

# Discussion Paper on National Decommissioning Policy for Nuclear Facilities



Department of Mineral Resources and Energy

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## FOREWORD

The Discussion Paper on Decommissioning Policy for Nuclear Facilities is hereby introduced.

We are at the point where the nuclear industry has to address the issues related to the decommissioning of nuclear facilities, and there is a need to debate these issues. One of the important issues to be addressed is the financing of decommissioning of nuclear facilities.

The development of the nuclear industry in South Africa has been based on a sound legislative framework, which includes the Nuclear Energy Policy, Nuclear Energy Act, the National Nuclear Regulator Act, the National Radioactive Waste Disposal Institute Act, and the Radioactive Waste Management Policy and Strategy.

The situational analysis conducted by the then Department of Energy through the international peer review missions such as the 2016 Integrated Regulatory Review Service Mission have recommended the need to strengthen the legislative framework on nuclear decommissioning.

The area of nuclear decommissioning is still developing but there can be lessons learned through the international benchmarking exercise. It is anticipated that the South African legal framework on decommissioning shall be improved to ensure to alignment with the international best practices, whilst focusing on addressing the unique South African challenges.

This discussion paper aims to present main policy issues in the area of nuclear decommissioning. These issues are discussed with the perspective of addressing recommendations from the international peer reviews.

## Abbreviations/abbreviations

DoE	Department of Energy
DME	Department of Minerals and Energy
DMRE	Department of Mineral Resources and Energy
D&D	Decommissioning and Decontamination
IAEA	International Atomic Energy Agency
IRRS	Integrated Regulatory Review Service Mission
KNPP	Koeberg Nuclear Power Plant
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
HLW	High Level Waste
Necsa	South African Nuclear Energy Corporation
NNR	National Nuclear Regulator
R&D	Research and Development
RWMPS	Radioactive Waste Management Policy and Strategy

## **1. Introduction**

The construction and operation of nuclear power plants started in the 1950s and 1960s, and most of the power plants have reached their operational life. The decommissioning of nuclear power plants (nuclear facilities) started in the 1980s and 1990s. During that time, nuclear decommissioning was developing and mostly adopted non-nuclear technologies.

Decommissioning of nuclear facilities has become an important part of the nuclear fuel cycle because of the increasing number of nuclear power plants with terminated operation. The main features of decommissioning process include complex activities, technological equipment and technological procedures, huge financial implications and typically long project duration (about 10 years or more).

Currently, South Africa has nuclear facilities undergoing decommissioning and the operating facilities will in future reach their end of lifespan, and thereafter the decommissioning phase.

The topic of nuclear decommissioning is arguably gaining more attention in the public.

## **2. Decommissioning**

Nuclear facilities represent a very large capital asset for the owners when operational, but become liabilities when closed down, at the end of their lifespan.

For the purpose of Government's policy development and this paper 'decommissioning' is defined, in line with the IAEA, as actions taken at the end of 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.

In addition, Decontamination is defined as the complete or partial removal of contamination by a deliberate physical, chemical or biological process.

### **3. The need for a Legislative Framework for Nuclear Decommissioning**

The RWMPs for South Africa issued by the then DME in 2005 states that to minimize the burden on future generations, decommissioning and closure of facilities should be implemented as soon as practicable. The outcomes of the IAEA's IRRS Mission Report for South Africa indicated that Government has not yet developed a national decommissioning policy and strategy, and recommends, among other things, that Government should develop and approve a national policy and strategy for decommissioning of facilities.

The existing major South African nuclear facilities are coming closer to reaching the end of their lifespan. Therefore, there is a need to strengthen the legal framework for nuclear decommissioning. The decommissioning policy needs to reflect the current challenges on decommissioning for the South African nuclear industry, and to adopt the international best practices for the South African situation.

### **4. Development of a Decommissioning Policy**

For nuclear energy related activities the Minister of DMRE is responsible for developing and implementing national policy, preparing and initiating legislation and performing any other executive function provided for in the Constitution or in national legislation (sec 85(2)(b), (d) and (e) of the Constitution).

In response to the IRRS recommendation and as an opportunity to review the South African decommissioning framework and improve the current arrangements, remains best practice, and that South Africa is positioned to respond to decommissioning challenges and opportunities now and into the future. The DMRE has prepared this Discussion Paper to serve as a preparatory phase for the development of a national policy for decommissioning of nuclear facilities in South Africa.

The successful development of a Decommissioning Policy for Nuclear Facilities will depend on the following two main factors:

- The active participation of all stakeholders in the policy deliberations, and

- Strategic policy development through coordinated leadership to ensure common goals and approaches on all sides.

Policy development discussions shall be channeled to the Minister of DMRE.

## **5. Purpose of the Discussion Paper**

The purpose of this Discussion Paper is to stimulate consideration of, and seek stakeholder and interested parties' feedback on potential issues with the decommissioning regime and options to improve it. This is to ensure that Government is aware of the full range of issues and potential options to address them, and to gauge levels of support for each, in order to inform due consideration of a national decommissioning policy.

Government recognizes the sensitivities associated with nuclear activities and wishes to ensure that its consideration of potential issues and proposals is transparent and informed by a range of views to ensure all interested parties are aware of options contemplated and provide insight into the Government's current views about their perceived merits, applicability and effectiveness.

## **6. Target audience and key stakeholders**

Government welcomes views from all interested parties to ensure any subsequent development of this policy is well informed. While views from all interested parties are welcomed, it is expected that the following stakeholders may have a particular interest:

- *Local communities in the vicinity of existing nuclear sites*
- *Nuclear operators*
- *Nuclear insurance providers*
- *Safety regulators*
- *National Health, Safety and Environmental authorities*
- *Non-governmental organizations*
- *Local government authorities and municipalities*
- *Members of the nuclear industry, and*

- *Business in the decommissioning, remediation and rehabilitation space.*

## 7. Consultation

### 7.1 Invitation to submit comments

The DMRE invites and encourages all interested parties and stakeholders to consider and address issues that rose in this Discussion Paper by providing written comments and supporting information, where relevant. Comments and submissions received will inform the DMRE’s approach in developing the decommissioning policy for nuclear facilities.

This Discussion Paper is made available on the DMRE website: [www.energy.gov.za](http://www.energy.gov.za).

The DMRE invites interested parties to comment by: **18 August 2020**

Comments and submissions may be lodged by e-mail, by post or hand delivered, directed to:

#### **The Director: Nuclear Safety, Liabilities, and Emergency Management**

##### ***E-mail:***

##### ***Post:***

##### ***Hand Delivery:***

[nucleardecomm@dmre.gov.za](mailto:nucleardecomm@dmre.gov.za)

Private Bag X96  
Pretoria  
0001

192 Visagie Street  
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### 7.2 Confidentiality and protection of information

The DMRE encourages comments and submissions that can be made public. However, comments and submissions provided may be subject to publication or disclosure in accordance with the Promotion of Access to Information Act, 2000 (Act No. 2 of 2000) or other applicable legislation and may be published on the DMRE’s website unless, on

the submission, a party clearly indicates that they would like their comments to be treated as confidential.

It would be helpful if an explanation as to why the information provided is regarded as confidential. If the DMRE receives a request for disclosure of the information it will take full account of the explanation, but cannot give an assurance that confidentiality can be maintained in all circumstances.

When the consultation period ends, the DMRE may publish or make public any information submitted. If it is referenced in a document for example, this would only be at an organization level and would not include people's personal names, addresses or other contact details.

### **7.3 Further consultations**

The DMRE shall publish details of a formal public consultation for the draft Decommissioning Policy.

### **7.4 Enquiries**

Any enquiries related to this Discussion Paper may be sent to: **nucleardecomm@dmre.gov.za**

## **8. Decommissioning Activities: International Perspective**

The IAEA defines decommissioning to mean the administrative and technical actions taken to remove all or some of the regulatory controls from an authorized facility so that the facility and its site can be reused. Decommissioning includes activities such as planning, physical and radiological characterization, facility and site decontamination, dismantling, and materials management.

The South African Joint Convention reports define decommissioning as “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”.

## **8.1 Decommissioning Principles**

Key principles for nuclear decommissioning are set out in the IAEA’s GSR Part 6 Decommissioning of Nuclear Facilities requirements (see Appendix 1). From these the selected following principles may be drawn:

*Principle 1: Protection of persons, property and the environment:*

When applying the protection of person, property and the environment measures, the following operational principles must be implemented: *Optimization of protection and safety in decommissioning; Graded approach in decommissioning, and Assessment of safety for decommissioning.*

*Principle 2: Setting out responsibilities for decommissioning:*

*Responsibilities of the Government* where Government shall establish and maintain a legislative framework within which all aspects of decommissioning, including management of the resulting radioactive waste, can be planned and carried out safely. This framework shall include a clear allocation of responsibilities, provision of independent regulatory functions, and requirements in respect of financial assurance for decommissioning.

*Responsibilities of the regulatory body* wherein the regulatory body shall regulate all aspects of decommissioning throughout all stages of the facility’s lifetime, shall establish the safety requirements for decommissioning, including requirements for management of the resulting radioactive waste, and shall adopt associated regulations and guides.

*Responsibilities of the licensee* where the licensee (authorization holder) shall plan for decommissioning, conduct the decommissioning actions in compliance with the authorization and with requirements derived from the national legal and regulatory framework and shall be responsible for all aspects of safety, radiation protection and

protection of the environment during decommissioning, including the financial obligations thereof.

*Principle 3: Decommissioning strategy*

The authorization holder shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the relevant legislative requirements.

*Principle 4: Financing of decommissioning*

Responsibilities in respect of financial provisions for decommissioning shall be set out in national legislation. These provisions shall include establishing a mechanism to provide adequate financial resources and to ensure that they are available when necessary, for ensuring safe decommissioning.

## **8.2 Decommissioning industry**

According to Loughran (2017), the IAEA indicated that about 200 nuclear reactors around the world will be shut down over the next quarter-century, mostly in Europe. This will result in job creation in the sector through the decommissioning and dismantling work. The dismantling of a nuclear power plant can take decades, and could cost up to €1bn (£880m), depending on the size and age of the plant. Once the spent fuel has been removed from the reactor, the reactor will need to be dismantled and the buildings demolished. The HLW will be packaged and disposed in a deep geological facility.

The first generation Nuclear Power Plants were designed and built to operate for about 30 years, but the latest reactors have a lifespan of about 40-60 years. Currently in the US, the NPPs are expected to be decommissioned after closure.

Status Quo in Decommissioning of Nuclear Power Reactors (IAEA, 2017) is as follows:

Situation	In operation	Shutdown/under decommissioning	Fully decommissioned
Nuclear Power Reactors Worldwide	449	160	15
Nuclear Power Reactors OECD NEA	350	148	15

### 8.3 The Financing/Costs of Decommissioning

According to Weber (2017) the objectives of decommissioning funding are:

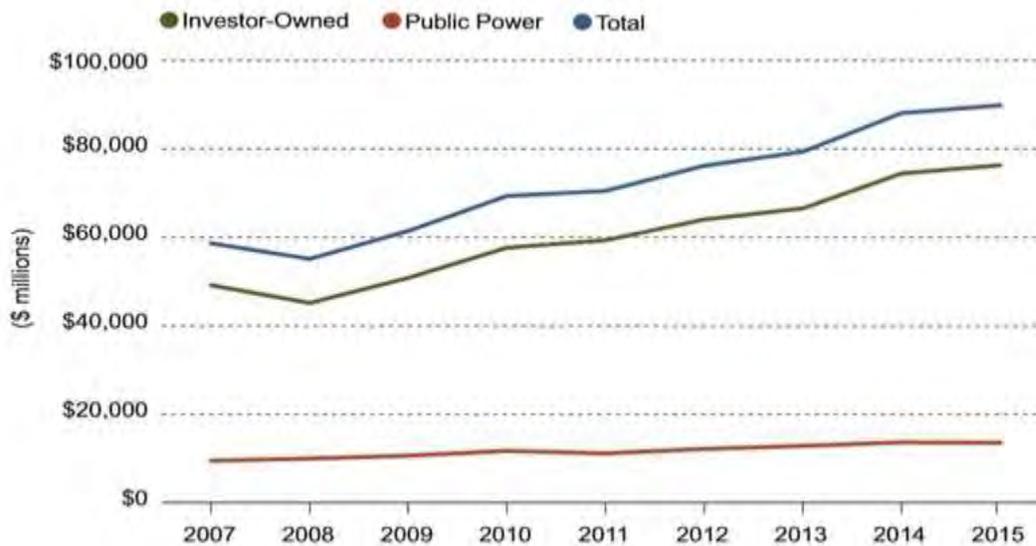
- To ensure the adequacy and availability of funding on time for safe decommissioning
- To reduce the risks of having residual unfunded liabilities and burden on future generations

The financing and costs of decommissioning is a key challenge in the nuclear sector. Nuclear operators are required to make financial provisions for decommissioning based on estimated costs, but there are very few completed decommissioning projects to use as a benchmark. The decommissioning cost estimates have been reported to vary widely between countries and corporations.

Weber (2017) indicates that the uncertainties around decommissioning financing are a major challenge and there are international efforts to address uncertainties in cost estimations. With only a few decommissioning projects completed thus far, there is still very limited cost data available. The IAEA and other involved stakeholders have developed a joint initiative to calculate decommissioning costs on the basis of an itemized list of cost factors.

The European Commission has indicated that France estimates that it will cost €300 million per gigawatt (GW) of generating capacity to decommission a nuclear reactor,

whereas Germany’s assumption is at €1.4 billion per GW, and the UK at €2.7 billion per GW. In France, the EDF’s decommissioning cost estimates for its 58-reactor fleet have been reported to appear too low, with 350 million euros per reactor, compared to European operators which range between 900 million and 1.3 billion euros per reactor. The following data from the United States shows that decommissioning cost estimates have increased over time:



Data from bodies such as NEA’s Decommissioning Cost Estimation Group (DCEG), which have conducted a research project to develop benchmarking approaches to decommissioning costs, can be used for benchmarking of decommissioning costs.

## 9. Decommissioning: The South African Perspective

### 9.1 History of the South African Nuclear Energy Programme

South Africa’s nuclear programme dates as far back as 1948, with its nuclear value chain reaching its peak during the 1970’s and 1980’s and leading to its self-sufficiency goal. The self-sufficiency goal means that South Africa had a complete value chain from mining of uranium, to the conversion of uranium, enrichment process, fuel fabrication, electricity generation and nuclear waste management.

These developments led to the inception of the SAFARI Research Reactor in 1965, the Koeberg Nuclear Power Plant in 1985 and the Vaalputs National Radioactive Waste Disposal Facility in 1986.

During the late 1970s, South Africa embarked on a nuclear weapons programme, mainly on the Pelindaba site (i.e. Necsa). Facilities such as Uranium Conversion and Enrichment Plants were established, as well as several other research facilities. The fuel fabrication plant was established in the main to provide for the security of Koeberg Nuclear Power Plant fuel supply.

In 1991, South Africa acceded to the Non-Proliferation Treaty and thereby surrendering its weapons programme. The associated facilities were rendered redundant, and are currently being decommissioned.

The Koeberg Nuclear Power Plant (KNPP) consists of two Framatome designed Pressurized Water Reactors (PWR) with 1800 MWe capacity. The power plant is owned and operated by Eskom, and produces about 5% of South Africa's electricity. KNPP showcases South Africa's successful history of nuclear power operations. It is the only commercial nuclear power station in Africa, and one of three in the Southern Hemisphere. It ranks amongst the safest of the world's top ranking PWR's, and is one of the most reliable.

## **9.2 Decommissioning activities in South Africa**

### *9.2.1 Decommissioning at Necsa: Past Strategic Nuclear Facilities*

When the Government resolved to close the past strategic nuclear facilities at Necsa, the responsibility to discharge institutional obligations of decommissioning and decontamination (D&D) of such facilities was delegated to Necsa by the Minister of the then Department of Minerals and Energy, in terms of Section 55 (2), read with section 1 (xii) (a) of the Nuclear Energy Act, 1999.

In 2004, Necsa quantified the total nuclear and related liabilities of these historical facilities to an amount of R1.8 billion. These liabilities were to be discharged over a

period of 30 years. Government approved the funding of the nuclear liabilities as divided into the following three major stages:

- D&D and related waste management of all past disused strategic nuclear facilities (Stage 1);
- D&D and related waste management of all remaining (currently operating) nuclear facilities i.e. past operational strategic nuclear facilities (Stage 2);
- Disposal of long-lived and high level waste when an appropriate disposal facility for such waste becomes available (Stage 3).

An oversight mechanism was also put in place to ensure financial accountability. The current reassessed decommissioning cost for Stage 1 liabilities is estimated to be R3.2 billion.

The decommissioning of other commercial facilities at Necsa is expected to be in line with the 'polluter pays principle'.

### *9.2.2 Decommissioning of Koeberg Nuclear Power Plant (KNPP)*

Based on a 40-year operational life, the decommissioning of KNPP is currently scheduled for after 2025. However, it is anticipated that the operational life of KNPP will be extended to 60 years and the decommissioning activities will only commence after 2045. Financial provision for decommissioning and used fuel management shall continue to be accumulated as required.

The financial provision made can be determined using calculations of the associated financial plans.

### *9.2.3 Other Decommissioning Activities*

It is expected that the uranium mining companies shall finance the decommissioning costs in line with the polluter pays principle.

## **10. The intent of the Decommissioning Policy**

It is the intention of Government that the anticipated National Decommissioning Policy must meet the following key objectives:

*Objective 1: Cover, and seek for the implementation of, the prescribed best practice principles applicable for the decommissioning of nuclear facilities.*

*Objective 2: Support core national priorities by considering and promoting social cohesion and security (safety, food, financial, energy etc.), economic inclusion, economic growth, and environmental sustainability.*

*Objective 3: to address the current decommissioning and decontamination challenges and to ensure future improvements to support the security of energy supply.*

In this regard, the anticipated policy must among other consideration cover and address the following aspects:

### **(a) Philosophy**

The philosophy that guides decisions on decommissioning strategies and options chosen based on best practices and national core priorities shall be outlined. The basic set of decommissioning principles shall be taken into account.

### **(b) Harmonization**

The decommissioning policy shall ensure that the concept of harmonisation is applied during decommissioning of nuclear facilities to ensure optimisation of the use of resources and the resulting benefits, in order to achieve a transformed nuclear industry.

For the policy to be effective, various participatory processes, initiatives and activities from the Government, operators, the regulators, persons living in the vicinity of nuclear facilities, businesses in the decommissioning and rehabilitation areas, and interested parties, all need to be effectively coordinated and integrated.

### **(c) Polluter Pays Principle**

One of the key principles that the Decommissioning Policy should be based upon is the “polluter pays” principle.

Section 2(4)(p) of NEMA states that “the costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or mitigating further pollution, environmental damage or adverse health effects must be paid for by those responsible for harming the environment.”

The NEMA imposes a duty of care and remediation for environmental damage and requires that “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 (section 28(1))”

The decommissioning policy must address the lack of safeguards (financial security) that ensure that funds for decommissioning will be available when needed to prevent pollution or degradation and to remedy damage caused by activities.

### **(d) Socio-economic impact of decommissioning**

It has been observed that a decommissioning programme can be impacted by considerable political, regulatory and commercial pressure to make progress.

Some of the factors that can influence the choice of the type of decommissioning strategy include impact on the environment, employment and economic benefits, and public perception about the nuclear hazards.

NEMA provides the following important national environmental management principles to be considered when this policy is developed:

- *Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life cycle.*
- *The participation of all interested and affected parties in environmental governance must be promoted,.....and effective participation and participation by vulnerable and disadvantaged persons must be ensured.*
- *Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognizing all forms of knowledge, including traditional and ordinary knowledge.*
- *The social, economic and environmental impacts of activities, including disadvantages and benefits must be considered, assessed and evaluated and decisions must be appropriate in the light of such consideration and assessment;*
- *Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law;*
- *There must be intergovernmental co-ordination and harmonization of policies, legislation and actions relating to the environment (sec 2(4)(e), (f), (g), (i) and (k).*

It is important for one to understand the impact of the lack of the decommissioning policy as well as the impact of its adoption in South Africa. The Government's prescribed Socio-Economic Impact Assessment Guidelines tool developed by the Department of Monitoring and Evaluation (DPME) shall be employed to establish the socio-economic impacts of this policy.

#### **(e) Technical aspects of decommissioning**

Estimated timelines for nuclear decommissioning inevitably can be affected by the technology advancements, changes in government policy, economic circumstances and environmental issues.

The IAEA indicates that nuclear decommissioning uses fairly well known and tested technologies, even though it may be necessary to develop special tools or means for remote operation or handling to ensure safety.

The policy needs to ensure that the following issues are strategically addressed:

- New/emerging technologies may have significant impact on future decommissioning need to be identified.
- The possibility of developing and/or adopting new techniques in the area of decommissioning (e.g. robotics).

#### **(f) Improved Legislative Framework**

The Decommissioning Policy needs to improve the national legislative framework on nuclear in a harmonised manner to achieve the goal of the safety of the public and the protection of the environment in accordance with the applicable prescripts of the IAEA Safety Standards, including the fundamental safety principles.

### **11. Current Situation and its Implications**

#### **11.1 Regulatory requirements for nuclear decommissioning in South Africa**

The NNR is the South African nuclear regulatory body responsible for regulating nuclear activities to ensure the safety of persons, property and the environment. The NNR Act is the primary national legislation regulating nuclear activities in South Africa. Under its provisions the SSRP Regulations have been published. The NNR, in addition to the legislation and regulations, further uses Regulatory Documents and Guides in its licensing and regulatory oversight activities.

Decommissioning activities are undertaken under the authorization process of the NNR. The authorization process for decommissioning of nuclear facilities is the same as for the authorization of an operational nuclear facility.

Several facilities on the Necsca site have been decommissioned or are still under decommissioning in accordance with the requirements of the NNR Act, section 5, the SSRP and RD-0026.

All the NNR requirements for decommissioning are contained in RD-0026, which deals with the following: *Protection of human health and the environment, decommissioning strategy, funding, decommissioning management, decommissioning implementation, and completion of decommissioning*. In general, the financing of decommissioning and waste management follows the principle of the polluter pays. In accordance with this principle, all holders of nuclear authorizations' are responsible for ensuring that sufficient resources are in place to meet their responsibilities regarding decommissioning and radioactive waste management.

It is furthermore a requirement of the SSRP that it must be demonstrated to the NNR that sufficient resources will be available from the time of cessation of the operation to the termination of the period of responsibility (release from regulatory control).

## **11.2 Issues, Opportunities and Potential Options**

As highlighted in the 2016 IRRS Review Mission Report, the IAEA's GSR Part 1 Requirement 10, states that "The government shall make provision for the safe decommissioning of facilities, the safe management and disposal of radioactive waste arising from facilities and activities, and the safe management of spent fuel." GSR Part 1 Requirement 10, para. 2.28 states that "Decommissioning of facilities ...shall constitute essential elements of governmental policy and the corresponding strategy ..."

IAEA's GSR Part 6 Requirement 4, states that "The government shall establish and maintain a governmental, legal and regulatory framework within which all aspects of decommissioning, including management of the resulting radioactive waste, can be planned and carried out safely. This framework shall include a clear allocation of responsibilities, provision of independent regulatory functions, and requirements in respect of financial assurance for decommissioning."

The DMRE has identified elements of South Africa's current decommissioning framework that have the potential to be improved. These include:

- Legislative requirements for nuclear decommissioning – clarifying who is responsible for ensuring decommissioning is carried out and the extent to which they are responsible.
- Financial responsibility – ensuring authorization holders have sufficient financial capacity to meet their decommissioning requirements and that appropriate financial responsibility mechanisms are in place.
- Decommissioning strategies – clarifying the South African position with regard to decommissioning strategies.
- Other issues and opportunities – exploring decommissioning related research and collaboration, whether there is interest and merit in creating a South African nuclear decommissioning industry, and if there are other issues relating to decommissioning Government should be aware of and cover in the policy.

The DMRE has also provided potential options for resolving issues and taking advantage of the opportunities that are outlined in this Discussion Paper. Any proposals discussed herein do not represent Government's final position, but are provided to stimulate thinking and discussion to assist in the formulation of the Decommissioning Policy.

## **A. Legislative requirements for nuclear decommissioning**

### **A.1 Issues: *Statutory responsibilities for financing decommissioning and prime responsibility for operators***

The IAEA GSR Part 6 Requirement 9 deal with financing of decommissioning and provides that the responsibilities in respect of financial provisions for decommissioning shall be set out in national legislation. These provisions shall include establishing a

mechanism to provide adequate financial resources and to ensure that they are available when necessary, for ensuring safe decommissioning.

## A.2 Opportunities and Potential Options

### A.2.1 Potential option:

Government needs to improve the national legislative framework to be consistent with IAEA legal instruments and Safety Standards.

#### Advantages and disadvantages of this option

- The key advantage of this option is that South African national legislation will be in compliance with best practices which require that the prime responsibility for safety, security and financial obligations of nuclear and radiation activities rests with authorization holders.
- This option also provides clarity to industry on their financial responsibilities in relation to decommissioning.
- A disadvantage of this option is a potential increase in financial burden for companies, which may act as a barrier to investment.

**Table 1: Comment Questions 1 - 2**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 1</b>	Should the national legislation make a requirement for operators to be expressly, made liable for the costs of carrying out their decommissioning obligations? <b>Please articulate why or why not</b>
	<b>If yes: Are there any responsibilities that should be excluded?</b>
<b>Question 2</b>	Should alternative liability arrangements be included in a revised framework, providing Government with the ability to pursue previous operators in the chain of ownership if the current authorization holder is unwilling or unable to decommission? <b>Please articulate why or why not</b>
	<b>If yes: Should this be implemented retrospectively or only prospectively?</b>

## **B. Financial Responsibility: Financial security for decommissioning**

### **B.1 Issues: *provision of financial security for decommissioning***

In this case, the operator is required to make provisions for decommissioning. If the operator lacks appropriate financial security arrangements, then there is a risk that the operator would fail to decommission appropriately. In such a case, the Government will be obliged to carry the liability. This will come at a cost to the Government and therefore the taxpayers.

### **B.2 Opportunities and Potential Options**

#### ***B.2.1 Potential Option 1: Implement a mandatory statutory requirement for financial security for decommissioning***

This option provides the most reliable financial security and protection for the Government and therefore the taxpayer, to directly mitigate the risk of incurring the costs of decommissioning.

Operators would be required to establish and provide financial security sufficient to discharge their decommissioning obligations. The requisite security amount held could then be assessed and updated regularly throughout to reflect the inventory of infrastructure at any point in time. The NNR would be responsible for regulating the provision, in terms of conducting assessments and oversight over maintenance of financial security for decommissioning purposes.

Similar to existing common financial assurance requirements, acceptable instruments may include: *Bonds* (including surety bonds); *Guarantees*; *Deposits of funds with a financial institution*; *Letters of credit* and *Insurance, etc.*

The amount of security required would be determined on a case-by-case basis based on an estimate of future decommissioning costs. Costs would need to be carefully estimated, to ensure the security required accurately reflects the amount needed to fully decommission the facilities.

Compliance with financial security requirements could be periodically assessed through routine inspections of companies' financials. To ensure security is accessible in the event where decommissioning needs to be done, it should also be a statutory requirement that the financial security is sufficiently liquid and payable when required. Security amounts required would be reduced as the operator carries out decommissioning.

#### Advantages and disadvantages of this option

- The key advantage of this option is the protection of the Government (and therefore the taxpayer) from decommissioning costs in the event of default by an authorization holder.
- This option also provides clarity to industry on their financial security obligations.
- This option would further encourage operators to consider decommissioning and costs thereof during project planning and factor this into their assessment of the project's commercial viability, and consider their decommissioning obligations regularly throughout the project's life.
- A disadvantage of this option is a potential increase in financial burden for companies. The administration of securities can also be potentially complex. These are, however, concerns associated with all financial security arrangements, and can be managed through careful planning and cost estimation. The complexity involved in administering securities also varies with the instrument or approach selected. The choice of financial security instrument would be largely left to the commercial discretion of authorization holders, although the form selected would need to be assessed and approved by Government.

#### ***B.2.2 Potential Option 2: Require financial security for decommissioning on a discretionary basis***

Government could be empowered to require operators to establish financial security for decommissioning if it is deemed necessary to do so. This could follow a request for

information regarding financial status, projected decommissioning costs, and other relevant matters.

The requirement to establish security, as well as the form and quantum of security required, could, for example, be set out in a notice issued to the operator. Non-compliance would be grounds for Government to take enforcement action, potentially including forbidding operations to commence until security has been provided in accordance with the notice.

#### Advantages and disadvantages of this option

- Similar to the statutory requirement option, acceptable forms of assurance could include: Bonds, Guarantees, Deposits of funds, Letters of credit and Insurance and compliance with any financial security requirements imposed could be assessed and updated as necessary through routine inspections.
- Similar to the statutory requirement option the key advantage of this option is the protection of the Government, and therefore the taxpayer, from decommissioning costs, however the element of discretion presents some risk for government in identifying when this option should be appropriately exercised.
- In contrast to the statutory requirement option, this option also provides Government with greater flexibility to take into account matters such as the operator's financial strength and compliance history, and current policy settings. It also gives Government greater scope to limit the financial burden on industry using a risk-based approach.
- This option has significant disadvantages arising from its discretionary nature. Administering securities can be complex, depending on the instrument selected. Introducing discretion could create uncertainty and inconsistencies for operators, which introduces further complexity to investment decisions. It may also result in the NNR, as the administering authority, assuming a degree of risk (e.g. if the discretion to require security is not exercised, and the authorization holder subsequently cannot or does not meet its obligations). To reduce the risk to

Government it is likely in practice that this discretion would be exercised in a risk-averse manner so as to require most or all operators to maintain security, essentially making it akin to a statutory requirement.

### ***B.2.3 Potential Option 3: Establish a dedicated decommissioning fund***

#### **(i) Individual Fund**

Operators could be required to contribute periodically to a dedicated decommissioning fund that is directly tied to the authorization and its associated decommissioning costs. This might be established at the start of the project or at predetermined points. The amount contributed at each interval might depend on overall decommissioning costs, estimated at the start of the project and updated throughout, with the timing of such contributions possibly structured around the timing of revenue streams; i.e. more contributed in higher-revenue periods.

At the time of shut down and end of facility lifespan, the fund should be ‘full’, and then used to cover the total cost of any decommissioning that remains to be done associated with the facility. Access to the fund would be allowed only as a decommissioning phase approaches, and then only to cover decommissioning costs. This would be linked to the approved decommissioning plan.

#### **(ii) Pooled Fund**

As an alternative to a dedicated decommissioning fund, operators could contribute periodically (e.g. through levies) to a pooled decommissioning fund, which would be used to cover the costs of decommissioning in the event of individual default. Potentially, operators could secure a partial or whole refund of their contributions following satisfactory completion of their own decommissioning project.

A pooled fund is not intended as a means of sharing or subsidizing the decommissioning liability. If the fund was used by Government to finance decommissioning, the defaulting operator would be required to reimburse the fund. However, the existence of the fund would mean that in the interim the necessary work

could be undertaken with minimal immediate financial risk to the Government and the taxpayer.

This approach could potentially be combined with regular oversight of financial responsibility of the operator. In the circumstance where the relevant operator could or did not reimburse the fund, the fund or interest earned on the fund would cover decommissioning costs.

#### Advantages and disadvantages of this option

- A pooled fund allows operators to meet financial security obligations at lower individual costs, and may encourage collaboration between operators. Interest from a pooled fund could be used to decommission legacy sites in the event that a defaulting authorization holder cannot be pursued to reimburse funds.
- The key disadvantage is that operators could, depending on the fund design, be required to contribute the full costs of decommissioning ahead of and in addition to paying for the decommissioning project itself (i.e. if the money in the fund was reimbursed to the authorization holder only after completion of the decommissioning work). This creates a cash flow issue, as opposed to net financial burden. A fund may also prove difficult for more mature projects, given the operator could be required to contribute total projected costs over just a few years.
- Using a pooled fund also creates the risk that a defaulting operator would contribute less than their total decommissioning costs, with the shortfall in theory picked up by the fund or the Government. Similarly, there is also a risk of compliant authorization holders inadvertently subsidizing their non-compliant authorization holders.

The DMRE will conduct a study on developing a decommissioning costs estimate methodology for nuclear facilities in South Africa to improve the transparency and accuracy of decommissioning costs. The data from OECD's NEA and the IAEA can be

relevant for comparison with South African estimates that will be calculated by operators for use in decommissioning costing.

The Decommissioning Policy therefore needs to address the following: Scope of Funding and Funding Mechanisms (i.e. Collection, Timeline and Management; Control and Oversight of Funds).

**Table 2: Comment Question 3**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 3</b>	Should industry be required to hold and demonstrate sufficient financial security to meet its decommissioning costs? <b>Please articulate why or why not</b>
	<b>If yes: What form of security should be implemented?</b>
	<b>How should the security be administered?</b>
	<b>When should the security be required and how might this be triggered?</b>
	<b>Should the security requirement apply to all operators?</b>

## **C. Decommissioning Strategies**

### **C.1 Issues**

#### ***C.1.1 South Africa currently does not have a policy position on decommissioning strategies***

The IAEA GSR Part 6 Requirement 8 states that “the licensee shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the national policy on the management of radioactive waste.”

Paragraph 5.1 of GSR Part 6 provides that the preferred decommissioning strategy shall be immediate dismantling. However, there may be situations in which immediate

dismantling is not a practicable strategy when all relevant factors are considered. Paragraph 5.2 states that the selection of a decommissioning strategy shall be justified by the licensee.

In terms of best practices Government must make provision for decision on decommissioning strategies. This is to enable authorization holders to select a decommission strategy to serve as a basis for their decommissioning plan.

The implication of the absence of a policy position on the decommissioning strategies for South Africa is that there is no clarity for the nuclear industry on the prescribed or preferred South African approach and in turn, that may affect industry's consideration of decommissioning costs during project planning and assessment of the project's commercial viability.

## **C.2 Opportunities and Potential Options**

***South Africa's policy on decommission should provide for preferred decommissioning strategies***

The IAEA identifies three decommissioning strategies, namely: *immediate dismantling*, *deferred dismantling* and *entombment*.

### ***C.2.1 Potential Option 1: Immediate dismantling, decontamination, or decommissioning***

Immediate dismantling (immediate decontamination/decommissioning) commences shortly after shut down, if necessary following a short transition period to prepare for implementation of the decommissioning strategy. Decommissioning is expected to commence after the transition period and continues in phases or as a single project until an approved end state including the release of the facility or site from regulatory control has been reached.

This is the relatively a quicker approach which can begin in a few months after closure of a facility, wherein the facility license is terminated within five years. Decontamination results in removal of about 99 percent of the facility's radioactivity, and makes it safer

for workers to complete the rest of the decommissioning process. The decision criteria for this option are: Availability of facility staff; Re-employment of staff; Use of specific expertise; Use of existing infrastructure, including an available repository; Experience with licensing procedures; No long-term site commitment; Unrestricted use of the grounds for other purposes; Public and political acceptance

#### Advantages and disadvantages of this option

- Advantages: Knowledgeable personnel from operation are available; Operating history is well known; Time scale and costs are well defined; Existing infrastructure can be used; No further consideration of duration of life are needed; Current laws and guidelines.
- Disadvantages: Higher collective dose; Greater complexity if shielding or remote controlled systems are used; Final repository is needed; Intermediate storage of radioactive waste is needed if no final repository exists.

#### ***C.2.2 Potential Option 2: Deferred decommissioning***

As an alternative strategy, decommissioning may be deferred for a period of up to several decades. Deferred decommissioning is a strategy in which a facility or site is placed in a safe condition for a period of time, followed by decontamination, dismantling and decommissioning. During the deferred decommissioning period, a surveillance and maintenance programme is implemented to ensure that the required level of safety is maintained. During the shutdown and transition phases, facility specific actions are necessary to reduce and isolate the source term in order to prepare the facility/site for the deferred decommissioning period.

This approach allows storage of radioactive material within the facility or off-site above ground until they become stable elements. The nuclear facility can be kept under care and maintenance for about 60 years with regulatory oversight, maintenance and security. When the nuclear material has decayed to acceptable levels, the facility will then be dismantled in a similar way as the decontamination approach. This approach can be put on hold at any point when the option 1 approach is viable.

The decision criteria for this option include the following: Lack of availability of a repository; Lack of funds for direct dismantling; Radioactive decay of some radionuclides to ensure reduction of local dose rates and reclassification of some radioactive wastes.

#### Advantages and disadvantages of this option

- Advantages: radioactivity is reduced (e.g. for Cobalt-60, or C-60, by a factor of 64 after 30 years); Lower collective dose; A greater part of the material can be reused (i.e. the radioactivity of the material below clearance).
- Disadvantages: Loss of knowledge and experience; Preliminary work must be done under same dose rates like immediate decommissioning – similar exposure risks; regulatory control must be established for about 30 years.

#### ***C.2.3 Potential Option 3: Entombment***

Entombment is a strategy in which the remaining radioactive material is permanently encapsulated on site. A Low- and Intermediate-Level Waste (LILW) repository is effectively established and the requirements and controls for the establishment, operation and closure of waste repositories are applicable.

Entombment is recommended by the IAEA only under exceptional circumstances, such as a severe nuclear accident. The radioactivity is allowed to reduce as low as possible and then enclosed indefinitely.

#### Advantages and disadvantages of this option

- Advantages: Fast; less expensive than other methods; only little material goes to final repository (no big storage capacity needed).
- Disadvantages: Preliminary work must be done under same dose rates like immediate decommissioning, but less work needed; Material cannot be reused and is regarded as waste; Site cannot be reused; Unwanted legacy for future generations; Local final repositories are created; there is negative public perception associated with this option.

The choice of an appropriate decommissioning strategy and the motivation thereof should include the feasibility and credibility of the option, as well as the compatibility and logical sequence of the steps to be taken.

### **C.3 General factors influencing strategy selection**

Some of the general factors influencing the selection of the decommissioning strategy are: national policies and regulatory framework; financial resources or cost of implementing a strategy; spent fuel and waste management system; health, safety and environmental impact; knowledge management and human resources; social impacts and stakeholder involvement; suitable technologies and techniques; physical conditions of the plant and owner's interest; future plans for use of the site.

Some of the constraints and conditions for the decommissioning activities, that influence the strategy selection are: inadequacy of available funds; limited or inadequate legal and regulatory framework; inadequate spent fuel and waste management systems; lack of education to the public about the nuclear field; the demand for reuse of the facility or site; and the state of the local economy. .

The approach of most countries is to implement a combination of these strategies as may be considered practicable on the basis of safety requirements or environmental requirements, technical considerations and other conditions, such as the intended future use of the site, or financial considerations.

The IAEA also highlights that the major factors that influence decision making for decommissioning strategies are decommissioning costs, waste disposal problems and political aspects.

**Table 3: Comment Question 4**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 4</b>	Should South Africa select a preferred national decommissioning strategy? <b>Please articulate why or why not</b>
	<b>If yes: Which form of strategy should be selected?</b>
	<b>Should such preferred strategy approach reflect in national legislation?</b>

## **D. Other issues and opportunities**

### **D.1 Research and collaboration**

Laraia (2008) indicated that the conclusion from the first IAEA Report on the Decommissioning of Nuclear Facilities in 1975, indicted that issues around policy, planning, timing, costs, waste disposal, safety criteria and regulatory aspects still need further development. Decommissioning industry is now considered to be mature, but it could still require improvement with the changes in the safety and environmental regulatory requirements, technological, progress, and also with changes in political perceptions and expectations. Through international peer reviews, the decommissioning knowledge and experience can be transferred to countries that will be decommissioning for the first time.

With more countries expecting to close and decommission nuclear facilities that have reached their end of life, the operators need to ensure that adequate financial provisions have been made. This could drive more research to be done on the financing and costs of decommissioning of nuclear facilities.

South Africa should assess the different cost estimate methodologies so that the developed decommissioning policy ensures that the estimated decommissioning costs are accurate.

**Table 4: Comment Question 5 – 7**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 5</b>	<b>Is there additional research (and/or development) being undertaken relevant to nuclear facilities decommissioning that government should be aware of?</b>
	<p><b>If yes: What research/development is being undertaken and by whom?</b>  <b>What is the timeframe for this research/development?</b>  <b>Will the results be made public and if so how/where?</b>  <b>Please provide details</b></p>
<b>Question 6</b>	<b>Is there additional research that should be undertaken on nuclear facilities decommissioning, and in particular on decommissioning costing?</b> <b>Please provide details.</b>
	<b>If yes: What areas should be researched? Should government be involved?</b> <b>Which entities should be involved and what should their roles be?</b>
<b>Question 7</b>	<b>Is there industry collaboration on facilities decommissioning to ensure the exploration of available opportunities in decommissioning and should more be done to encourage such collaboration?</b> <b>Please articulate why or why not</b>
	<b>Should collaborations be encouraged by Government? If yes: What are the current barriers to collaboration? What is suggested to break these down? Who should be responsible for this? Should government be involved? If so, how?</b>

## **D.2 Decommissioning market opportunities**

Nuclear facilities decommissioning activities are on the rise worldwide and may present a new growth opportunity for South African companies both locally and internationally.

Currently, the South Africa’s liability for the decommissioning of its historical strategic nuclear facilities has been costed to an amount of R3.2 billion.

Building on the reputation of Koeberg nuclear power plant impeccable safety record and a pool of well experienced nuclear and radiation professionals and specialists from

Necsa and Eskom, South Africa may expand its expertise to nuclear facilities decommissioning projects and could rely on local expertise, rather than imported skills, as well as provide attractive services and skills for export.

**Table 5: Comment Question 8 – 9**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 8</b>	<b>Is there interest and merit in expanding the South African nuclear industry through involvement in decommissioning of nuclear facilities? Please articulate why or why not</b>
	<b>If yes: What opportunities are there? If so, how can the Government be involved?</b>
<b>Question 9</b>	<b>Please outline possible options for involvement of other industries in the decommissioning of nuclear facilities.</b>
	<b>If so, which entities should be involved and what should their roles be?</b>

### **D.3 Broader decommissioning issues and opportunities**

While this Discussion Paper focuses on clarifying and strengthening the legislative framework for decommissioning of nuclear facilities, the DMRE welcomes ideas on ways Government might best encourage, support or help facilitate industry innovation and participation in the field of nuclear decommissioning.

In this regard, the DMRE also welcomes suggestions for improving and enhancing the oversight on nuclear decommissioning activities.

Where these ideas and suggestions relate to areas for which other Government organisations hold primary responsibility and oversight, the DMRE will provide these ideas to the relevant organisation(s) for their consideration as appropriate.

**Table 6: Comment Question 10**

<b>Interested parties making submissions may wish to consider and comment on the following:</b>	
<b>Question 10</b>	<b>Are there other issues relating to decommissioning that are not covered in this Discussion Paper and you think it is appropriate for Government to be involved in?</b>
	<b>If yes: What are they? What is the suggested government involvement?</b>

## **12. Next steps**

The DMRE encourages everyone involved in or affected by the nuclear facilities decommissioning regime to participate in providing comments and inputs on this Discussion Paper.

Comments are welcomed on some or all of the issues, opportunities, options and questions posed in this Discussion Paper, as well as proposals for enhancements to the current decommissioning framework of South Africa.

Comments can be submitted as provided in Section 7.1 hereof.

**Comments on this Discussion Paper close on 18 August 2020**

**APPENDIX 1**  
**IAEA GSR PART 6 DECOMMISSIONING OF NUCLEAR FACILITIES**

Decommissioning Requirements

*Protection of persons, property and the environment*

*Requirement 1: Optimization of protection and safety in decommissioning:*

Exposure during decommissioning shall be considered to be a planned exposure situation and the relevant requirements of the Basic Safety Standards shall be applied accordingly during decommissioning.

*Requirement 2: Graded approach in decommissioning*

A graded approach shall be applied in all aspects of decommissioning in determining the scope and level of detail for any particular facility, consistent with the magnitude of the possible radiation risks arising from the decommissioning.

*Requirement 3: Assessment of safety for decommissioning*

Safety shall be assessed for all facilities for which decommissioning is planned and for all facilities undergoing decommissioning.

*Responsibilities for decommissioning*

*Requirement 4: Responsibilities of the Government for decommissioning*

The Government shall establish and maintain a governmental, legal and regulatory framework within which all aspects of decommissioning, including management of the resulting radioactive waste, can be planned and carried out safely. This framework shall include a clear allocation of responsibilities, provision of independent regulatory functions, and requirements in respect of financial assurance for decommissioning.

*Requirement 5: Responsibilities of the regulatory body for decommissioning*

The regulatory body shall regulate all aspects of decommissioning throughout all stages of the facility's lifetime, from initial planning for decommissioning during the siting and design of the facility, to the completion of decommissioning actions and the termination of authorization for decommissioning. The regulatory body shall establish the safety requirements for decommissioning, including requirements for management of the resulting radioactive waste, and shall adopt associated regulations and guides. The regulatory body shall also take actions to ensure that the regulatory requirements are met.

*Requirement 6: Responsibilities of the licensee for decommissioning*

The licensee shall plan for decommissioning and shall conduct the decommissioning actions in compliance with the authorization for decommissioning and with requirements derived from the national legal and regulatory framework. The licensee shall be responsible for all aspects of safety, radiation protection and protection of the environment during decommissioning.

*Management of decommissioning*

*Requirement 7: Integrated management system for decommissioning*

The licensee shall ensure that its integrated management system covers all aspects of decommissioning.

*Decommissioning strategy*

*Requirement 8: Selecting a decommissioning strategy*

The licensee shall select a decommissioning strategy that will form the basis for the planning for decommissioning. The strategy shall be consistent with the national policy on the management of radioactive waste.

*Financing of decommissioning*

*Requirement 9: Financing of decommissioning*

Responsibilities in respect of financial provisions for decommissioning shall be set out in national legislation. These provisions shall include establishing a mechanism to provide adequate financial resources and to ensure that they are available when necessary, for ensuring safe decommissioning

*Planning for decommissioning during lifetime of facility*

*Requirement 10: Planning for decommissioning*

The licensee shall prepare a decommissioning plan and shall maintain it throughout the lifetime of the facility, in accordance with the requirements of the regulatory body, in order to show that decommissioning can be accomplished safely to meet the defined end state.

*Requirement 11: Final decommissioning plan*

Prior to the conduct of decommissioning actions, a final decommissioning plan shall be prepared and shall be submitted to the regulatory body for approval.

### *Conduct of decommissioning actions*

#### *Requirement 12: Conduct of decommissioning actions*

The licensee shall implement the final decommissioning plan, including management of radioactive waste, in compliance with national regulations.

#### *Requirement 13: Emergency response arrangements for decommissioning*

Emergency response arrangements for decommissioning, commensurate with the hazards, shall be established and maintained, and events significant to safety shall be reported to the regulatory body in a timely manner.

#### *Requirement 14: Radioactive waste management in decommissioning*

Radioactive waste shall be managed for all waste streams in decommissioning.

#### *Requirement 15: Completion of decommissioning actions and termination of the authorization for decommissioning*

On the completion of decommissioning actions, the licensee shall demonstrate that the end state criteria as specified in the final decommissioning plan and any additional regulatory requirements have been met. The regulatory body shall verify compliance with the end state criteria and shall decide on termination of the authorization for decommissioning.

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