questions

NR:	QUESTIONS:
1.	Describe the different types of iron and steelmaking and the phases involved as part of the different types of steelmaking?
2.	As part of the iron and steelmaking process, describe the recycling, recover and re-use opportunities as defined in terms of the NEMWA that forms part of the different types and phases of the steelmaking process?
3.	What are the differences between the current regulation of waste in terms of NEMWA and the previous regulation of waste management in terms of previous environmental legislation, with specific reference to the ECA as well as the NEMA?
4.	What are the problems/challenges associated with the current legislative regime pertaining to waste management in terms of the NEMWA in comparison with challenges associated with the previous legislative regime?
5.	Which legislative regime is preferred by the iron and steelmaking industry and provide reasons for the preferred option?
6.	According to the iron and steelmaking industry, what are the possible solutions to the aforementioned problems / challenges identified in terms of the current legislative regime?

The following is a list of the main interviewee as well as of the other interviewees, currently all members of SAISI:

### List of Interviewees

NR:	NAME:	DESIGNATION:
1.	S Spanig	Group Manager: Environment ArcelorMittal SA (Ltd). Chairperson: Environmental Committee: SAISI Main Interviewee
2.	P Scurr	Environmental Manager: Columbus Stainless Steel (Pty) Ltd.
3.	J Prinsloo	Environmental Manager: Pretoria Works, ArcelorMittal SA (Ltd).
4.	D van Rensburg	Environmental Manager: Cape Gate (Pty) Ltd.
5.	S Mntambo	Environmental Manager: Newcastle Works, ArcelorMittal SA (Ltd).
6.	T Notshe	Environmental Manager: Vereeniging Works: ArcelorMittal SA (Pty) Ltd.
7.	Y Dell	Environmental Manager: Scaw Metals (Pty) Ltd.
8.	O Scribante	Environmental Manager: Saldanha Works: ArcelorMittal SA (Pty) Ltd.
9.	K Zantow	Environmental Manager: Vanderbijlpark Works: ArcelorMittal SA (Pty) Ltd.

All interviewees were interviewed during October and November 2011 except for the interview conducted with Mr S Spanig, which was conducted on the 18<sup>th</sup> of March 2011.

## Annexure 2: Listed Processes in terms of NEMQAQ

The following are waste related processes listed in terms of Section 21(1)(a) as contained in the NEMQAQ, as well as the minimum emission standards for these listed activities as contemplated in section 21(3)(a) and (b) of the NEMQAQ published under Government Notice 248 in Government Gazette 33064 of 31 March 2010:

### Subcategory 2.3: Industrial fuel oil recyclers:

<b>Description:</b>	<b>Installations used to recycle or recover oil from waste oils.</b>		
<b>Application:</b>	<b>Industrial fuel oil recyclers with a throughput &gt; 5000 ton/month.</b>		
Substance or mixture of substances		Plant status	mg/Nm <sup>3</sup> under normal conditions of 273 Kelvin and 101.3 kPa.
Common name	Chemical symbol		
Carbon monoxide	CO	New	130
		Existing	250
Sulphur dioxide	SO <sub>2</sub>	New	500
		Existing	3500
Total volatile organic compounds from vapour recovery / destruction units.	N/A	New	40
		Existing	90

**Subcategory 4.20: Slag processes:**

Description:	The processing or recovery of metallurgical slag by the application of heat.		
Application:	All installations.		
Substance or mixture of substances	Plant status	mg/Nm <sup>3</sup> under normal conditions of 273 Kelvin and 101.3 kPa.	
Common name	Chemical symbol		
Particulate matter	N/A	New	50
		Existing	100
Sulphur dioxide	SO <sub>2</sub>	New	1500
		Existing	2500
Oxides of nitrogen	NO <sub>x</sub> expressed as NO <sub>2</sub>	New	350
		Existing	2000



**Subcategory 4.21: Metal recovery:**

Description:	The recovery of non-ferrous metal from any form of scrap material containing combustible components by the application of heat.		
Application:	All installations.		
Substance or mixture of substances	Chemical symbol	Plant status	mg/Nm <sup>3</sup> under normal conditions of 10% O <sub>2</sub> , 273 Kelvin and 101.3 kPa.
Common name			
Particulate matter	N/A	New	10
		Existing	25
Carbon monoxide	CO	New	50
		Existing	75
Sulphur dioxide	SO <sub>2</sub>	New	50
		Existing	50
Oxides of nitrogen	NO <sub>x</sub> expressed as NO <sub>2</sub>	New	200
		Existing	200
Hydrogen chloride	HCl	New	10
		Existing	10
Hydrogen fluoride	HF	New	1
		Existing	1
Sum of Lead, arsenic, antimony, chromium, cobalt, copper, manganese, nickel, vanadium	Pb+ As+ Sb+ Cr+ Co+ Cu +Mn+Ni+V	New	0.5
		Existing	0.5
Mercury	Hg	New	0.05
		Existing	0.05
Cadmium Thallium	Cd+Tl	New	0.05
		Existing	0.05
Substance or mixture of substances		Plant	mg/Nm <sup>3</sup> under normal conditions of
Total organic compounds	TOC	New	10
		Existing	10
Ammonia	NH <sub>3</sub>	New	10
		Existing	10

			ng I-TEQ /Nm <sup>3</sup> under normal conditions of 10% O <sub>2</sub> , 273 Kelvin and 101.3 kPa.
Dioxins and furans	PCDD/PCDF	New	0.1
		Existing	0.1

Category 8: Disposal of hazardous and general waste:

Description:	Facilities where general and hazardous waste including health care waste, crematoria, veterinary waste, used oil or sludge from the treatment of used oil are incinerated.		
Application:	Facilities with an incinerator capacity of 10 kg of waste processed per hour or larger capacity.		
Substance or mixture of substances		Plant status	mg/Nm <sup>3</sup> under normal conditions of 10% O <sub>2</sub> , 273 Kelvin and 101.3 kPa.
Common name	Chemical symbol		
Particulate matter	N/A	New	10
		Existing	25
Carbon monoxide	CO	New	50
		Existing	75
Sulphur dioxide	SO <sub>2</sub>	New	50
		Existing	50
Oxides of nitrogen	NO <sub>x</sub> expressed as NO <sub>2</sub>	New	200
		Existing	200
Hydrogen chloride	HCl	New	10
		Existing	10
Hydrogen fluoride	HF	New	1
		Existing	1
Sum of Lead, arsenic, antimony, chromium, cobalt, copper, manganese, nickel, vanadium	Pb+As+Sb+ Cr+Co+ Cu + Mn+ Ni+ V	New	0.5
		Existing	0.5
Mercury	Hg	New	0.05
		Existing	0.05
Cadmium Thallium	Cd+Tl	New	0.05
		Existing	0.05
Total organic compounds	TOC	New	10
		Existing	10

Ammonia	NH <sub>3</sub>	New	10
		Existing	10
			ng I-TEQ /Nm <sup>3</sup> under normal conditions of 10% O <sub>2</sub> , 273 Kelvin and 101.3 kPa.
Dioxins and furans	PCDD/PCDF	New	0.1
		Existing	0.1

**Category 9: Pulp and Paper Manufacturing Activities, including By-Products Recovery:**

Subcategory 9.1: Lime recovery kiln:

Description:	The recovery of lime from the thermal treatment of paper-making waste.		
Application:	All installations producing more than 1 ton per month.		
Substance or mixture of substances	Plant status	mg/Nm <sup>3</sup> under normal conditions of 6% O <sub>2</sub> , 273 Kelvin and 101.3 kPa.	
Common name	Chemical symbol		
Particulate matter	N/A	New	50
		Existing	100
Total reduced sulphur	H <sub>2</sub> S	New	10
Substance or mixture of substances	Plant	mg/Nm <sup>3</sup> under normal conditions of 6% O <sub>2</sub> , 273	
compounds measured as H <sub>2</sub> S		Existing	10
Oxides of nitrogen	NO <sub>x</sub> expressed as NO <sub>2</sub>	New	600
		Existing	2000

Subcategory 9.2: Alkali waste chemical recovery furnaces:

Description:	The recovery of alkali from the thermal treatment of paper-making waste.		
Application:	All installations producing more than 1 ton per month.		
Substance or mixture of substances	Plant status	mg/Nm <sup>3</sup> under normal conditions of 273 Kelvin and 101.3 kPa.	
Common name	Chemical symbol		
Particulate matter	N/A	New	50
		Existing	100
Hydrogen	H <sub>2</sub> S	New	15

sulphide		Existing	15
Sulphur dioxide	SO <sub>2</sub>	New	30
		Existing	300
Oxides of nitrogen	NO <sub>x</sub> expressed as NO <sub>2</sub>	New	300
		Existing	300

Subcategory 9.3: Copeland alkali waste chemical recovery process:

Description:	The recovery of alkali from the thermal treatment of paper-making waste using a Copeland process		
Application:	All installations producing more than 1 ton per month		
Substance or mixture of substances		Plant status	mg/Nm <sup>3</sup> under normal conditions of 273 Kelvin and 101.3 kPa.
Common name	Chemical symbol		
Particulate matter	N/A	New	No plant of this type will be authorised in the future
		Existing	100
Sulphur dioxide	SO <sub>2</sub>	New	No plant of this type will be authorised in the future
		Existing	800

**Category 10: Animal matter processing:**

Description:	Processes for the rendering cooking, drying, dehydrating, digesting, evaporating or protein concentrating of any animal matter not intended for human consumption.
Application:	All installations handling more than 1 ton of raw materials per day.

## Annexure 3: Summary of Legal Opinions

Counsel / Consultant	Title / Questions	Conclusions:
<p><b>Counsel:</b> L Vorster, SC</p> <p><b>Consultant:</b> The South African Iron and Steel Institute ('SAISI').</p>	<p>'Advise on the legal interpretation of certain concepts defined in the new National Environmental Management: Waste Act, No 59 of 2008. In particular, the definition of 'waste' as defined in the Act is at stake'</p> <p>Specific questions:</p> <ol style="list-style-type: none"> <li>1. Will Scrap metal used as input material for the production of steel classify as 'waste' defined in terms of the NEMWA?</li> <li>2. Should slags produced as part of the steelmaking process be regarded as waste?</li> </ol>	<p>Scrap metal used as input material for the production of steel will not classify as 'waste' defined in terms of the NEMWA;</p> <p>Slags produced as part of the steelmaking process is not to be regarded as waste</p>
<p><b>Counsel:</b> L Vorster, SC</p> <p><b>Consultant:</b> The New Reclamation Group (Pty) Ltd.</p>	<p>'The interpretation of the National Environmental Management: Waste Act, No 59 of 2008'</p> <p>Specific questions:</p> <ol style="list-style-type: none"> <li>1. Does recyclable unprocessed scrap metal, which is received by our operations constitute waste as defined in the Act; and in the event that it does,</li> <li>2. Does recycled processed scrap, which is received at our port sites for export, constitute waste as defined?</li> </ol>	<p>This was a follow-up opinion to the opinion mentioned in 1 above.</p> <p>In terms of the opinion, the answer to the first question is negative.</p> <p>As far as question 2 is concerned, there can be no question that recycled processed scrap which is received at the port sites for export, does not constitute waste. In terms of paragraph D(ii) of the definition of 'waste' in the Act, any recycled and processed scrap cannot be regarded as waste as it ceases to be waste once it is re-used, recycled and/or recovered.</p>
<p><b>Counsel:</b> Adv. W Trengove, SC</p> <p><b>Consultant:</b></p>	<p>'Does processed scrap Metal constitute 'Waste'?'</p>	<p>Processed scrap metal does not constitute 'waste' for two reasons:</p> <ol style="list-style-type: none"> <li>1. The first is that it no longer constitutes a substance of the kind described in paragraphs (a) to (d):</li> </ol>

<p>The New Reclamation Group (Pty) Ltd</p>		<ul style="list-style-type: none"> <li>• It is no longer surplus, unwanted, rejected, discarded, abandoned or disposed of within the meaning of paragraph (a) (read with the definition of 'disposal'). It is not a substance of the kind described in paragraph (a). It does not make sense to ask whether the original generator of the scrap metal has any further use for it for purposes of production. The original generator has disposed of it and no longer has any intention in relation to it. Consultant has acquired it for purposes of resale as raw material.</li> <li>• The scrap metal no longer needs to be 'treated' or 'disposed of' within the meaning of paragraph (c) (read with the definitions of 'treatment' and 'disposal').</li> <li>• The Minister has not identified the scrap metal as waste in terms of paragraph (d).</li> </ul> <p>2. But even if the waste metal is still a substance within the meaning of paragraphs (a) to (d), it has in any event ceased to be waste because it has been 'recycled' within the meaning of paragraph (ii) read with the definition of 'recycle'. It has been reclaimed for further use by a process which involves its separation from a waste stream and its processing as raw material.</p> <ul style="list-style-type: none"> <li>• Processed scrap metal does not constitute waste because it is not a substance of the kind described in paragraphs (a) to (d) and has in any event been recycled and thus ceased to be waste in terms of paragraph (ii).</li> </ul>
<p><b>Counsel:</b> Adv. W Trengove, SC</p> <p><b>Consultant:</b> The New Reclamation Group (Pty) Ltd</p>	<p>'Does unprocessed scrap Metal constitute 'Waste'?'</p>	<p>Opinion concludes that the unprocessed scrap metal reclaimed by Consultant before it undergoes the processing procedure described in the previous opinion under 2 constitutes waste in that it is a substance of the kind described in the definition of waste</p>
<p><b>Counsel:</b> Adv. SJ Maritz, SC</p>	<p>'Waste generation in steel production'</p>	<ul style="list-style-type: none"> <li>• According to the opinion, the use of slags should be regarded as a by-product if the materials is used without</li> </ul>

<p><b>Consultant:</b> The South African Iron and Steel Institute ('SAISI')</p>	<p>Specific questions:</p> <ol style="list-style-type: none"> <li>1. What is the legal position of the members of Consultant in regard to such by-products with reference to the National Environmental Management: Waste Act No 59 of 2008, to which reference will be made herein as 'the Act'?</li> <li>2. Members of Consultant also buy steel and metal products, which have been recovered from the waste stream, in the open market. Consultant also seeks an opinion as to the position in respect of those products in terms of the provisions of the Act?</li> </ol>	<p>changing the substance of the materials (changing the form is acceptable)</p> <ul style="list-style-type: none"> <li>• Use of slags where the substance of the material is changed should be viewed as part of a further production process / line.</li> </ul>
<p>The Department of Environmental Affairs</p>	<p>'When does a material cease to be a waste?'</p> <p>Official interpretation by the DEA.</p>	<p>According to the DEA, a by-product must fulfil the following conditions:</p> <ul style="list-style-type: none"> <li>• The substance produced must be produced as part of a process that is primarily intended to produce another substance or product;</li> <li>• The substance must demonstrate the equivalent <b>chemical</b> and physical characteristic of an equivalent virgin product or material;</li> <li>• The substance or object can be used directly without any further processing.</li> </ul> <p>The DEA then goes on to try and answer the question as to exactly what constitute a waste by quoting the definition of waste as contained in NEMWA. According to the DEA, the words '<i>surplus</i>', '<i>unwanted</i>', '<i>rejected</i>', '<i>discarded</i>', '<i>abandoned</i>', or '<i>disposed of</i>' are not defined and the ordinary dictionary meaning should be used. '<i>Surplus</i>' should be interpreted in the context of '<i>unwanted</i>', '<i>rejected</i>', '<i>discarded</i>', '<i>abandoned</i>' or '<i>disposed of</i>'.</p> <p>The fact that waste can be reduced, re-used, recovered and recycled is irrelevant for the purpose of determining whether it is 'waste' or not.</p>



		The usage of the terms ' <i>unwanted</i> ', ' <i>rejected</i> ', ' <i>discarded</i> ', ' <i>abandoned</i> ' does not mean that ' <i>waste</i> ' that could have a value is not waste.
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