



## **DEPARTMENT OF MINERALS AND ENERGY**

# **RADIOACTIVE WASTE MANAGEMENT POLICY AND STRATEGY FOR THE REPUBLIC OF SOUTH AFRICA**

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## **VISION**

**The management of radioactive waste in South Africa shall be in accordance with national objectives and recognized international principles as set out in Government Policy.**

## **PURPOSE OF THE DOCUMENT**

**To ensure the establishment of a comprehensive radioactive waste governance framework by formulating, additional to nuclear legislation, a policy and implementation strategy in consultation with all stakeholders.**

## **MINISTERIAL FOREWORD**

The development of a lasting solution to radioactive waste management is one of the critical issues for the future of nuclear applications. Wastes have arisen from activities associated with nuclear power as well as those associated with other programmes, some of which have been discontinued. In the past, owing to a lack of consultation, secrecy was commonly associated with certain activities. As a result, a waste policy could not be developed, because this would have entailed an indication of the scale of activities being undertaken. Since 1994, Government has committed itself to transparency, a culture of consultation and structured stakeholder participation. In our Energy Policy White Paper we undertook to develop a waste management policy.

We present to you this Policy and Strategy document, which we believe will serve as a solid basis for consultation on options for National Radioactive Waste Management. The document is an input to the consultation process that will unfold as we discuss how best to manage the waste that has been and continues to be generated in the various applications of nuclear technology. Radioactive waste in South Africa is currently being managed without a common framework, which this policy and strategy will direct. It is clear that the bulk of the waste was generated during a period that was characterized by a need to ensure self-sufficiency at any cost. The global village in which we live has since reached consensus against such practices. As a result of the curtailment of most of the front-end activities in the nuclear fuel cycle and modern waste management practices, it is unlikely that huge volumes of waste would again be generated over such a short period.

The National Radioactive Waste Management Policy and Strategy lays down options to be considered for managing spent fuel and high-level waste. The latter is the main concern among all the different classes of waste. The low volumes of this kind of waste produced by South Africa makes these decisions even more challenging. Nevertheless, with the participation of all stakeholders, the various options will be discussed and Government will then make an informed decision on the most suitable management option.

As one studies the document, one's mind should shift from considering only disposal and/or reprocessing to considering what option would be best for safe management, as that is what the objective of the policy will be. I trust that you will find this document as an indication of the direction Government intends taking in addressing radioactive waste management.

Minister of Minerals and Energy

## **DEPUTY MINISTER'S FOREWORD**

The Radioactive Waste Management policy and strategy outlines government's thinking in relation to Radioactive Waste management. This document sets out the main policy principles that the Department of Minerals & Energy will endeavour to implement through its institutions in order to achieve the overall policy objective. This policy gives us a formidable framework to interact with the world, and our own past, present and future.

This is a bold policy with a broad vision founded on respect for all the relevant principles for the safe management of radioactive waste. Chief among these is the protection of human health and the commitment to protect future generations in its implementation. Another of its great achievements is its participatory process that produced it and the continued partnerships among government departments.

The radioactive waste management policy is founded on the belief that all nuclear resources of South Africa are a national asset and the heritage of its entire people, and should be managed and developed for the benefit of present and future generations in the country as a whole.

It is the objective of the radioactive waste management policy to improve the overall contribution from the nuclear industry to this belief. Since nuclear is a relatively small sector within the national economy, its contribution will remain modest when measured in terms of macro-economic significance.

Radioactive waste management is not the exclusive preserve of government. The private sector and civil society have crucial roles to play. The fostering of partnerships between government and the private sector is a prerequisite for sustainable and effective radioactive waste management to take place. Similarly, the spirit of partnerships and co-operative governance between organs of state is equally important due to the crosscutting nature of radioactive waste management.

Monitoring and collection of information on waste generation are crucial for the implementation of waste reduction measures. Moreover, the sharing of such information and creating awareness about the issues will enable all stakeholders, including communities, to gain a better understanding of the relation between radioactive waste management and the quality of life.

Deputy Minister of Minerals & Energy

# 1 INTRODUCTION AND SCOPE

Most human enterprises produce waste, some of which is radioactive. Radioactive waste contains materials that emit ionising radiation, which has been recognised as a potential hazard to human health since the beginning of the 20<sup>th</sup> century. The safe management of radioactive waste is therefore essential for the protection of human health and the environment, in the present and future.

Radioactive waste is produced during the operational and decommissioning phases of facilities associated with the following activities:

- The operation of nuclear reactors and other facilities within the nuclear fuel cycle.
- The production and use of radioactive materials in the fields of research, medicine, industry, agriculture, commerce, education and defence.
- The extraction, processing and combustion of raw materials containing naturally occurring radioactive materials.
- Environmental restoration programmes associated with any of the above.

Radioactive waste may occur in a gaseous, liquid or a solid form that may range from low radioactivity, for example medical and laboratory waste, and certain mining wastes, to highly radioactive waste, for example spent fuel and certain spent radioactive sources. The physical and chemical characteristics of the various wastes e.g. the activity concentration, half-life (rate of decay), mixture of radioactive nuclides, chemical toxicity and radio-toxicity, varies widely. Radioactive waste may also occur together with other hazardous chemical or biological materials. The levels of radiation associated with radioactive waste should be seen in perspective to the natural background radiation to which everyone is exposed in everyday life.

Radioactive wastes generated by facilities, range from low volumes, such as spent radioactive sources, to large and diffuse volumes, such as tailings from the mining and milling of ores that contain uranium and thorium, and their radioactive decay products.

This Radioactive Waste Management Policy and Strategy serves as a national commitment to address the country's radioactive waste issues in a co-ordinated and co-operative manner.

The emphasis of this policy and strategy document is on the nuclear industry in South Africa within which the management of radioactive waste is a national responsibility assigned to the Minister of Minerals and Energy as per the Nuclear Energy Act of 1999. The scope of this policy relates to all radioactive wastes, except operational radioactive liquid and gaseous effluent (waste discharges), which is permitted to be released to the environment routinely under the authority of the relevant regulators.

It is recognised that waste containing un-concentrated natural occurring radioactive materials from the mining industry, minerals processing industries and the combustion of coal will also be managed as set out in the Integrated Pollution & Waste Management policy of the Department of Environmental Affairs and Tourism and other relevant legislation.

## A. NATIONAL RADIOACTIVE WASTE POLICY FRAMEWORK

### 2. INTERNATIONAL RADIOACTIVE WASTE MANAGEMENT POLICY PRINCIPLES

The international community through the International Atomic Energy Agency (IAEA) has developed a comprehensive set of principles for the safe management of radioactive waste. These basic principles are applicable to all countries and can be applied to all types of radioactive waste, regardless of its physical and chemical characteristics or origin.

As a member state of the IAEA, and in accordance with National and International objectives, it is Government's policy to deal with radioactive waste in a manner that protects human health and the environment, now and in the future in accordance with the following principles:

- **Protection of Human Health:** Radioactive waste shall be managed in such a way as to secure an acceptable level of protection for human health.
- **Protection of the Environment:** Radioactive waste shall be managed in such a way as to provide an acceptable level of protection of the environment, including natural resources.
- **Protection Beyond South Africa's Borders:** Radioactive waste shall be managed in such a way as to ensure that the possible effects on human health and the environment beyond national borders will be taken into account.
- **Protection of Future Generations:** Radioactive waste shall be managed in such a way that predicted impacts on the health of future generations will not be greater than relevant levels of impact that are acceptable today.
- **Burden on Future Generations:** Radioactive waste shall be managed in such a way that will not impose undue burdens on future generations.
- **National Legal Framework:** Radioactive waste shall be managed within an appropriate national legal framework, including clear allocation of responsibilities and the provision for independent regulatory functions.
- **Control of Radioactive Waste Generation:** The generation of radioactive waste shall be kept to the minimum practicable.
- **Radioactive Waste Generation and Management Interdependencies:** Interdependencies among all steps in radioactive waste generation and management shall be appropriately taken into account.
- **Safety of Facilities:** The safety of facilities for radioactive waste management shall be appropriately assured during each phase of the facility's lifecycle.

### 3 NATIONAL RADIOACTIVE WASTE MANAGEMENT POLICY PRINCIPLES

The above-mentioned objectives tie-in with the objective of sustainable development, which is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In addition to the internationally accepted principles, waste management in South Africa shall be managed in accordance with the following policy principles:



- **Polluter pays principle:** The financial burden for the management of radioactive waste shall be borne by the generator of that waste.
- **Transparency regarding all aspects of radioactive waste management:** All radioactive waste management activities shall be conducted in an open and transparent manner and the public shall have access to information regarding waste management where this does not infringe on the security of radioactive material.
- **Sound decision-making based on scientific information, risk analysis and optimisation of resources:** Decision-making shall be based on proven scientific information and recommendation of competent national and international institutions dealing with radioactive waste management.
- **Precautionary principle:** Where there is uncertainty about the safety of an activity a conservative approach shall be adopted.
- **No Import nor Export of Radioactive waste:** In principle South Africa will neither import nor export radioactive waste.
- **Co-operative governance and efficient national co-ordination:** Due to their crosscutting nature all activities involving radioactive waste management shall be managed in a manner that prevents duplication of effort and maximises coordination.
- **International cooperation:** The government recognises that it shares a responsibility with other countries for global and regional radioactive waste management issues. Its actions shall follow the principles in this policy and in relevant regional and international agreements.
- **Public Participation:** Radioactive waste management shall take into account the interests and concerns of all interested and affected, when decisions are being made.
- **Capacity building and education:** The government shall create opportunities to develop people's understanding, skills and general capacity concerning radioactive waste management.

The government will use these principles to develop, test and apply its policy. The government will also use the principles for decision making and where necessary amending laws and regulations

In implementing the national policy for radioactive waste management due cognisance must be taken of the requirement to comply with the prescripts of the "White Paper on integrated pollution and waste management for South Africa".

## 4 APPLICABLE NATIONAL LEGISLATION

Radioactive waste shall be managed under such Authority as provided for in the Nuclear Energy Act and in a co-operative manner as provided for in the Constitution, the National Environmental Management Act and the National Nuclear Regulator Act.

The governance and regulation of radioactive waste management shall be in accordance with the provisions of international agreements to which South Africa is a signatory and the following acts:

### 4.1 Nuclear Energy Act, 1999 (Act No. 46 of 1999)

- **Section 45:** The authority over the management of radioactive waste and the storage of irradiated nuclear fuel vests in the Minister of Minerals and Energy. The Minister, in consultation with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry, may make regulations prescribing the manner of management, storage and discarding of radioactive waste and irradiated nuclear fuel. The Minister must perform this function with due regard to the provisions of the National Nuclear Regulator Act, 1999. The previous arrangements and responsibilities regarding radioactive waste management related to the South African Nuclear Energy Corporation (for example Vaalputs and Thabana) continue by virtue of section 60 of Act 46 of 1999.
- **Section 46:** Discarding of radioactive waste and storage of irradiated nuclear fuel require the written permission of the Minister and are subject to any conditions that the Minister, in concurrence with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry, deems fit to impose. The conditions so imposed will be additional to any conditions contained in a nuclear authorization as defined in the National Nuclear Regulator Act, 1999.
- **Section 50:** The responsibility for the Republic's institutional nuclear obligations vests in the Minister. The management of nuclear waste disposal on a national basis is one of these obligations as defined in section 1(xii) of the Act.
- **Section 34(1)(s):** In terms of the responsibilities of the Minister of Minerals and Energy regarding nuclear non-proliferation, authorisation is required to dispose of, store or reprocess any radioactive waste or irradiated fuel.

### 4.2 National Nuclear Regulator Act, 1999 (Act No. 47 of 1999)

- **Section 5:** The responsibility of the National Nuclear Regulator is to provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices and to exercise regulatory control related to safety over the siting, design, construction, operation, manufacture of component parts and decontamination, decommissioning and closure of nuclear installations and other actions to which this Act applies. These would include radioactive waste management facilities associated with nuclear power stations, nuclear fuel cycle facilities and those facilities that mine and process radioactive ores and minerals.

- **Section 6:** The Regulator must conclude co-operative governance agreements with every relevant organ of state, as defined in section 239 of the Constitution, on which functions in respect of the monitoring and control of radioactive material or exposure to ionising radiation are conferred.
- **Section 7(1)(h):** For the purposes of Act 47 of 1999, the National Nuclear Regulator acts as the national competent authority in connection with the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material.

#### **4.3 Hazardous Substances Act, 1973 (Act No. 15 of 1973)**

- The Hazardous Substances Act provides for the control of Group IV hazardous substances (radioactive material not at nuclear installations or not part of the nuclear fuel cycle, for example fabricated radioactive sources, medical isotopes) and Group III hazardous substances (involving exposure to ionising radiation emitted from equipment). Radioactive waste arising from activities authorized under this Act falls under the regulation of the Department of Health's Directorate of Radiation Control. In practice, the Department of Health does not regulate naturally occurring radioactive material.
- For the purposes of Act 15 of 1973, the Department of Health's Directorate of Radiation Control acts as the national competent authority in connection with the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material.

#### **4.4 Mine Health and Safety Act, 1996 (Act No. 29 of 1996)**

- Act 29 of 1996 makes provision for the protection of the health and safety of employees and other persons at mines. Any hazardous materials, including waste that is radioactive, therefore also fall under the inspection and enforcement tasks of the Mine Health and Safety Inspectorate.

#### **4.5 Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)**

- The holder of a prospecting or mining right is required to manage all environmental impacts in accordance with an approved environmental management programme/plan, must as far as it is reasonably practicable rehabilitate the affected environment, describe the manner of compliance with prescribed waste standards and make the prescribed financial provision for rehabilitation.

#### **4.6 National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA)**

- NEMA makes provision for co-operative environmental governance.

#### **4.7 National Water Act, 1998 (Act No. 36 of 1998)**

- Section 19 provides for measures to prevent any pollution of a water resource from occurring, continuing or recurring. This includes activities on land, which may pollute groundwater. Section 27 provides for the issuing of licences.

#### **4.8 Dumping at Sea Control Act, 1980 (Act No. 73 of 1980)**

- The Dumping at Sea Act falls under the administration of the Minister of Environmental Affairs and Tourism. This Act prohibits the dumping at sea of "high-level radioactive waste or other high-level

radioactive matter prescribed by regulation with the concurrence of the Minister of Minerals and Energy".

## **5 RESPONSIBILITIES**

### **5.1 Government**

Government is responsible for:

- Policy making
- Establishing and implementing a legal framework
- Establishing regulatory bodies
- Ensuring co-operative governance
- Radioactive waste management where the generator no longer exists (Ownerless radioactive waste)
- The provision of institutional control over closed disposal facilities and the funding thereof
- Ensuring a nationally co-ordinated approach to radioactive waste management
- Fulfilling national obligations in terms of international agreements where applicable
- Reviewing and updating of the national policy and strategy for radioactive waste management
- Ensuring adequate national competence and capacity
- Ensuring compliance with this policy
- Ensuring the implementation of the strategy

The responsibilities for radioactive waste management are clearly provided for in the national legislation as set out in the "Status of radioactive waste management in South Africa". The Minister of Minerals and Energy is the responsible line Minister with the authority over radioactive waste in terms of the Nuclear Energy Act, 1999, which is administered by the Department of Minerals and Energy. The Minister must exercise these responsibilities in consultation with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry. The Minister of Minerals and Energy will also exercise these responsibilities after consultation with the Minister of Health, as appropriate.

### **5.2 Regulatory bodies**

Regulatory bodies shall work in a co-operative manner and be responsible to enforce compliance with legal requirements and advising government as appropriate. The responsible regulators are:

- Minister of Minerals and Energy in concurrence with the Minister of Environmental Affairs and Tourism and the Minister of Water Affairs and Forestry (Nuclear Energy Act, 1999)
- National Nuclear Regulator (National Nuclear Regulator Act, 1999)
- Department of Health, Directorate Radiation Control (Hazardous Substances Act, 1973)
- Department of Minerals and Energy (Mineral and Petroleum Resources Development Act, 2002)
- Mine Health and Safety Inspectorate (Mine Health and Safety Act, 1996)
- The Department of Water Affairs and Forestry (National Water Act, 1998 (Act No. 36 of 1998))

### **5.3 Generators and operators**

Generators of radioactive waste, or operators of radioactive waste disposal facilities, as the case may be, shall be responsible for:

- The technical, financial and administrative management of such wastes within the national regulatory framework and within any applicable co-operative governance arrangements
- Development and ongoing review of site / industry specific Waste Management Plans which are to be based on the national radioactive waste management policy & strategy.
- Execution of Waste Management Plans by the establishment of appropriate waste management facilities and processes and the development of site / industry specific waste management systems.
- Site / industry waste management in accordance with waste management systems to reflect sustainable development and principles such as continued improvement and Best Available Technology Not Entailing Excessive Cost (BATNEEC) and other elements of the national strategy.

The responsibility of the generators of radioactive waste, or operators of radioactive waste disposal facilities, as the case may be, will be terminated upon closure of the disposal facility at which time institutional control (where required) will commence.

## **6 DEFINITION AND CLASSIFICATION OF RADIOACTIVE WASTE**

For the purposes of implementing a national policy and establishing a national strategy for radioactive waste management, South Africa shall follow the guidelines of the International Atomic Energy Agency regarding the definition and classification of radioactive waste, unless deviations therefrom can be justified.

Consistent with internationally acceptable practice “radioactive waste for legal and regulatory purposes may be defined as material that contains or is contaminated with radio-nuclides at concentrations or activities greater than clearance levels as established by the regulatory body, and for which no use is foreseen. (It should be recognised that this definition is purely for regulatory purposes, and that material with activity concentrations equal to or less than clearance levels is radioactive from a physical viewpoint, although the associated radiological hazards are negligible).”

Radioactive material which could satisfy requirements for clearance, reuse, reprocessing or recycling is considered as Potential Radioactive Waste, for example contaminated metal and spent nuclear fuel.

Ownerless radioactive waste is radioactive waste where the generator no longer exists or cannot be identified through reasonable means or does not have the resources to manage such waste.

## B. NATIONAL RADIOACTIVE WASTE MANAGEMENT STRATEGIC FRAMEWORK

### 7 PRINCIPLES APPLICABLE TO RADIOACTIVE WASTE MANAGEMENT STRATEGY

The following principles apply and render the strategic point of reference (not in the order of priority).

- It is regarded as essential by formulation of recommendations to the relevant decision makers to legitimise a decision to proceed with a particular primary course of action (e.g. deep geological disposal) on the basis of the principle of reasonable consensus. (“Decide-announce-defend” approach is not acceptable)
- The guiding principles for the development of a new course of action:
  - Openness;
  - Involvement of stakeholders;
  - A deliberative and accessible process;
  - Commitment to participative peer review of the science; and
  - Provision of adequate time for the resolution of issues
- Final disposal is regarded as the ultimate step in the radioactive waste management process although a step-wise waste management approach is acceptable. Long-term storage of certain types of wastes e.g. HLW, LLW and spent sources may be regarded as one of the steps in the management process.
- The aim shall be to achieve a maximum degree of passive safety in storage and disposal.
- The establishment, operation, decommissioning and closure of waste generating and disposal facilities shall be in accordance with all applicable regulatory requirements.
- The following hierarchy of waste management options shall be followed where practicable.
  - Waste Avoidance and Minimisation
  - Re-use, Reprocessing and Recycling
  - Storage
  - Conditioning and Disposal
- The national radioactive waste management strategy shall cover the total life cycle of waste management – generation to institutional control.
- Although a degree of institutional control in respect of some facilities may almost be required for an indefinite period, the relevant regulatory body must specify the period for which an active institutional control may be assumed for purposes of safety assessments.
- To provide future generations with freedom of choice and to build confidence, all radioactive waste disposal options shall provide for a defined period during which retrievability will be possible. The Minister of Minerals and Energy shall determine such a period on the recommendation of the National Executive Committee on Radioactive Waste Management (NECRWM).
- Measures aimed at enhancing retrievability should not compromise the operational and long-term safety of a disposal option.
- The transfer of waste among generators shall be considered provided all issues pertaining to ownership and liability and safety are addressed.

- To minimise the burden on future generations, decommissioning and closure of facilities should be implemented as soon as practicable.
- The deliberate dilution of radioactive waste is not acceptable, however in the case of NORM waste the dilution of higher concentration material with lower concentration material will be considered provided all relevant regulatory concerns are addressed.

## **8 MANAGEMENT STRUCTURES FOR RADIOACTIVE WASTE**

### **8.1 National Executive Committee on Radioactive Waste Management (NECRWM)**

***Government shall establish a National Executive Committee on Radioactive waste Management which will oversee the implementation of this policy and strategy.***

To ensure that this policy and strategy is translated into practice, the Department of Minerals and Energy, as the government's lead agent for nuclear matters, will consult with other government departments and regulatory bodies to develop and maintain a national action plan.

To give effect to the responsibilities of the Minister of Minerals and Energy in terms of the Nuclear Energy Act, the Committee shall be chaired by a representative from the Department of Minerals and Energy.

To give effect to Cooperative Governance as per the constitution of the Republic, the following Government Departments shall be represented: The Department of Environmental Affairs and Tourism, The Department of Health (Directorate Radiation Control), the Department of Water Affairs and Forestry. The National Nuclear Regulator shall also be a member of the NECRWM.

#### **8.1.1 The Main Objectives of NECRWM**

The Objectives of NECRWM will be as follows:

- Executive Co-ordination of radioactive waste management on a national level.
- Review and recommendation to the Minister of Minerals and Energy for approval of site/industry specific Radioactive Waste Management Plans required in terms of this document
- Monitor the implementation of Radioactive Waste Management Plans
- Recommend to the Minister of Minerals and Energy the issuing of management directives to NRWMA as appropriate
- Coordinate radioactive waste management research and development activities of national interest.
- The NECRWM shall on an annual basis publish a report in respect of radioactive waste management on the basis of information received, validated and processed by the various NECRWM members.

Waste management plans required to be submitted through other legal mechanisms (DEAT, DWAF) in the areas of mining, minerals processing and the combustion of coal may be reviewed and commented on by the NECRWM, where considered appropriate.

### **8.2 National Radioactive Waste Management Agency (NRWMA)**

Government shall within a reasonable period establish a Radioactive Waste Management Agency. This Agency shall be a wholly owned subsidiary of NECSA.

Under the provisions of sections 55(1) and 55(2) of the Nuclear Energy Act, 1999, the Minister/Director-General assigns the management of radioactive waste disposal on a national basis (institutional obligation) to the NRWMA, which shall be an independent division of NECSA. *The NRWMA will not be a regulatory body.*

### **8.2.1 Terms of reference of NRWMA:**

- Reports to the Minister of Minerals and Energy
- Serviced by the NECSA infrastructure
- Ring-fenced budget allocated by DME (The funds shall be sourced from the Radioactive Waste Management Fund)

### **8.2.2 Functions of NRWMA:**

- Operation of the Vaalputs site.
- Site, design, construct and operate new national radioactive waste disposal facilities.
- Implement any radioactive waste management directives from the Minister.
- Management of ownerless waste on behalf of the Government, including the development of radioactive waste management plans for such waste.
- Establish waste acceptance criteria.
- Define and conduct Research and Development programs for long-term waste management with regard to long-term storage and disposal.
- Assist generators of small quantities of radioactive waste in all aspects related to management of such waste. The cost of providing such assistance shall be borne by the generator.
- Implementation of institutional control, including radiological monitoring and maintenance as appropriate on behalf of Government.
- Maintain a national radioactive waste database and publish on an annual basis the inventory and location of all radioactive waste in South Africa.
- Advise nationally on radioactive waste management.

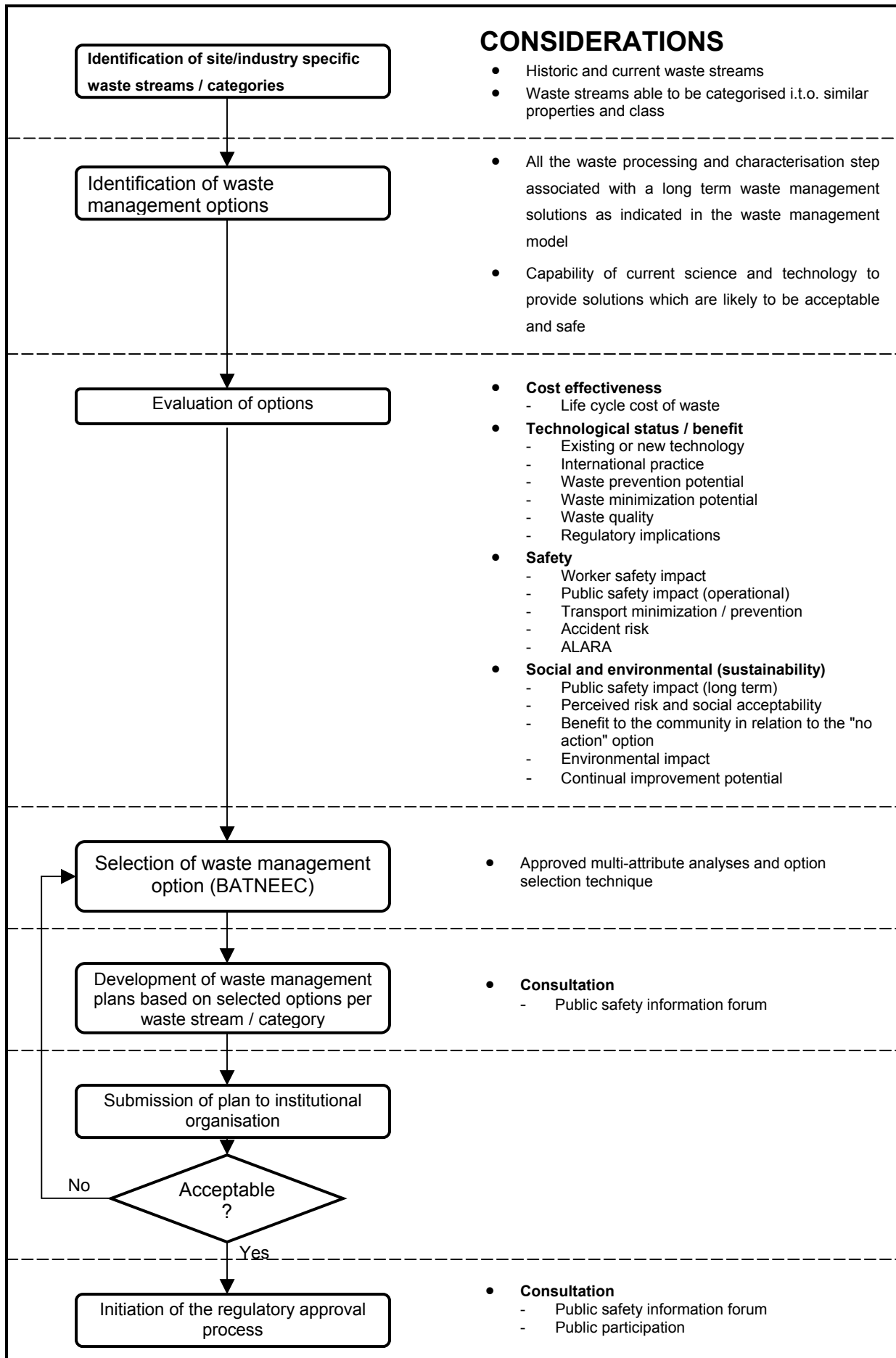
## **9 NATIONAL PROCESS FOR IMPLEMENTING THE RADIOACTIVE WASTE MANAGEMENT STRATEGY**

- 9.1** Radioactive waste stream/category specific waste management plans per site/ industry shall be based on an evaluation process and authorization as described in this document. The elements for the process are:
- Identification and nature of site specific radioactive waste stream/categories and associated waste management issues.
  - Consideration and listing of realistic options for the long-term management of specific radioactive waste management streams/categories.
  - Systematic evaluation of the merits and disadvantages of each option (Multi-attribute analysis covering cost-effectiveness, technological status, operational safety, social and environmental factors).
  - Identification of the Best Available Technology Not Entailing Excessive Cost (BATNEEC)
  - Acceptance of BATNEEC as waste stream/category specific strategy.
  - Review mechanisms of industry/site specific waste management plans.



- 9.2** Site / industry specific radioactive waste management plans (action plans) shall be developed in accordance with the process described in this document and submitted to the NECRWM for acceptance and approval or comment as appropriate (where covered by other legal mechanisms).
- 9.3** Framework for the development of site / industry specific radioactive waste management plans
- The development and submission of plans shall be scheduled with the NECRWM. Separate plans and proposals may be submitted for specific waste streams/ categories and scheduled according to the anticipated time required for the development of plans.
  - Plans shall cover all waste streams / categories on a site or in a specific industry.
  - Plans shall identify all waste management options as well as the applicable pre-disposal management steps required for a specific option, and the details thereof.
  - The merits and disadvantages of each of the listed options shall be evaluated in a balanced and systematic way using a multi-attribute analysis approach. The methodology for evaluation and selection of an option (BATNEEC) shall be described and justified per site / industry. This should be submitted to the NECRWM prior to the submission of waste management plans for concurrence on methodology. It should be noted that all regulatory requirements must be met.
  - Approved waste management plans shall be reviewed and re-submitted at a frequency determined by the institutional organisation.
  - The development process and associated considerations of the radioactive waste management plan are indicated in Figure 1.

**Figure 1: Radioactive waste management plan development process**



## 10. NATIONAL RADIOACTIVE WASTE CLASSIFICATION SCHEME

Waste Class	Waste Description	Waste type / Origin	Waste Criteria	Generic waste treatment / conditioning requirements <sup>(1)</sup>	Disposal / Management Options
1 HLW	Heat generating radioactive waste with high long and short-lived radionuclide concentrations.	<ol style="list-style-type: none"> <li>1 Spent fuel declared as waste or spent fuel recycling products</li> <li>2 Sealed sources</li> </ol>	<ol style="list-style-type: none"> <li>1 Thermal power &gt; 2 kW/m<sup>3</sup>. <b>OR</b></li> <li>2 Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels &gt; levels specified for LILW-LL</li> <li>3 <b>OR</b> Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels that could result in inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) above 100 mSv per annum</li> </ol>	Waste package suitable for handling, transport and storage (storage period in the order of 100 years). The waste form shall be solid with additional characteristics as prescribed for a specific repository.	<ol style="list-style-type: none"> <li>1 <ul style="list-style-type: none"> <li>(a) Regulated deep disposal (100's of metres).</li> <li>(b) Reprocessing, Conditioning and Recycling</li> <li>(c) Long Term Above Ground Storage</li> </ul> </li> </ol>
2 LILW-LL	Radioactive waste with low or intermediate short-lived radionuclide and intermediate long-lived radionuclide concentrations.	<ol style="list-style-type: none"> <li>1 Irradiated uranium (isotope production).</li> <li>2 Un-irradiated uranium (nuclear fuel production).</li> <li>3 Fission and activation products (nuclear power generation and isotope production)</li> <li>4 Sealed sources.</li> </ol>	<ol style="list-style-type: none"> <li>1 Thermal power (mainly due to short-lived radio nuclides (<math>T_{1/2} &lt; 31 \text{ y}</math>) &lt; 2 kW/m<sup>3</sup>) <b>AND</b></li> <li>2 Long-lived radio nuclides (<math>T_{1/2} &gt; 31 \text{ y}</math>) concentrations. <ul style="list-style-type: none"> <li>❖ Alpha: &lt; 4000 Bq/g</li> <li>❖ Beta and gamma: &lt; 40000 Bq/g</li> </ul>                     (Maximum per waste package up to 10x the concentration levels specified above). <b>OR</b></li> <li>3 Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels that could result in inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) between 10 and 100 mSv per annum</li> </ol>	Waste package suitable for handling, transport and storage (storage period in the order of 50 years). The waste form shall be solid with additional characteristics as for a specific repository.	<ol style="list-style-type: none"> <li>1 Regulated medium depth disposal (10's of metres).</li> <li>2 Managed as NORM-E waste (un-irradiated uranium)</li> </ol>

Waste Class	Waste Description	Waste type / Origin	Waste Criteria	Generic waste treatment / conditioning requirements <sup>(1)</sup>	Disposal / Management Options
3 LILW-SL	Radioactive waste with low or intermediate short-lived radionuclide and / or low long-lived radionuclide concentrations.	1 Un-irradiated uranium (nuclear fuel production). 2 Fission and activation products (nuclear power generation and isotope production). 3 Sealed sources.	1 Thermal power (mainly due to short-lived radio nuclides ( $T_{1/2} < 31 \text{ y}$ ) $< 2 \text{ kW/m}^3$ . <b>AND</b> 2 Long-lived radio nuclide ( $T_{1/2} > 31 \text{ y}$ ) concentrations. ❖ Alpha: $< 400 \text{ Bq/g}$ ❖ Beta and gamma: $< 4000 \text{ Bq/g}$ (Maximum per waste package up to 10x the concentration levels specified above). 3 <b>OR</b> Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels that could result in inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) below 10 mSv per annum	Waste package suitable for handling, transport and storage (storage period in the order of 10 years). The waste form shall be solid with additional characteristics as for a specific repository.	1 Regulated near surface disposal ( $< 10$ metres). 2 Managed as NORM-E waste (un-irradiated uranium)
4 VLLW	Radioactive waste containing very low concentration of radioactivity.	1 Contaminated or slightly radioactive material originating from operation and decommissioning activities.	1 Clearance or authorised discharge or reuse criteria and levels approved by the relevant regulator.	Waste stream specific requirements and conditions.	1 Clearance. 2 Authorized disposal, discharge or reuse
5 NORM-L (low activity)	Potential Radioactive waste containing low concentrations of NORM.	1 Mining and minerals processing. 2 Fossil fuel electricity generation. 3 Bulk waste - un-irradiated uranium (Nuclear fuel production).	1 Long-lived radio nuclide concentration: $< 100 \text{ Bq/g}$ .	Unpackaged waste in a miscible waste form.	1 Re-use as underground backfill material in an underground area. 2 Extraction of any economically recoverable minerals, followed by disposal in any mine tailings dam or other sufficiently 3 4 confined surface

Waste Class	Waste Description	Waste type / Origin	Waste Criteria	Generic waste treatment / conditioning requirements <sup>(1)</sup>	Disposal / Management Options
					<p>impoundment</p> <p>Authorised disposal</p> <p>Clearance</p>
6 NORM-E (enhanced activity)	Radioactive waste containing enhanced concentrations of NORM.	<p>1 Scales</p> <p>2 Soils contaminated with scales</p>	1 Long-lived radio nuclide concentration: > 100 Bq/g.	Packaged or unpackaged waste in a miscible or solid form with additional characteristics for a specific repository.	<p>1 Dilute and re-use as underground backfill material in an identified underground area.</p> <p>2</p> <p>3 Extraction of any economically recoverable minerals, followed by dilution and disposal in an identified mine tailings dam or other sufficiently confined surface impoundment</p> <p>Regulated deep or medium depth disposal.</p>

<sup>(1)</sup> Treatment and conditioning requirements are mainly dependant on specific waste type in a waste class.

## 11 FINANCIAL PROVISION FOR RADIOACTIVE WASTE

Government shall within two years following approval of this policy establish a Radioactive Waste Management Fund (RWMF). In keeping with the polluter pays principle, the contributions to the fund will be from the generators of radioactive waste. The contributions shall amongst others be based on classification of the waste as well as the volumes.

The purpose of the fund shall be to ensure that there are sufficient provisions for the long-term management options of the various waste forms. These shall include:

- Fees for disposal activities
- Provisions for decommissioning and decontamination
- Research and Development activities including investigations into waste management options
- Capacity building initiatives for radioactive waste management
- Fees for other activities related to radioactive waste management

The manner of the management of the fund shall be determined by Government and shall be reported upon annually. The fund shall be managed by a representative Board of Directors or shall be administered by an entity (private or public) on behalf of the Government. The fund managers shall be appointed by the Minister of Minerals and Energy in consultation with the Ministers of Finance, Environmental Affairs and Tourism and Water Affairs and Forestry. The role of the fund managers will be to ensure that the funds are managed in accordance with accepted investment principles and will also be responsible for making and recording payments into and out of the fund. The reports of the fund shall be subject to the Auditor General's examination.

Each of the generators shall enter into an agreement with the RWMF for managing long-term provisions for institutional control measures.

The Government (responsible line Departments) shall set aside funds through the RWMF for the management of radioactive waste from its institutions.

***The DME shall develop a statute setting up the fund and defining its scope and purpose.***

## 12 NATIONAL MODEL FOR RADIOACTIVE WASTE AND SPENT NUCLEAR WASTE MANAGEMENT

The model, as schematically presented in Figure 2, indicates the waste management process from waste generation to the main waste management end-points and institutional control. Although not all the steps may apply to all the waste streams / categories, the listed predisposal management steps should be considered.

## 12.1 Waste Generation

Radioactive waste spent nuclear fuel and materials that are potential radioactive waste are continuously generated during the execution of regulated activities. Radioactive waste may also exist due to previous activities and / or historic processing of radioactive materials.

## 12.2 Pre-disposal Management of Radioactive Waste

Pre-disposal management of radioactive waste is required to ensure:

- Waste prevention and waste minimization.
- The selection of suitable waste management options.
- A waste package that meets acceptance criteria for disposal, storage and for any associated handling and transportation activities.
- Waste or material that is suitable for authorized disposal / discharge, authorized re-use / recycling and clearance from regulatory control.

During the generation of radioactive waste the emphasis shall be on the control of waste generation and minimization. Unavoidable radioactive waste shall be classified to enable category specific waste management.

The options for management disposal of each waste category shall be evaluated in a systematic way as a multi attribute analysis. The outcome of the multi attribute analysis is regarded as the Best Available Technology Not Entailing Excessive Cost (BATNEEC).

The extent of the waste processing (the remainder of the pre-disposal management steps) shall depend on the waste acceptance criteria for regulated disposal and the anticipated acceptance criteria and storage period in the case of regulated storage. Category specific waste processing namely pre-treatment, treatment and conditioning shall be performed to obtain waste packages, that are suitable for storage and / or disposal.

Waste shall be characterized throughout the pre-disposal management steps. Waste category specific characterization requirements shall be specified and shall cover the establishment of physical, chemical, biological and radiological properties to determine waste processing needs and the ultimate suitability of a waste package for storage and disposal. Waste characterization data and records shall be used for verification and quality assurance purposes

Transportation of waste may be required in between the various pre-disposal management steps and may include on and off-site transportation.

In the case of regulated disposal, waste packages shall be stored temporarily and transported to a waste repository. In the case of regulated storage waste and / or waste packages shall be stored for an authorized period for future processing and / or disposal.

### **12.3 Waste management options**

The main waste management options are:

- Regulated disposal;
- Authorized disposal / discharge;
- Authorized re-use / recycling;
- Regulated reprocessing (spent nuclear fuel)
- Regulated storage and
- Clearance.

(The above terms are defined in the waste management glossary.)

In the case of authorized disposal / discharge, re-use / recycling and clearance, the following category specific factors are specified:

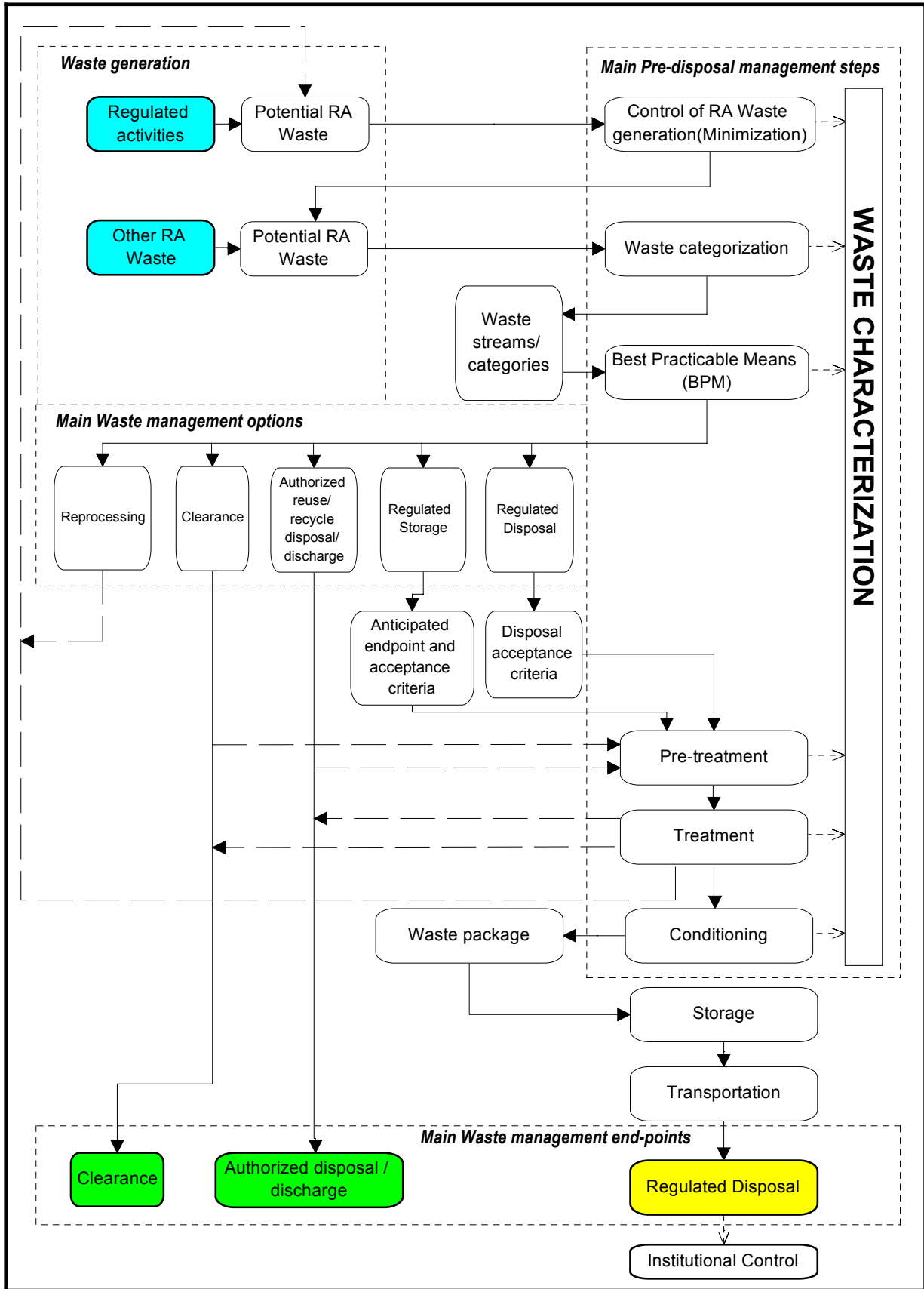
- Pre-treatment and treatment requirements;
- Conditions and criteria for disposal / discharge / re-use / recycle and clearance; and
- Criteria and condition verification methodology.

### **12.4 Waste management end-points**

The main waste management end-points correspond with the waste management options and may be regarded as the outcome of a specific waste management option. Regulated disposal requires continued regulation of the disposal site for a predetermined duration where after the site will be placed under institutional control.



**Figure 2: National Radioactive Waste and Potential Radioactive Waste Management Model**



## 13. LONG-TERM WASTE MANAGEMENT ISSUES

There are two long-term waste management options employed in South Africa at present

1. Above ground disposal in engineered facilities for the bulk of the mining waste.
2. Near surface disposal for Low and Intermediate Level Waste at Vaalputs in the Northern Cape.

Disposal presents the most challenges and it is an area where coordination is of utmost importance.

One site shall be developed for each of the waste classes (excluding NORM waste). This is to maximise benefits from economies of scale for all activities associated with disposal waste management.

***Vaalputs shall continue to be used as a National Disposal Site for Low and Intermediate Level Waste. The disposal shall be conducted within the nuclear authorisation framework of the National Nuclear Regulator.***

The Government shall initiate investigations into the best long-term option for the management of Spent Fuel. The process of selecting a site for long-term waste management shall involve a comprehensive public participation process.

### 13.1 SPENT NUCLEAR FUEL AND HIGH LEVEL WASTE MANAGEMENT

Two mechanisms (Dry and Wet storage) are currently in use in South Africa. Koeberg Spent Fuel is currently stored in authorised spent fuel pools on the site as well as Casks designed and constructed for storage of spent fuel. There is enough storage capacity for the current operational lifetime of Koeberg. The Spent Fuel from SAFARI Research Reactor is currently stored at an authorised dry storage facility on the Pelindaba site as well as in the Reactor pool.

***In the interim Spent Nuclear Fuel is and shall continue to be stored in authorised facilities within the generator's sites.***

The storage on these sites is finite and the practice of storing spent fuel on a reactor site is not sustainable over long periods of time. Government shall ensure that investigations are conducted within set timeframes to investigate the various options for safe management of these wastes in South Africa. Included in the options for investigation shall be the following:

#### **A. LONG-TERM ABOVE GROUND STORAGE ON AN OFF-SITE FACILITY LICENSED FOR THIS PURPOSE**

The size of the industry dictates that this be a consideration although it may not be in line with some of the principles for Radioactive Waste Management.

The strength of this option is that if more appropriate technologies are developed in future, then the waste can be dealt with using those technologies.

It can be argued that storing above ground indefinitely may result in an undue burden on future generations.

## **B. REPROCESSING, CONDITIONING AND RECYCLING**

An investigation commissioned by the Department of Minerals and Energy has concluded that it would not be advisable to exclude the reprocessing, conditioning and recycling of spent fuel. This option is normally associated with proliferation concerns however as South Africa has concluded Safeguards Agreements and the Additional Protocol, this should not be an issue for South Africa.

### **In South Africa**

This option will require dedicated specialised facilities and the cost implication of building facilities could mitigate against reprocessing in South Africa. This option will however be amongst the options to be investigated

### **In a Foreign Country**

There are available reprocessing facilities in some countries and the option of sending South Africa's Spent Fuel for reprocessing shall be investigated and compared to the other options.

## **C. DEEP GEOLOGICAL DISPOSAL**

In terms of meeting most of the waste policy principles it is currently the most internationally acceptable option and as such will require very careful consideration. Internationally this option has taken the best part of a decade and as such investigations in South Africa shall commence with immediate effect. ***If chosen as a preferred option in South Africa, geological disposal of radioactive waste shall take place with an option for retrieving the waste. (This is so as not to foreclose on the possibility of future technology for better management options)***

## **D. TRANSMUTATION**

A fourth option (**Transmutation**) has been - and continues to be - investigated in a number of countries, however it has not been proven to be a workable solution and also requires major investment in technology. ***The Government shall continue to monitor developments internationally however this option will not be investigated in South Africa.***

The choice of the most suitable option shall take due cognisance of the policy principles and shall clearly demonstrate how the option satisfies the national policy objectives. All conclusions on investigations shall be subject to public scrutiny.

**END**

## 14 REFERENCES

- [1] White Paper on Energy Policy for the Republic of South Africa, Pretoria, 1998.
- [2] White Paper on Integrated Pollution and Waste Management for South Africa, Pretoria, 17 March
- [3] The Principles of radioactive waste management, Safety Series 111-F, International Atomic Energy Agency, Vienna, 1995. [4] Classification of Radioactive Waste, Safety Series 111-G-1.1, International Atomic Energy Agency, Vienna, 1994.
- [5] Status of Radioactive Waste Management in South Africa, Department of Minerals and Energy, December, 2001.

## ANNEXURE A: RADIOACTIVE WASTE MANAGEMENT TERMINOLOGY

TERM	EXPLANATION OF TERM
<b>Activity</b>	The number of spontaneous nuclear disintegrations occurring in a given quantity of material during a suitable small interval of time divided by that interval of time. The SI derived unit of activity is the becquerel (Bq). 1 Bq = 1 disintegration per second.
<b>Activity concentration</b>	The activity of a radionuclide per unit mass (or per unit volume) of a material.
<b>Closure</b>	The term closure refers to the status of, or an action directed at, a disposal facility at the end of its operating life. A disposal facility is placed into closure usually after completion of waste emplacement, by covering of a near surface disposal facility, by backfill and/or sealing of a geological repository and the passages leading to it, and termination and completion of activities in any associated structures.
<b>Conditioning</b>	Those operations that produce a waste package suitable for handling, transportation, storage and/or disposal. Conditioning may include the conversion of the waste to a solid waste form, enclosure of the waste in containers and, if necessary, provision of an overpack.
<b>Decommissioning</b>	Actions taken at the end of the useful life of a facility, other than a repository or disposal facility, in retiring it from service with adequate regard for the health and safety of workers and members of the public and protection of the environment. Actions include shutdown, dismantling and decontamination, care and maintenance.
<b>Discharge</b>	A planned and controlled release of radionuclides into the environment. Such releases should meet all restrictions imposed by the regulatory body.
<b>Disposal</b>	The emplacement of waste in an approved specified facility (for example, near surface or geological repository) without the intention of retrieval.
<b>Geological disposal,</b>	Isolation of radioactive waste, using a system of engineered and natural barriers at depths up to several hundred meters in a geologically stable formation.
<b>High level waste (HLW)</b>	<ul style="list-style-type: none"> <li>(a) The radioactive liquid containing most of the fission products and actinides originally present in spent fuel – which forms the residue from the first solvent extraction cycle in reprocessing - and some of the associated waste streams.</li> <li>(b) Solidified HLW from (a) above and spent fuel (if it is declared a waste).</li> <li>(c) Any other waste with an activity level comparable to (a) or (b). High-level waste in practice is considered long lived. One of the characteristics, which</li> </ul>

	distinguish HLW from less active waste, is its level of thermal power ( $>2 \text{ kW/m}^3$ ).
<b>Institutional control</b>	Control of a waste site (for example, disposal site) by an authority or institution designated under the laws of a country or state. This control may be active (monitoring, surveillance, remedial work) or passive (land use control) and may be a factor in the design of a nuclear facility (for example, near surface disposal facility).
<b>Long lived waste (LLW)</b>	Radioactive waste containing long-lived radionuclides having sufficient radio toxicity in quantities and/or concentrations requiring long-term isolation from the biosphere. The term "long lived radio nuclide" refers to half-lives usually greater than 31 years.
<b>Low and intermediate level waste (LILW)</b>	Radioactive wastes in which the concentration of or quantity of radio nuclides above clearance levels established by the regulatory body, but with a radio nuclide content and thermal power below those of HLW. Low and intermediate level wastes are often separated into short-lived and long-lived wastes. Short-lived wastes may be disposed of in near surface disposal facilities.
<b>Natural occurring radioactive material (NORM)</b>	Material containing no significant amounts of radionuclides other than naturally occurring radionuclides.
<b>Near surface disposal,</b>	Disposal of waste, with or without engineered barriers, on or below the ground surface where the final protective covering is of the order of a few meters thick, or in caverns a few tens of meters below the Earth's surface.
<b>Nuclear fuel cycle</b>	All operations associated with the production of nuclear energy, including mining, milling, processing and enrichment of uranium or thorium; manufacture of nuclear fuel; operation of nuclear reactors; reprocessing of nuclear fuel; decommissioning; and any action for radioactive waste management and any research or development action related to any of the foregoing.
<b>Pre-disposal</b>	Any waste management steps carried out prior to waste disposal such as: - Pre-treatment, treatment, conditioning, storage, transportation activities.
<b>Pre-treatment</b>	Any or the entire operations prior to waste treatment, such as: Collection, segregation, chemical adjustment, and decontamination.
<b>Repository</b>	A nuclear facility (for example, geological repository) where waste is emplaced for disposal. Future retrieval of the waste from the repository is not intended. (See also disposal.)
<b>Reprocessing</b>	A process or operation, the purpose of which is to extract radioactive isotopes from spent fuel for further use.
<b>Spent fuel</b>	Nuclear fuel removed from a reactor following irradiation, which is no longer usable in its present form because of depletion of fissile material, poison build-up or radiation damage.

<b>Spent sources</b>	Sources of which the useful lifetime have lapsed.
<b>Storage</b>	The placement of radioactive waste in a nuclear facility where isolation, environmental protection and human control (for example, monitoring) are provided with the intent that the waste will be retrieved.
<b>Transmutation</b>	The conversion of one nuclide into another through one or more nuclear reactions, and more specifically, the conversion of an isotope of one element into an isotope of another element through one or more nuclear reactions. For example, $^{238}\text{U}$ is converted into $^{239}\text{Pu}$ by neutron capture followed by the emission of two beta particles.
<b>Transportation</b>	Operations and conditions associated with and involved in the movement of radioactive material by any mode on land, water or in the air. The terms 'transport' and 'shipping' are also used.
<b>Treatment</b>	Operations intended to benefit safety and/or economy by changing the characteristics of the waste. Three basic treatment objectives are: volume reduction, removal of radionuclides from the waste, change of composition. After treatment, the waste may or may not be immobilized to achieve an appropriate waste form.
<b>Waste acceptance criteria</b>	Those criteria relevant to the acceptance of waste packages for handling, storage and disposal.
<b>Waste category</b>	Waste/waste package identifiable in terms of waste stream, waste type, waste sub-type, waste class and waste endpoint.
<b>Waste characterization</b>	The determination of the physical, chemical and radiological properties of the waste to establish the need for further adjustment, treatment, conditioning, or its suitability for further handling, processing, storage or disposal.
<b>Waste class</b>	Waste grouping based on the radiological characteristics of the waste package (Radioactive waste classification scheme)
<b>Waste package</b>	The product of conditioning that includes the waste form and any container(s) and internal barriers (e.g. absorbing materials and liner), as prepared in accordance with requirements for handling, transportation, storage and/or disposal
<b>Waste processing</b>	Any operation that changes the characteristics of a waste, including waste pre-treatment, treatment and conditioning.
<b>Waste stream</b>	Waste which may consist of one or more waste types that originate from a specific process, for example uranium conversion, uranium enrichment or isotope production.
<b>Waste type</b>	Waste from a specific waste stream collected on the basis of similar radiological and physical properties.

## ANNEXURE B: ACRONYMS

ALARA	<b>As Low As Reasonably Achievable</b>
BATNEEC	<b>Best Available Technology Not Entailing Excessive Cost</b>
DEAT	<b>Department of Environment and Tourism</b>
DME	<b>Department of Minerals and Energy</b>
DOH	<b>Department of Health</b>
DWAF	<b>Department of Water Affairs and Forestry</b>
EMP	<b>Environmental Management Programme</b>
HLW	<b>High Level Waste</b>
IAEA	<b>International Atomic Energy Agency</b>
LILW	<b>Low and intermediate level waste</b>
LILW (I) – LL	<b>Low and intermediate level waste – long lived – intermediate dose rate</b>
LILW (I) – SL	<b>Low and intermediate level waste – short lived – intermediate dose rate</b>
LILW (L) – LL	<b>Low and intermediate level waste – long lived – low dose rate</b>
LILW (L) – SL	<b>Low and intermediate level waste – short lived – low dose rate</b>
LLW	<b>Long Lived Waste</b>
NACRWM	<b>National Advisory Committee on Radioactive Waste Management</b>
NEA	<b>Nuclear Energy Act</b>
NECRWM	<b>National Executive Committee on Radioactive Waste Management</b>
NECSA	<b>South African Nuclear Energy Corporation</b>
NNR	<b>National Nuclear Regulator</b>
NORM	<b>Naturally Occurring Radioactive Material</b>
NRWMA	<b>National Radioactive Waste Management Agency</b>
VLLW	<b>Very Low Level Waste</b>