| Eskom | Plan | Koeberg Operating Unit |
|---|---|---|

Title: **Solid Radioactive Waste Management Plan for Koeberg Nuclear Power Station**

Document Identifier: **240-113228853**

Alternative Reference Number: **FBF-028**

Area of Applicability: **Eskom Holdings SOC Ltd**

Functional Area: **Nuclear Fuel**

Revision: **1**

Total Pages: **45**

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| Date: | Date: | Date: | Date: | Date: |

## Nuclear Additional Classification Information

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| Working Document: | **3** |
| Importance Classification: | **N/A** |
| NNR Approval: | **N/A** |
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## Content



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# 1. Introduction

Eskom is bound by law to develop and implement a strategic plan for the management and disposal of solid radioactive waste generated by the operations of its Koeberg nuclear power station, which is hereinafter referred to as 'Koeberg'. Koeberg is the only nuclear power station in the country and has a total generating capacity of 1 800 megawatts (MWe) from its two pressurised water reactors (PWR). During its operating lifespan, Koeberg produces volumes of radioactive waste which must be safely managed and disposed of in proper facilities. These volumes consist of day-to-day process wastes and replaced components such as the original steam generators, all of which are classified as short-lived low and intermediate level radioactive wastes (LILW-SL). The power station further generates quantities of highly radioactive used nuclear fuel assemblies. These are stored in spent fuel pools (SFPs) on site as soon as they have been discharged from the reactors, and some of the older assemblies are stored in dry storage casks to ensure availability of storage capacity in the pools. Large quantities of radioactive waste will also be generated during the decommissioning of Koeberg at the end of its operating life. The fate of these radioactive wastes and used fuel inventories must therefore be established and described in a comprehensive plan as a mandatory requirement for compliance with the applicable national legislation and policies for radioactive waste management. This document entails that plan.

# 2. Supporting Clauses

## 2.1 Scope

This plan covers the description of and the actions required to manage the following inventories arising from Koeberg:

- Process waste, being very low level waste (VLLW) and LILW-SL;
- Maintenance and project waste from refuelling and maintenance operations, being LILW-SL;
- Plant decommissioning waste, being VLLW and LILW-SL; and
- Used nuclear fuel, being high level radioactive waste (HLW), unless it is stored for possible re-use.

Operational radioactive liquid and gaseous effluents are managed separately under regulatory authorisation and are therefore excluded from this document.

### 2.1.1 Purpose

The purpose of the document is to develop and describe the radioactive waste management plan for Koeberg and it serves as a basis for the evaluation and authorisation of Eskom's future requirements and actions for radioactive waste management. Through this plan, Eskom commits to managing radioactive waste in a manner that maintains confidence and acceptance by the public, keeping the public, property and environment as safe as possible, and adhering to the as-low-as-reasonably-achievable (ALARA) principles as established by the International Commission on Radiation Protection (ICRP) [1].

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This document also prescribes the methodology to be applied when developing radioactive waste management plans for Koeberg. The radioactive waste management plans will be submitted to the National Committee on Radioactive Waste Management (NCRWM) for evaluation and recommendation to the Minister of Energy for approval.

### 2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

### 2.1.3 Effective date

This document is effective from approval date.

## 2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

### 2.2.1 Normative

[1] International Commission on Radiological Protection, ICRP Publication 103, Annals of the ICRP 37(2-4), 2007.

[2] Radioactive Waste Management Policy and Strategy for the Republic of South Africa, Department of Minerals and Energy, 2005.

[3] International Atomic Energy Agency, Fundamental Safety Principles, SF-1, 2006.

[4] Nuclear Energy Act, 1999 (Act No. 46 of 1999).

[5] National Radioactive Waste Disposal Institute Act, 2008 (Act No. 53 of 2008).

[6] VLP-WAC-001: Waste Acceptance Criteria for Vaalputs, Necsa, 2016.

[7] 238-51: Radioactive Waste Management, 2018.

[8] Koeberg Safety Analysis Report II-5.1.6.2.

[9] VLP-WAC-002: Approval Process for Waste Containers, 2013.

[10] 238-54: Radiation Protection Licensing Requirements for Koeberg Nuclear Power Station, 2019.

[11] International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, SSR-6, 2018.

[12] DSG-318-003: Manufacture of TES Concrete Waste Disposal Drums, 2008.

[13] 240-127949130: Qualification Testing of TES Concrete Waste Disposal Drums, 2017.

[14] DSG-314-238: Radwaste Open Head Metal Drums Design Specification, 2020.

[15] DSG-318-002: Design and Qualification Testing of TES Metallic Waste Disposal Drums, 2020.

[16] 238-185: Reference Technical Plan for Long-Term Used Nuclear Fuel Management.

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### 2.2.2 Informative

[17] International Atomic Energy Agency, Application of the Exclusion, Exemption and Clearance, Safety Series No. RS-G-1.7, IAEA 2004.

## 2.3 Definitions

| Term | Description |
|---|---|
| Authorisation | The granting by a regulatory body or other governmental body of written permission for an operator to perform specified activities. Authorisation could include, for example, licensing, certification and registration. |
| Characterisation | Determination of the physical, chemical and radiological properties of the waste to establish the need for further adjustment, treatment or conditioning; or its suitability for further handling, processing, storage or disposal. |
| Clearance | Removal of radioactive materials or radioactive objects within authorised practices from any further regulatory control by the regulatory body. |
| Conditioning | Those operations that produce a waste package suitable for handling, transport, storage and/or disposal. Conditioning may include the conversion of the waste into a solid waste form, enclosure of the waste in containers, and, if necessary, providing an overpack. |
| Decommissioning | Administrative and technical actions taken to allow the removal of some or all of the regulatory controls from a facility. |
| Decommissioning waste | Waste expected to be generated from the decommissioning of the power station. |
| Deep geological disposal | The disposal of radioactive waste underground (usually several hundred metres or more below the surface) in a geological formation to provide long-term isolation of radionuclides from the biosphere. |
| Disposal | Emplacement of waste in an appropriate facility without the intention of retrieval. |
| High level waste | The radioactive liquid containing most of the fission products and actinides present in used fuel – which forms the residue from the first solvent extraction cycle in reprocessing – and some of the associated waste streams; this material following solidification; used fuel (if it is declared a waste); or any other waste with similar radiological characteristics. Typical characteristics of HLW are thermal powers above about 2 $kW/m^3$ and long-lived radionuclide concentrations exceeding the limitations for short-lived waste |
| Intermediate level waste | Radioactive waste containing intermediate levels of beta, gamma and alpha radionuclides which have intermediate radiotoxicity and low heat output. |
| Long-lived waste | Radioactive waste that contains significant levels of radionuclides with half-lives greater than 31 years. Typical characteristics are long-lived radionuclide concentrations exceeding the limitations for long-lived waste. |

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| Term | Description |
|---|---|
| Low and intermediate level waste | Radioactive waste with radiological characteristics between those of exempt waste and high level waste. These may be long-lived waste (LILW-LL) or short-lived waste (LILW-SL). Typical characteristics of LILW are activity levels above clearance levels and thermal power below 2 kW/m$^3$. |
| Low level waste | Radioactive waste containing low levels of beta, gamma and insignificant alpha radionuclides which have low radiotoxicity and insignificant heat output. |
| Maintenance waste | Waste generated from the power station during maintenance. This waste includes non-compactable waste, compactable trash, scrap, etc. |
| Near-surface disposal | The disposal of radioactive waste at or within a few tens of metres from the earth's surface. |
| Pre-treatment | Any or all of the operations prior to waste treatment, such as collection, segregation, chemical adjustment and decontamination. |
| Process waste | Waste generated when the power station is in normal operation and includes resins, filters from process systems, evaporator concentrates, non-compactable waste, compactable trash and sludge from decontamination activities. |
| Project waste | Project-generated waste such as reactor components and auxiliary equipment that is taken out of service. |
| Repository | A nuclear facility where waste is emplaced for disposal. |
| Reprocessing | The process or operation, the purpose of which is to extract radioactive isotopes from used fuel for further use. |
| Short-lived waste | Radioactive waste that does not contain significant levels of radionuclides with half-lives greater than 31 years. Typical characteristics are restricted long-lived radionuclide concentrations (limitation of long-lived radionuclides to 4 000 Bq/g in individual waste packages and to an overall average of 400 Bq/g per waste package). |
| Storage | The holding of used fuel or of radioactive waste in a facility that provides for its containment, with the intention of retrieval. Storage is by definition an interim measure, and the term interim storage would therefore be appropriate only to refer to short-term temporary storage when contrasting this with the longer term fate of the waste. Storage as defined above should not be described as interim storage. |
| Treatment | 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 and change of composition. Treatment may result in an appropriate waste form. |
| Used fuel | Nuclear fuel removed from a reactor following irradiation, which is no longer usable in its present form because of the depletion of fissile material, build-up of poison or radiation damage. Used fuel is not classified as waste unless it is declared as such. Also referred to as spent fuel. |
| Waste | Material in gaseous, liquid or solid form for which no further use is foreseen. |

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| Term | Description |
|---|---|
| Waste acceptance criteria | Quantitative or qualitative criteria specified by the regulatory body, or specified by an operator and approved by the regulatory body, for radioactive waste to be accepted by the operator of a repository for disposal, or by the operator of a storage facility for storage. Waste acceptance requirements might include, for example, restrictions on the activity concentration or the total activity of particular radionuclides (or types of radionuclide) in the waste or requirements concerning the waste form or waste package. |
| Waste characterisation | 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. |
| Waste classification | A method used to group various types of radioactive waste according to their physical characteristics. |
| Waste form | Waste in its physical and chemical form after treatment and/or conditioning (resulting in a solid product) prior to packaging. The waste form is a component of the waste package. |
| Waste processing | Any operation that changes the characteristics of waste, including pre-treatment, treatment and conditioning. |
| Very low level waste | Radioactive waste considered suitable by the regulatory body for authorised disposal, subject to specified conditions, with ordinary waste in facilities not specifically designed for radioactive waste disposal. |

## 2.4 Abbreviations

| Abbreviation | Description |
|---|---|
| ALARA | As Low as Reasonably Achievable |
| APG | Steam Generator Blowdown System |
| ATE | Polishing Plant |
| BA | Tank |
| BATNEEC | Best Available Technology Not Entailing Excessive Cost |
| Bq/g | Becquerel per gram |
| CISF | Centralised Interim Storage Facility |
| CSB | Cask Storage Building |
| DE | Demineraliser |
| HLW | High Level Waste |
| IAEA | International Atomic Energy Agency |
| ICRP | International Commission on Radiological Protection |
| ILW | Intermediate Level Waste |
| LILW-LL | Low and Intermediate Level Waste – Long-Lived |
| LILW-SL | Low and Intermediate Level Waste – Short-Lived |

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| Abbreviation | Description |
|---|---|
| LLW | Low Level Waste |
| LLWB | Low Level Waste Building |
| MWe | Megawatts Electrical Output |
| NAB | Nuclear Auxiliary Buildings |
| NBM | Nuclear Backend Management |
| NCRWM | National Committee on Radioactive Waste Management |
| NCW | Non-Compactable Waste |
| NNR | National Nuclear Regulator |
| NRWDI | National Radioactive Waste Disposal Institute |
| PTR | Reactor Cavity and Spent Fuel Pit Cooling System |
| PWR | Pressurised Water Reactor |
| RCV | Chemical and Volume Control System |
| REA | Reactor Boron and Water Make-up System |
| RCP | Reactor Coolant System |
| RP | Radiation Protection |
| RTP | Reference Technical Plan for Long-Term Used Nuclear Fuel Management |
| SEU | Plant Sewer System |
| SFP | Spent Fuel Pool |
| TEP | Boron Recycle System |
| TES | Solid Waste Treatment System |
| TEU | Liquid Waste Treatment System |
| TISF | Transient Interim Storage Facility |
| WAC | Waste Acceptance Criteria |
| VLLW | Very Low Level Waste |

## 2.5 Roles and Responsibilities

The responsibilities for radioactive waste generators (including Eskom), NRWDI, government and regulators are laid out in the National Radioactive Waste Management Policy and Strategy [2] and summarised in Figure 1.

The Nuclear Backend Management (NBM) section of the Nuclear Fuel functional area is responsible for the development and maintenance of the radioactive waste management plan. NBM is also responsible for the submission of the radioactive waste management plan to the NCRWM.

## 2.6 Process for Monitoring

N/A

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### 2.7 Related/Supporting Documents

N/A

## 3. Radioactive Waste Management Framework

### 3.1 Policy and International Principles

This radioactive waste management plan is predicated on the national policy and strategic principles covered in the Radioactive Waste Management Policy and Strategy for the Republic of South Africa [2] and on the ICRP and IAEA Fundamental Safety Principles [3]. Both the national and IAEA principles provide a commonly understood basis for guiding all activities related to the safe and sustainable management of radioactive waste.

### 3.2 National Legislation

This radioactive waste management plan is further based on a set of applicable legislations that, together with the institutional roles and responsibilities, are enshrined in and elaborated on in the Radioactive Waste Management Policy and Strategy for the Republic of South Africa [2] and the Nuclear Energy Act for the Republic of South Africa [4]. These are:

- Nuclear Energy Act, 1999 (Act No. 46 of 1999);
- National Nuclear Regulator Act, 1999 (Act No. 47 of 1999);
- Hazardous Substances Act, 1973 (Act No. 15 of 1973);
- Mine Health and Safety Act, 1996 (Act No. 29 of 1996);
- Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002);
- National Environmental Management Act, 1998 (Act No. 107 of 1998) ;
- National Water Act, 1998 (Act No. 36 of 1998);
- Dumping at Sea Control Act, 1980 (Act No. 73 of 1980);
- National Road Traffic Act, 1996 (Act No. 93 of 1996); and
- National Radioactive Waste Disposal Institute Act, 2008 (Act No. 53 of 2008).

### 3.3 Disposal Framework

The framework for the disposal of radioactive waste, which is based on the Radioactive Waste Management Policy and Strategy for the Republic of South Africa [2] and the NRWDI Act [5], is illustrated in Figure 1.

In terms of the NRWDI Act, Eskom is responsible for the technical, financial and administrative management of radioactive waste within the national regulatory framework at its premises, as on the Koeberg site, and when such waste is transported to an authorised waste disposal facility, as at the Vaalputs National Radioactive Waste Disposal Facility.

Furthermore, in terms of the Act, Eskom must:

(a) Develop and implement site-specific waste management plans based on national policy;

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(b) Provide all relevant information on radioactive waste as required by the chief executive officer of NRWDI;

(c) Demonstrate compliance with any conditions of a radioactive waste disposal certificate; and

(d) Provide site access to staff of NRWDI for inspection against any conditions of the radioactive waste disposal certificate.

In terms of the Act, Eskom remains responsible for all liabilities in connection with such radioactive waste under its control until such time as the radioactive waste has been received and accepted in writing by NRWDI, following an inspection, at which time liability shall pass to NRWDI.

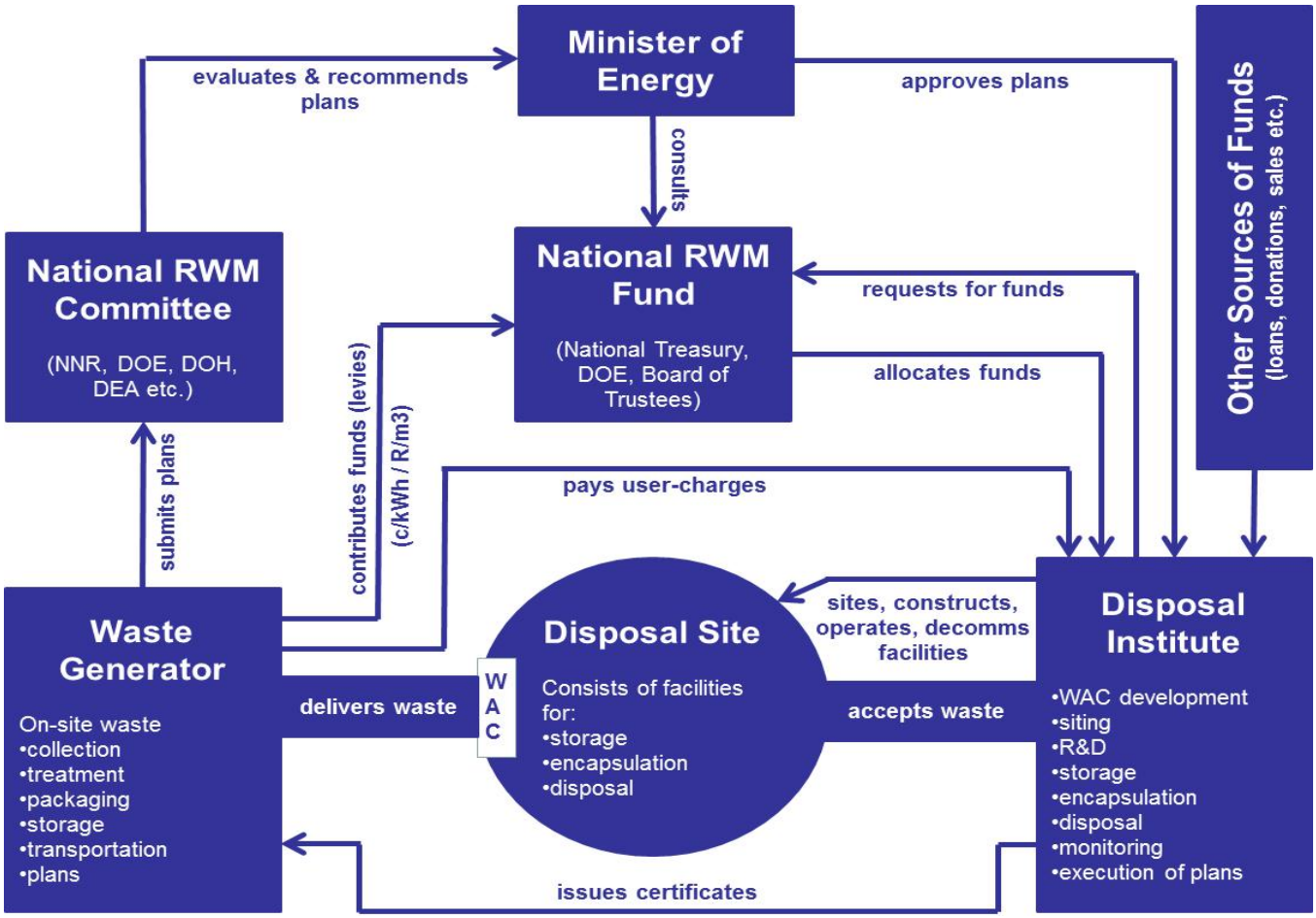


**Figure 1:** Radioactive Waste Disposal Framework

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# 4. Radioactive Waste Classification and Characterisation

Eskom's solid radioactive waste generated by Koeberg is classified as VLLW, LILW-SL and HLW. Large amounts of VLLW are also expected to be generated during the decommissioning of Koeberg in future. This classification is aligned with the national waste classification scheme [2], as shown in Appendix A.

## 4.1 Very Low Level Waste

This waste is contaminated or slightly radioactive material. VLLW is managed and regulated in a manner different from LILW-SL and HLW. Typical waste in this class includes soil, rubble, concrete slabs, polishing plant resin, oil and decommissioning waste with very low levels of activity concentration.

## 4.2 Low and Intermediate Level Waste

LILW is defined as radioactive waste with radiological characteristics between those of exempt waste and high level waste. LILW has activity levels above clearance levels and thermal powers below 2 kW/m$^3$. Low level waste (LLW) contains low levels of beta, gamma and insignificant alpha radionuclides which have low radiotoxicity and insignificant heat output, i.e. trash, plastics and paper. Intermediate level waste (ILW) contains intermediate levels of beta, gamma and alpha radionuclides which have intermediate radiotoxicity and low heat output i.e. spent resins and filter cartridges.

LILW-SL is defined as LILW that does not contain significant levels of radionuclides with half-lives greater than 31 years, typically having restricted long-lived radionuclide concentrations (limitation of long-lived radionuclides to 4 000 Bq/g in individual waste packages and to an overall average of 400 Bq/g per waste package).

LILW-LL is defined as LILW that contains significant levels of radionuclides with half-lives greater than 31 years, with long-lived radionuclide concentrations exceeding limitations for short-lived waste.

## 4.3 High Level Waste

This waste is defined as radioactive liquid containing most of the fission products and actinides present in used fuel (which form the residue from the first solvent extraction cycle in reprocessing) and some of the associated waste streams; this material following solidification; used fuel (if it is declared a waste); or any other waste with similar radiological characteristics. Typical characteristics of HLW are thermal power above 2 kW/m3 and long-lived radionuclide concentrations exceeding the limitations for long-lived waste.

# 5. Radioactive Waste Management Plan Development Methodology

This section establishes the methodology for the evaluation of radioactive waste in order to establish management plans for such waste. The guiding principles and assumptions form the basis for establishing the methodology and plans for Koeberg radioactive waste.

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## 5.1 Guiding Principles

The following principles, as prescribed in the Radioactive Waste Management Policy and Strategy for the Republic of South Africa [2], apply to the management of waste at Koeberg:

- Waste management is aimed at the optimisation of the processes from waste generation to waste disposal
- The hierarchy for the selection of waste management options is as follows:
    - Waste avoidance and minimisation;
    - Waste re-use, reprocessing and recycling;
    - Waste conditioning;
    - Waste storage; and
    - Waste disposal.
- Final disposal is regarded as the ultimate step in the radioactive waste management process, although a step-wise waste management approach is acceptable. The long-term storage of certain types of wastes, e.g. HLW and LLW, 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 in force at that time.
- Radioactive waste management plans shall cover the total life cycle of waste management, from generation to institutional control over closed radioactive waste disposal facilities.
- To minimise the burden on future generations, the decommissioning and closure of facilities should be implemented as soon as practicable.

## 5.2 Assumptions

In order to develop a waste management plan, certain assumptions have to be made regarding disposal endpoints, storage durations, waste acceptance criteria and existing waste management processes.

### 5.2.1 Disposal Endpoints

There are currently still some aspects of waste management on a national as well as Koeberg level that need to be resolved. In order to develop the Eskom Radioactive Waste Management methodology and plans, the following assumptions are made:

- The endpoint for VLLW will be clearance, reuse or authorised disposal in a landfill-type disposal facility. These endpoints are subject to set criteria and levels approved by the regulator.
- The endpoint for LILW-SL will be disposal in a near-surface disposal facility at Vaalputs.

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- An endpoint for HLW has not yet been decided. For the purpose of this document, disposal in a deep geological facility is assumed for this waste category. NRWDI is ultimately responsible for the disposal of high level waste in a deep geological repository. However, until NRWDI accepts the used fuel, Koeberg is responsible for storing the used fuel. According to the National Radioactive Waste Management Policy and Strategy document, on-site storage is not suitable for the long-term storage of this waste class. Interim storage off-site before final disposal will, however, form part of the waste management plan for this waste class.

A summary of disposal endpoints for the waste classes is provided in Table 1. These endpoints will form a basis for developing waste management plans for Koeberg's radioactive waste.

**Table 1:** Disposal endpoints for applicable waste classes.

| Waste Class | Disposal Endpoint | Disposal Facility |
|---|---|---|
| VLLW | Clearance, reuse or authorised disposal in a landfill-type facility. | Landfill-type Disposal Facility |
| LILW-SL | Disposal in a near-surface disposal facility. | Vaalputs National Radioactive Waste Disposal Facility |
| HLW | Disposal in a deep geological repository. | Deep Geological Repository |

### 5.2.2 Storage Duration

All LILW generated at Koeberg is conditioned and temporarily stored in the low level waste building (LLWB) on site until it is transported to Vaalputs according to a predetermined schedule.

It is assumed that used fuel will be disposed of after a minimum storage period of 50 years subsequent to being discharged from the reactors. All used fuel generated at Koeberg is temporarily stored on the Koeberg site. It is assumed that an off-site long-term storage facility for used fuel, the Centralised Interim Storage Facility (CISF), will be made available by 2025. This facility could also serve to store high level waste from the reprocessing of used fuel.

### 5.2.3 Waste Acceptance Criteria

Waste Acceptance Criteria (WAC) have been established for the disposal of LILW at the Vaalputs National Radioactive Waste Disposal Facility [6]. WAC are used to determine the treatment and conditioning process and requirements for waste streams which will form the final waste package for disposal. The WAC for some of the waste especially in situations where endpoints have not yet been decided upon, have not been finalised. Since the WAC dictates the waste treatment and conditioning process, generic WAC are therefore assumed.

### 5.2.4 Existing Waste Management Processes

The existing waste management processes at Koeberg will be regarded as the preferred pre-disposal waste management options for the respective waste categories already defined in this document. This decision, however, will be reviewed as part of the continual improvement programme and the processes will be replaced, modified or adapted as appropriate.

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## 5.3 Radioactive Waste Management Plan Development Process

The Radioactive Waste Management Policy and Strategy for the Republic of South Africa [2] proposes the use of the Best Available Technology Not Entailing Excessive Cost (BATNEEC) process to evaluate waste management options. The methodology to be applied when developing Koeberg radioactive waste management plans is illustrated in Figure 2, and is stipulated in the Eskom Standard 238-51 [7] as follows:

- Identification, collection and segregation of waste streams;
- Classification and categorisation of waste streams;
- Identification of waste management options;
- Evaluation of the different waste management options in terms of cost-effectiveness, technological benefits, safety, as well as social and environmental sustainability;
- Selection of the waste management option;
- Development of waste management plans via consultation;
- Submission of waste management plans to institutional organisation;
- Approval of waste management plans; and
- Implementation of plans via the regulatory processes.

The options for the management and disposal of each waste category must be evaluated in a systematic way as a multi-attribute analysis. The criteria set out in Table 2 will be used for evaluating radioactive waste management options. The outcome of the multi-attribute analysis will be regarded as BATNEEC. The development and approval of the radioactive waste management plans will require consultation with the public through public safety information forums. Once the plans have been approved by the Minister of Energy, they will be implemented through the regulatory processes.

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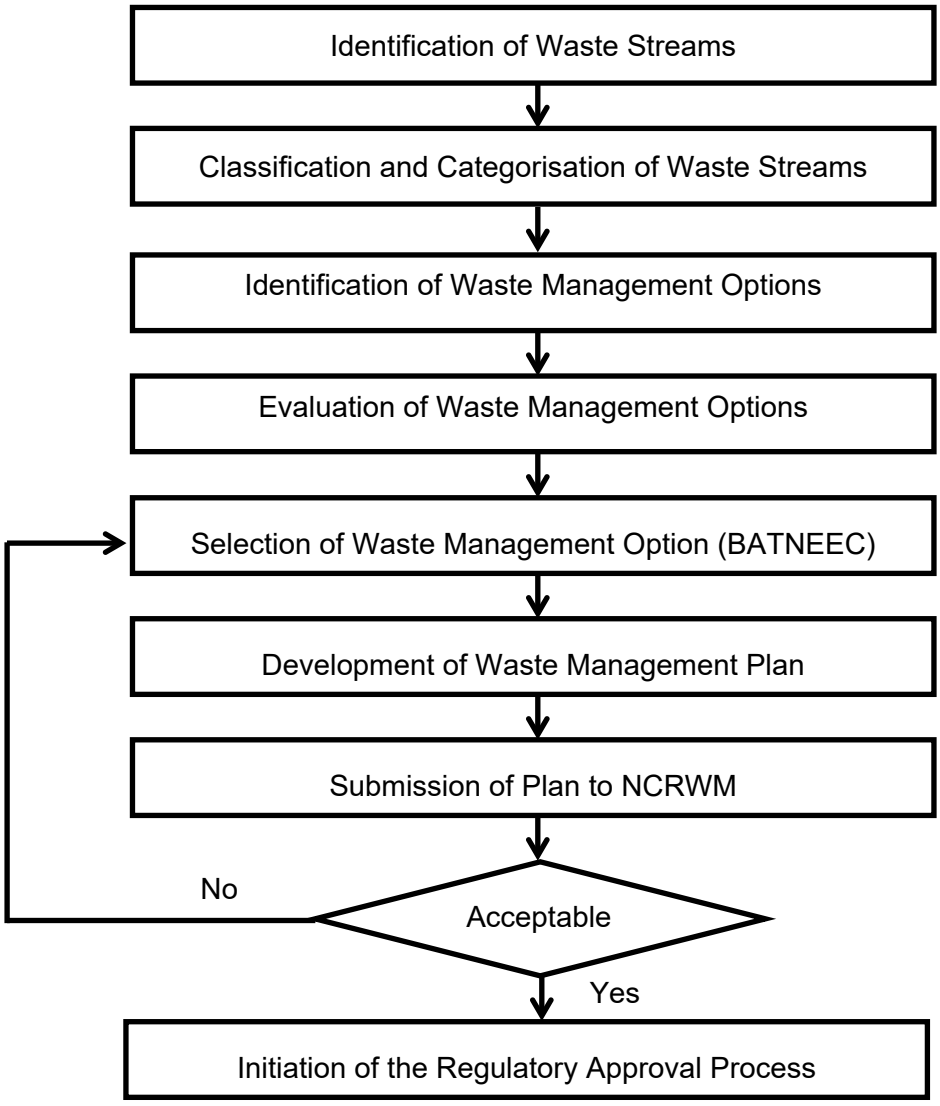


**Figure 2:** The Radioactive Waste Management Plan Development Process

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**Table 2:** Evaluation criteria for radioactive waste management options

| Element | | Sub-element | |
|---|---|---|---|
| A | Cost effectiveness | A1 | Life cycle cost of waste |
| B | Technological status / benefit | B1 | Existing or new technology |
| | | B2 | International practice |
| | | B3 | Waste prevention potential |
| | | B4 | Waste minimisation potential |
| | | B5 | Waste quality |
| | | B6 | Regulatory implications |
| C | Safety | C1 | Worker safety impact |
| | | C2 | Public safety impact (operational) |
| | | C3 | Transport minimisation / prevention |
| | | C4 | Accident risk |
| | | C5 | ALARA |
| D | Social and environmental sustainability | D1 | Public safety impact (long term) |
| | | D2 | Perceived risk and social acceptability |
| | | D3 | Benefit to the community in relation to the "no action" option |
| | | D4 | Environmental impact |
| | | D5 | Continual improvement potential |

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## 6. Eskom Radioactive Waste Management System

The design basis of the radioactive waste processing systems is described in the Koeberg Safety Analysis Report [8]. The Eskom Standard 238-51 [7] provides the requirements for managing radioactive waste in alignment with the National Radioactive Waste Management Policy and Strategy and sound waste management practices. The principles of waste prevention and waste minimisation are of utmost importance in the overall Koeberg waste management system. These principles are entrenched in every step of the waste management process, from the point of operation to the decisions on the options for the management of different waste categories.

Radioactive waste is managed, collected, handled, treated, conditioned, transported, stored and disposed of in accordance with the requirements prescribed in the Eskom Standard 238-51 [7]. The activity and volumes of radioactive waste generated from Koeberg are kept to the minimum practicable. Process waste, maintenance waste, project waste, plant decommissioning waste and used fuel generated by Koeberg are grouped as follows:

- **Very Low Level Waste**: contaminated or slightly radioactive material originating from decommissioning activities. Clearance, reuse or authorised disposal of the waste will depend on the set criteria and levels approved by the National Nuclear Regulator (NNR).
- **Compactable waste (LILW-SL)**: this grouping allows for treatment through volume reduction and conditioning for regulated disposal at Vaalputs.
- **Non-compactable waste (NCW) (LILW-SL)**: waste that cannot be compressed but can be treated by other means and conditioned for regulated disposal at Vaalputs.
- **Wet waste (LILW-SL)**: waste requiring immobilisation and conditioning for regulated disposal at Vaalputs.
- **Large Equipment (LILW-SL)**: waste including decommissioned scrap equipment and reactor components that cannot be compacted into packages and for which there is no established WAC.
- **High Level Waste**: waste to be conditioned for regulated deep geological disposal and managed according to a stepwise process which includes long-term storage until such time that a final disposal facility is available.

The groupings for Koeberg radioactive waste are illustrated in Figure 3 and managed according to the matrix provided in Table 3. For the purpose of this plan, it is assumed that used fuel will be declared as waste, this being the most conservative option from a waste management perspective. Sections 9, 10, 11 and 12 outline the plans for managing the different waste groups.

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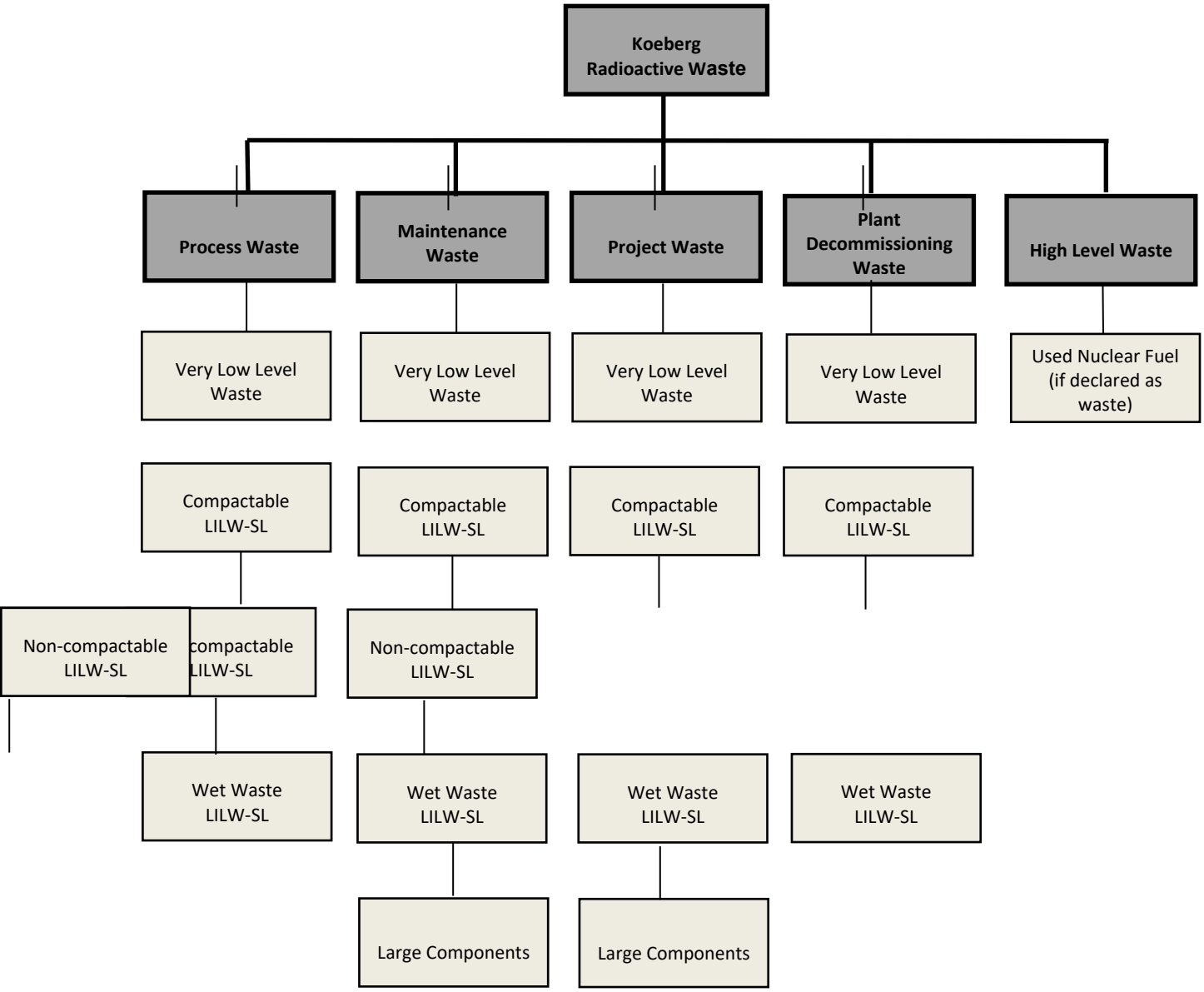


**Figure 3:** Koeberg radioactive waste groups.

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**Table 3:** Waste management processes for identified waste groups

| Waste Stream/Group | Management Option | Treatment Required | Treatment Process Exists at Koeberg | Treatment Methodology | Conditioning Required | Disposal Endpoint |
|---|---|---|---|---|---|---|
| Very Low Level Waste | Clearance, Reuse or Authorised Disposal or Regulated Disposal | Yes | Yes | Depends on waste stream | Depends on waste stream. | Clearance or Authorised Disposal or Regulated Disposal |
| Compactable Waste LILW-SL | Regulated Disposal | Yes | Yes | Volume reduction | Yes | Vaalputs |
| Non-compactable Waste LILW-SL | Regulated Disposal | Yes | No | Depends on waste stream | Yes | Vaalputs |
| Wet Waste LILW-SL | Regulated Disposal | Yes | Yes | Immobilisation | Yes | Vaalputs |
| High Level Waste | Regulated storage/disposal | No | N/A | N/A | Yes (to be developed) | Deep Geological Repository |

## 7. Plan for Managing Process Waste

As mentioned in Section 7.2.4, it is assumed that the existing radioactive waste management processes are regarded as the preferred pre-disposal waste management options. The plan for the management of Koeberg process waste is outlined in this section and summarised in Appendix E.

### 7.1 Identification, Classification and Characterisation of Waste

The different streams for Koeberg process waste are shown in Figure 4.

Solid radioactive waste is surveyed before packaging and is thus categorised according to the activity and dose rate in order to be placed in the appropriate container. This waste is classified according to [2].

### 7.2 Collection and Treatment of VLLW

A certain amount of VLLW is produced from Koeberg, i.e. plant sewer system (SEU) sludge, oil and polishing plant resin. The handling of this waste is dealt with in accordance with [17] as far as possible, in order to keep radioactive waste volumes ALARA. A summary of the collection and treatment is provided in this section and tabulated in Appendix E.

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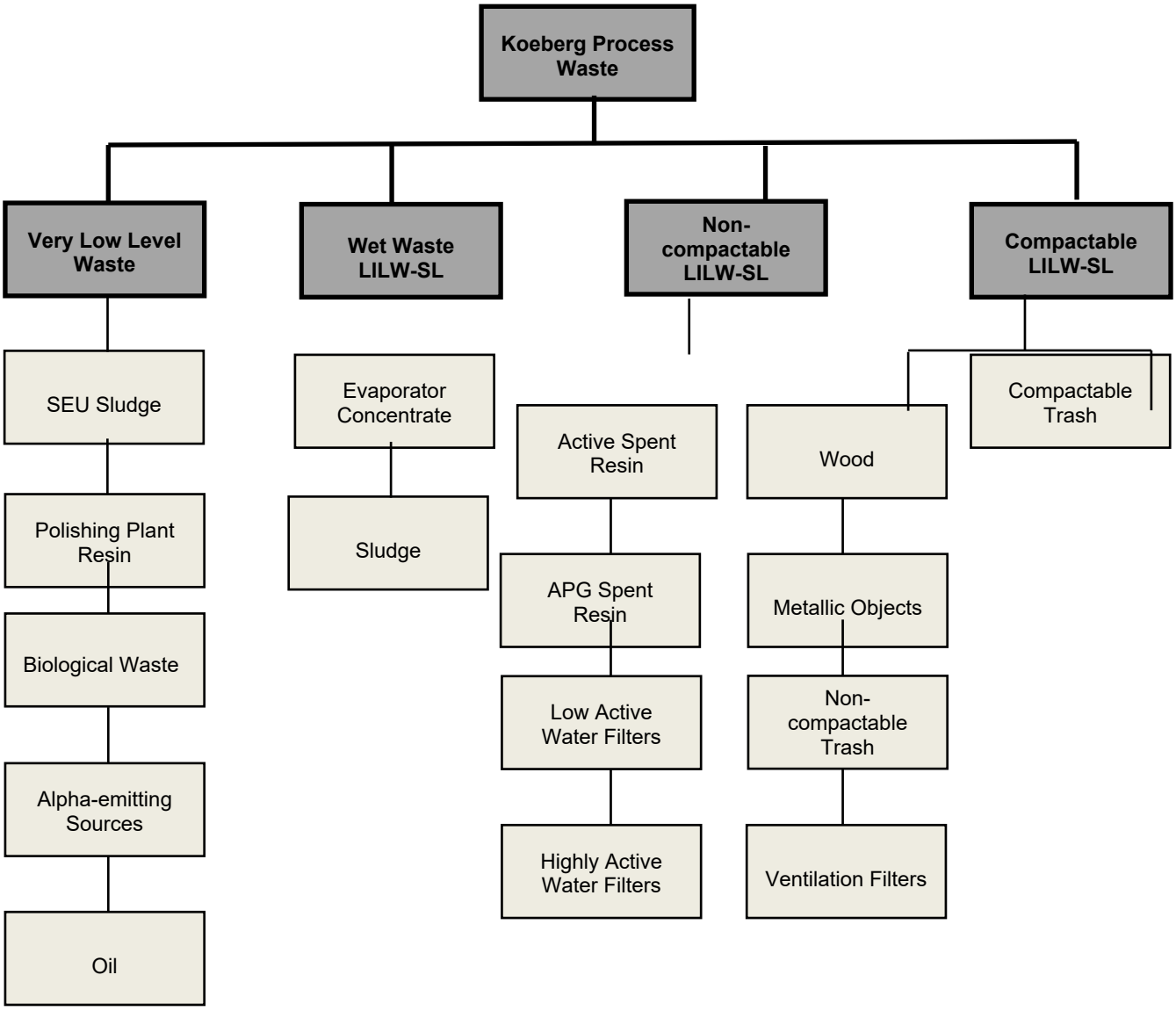


**Figure 4:** Identification, classification and characterisation of process waste streams.

### 7.2.1 SEU Sludge

SEU sludge is collected from SEU tanks and dried on a sand bed before being placed in steel drums. This waste is then stored in steel drums in the LLWB for decay until it is cleared for disposal in a landfill. Dried sludge was sent to Vaalputs in the past as part of a once-off approval for a number of drums.

### 7.2.2 Polishing Plant Resin

The waste originates from ATE resin tanks and is placed in steel drums. The waste drums are intermediately stored in the LLWB for decay and clearance or until they are shipped for disposal at Vaalputs.

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### 7.2.3 Oil

Oil is collected from various plant components in controlled zones and then stored in collection tanks. Once the sediment has settled at the bottom of the tank, the oil is then filtered and disposed of as conventional waste. The sediment is then allowed to decay in the collection tanks.

### 7.2.4 Biological Waste

Dead birds and animals are collected from controlled zones and placed in steel drums to allow for decay. No disposal end-point has been established for biological waste. NRWDI will set the WAC for accepting biological waste at Vaalputs.

### 7.2.5 Alpha-Emitting Sources

Fire detectors are collected from various locations and then dismantled to remove the alpha-emitting sources. The sources are placed in steel drums and stored at N040. There is currently no disposal path for the sources. NRWDI will set the WAC for accepting sources at Vaalputs.

## 7.3 Collection and Treatment of LILW-SL

### 7.3.1 Active Spent Resin

Active spent resins originate from the water demineralisation and clean-up of systems linked to the primary and auxiliary systems, i.e. RCV, TEP, and PTR. The activity on active spent resins is expected to be high owing to their close link to the RCP system. Collection and storage of the resin will be in either of the two resin holding tanks (9 TES 002 & 003 BA), depending on the activity and/or system origin.

Active spent resins are treated by encapsulation into concrete drums (C1 and C2). The type of drum to be used depends on the activity of the resin to be drummed. For dose rates < 2 mSv/h, treatment is through encapsulation of the resin into C1 concrete drums. For dose rates ≥ 2 mSv/h, treatment is through encapsulation of the resin into C2 concrete drums. During the drumming of active resin, the two resin holding tanks are intermixed into a mixing pot, concentrating the active resin into C1 drums and diluting the active resin into C2 drums to optimise the volume of active resin while maintaining the surface contact dose rates below 2 mSv/h. The drums are then kept in the plant for the mix to set before a clean layer of concrete is poured to cap the drum. After the capping has set, the drums are moved to the intermediate storage area (LLWB) before they are shipped for final disposal.

### 7.3.2 APG Spent Resin

APG resins originate from the demineralisation of the steam generator blow-down system (APG). Resins that have traces of radioactivity in excess of the clearance levels are classified as radioactive waste. The resins are collected into the holding tank 9 TES 011 BA and kept to drain before the tank is emptied into 210-litre metal drums. The drums are layered with vermiculite to absorb excess moisture. Although highly unlikely, APG resin that is found to contain high activity will result in alternative containers being considered. After encapsulation, the metal drums are moved to the intermediate storage area (LLWB) before they are shipped to the disposal facility.

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### 7.3.3 Evaporator Concentrate

Evaporator concentrate originates from the TEU evaporator loop, resulting from liquid waste effluent treatment in the TEU system. Evaporator loop concentrate is collected and stored in a holding tank (9 TES 001 BA). The pre-requirement is a boron concentration of 50 000 ppm.

For all dose rates, the pre-treatment is to keep the temperature at an average of 60 °C until drumming, in order to prevent the crystallisation of the high-concentration boron fluid. Elevated temperatures will cause excessive steaming and lead to the thermal expansion of the waste package. The evaporator concentrate is then encapsulated in a C1 or C2 concrete drum. The evaporator concentrate is temporarily stored in the plant after encapsulation and intermediately stored in the LLWB until it is shipped to the disposal facility.

### 7.3.4 Low Active Water Filters

This waste originates from the low active water circuits (e.g. TEU, REA, TEP and APG). These filters are either changed-out on a high delta pressure across the filter, high dose rate or on time-in-service.

For dose rates < 15 mSv/h on the filter housing, more radiological surveillance is required to assess or indicate whether change-out by hand would be feasible. The filters are encapsulated in concrete inside C1 or C4 concrete drums.

### 7.3.5 Highly-Active Water Filters

The sources of this waste are the systems that are directly linked to the primary system (RCP) (e.g. RCV & PTR). The radioactive water filters are changed-out when a high delta pressure across the filter is observed, when a high dose on the filter is recorded or on time-in-service.

For dose rates < 500 mSv/h, radiological surveillance is required to assess or indicate the change-out methods to be used. Change-out is either by hand or chateaux (leaded inverted U-tube). The waste is then encapsulated in concrete and packaged in C4 concrete drums. The waste is temporarily stored in the plant after encapsulation and, following capping and setting of the cap, stored in the LLWB until it is shipped for disposal.

For dose rates ≥ 500 mSv/h on the filter housing, radiological surveillance is required to assess the change-out method to be used (by hand or by chateaux). The waste is then encapsulated in concrete and packaged in C2F concrete drums, which provide more shielding. The waste is temporarily stored in the plant after encapsulation and intermediately stored in the LLWB until it is shipped for disposal.

### 7.3.6 Ventilation Filters

Ventilation filters are collected during replacement. The particulate and iodine filters are intermediately stored in the LLWB to allow for decay before final disposal.

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### 7.3.7 Metallic Objects

The waste ranges from contaminated metallic objects, metal plates, piping, pumps, spares, valves, etc. Collection points are the NAB and Decontamination Workshop. A pre-requirement is that objects have to be opened to allow the free flow of the wet-mix cement to fill all voids and metal bars, or flat plating has to be cut to size in order to optimise drum capacity.

For dose rates < 2 mSv/h, the waste is treated as NCW and is placed in a 210-litre steel drum. For dose rates ≥ 2 mSv/h, the waste is decontaminated as a first option. The second option is to cut the waste to size in order to optimise the drum capacity. This is done in accordance with ALARA principles. Objects are required to be open-ended and allowed to be mixed with other NCW objects. After treatment, no voids are allowed to be present. The waste is then treated as NCW and is packaged in a C1 or C2 concrete drum. The drum is then temporarily stored in the plant after encapsulation and intermediately stored in the LLWB until it is shipped for disposal.

### 7.3.8 Sludge

Sludge is collected in liquid waste holding tanks (TEU, TEP and REA tanks) and is recovered during the cleaning of tanks. The sludge is allowed to settle and then transferred to C1 concrete drums before being temporarily stored in room N030. The sludge is required to be preserved or kept in water or liquid form for ease of treatment or further conditioning. For all dose rates, the pre-treatment is for the sludge to be transferred from storage containers into a C1 concrete drum. The sludge is then encapsulated in concrete and packaged in a C1 concrete drum. The drum is temporarily stored in the plant after encapsulation and intermediately stored in the LLWB until it is shipped for disposal.

### 7.3.9 Wood

This waste includes uncovered/untreated and contaminated wood collected or stored in the Radiological Control Zones if usage in a controlled zone is unavoidable. The waste volume is kept to a minimum and is required to be removed from the Radiological Controlled Zones (Decontamination Workshop, NAB, LLWB and MMPS Workshop). The use of wood is kept to a minimum through RP control and use of specific scaffolding materials not including wood, as well as removing wooden and other packaging materials before movement into the controlled zone.

The pre-treatment of wood requires cutting to size to optimize drum capacity and then it is encapsulated in concrete drums with concrete for high active wood pieces and in steel drums immobilised with vermiculite in steel drums. The waste in concrete drums is temporarily stored in the plant for concrete setting and then transferred to the LLWB until they are shipped for disposal. Steel drums are transferred to the LLWB right after encapsulation and stored until they are shipped for disposal.

### 7.3.10 Trash

Dry or compactable radioactively contaminated materials (e.g. cloths, plastic products, rubber products, and paper) are all types of miscellaneous waste. The RP decontamination team collects the waste from different work sites or step-off pads inside the NAB and other Radiological Controlled Zones. No metal pieces, pressurised containers, grease, oil or fluorescent tubes are allowed to be disposed of in yellow bags for treatment at the TES compacting station.

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Trash with contact dose rates below 2 mSv/h is compacted into steel drums, layered with vermiculite and transferred to the LLW for intermediate storage until it is shipped for disposal.

Trash that cannot be compacted due to the nature of material and trash with contact dose rates above 2 mSv/h is drummed and solidified in concrete drums. The concrete drums are kept in the plant for concrete setting and thereafter transferred to the LLWB until they are sent for disposal at the disposal facility.

### 7.4 Conditioning and Storage

In order to meet the transport and disposal requirements as per Vaalputs WAC [6] and approval process for waste containers [9], the processing of the waste must be such that the packaging meets the requirements of the Eskom Standard 238-54 [10] and 238-51 [7]. The waste containers are manufactured and type tested as required by the IAEA transport regulations [11] and outlined in the documents DSG-318-003 [12] and DSG-318-011 [13] for concrete drums, as well as DSG-314-238 [14] and DSG-318-002 [15] for metal drums.

Process waste is temporarily stored in the LLWB at Koeberg. Quantities of process waste generated at Koeberg are provided in Appendices B and C. The types of drums, contents and volumes used for the conditioning of process waste are presented in Appendix D.

### 7.5 Transport

Process waste is transported from Koeberg in accordance with the IAEA transport regulations [11].

### 7.6 Disposal

Process waste from Koeberg complies with the WAC for Vaalputs [6] and is disposed of at Vaalputs.

## 8. Plan for Managing Maintenance Waste

Maintenance waste that already meets the established WAC is managed in the same manner as stipulated in the plans for managing process waste (see Section 9 and Appendix E).

Concrete slabs are collected from various areas in the plant. The concrete can be scaled to reduce size before placement in steel drums. The waste drums are intermediately stored in the LLWB until they are shipped for disposal at Vaalputs.

Contaminated asbestos is collected from buildings and old structures during refurbishments. The asbestos is wiped to remove surface contamination and wrapped in plastic before placing them in steel drums. The asbestos is handled only by trained asbestos handlers. There is no disposal end-point for the contaminated asbestos yet. The asbestos is stored in the LLWB to allow for decay. NRWDI will establish WAC for accepting contaminated asbestos as waste.

The management of other maintenance waste not meeting the existing WAC will depend on the waste stream. Detailed plans for the maintenance wastes will be developed based on the methodology described in this document.

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## 9. Plan for Managing Project Waste

Project waste that already meets the established WAC is managed in the same manner as stipulated in the plans for managing process waste (see Section 9 and Appendix E).

The management of project waste not meeting the existing WAC will depend on the establishment of the work. Detailed plans for the project wastes will be developed based on the methodology described in this document.

## 10. Plan for Managing Decommissioning Waste

Large volumes of waste are expected to be generated from the decommissioning of Koeberg after shutdown. The actual quantities of such waste will be determined by the plant decommissioning plan. A decommissioning waste management plan will be developed based on the plant decommissioning plan and the radioactive waste management methodology described in this document.

## 11. Plan for Managing High Level Waste

The Reference Technical Plan for Long-Term Used Nuclear Fuel Management (RTP) [16] provides a detailed plan for the management of Koeberg used fuel. In the reference plan, it is assumed that the used fuel will be declared as waste and disposed of in a deep geological repository.

The RTP makes provision for the entire inventory of Koeberg used fuel for both the 40-year and 60-year life-of-plant scenarios. The plan consists of the following sequential elements:

- Store used fuel, which has just been discharged from the reactors, in SFPs at the fuel building to allow for cooling for at least 10 years.
- Store some of the used fuel that is more than 10 years old in the cask storage building (CSB) and the Transient Interim Storage Facility (TISF) on Koeberg site to recover storage capacity in the SFPs.
- Store all used fuel further at the off-site CISF until it is ready for disposal.
- Encapsulate all used fuel in an encapsulation facility and simultaneously dispose of it in a deep geological repository.

Alternative used fuel management options, e.g. reprocessing, are continually investigated in accordance with the national Radioactive Waste Management Policy requirements [2], and will be implemented if and when required.

## 12. Acceptance

This document has been seen and accepted by:

| Name | Designation or Business Area |
|---|---|
| T Karsten | Radiation Protection |
| C Le Roux | Radioactive Waste Management |
| K Makhothe | Plant Engineering |
| J Nzimande | Nuclear Projects |
| X Motlhale | Nuclear Projects |

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| Name | Designation or Business Area |
|---|---|
| R Lavelot | Nuclear Projects |
| D Jeannes | Nuclear Environmental Manager |

## 13. Revisions

| Date | Rev. | Compiler | Remarks |
|---|---|---|---|
| June 2020 | 1 | P Thauge | Document updated as per three-year review cycle. Information contained in the document remains the same (as accepted by NRWDI, the NNR and the Minister of Energy). Changes made to the document are:<br>• Definition of short-lived waste changed to 31 years instead of 30 years in line with [2].<br>• Definition of HLW updated to be in line with [2].<br>• References were updated.<br>• Waste inventories up to March 2020 were included in this revision. |
| September 2016 | 0 | P Thauge | New document to specify the solid radioactive waste management plan for Koeberg. |

## 14. Development Team

The following people were involved in the development of this document:

| Name | Designation or Business Area |
|---|---|
| P Thauge | Nuclear Back-End Management |
| M Minnaar | Radiation Protection |

## 15. Record Keeping

Records are kept of all relevant aspects of the generation, control and storage of radioactive waste as per [7].

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## Appendix A: National Radioactive Waste Classification Scheme

| Waste Class | Waste Description | Waste Type/ Origin | Waste Criteria | Generic Waste Treatment/ Conditioning Requirements | Disposal/ Management Options |
|---|---|---|---|---|---|
| HLW | Heat generating<br>Radioactive waste with high long and short-lived radionuclide concentrations. | 1 Used fuel declared as waste or used fuel recycling products<br>2 Sealed sources | 1 Thermal power > 2 kW/m$^3$<br>OR<br>2 Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels > levels specified for LILW-LL<br>OR<br>3 Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels that could result in an inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) above 100 mSv per annum | 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 | (a) Regulated deep disposal (100's of metres).<br>(b) Reprocessing, conditioning and recycling<br>(c) Long-term above ground storage |
| LILW-LL | Radioactive waste with low or intermediate short- | 1 Irradiated uranium (isotope production) | 1 Thermal power (mainly due to short-lived radio | Waste package suitable for handling, transport and storage (storage | 1 Regulated medium depth disposal (10s of |

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| Waste Class | Waste Description | Waste Type/ Origin | Waste Criteria | Generic Waste Treatment/ Conditioning Requirements | Disposal/ Management Options |
|---|---|---|---|---|---|
| | lived radionuclide and intermediate long-lived radionuclide concentrations. | 2 Un-irradiated uranium (nuclear fuel production)<br><br>3 Fission and activation products (nuclear power generation and isotope production)<br><br>4 Sealed sources | nuclides<br>(T ½ < 31 y) < 2 kW/m$^3$)<br>AND<br>2 Long-lived radio nuclides (T ½ > 31 y) concentrations.<br>Alpha: < 4000 Bq/g<br>Beta and gamma:<br>< 40000 Bq/g<br>(Maximum per waste package up to 10x the concentration levels specified above)<br>OR<br>3 Long-lived alpha, beta and gamma emitting radionuclides at activity concentration levels that could result in an inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) between 10 and 100 mSv per annum | period in the order of 50 years). The waste form shall be solid with additional characteristics as for a specific repository | metres).<br><br>2 Managed as NORM-E waste (un-irradiated uranium) |

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| Waste Class | Waste Description | Waste Type/ Origin | Waste Criteria | Generic Waste Treatment/ Conditioning<br>Requirements | Disposal/ Management Options |
|---|---|---|---|---|---|
| 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)<br><br>2 Fission and activation products (nuclear power generation and isotope production)<br><br>3 Sealed sources | 1 Thermal power (mainly due to short-lived radionuclides (T ½ < 31 y) < 2 kW/m$^3$<br><br>AND<br><br>2 Long-lived radionuclide (T ½ > 31 y) concentrations.<br><br>Alpha: < 400 Bq/g<br><br>Beta and gamma:<br><br>< 4000 Bq/g<br><br>(Maximum per waste package up to 10x the concentration levels specified above)<br><br>OR<br><br>3 Long-lived alpha, beta and gamma-emitting radionuclides at activity concentration levels that could result in an inherent intrusion dose (the intrusion dose assuming the radioactive waste is spread on the surface) | 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)<br><br>2 Managed as NORM-E waste (un-irradiated uranium) |

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| Waste Class | Waste Description | Waste Type/ Origin | Waste Criteria | Generic Waste Treatment/ Conditioning Requirements | Disposal/ Management Options |
|---|---|---|---|---|---|
| | | | below 10 mSv per annum | | |
| VLLW | Radioactive waste containing a very low concentration of radioactivity | Contaminated or slightly radioactive material originating from operation and decommissioning activities | Clearance or authorised discharge or reuse criteria and levels approved by the relevant regulator | Waste stream specific requirements and conditions | 1 Clearance<br>2 Authorised disposal, discharge or reuse |
| NORM-L (low activity) | Potential radioactive waste containing low concentrations of NORM | 1 Mining and minerals processing<br>2 Fossil fuel electricity generation<br>3 Bulk waste: un-irradiated uranium (nuclear fuel production) | Long-lived radio nuclide concentration: < 100 Bq/g | Unpackaged waste in a miscible waste form | 1 Re-use as underground backfill material in an underground area<br>2 Extraction of any economically recoverable minerals, followed by disposal in any mine tailings dam or other sufficiently confined surface impoundment<br>3 Authorised disposal<br>4 Clearance |
| NORM-E (enhanced activity) | Radioactive waste containing enhanced concentrations of NORM | 1 Scales<br>2 Soils contaminated with scales | Long-lived radionuclide concentration: > 100 Bq/g. | Packaged or unpackaged waste in a miscible or solid form with additional characteristics for a | 1 Dilute and re-use as underground backfill material in an identified underground area |

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| Waste Class | Waste Description | Waste Type/ Origin | Waste Criteria | Generic Waste Treatment/ Conditioning Requirements | Disposal/ Management Options |
|---|---|---|---|---|---|
| | | | | specific repository | 2 Extraction of any economically recoverable minerals, followed by dilution and disposal in an identified mine tailings dam or other sufficiently confined surface impoundment<br>3 Regulated deep or medium depth disposal |

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## Appendix B: Summary of Koeberg Nuclear Power Station Radioactive Waste Drums Produced

| | Concentrate | | Resin | | Filter | | NCW | | Sludge | Metal Drums | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of drum | C1 | C2 | C1 | C2 | C2F | C4 | C1 | C2 | C1 | Trash | Resins | Charcoal | Other |
| Total drums produced March 1984 – April 2016 | 2 776 | 5 | 706 | 589 | 237 | 192 | 453 | 1 | 13 | 15 308 | 5 296 | 12 | 640 |
| Total drums shipped March 1984 – April 2016 | 2 619 | 5 | 441 | 267 | 143 | 138 | 367 | 0 | 8 | 14 687 | 5 001 | 12 | 47 |
| Total drums in intermediate storage at Koeberg – April 2016 | 157 | 0 | 265 | 322 | 94 | 54 | 86 | 1 | 5 | 621 | 295 | 0 | 593 |

| | Concentrate | | Resin | | Filter | | NCW | | Sludge | Metal Drums | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type of drum | C1 | C2 | C1 | C2 | C2F | C4 | C1 | C2 | C1 | Trash | Resins | Charcoal | Other |
| Total drums produced March1984 – March 2020* | 2 903 | 5 | 717 | 651 | 315 | 218 | 474 | 1 | 15 | 17 028 | 6 816 | 12 | 1 068 |
| Total drums shipped March1984 – March 2020* | 2 619 | 5 | 441 | 267 | 143 | 138 | 386 | 0 | 8 | 16 092 | 5 241 | 12 | 47 |
| Total drums in intermediate storage at Koeberg – March 2020* | 284 | 0 | 276 | 384 | 172 | 80 | 88 | 1 | 7 | 936 | 1 575 | 0 | 1 021 |

*Updated values since the first issue of the Solid Radioactive Waste Management Plan.

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## Appendix C: Summary of Koeberg Nuclear Power Station Radioactive Waste Volumes Produced

| | Concrete Drum | | Metal Drum | |
|---|---|---|---|---|
| Type of drum | Volume ($m^3$) | Capacity ($m^3$) | Volume ($m^3$) | Capacity ($m^3$) |
| Total volume produced ($m^3$) March 1984 – April 2016 | 1 505.220 | 3 398.260 | 3 392.200 | 4 463.760 |
| Total volume shipped ($m^3$) March 1984 – April 2016 | 1 274.962 | 2 841.596 | 3 118.780 | 4 146.870 |
| Total volume in intermediate storage at Koeberg ($m^3$) – April 2016 | 230.258 | 556.664 | 273.420 | 316.890 |

| | Concrete Drum | | Metal Drum | |
|---|---|---|---|---|
| Type of drum | Volume ($m^3$) | Capacity ($m^3$) | Volume ($m^3$) | Capacity ($m^3$) |
| Total volume produced ($m^3$) March 1984 – March 2020* | 1 577.772 | 3 583.256 | 4 042.080 | 5 234.040 |
| Total volume shipped ($m^3$) March 1984 – March 2020* | 1 284.652 | 2 856.188 | 3 365.880 | 4 492.320 |
| Total volume in intermediate storage at Koeberg ($m^3$) – March 2020* | 293.120 | 727.068 | 676.200 | 741.720 |

*Updated values since the first issue of the Koeberg Solid Radioactive Waste Management Plan.

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## Appendix D: Types of Koeberg Nuclear Power Station Drums, Contents and Active Volumes

| CONCENTRATES | | |
|---|---|---|
| DRUM TYPE | VOLUME ($m^3$) | VOLUME (litres) |
| C1 | 0.342 | 342 |
| **RESINS AND FILTERS** | | |
| DRUM TYPE | VOLUME ($m^3$) | VOLUME (litres) |
| C1 | 0.298 | 298 |
| C2 | 0.128 | 128 |
| C3 | 0.043 | 43 |
| C2F | 0.042 | 42 |
| C4 | 0.123 | 123 |
| **NCW** | | |
| DRUM TYPE | VOLUME ($m^3$) | VOLUME (litres) |
| C1 | 0.510 | 510 |
| **METAL DRUMS** | | |
| DRUM TYPE | VOLUME ($m^3$) | VOLUME (litres) |
| Trash | 0.140 | 140 |
| Resins | 0.210 | 210 |
| **SLUDGE** | | |
| DRUM TYPE | VOLUME ($m^3$) | VOLUME (litres) |
| C1 | 0.360 | 360 |

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## Appendix E: Summary of the Koeberg Nuclear Power Station Waste Management Plan

| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| VLLW | SEU Sludge | Sludge collected from SEU tanks. | SEU tanks | Dried on a sand bed. | The dried sludge is placed in steel drums. | Intermediately stored in the LLWB for decay until clearance. | Landfill-type |
| VLLW | Oil | Various plant components. | Controlled zones | Stored in collection tanks. Sediment settles at the bottom of the tank. Oil is filtered and disposed of as conventional waste. | Stored in collection tanks. | Intermediately stored in the LLWB. | Landfill-type: oil is cleared as conventional waste and sediment is stored for decay. |
| VLLW | Polishing Plant Resin | ATE | Resin tanks | None | The resins are placed in steel drums. | Intermediately stored in the LLWB until clearance or disposal. | Decay for clearance or disposal at Vaalputs. |
| VLLW | Concrete Slabs | Various areas | | Concrete could be scaled to reduce size. | The concrete slabs are placed in steel drums. | Intermediately stored in the LLWB until disposal. | Vaalputs |
| VLLW | Contaminated Asbestos | Buildings/old structures | Collected during refurbishment. | Wiped to remove surface contamination | The contaminated asbestos is placed in steel drums. | Intermediately stored in the LLWB. | No disposal end-point yet. Waste is stored for |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| | | | | (done by trained asbestos handlers) and wrapped in plastic. | | | decay. NRWDI to establish criteria for disposal at Vaalputs. |
| VLLW | Alpha-emitting Sources | Fire detectors | Various locations. | Dismantle and remove source. | Placed in steel drums. | N040 | No disposal end-point yet. NRWDI to establish criteria for disposal at Vaalputs. |
| VLLW | Biological Waste | Dead birds and animals found inside controlled zones. | Controlled zones. | None | Placed in steel drums. | Intermediately stored in the LLWB. | No disposal end-point yet. The waste is stored to allow for decay. NRWDI to establish criteria for disposal at Vaalputs. |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Active Spent Resin | Water filtration and clean-up systems linked to the primary and auxiliary systems, i.e. RCV, TEP, PTR. | Transfer and store radioactive resin in resin holding tanks 9 TES 002 & 003 BA | Depending on the activity or system origin the spent resin is transferred and stored in the two tanks respectively. | Dose rates < 2 mSv/h: Encapsulated in cement inside C1 concrete drum.<br>Dose rates ≥ 2 mSv/h: Encapsulated in cement inside C2 concrete drum. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |
| LILW-SL | APG Spent Resin | 1 & 2 APG Demineralisers | Transferred and stored in portable holding tank 9 TES 011 BA. | Dose rates < 2 mSv/h: After transfer into the portable tank, resin to be drained for at least 24 hours before being transferred for further treatment or conditioning. | Dose rates < 2 mSv/h: Resin is transferred and sealed in 210-litre steel drums.<br>Spent resins are layered with vermiculite to absorb excess moisture. | Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Evaporator Concentrate | TEU Evaporator loop, resulting from liquid waste (effluent) treatment in the TEU-system. | Transfer and store the evaporator loop concentration in holding tank 9 TES 001 BA. | Boron concentration of 50 000 ppm.<br>Temperature < 60°C until encapsulation (maintain 60°C average). | Encapsulated in cement inside C1 or C2 concrete drum. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Trash | Dry or combustible radioactively contaminated materials (e.g. cloths, plastic products, rubber products, and paper) | Controlled zones. | No metal pieces, pressurised containers, grease, oil or fluorescent tubes are allowed to be disposed of in yellow bags for treatment at the TES compacting station.<br>Dose rates < 2 mSv/h: Radiation worker will segregate materials at the work-site inside a controlled zone before disposal.<br>Dose rates ≥ 2 mSv/h: Bagged waste is placed into a C1 concrete drum inside a temporary storage area in the plant. | Dose rates < 2 mSv/h: Dry waste is compacted into 210 litre steel drums.<br>Dose rates ≥ 2 mSv/h: Encapsulated in cement inside C1 concrete drums. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Low Active Water Filters | Low Active Water Circuits (e.g. TEU, REA, TEP, APG). | Controlled zones. | A radiological surveillance is required to assess or indicate the change-out precautions to be used. Change-out by hand. | Dose rates < 15 mSv/h: Encapsulated in cement inside C1 concrete drums. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |
| LILW-SL | Highly Active Water Filters | Primary (linked) Water Systems (e.g. RCV, PTR). | Controlled zones. | A radiological surveillance is required to assess or indicate the change-out methods to be used. Change-out either by hand or chateaux. | Dose rates < 500 mSv/h: The waste is encapsulated in cement inside C4 concrete drums.<br>Dose rates ≥ 500 mSv/h: The waste is encapsulated in cement inside C2F concrete drums. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |
| LILW-SL | Ventilation Filters | HEPA and iodine filters | Controlled zones. | Particulate filters must be compacted.<br>Both particulate and iodine filters are wrapped in plastic. | Particulate filters are placed in steel drums.<br>Iodine filters are placed in IP-2 containers. | Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Metallic Objects | Contaminated metallic objects (metal plates, piping, pump spares, valves, etc.). This also includes maintenance and project-generated waste. | Controlled zones. | Objects have to be opened to allow free flow or entry of the wet-mix cement to fill all voids and metal bars or flat plating has to be cut to size.<br>Dose rates ≥ 2 mSv/h: Decontaminated and cut to size. Objects should be open-ended.<br>Metallic objects are allowed to be mixed with other NCW objects.<br>After treatment, no voids must be present. | Dose rates < 2 mSv/h: waste should be treated as NCW and placed in a 210 litre steel drum.<br>Dose rates ≥ 2 mSv/h: waste is treated as a NCW and encapsulated in cement inside C1 or C2 concrete drums. | Temporarily stored in the plant.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Sludge | Collected from liquid waste holding tanks (SRE, RPE, TEU, TEP and REA tanks) during routine decontaminati on. | Controlled zones. | All dose rates: The requirement is that the sludge has to be preserved or kept in water or liquid form for ease of treatment or further conditioning.<br>Pre-treatment is that the sludge has to be transferred from storage containers into a C1 concrete drum. | For all dose rates, waste will be encapsulated in cement inside C1 concrete drums. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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| Waste Class | Waste Description | Waste Type/ Origin | Collection | Pre-treatment/ Pre-requirement | Waste Treatment | Storage | Disposal Site |
|---|---|---|---|---|---|---|---|
| LILW-SL | Wood | Uncovered and contaminated wood collected or stored in Radiological Control Zones. | Controlled zones. | For all dose rates: Pre-treatment is to cut the wood to size. | For all dose rates, waste will be encapsulated in cement and packaged in C1 concrete drums or 210-litre steel drums depending on the dose rate. | Temporarily stored in the plant after encapsulation.<br>Intermediately stored in the LLWB until disposal at the repository. | Vaalputs |

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