NATIONAL NUCLEAR REGULATOR

For the protection of persons, property and the environment against nuclear damage

REGULATORY GUIDE

INTERIM GUIDANCE ON THE MANAGEMENT OF NORM TAILINGS AND WASTE ROCK

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Rev 0

professionalism integrity value our people excellence teamwork openness & transparency

UNRESTRICTED

APPROVAL RECORD

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1 BACKGROUND

Regulations are mandatory and set specific requirements to be fulfilled by the authorisation holder or an applicant for a nuclear authorisation. Guidance documents are developed to assist authorisation holders or/and applicants for authorisations in meeting the regulatory requirements. In general, guidance documents have to be adhered to by the holder/applicant. Any deviation from the guidance provided by the Regulator has to be justified.

The National Nuclear Regulator (NNR) exercises regulatory control related to nuclear safety and security for all the activities and facilities as defined in the NNR Act [2]. The process waste generated at a mining and minerals processing facility, also known as slurry, is naturally radioactive because of the associated radionuclides in the uranium and thorium decay series that accompany the metals that are mined. The slurry, also referred to as Naturally Occurring Radioactive Material (NORM) residue, is pumped to containment areas for permanent or temporary storage and thus qualifies as radioactive waste facilities named NORM tailings dams, also interchangeably referred to as Tailings Storage Facilities (TSF).

Section 4.6 of the Safety Standards and Regulatory Practices (SSRP R.388) [3] currently sets out the requirements for Radioactive Waste Management for the set-up of a waste management programme, the long-term waste storage management and the requirements specific to the waste material. Further details regarding the management of radioactive waste for the NORM industry is detailed in RD-004, Requirements for Radioactive Waste Management: Mining and Minerals Processing, but no guidance document on the requirements is available.

Waste rock is also produced during various stages of the mining process and the rock may contain NORM or none at all. The waste rock is piled and stored on authorised sites until viable or feasible options have become appropriate, such as feed material for the minerals processing plant (grade dependent) or for sale in the use of the construction industry (provided exemption criteria are met). Since the material is covered in the regulatory framework, the current legislation applicable to the waste rock is detailed in Section 2.2 of the SSRP Exemption, no guidance is available in the management of such waste rock.

2 PURPOSE

This document provides guidance for the implementation of the requirements as set out in the draft General Nuclear Safety Regulations on the management of NORM tailings and waste rock. Due to the lengthy promulgation process for regulations, and the fact that the guidance provided is based on draft regulations, the Executive has resolved to issue this document as interim guidance. This document will be revised once the regulations in question have been promulgated.

The guidance is applicable to all NORM facilities which carry out activities and operations involving NORM tailings and waste rock containing uranium, thorium and their progeny. This guide extends to both authorised facilities regulated by the NNR and prospective applicants who wish to handle, process and dispose of NORM tailings and waste rock in terms of the provisions of the NNR Act and associated regulations.

This guidance document clarifies regulatory requirements by providing a how-to approach, process and procedural guidance, and best practice associated with topics as listed in Section 6 of the document.

3 SCOPE

The document applies to all holders and prospective holders of NNR authorisations and facilities that carry out activities and operations involving NORM.

4 TERMS, DEFINITIONS AND ABBREVIATIONS

In this RG any word or expression to which a meaning has been assigned in the NNRA [2] or the regulations promulgated in terms of the NNRA [3], shall have the meaning so assigned. Only additional terms, definitions and abbreviations are provided. Definitions as per the IAEA Safety Glossary are also applicable [5].

4.1 Terms and Definitions

In this guide, the word “should” is used to express guidance, i.e. a provision that an authorisation holder or applicant should satisfy in order to comply with regulatory requirements. The word “may” is used to express an option or that which is permissible within the limits of this regulatory document. “Can” is used to express possibility or capability.

“**NORM residue**” means NORM tailings. The two terms are used interchangeably in the document.

“**Radioactive waste**” means any material, whatever its physical form, remaining from a facility or activity requiring a nuclear licence, nuclear vessel licence or certificate of registration and for which no further use is foreseen. The matter contains or is contaminated with radioactive material and does not comply with the requirements for clearance.

4.2 Abbreviations

DEA	Department of Environmental Affairs
DMR	Department of Mineral Resources
IAEA	International Atomic Energy Agency
LD	Licensing Document
LG	Licensing Guide
NEMA	National Environmental Management: Waste Act (Act No. 59 of 2008)
NEMWA	National Environmental Management: Waste Amendment Act (Act No. 26 of 2014)
NNR	National Nuclear Regulator
NNRA	National Nuclear Regulator Act (Act No. 47 of 1999)
NORM	Naturally Occurring Radioactive Material
RG	Regulatory Guidance Document
RD	Requirements Document

SSRP	Regulations in terms of section 36, read with section 47 of the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999), on Safety Standards and Regulatory Practices
TSF	Tailings Storage Facility

5 REGULATORY FRAMEWORK

5.1 Applicable Legislation

1) The radiological characteristics in NORM tailings and waste rock from NORM processing qualifies it as radioactive waste and hence proper radioactive waste management should be applied.
2) The following specific regulations apply to NORM tailings and waste rock from the NORM industry:
    a) The current NNR Regulations (SSRP) Section 4.6 – Radioactive Waste Management; and
    b) The draft NNR Regulations Part Six, Section 10 – Radioactive Waste Management [1].
3) The draft NNR Regulations Part Six, Section 10 – Radioactive Waste Management [1] requires amongst others that:
    a) Radioactive material for which no further use is foreseen and with characteristics that make it unsuitable for authorised discharge, authorised use or clearance from regulatory control, shall be processed as radioactive waste [1]; and
    b) At various steps in the predisposal management of radioactive waste and used fuel, the radioactive waste and used fuel shall be characterised and classified in accordance with the classification scheme in Annexure 5.
4) The table attached, Attachment A, is an extract from Annexure 5 in the draft NNR Regulations.

5.2 Scope of Regulatory Control

1) Material that contains radioactive traces involving activities will qualify to be under the scope of regulatory control as set out in the regulations as per the provisions of the NNR Act.
2) The applicability of exclusion or exemption will be applied as per the criteria set out in the regulations. Any activity contemplated in the NNR Act, or any condition associated with such activity, which does not qualify for exclusion in terms of the regulations may qualify for exemption if it complies with the exemption criteria as per the regulations.
3) In respect to this guide, the scope would naturally cover new and old tailings dams. This includes: new and old waste rock dumps, sites where deposition has been discontinued as well as mega tailings dams currently in operation and new tailings dams about to be constructed.
4) The scope also includes the transport of the slurry through the various pipelines and networks to and from the deposition sites and processing plants respectively. This is due to the possibility of slurry spillages and pipe integrity problems experienced by authorisation holders.
5) Exposure to natural sources, including NORM, is considered to be an existing exposure situation. However, for activities involving higher concentration NORM residues, the formal system of

regulatory control for planned exposures applies. This distinction is articulated in Part TWO: Scope of Regulatory Control in the General Nuclear Safety Regulations, by means of activity concentration criteria:

a) If, in every process material, the activity concentrations of all radionuclides in the ^{238}U and ^{232}Th decay series are 0.5 Bq/g or less and the activity concentration of ^{40}K is 10 Bq/g or less, the material is not regarded as NORM, and the requirements for existing exposure situations apply.

b) If, in any process material, the activity concentration of any radionuclide in the ^{238}U or ^{232}Th decay series exceeds 0.5 Bq/g, or if the activity concentration of ^{40}K exceeds 10 Bq/g, that material is regarded as NORM, and the requirements for planned exposure situations apply.

6) The key difference in the treatment of planned and existing exposure situations is the degree to which regulatory control applies. For planned exposures, authorisation is required, with exemptions granted where the risks do not warrant that level of control. For existing exposure situations, parties are responsible for protecting workers and the public, therefore the main regulatory role is providing guidance and the system of authorisation and licensing will not apply.

6 INTERNATIONAL BEST PRACTICES AND NATIONAL GUIDELINES

6.1 International Standards and Best Practices

1) The intention and purpose of this regulatory guide is to be in line with international practices and accepted approaches in dealing with NORM tailings and waste rock.

2) Therefore, the establishment of this document takes into consideration the following publications:

a) International Atomic Energy Agency Safety Standards Series No. WS-G-1.2, Management of Radioactive Waste from the Mining and Milling of Ores, Vienna, Austria (2002) [5];

b) European Commission, Reference Document on Best Available Techniques for Management of Tailings and Waste Rock in Mining Activities, Seville, Spain (2009) [7];

c) International Atomic Energy Agency Technical Document – Exposure of the Public from Large Deposits of Mineral Residues, Vienna, Austria (2011) [8];

d) Management of Uranium Mine Waste Rock and Mill Tailings – Regulatory Document RD/GD-370: Canadian Nuclear Safety Commission (2012) [6];

e) International Atomic Energy Agency Draft Safety Guide No. DS 459, Management of Radioactive Residues from Uranium Production and other NORM Related Activities, Vienna, Austria [11]; and

f) International Atomic Energy Agency Technical Document Safety Report Series No. 27 – Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium, Vienna, Austria (2002) [12].

6.2 Additional Documents Considered

1) The following additional references have also been considered and consulted:

a) Department of Mineral Resources, Mine Health and Safety Act, 1996 (Act No. 29 of 1996) [10];

b) Department of Mineral Resources – Guideline for the Compilation of a Mandatory Code of Practice on Mine Residue Deposits, Pretoria, South Africa (2000) [9];

c) Department of Environmental Affairs, National Environmental Management: Waste Act (Act No. 59 of 2008) [13]; and

d) Department of Environmental Affairs, National Environmental Management: Waste Amendment Act (Act No. 26 of 2014) [14].

7 GENERAL GUIDANCE FOR MANAGING NORM WASTE

7.1 Radioactive Waste Management Programme

1) NNR regulations require that radioactive waste management programmes be established, implemented and maintained for the safe storage of radioactive waste with key control measures implemented for the duration of the storage of the waste.

2) Radioactive waste management programmes should be established, implemented and maintained in order to:

   a) Ensure waste generation control;

   b) Ensure the identification, quantification, characterisation and classification of any radioactive waste generated;

   c) Provide for the necessary treatment and other waste management steps leading to safe clearance, or authorised discharge, disposal, reuse or recycling; and

   d) Provide for the safe storage of radioactive waste between any waste management processes.

3) Radioactive waste should not be generated in an uncontrolled manner; the waste needs to be properly identified, quantified, classified and characterised accordingly.

4) NNR regulations also require the treatment or processing of the waste. Waste that qualifies for clearance, recycling, disposal, reuse or discharge should be handled according to an approved methodology.

5) Radioactive waste should also be stored safely as it is being processed.

6) The draft regulations [1] Part Six Section 9 – Radioactive Waste Management Subsection (4) Radioactive Waste Management Plan, state the following:

   a) Each generator of radioactive waste or used fuel shall develop and submit a radioactive waste management plan to the Regulator for approval.

   b) The radioactive waste management plan referred to in subregulation (a) above shall cover all applicable radioactive waste streams or categories and shall identify the associated waste management options including the applicable predisposal management steps required for each option and the details thereof.

   c) The radioactive waste management plan and used fuel management plan shall detail the interdependencies among all steps in the predisposal management of radioactive waste and the impact of the anticipated disposal option shall be appropriately taken into account.

d) Each generator of radioactive waste or used fuel shall ensure that the following hierarchy of waste management options shall be followed to the practicable extent:

   i) Waste avoidance and minimisation;

   ii) Reuse, reprocessing and recycling;

   iii) Storage; and

   iv) Conditioning and final disposal.

7) Point 6)(d)(ii) and (iii) require the plan to account for the reprocessing, reuse and recycling of the radioactive waste, but the storage aspects must also be accounted for.

8) It has now been established that the tailings material and waste rock, as radioactive waste from the gold and uranium processing facilities, must be controlled and stored as per the above under authorisation from the NNR.

7.2 Strategy for Waste Management

1) The design of mining and milling facilities will influence the optimisation of protection from exposure due to radioactive waste and should be considered with waste management in mind. The mining and milling activities should be designed to reduce, as far as practicable, the amount of waste to be managed. This can be accomplished through the choice of appropriate mining methods and milling processes, and the recycle and reuse of equipment, materials and waste.

2) The closure of the waste management facilities should be considered in all phases of the mining and milling operation, that is, during siting, design, construction and operation. Planning for the management of mining and milling waste at closure should not be delayed until the closure stage. For example, taking measures at an early stage to reduce the migration of waterborne and airborne contamination to the surrounding environment will facilitate management of the closure phase.

3) Waste quantities should be kept to a practicable minimum. Options for viable and safe reuse or recycling should be sought before designating NORM residues as waste.

4) The waste management plan should address reducing the amount and activity of radioactive waste to a level as low as reasonably achievable at all stages, from the design of a facility or activity through to decommissioning. This includes recycling and reuse, and treatment of all types of waste.

5) Pretreatment consists of, for example, collection, segregation, chemical adjustment and decontamination, including a period of interim storage. This characterisation step is important because it provides in many cases an opportunity to segregate waste streams and, for example, could lead to recycling or management as non-radioactive waste when the quantities of radioactive materials they contain are exempt from regulatory controls. It also provides the opportunity to segregate radioactive waste for long-term management above or below grade.

6) Treatment of radioactive waste includes those operations intended to improve safety by changing the characteristics of the radioactive waste. The basic treatment concepts are volume reduction, radionuclide removal and change of composition. Examples of such operations are: incineration of combustible waste or compaction of dry solid waste (volume reduction); evaporation, filtration

or ion exchange of liquid waste streams (radionuclide removal); and precipitation or flocculation of chemical species (change of composition).

Often several of these processes are used in combination to provide effective decontamination of a liquid waste stream. This may lead to several types of secondary radioactive waste to be managed (contaminated filters, spent resins, sludges).

7) Conditioning of NORM residues involves those operations that transform them into a form suitable for handling, transportation, storage and long-term management. The operations may include immobilisation, stabilisation and packaging. Common immobilisation methods include solidification of liquid residues, for example in cement. Stabilisation methods can include dewatering and chemical adjustment.

8) Residues containing hazardous constituents that are mobile in the environment, or constituents that enhance the mobility of radionuclides, should be immobilised or stabilised. This is particularly important for the large volumes of mining and processing tailings and stockpiles of NORM residues from processed raw materials, such as phosphogypsum and red mud.

9) Implementation of reuse and recycling options requires the availability of suitable criteria, including clearance criteria, a suitable measurement methodology and suitable instrumentation.

7.3 Classification of Waste

1) At the outset, all waste associated with any mining and minerals processing facility should be considered as suspect in terms of the potential presence of radioactive contamination.

2) Before one can identify potentially radioactive waste there is first the need to identify all waste streams in general and to subsequently segregate waste streams into:

   a) Non-process waste; or

   b) Process waste.

3) Non-process waste is waste for which it is considered unlikely that any radioactive contamination of the waste could have occurred up to the time that this segregation is made. A suitable justification for this segregation should be provided in all instances in order to ensure a priori that there is a high level of confidence that the waste has not been incorrectly labeled as non-process waste.

4) Such a justification should be based upon:

   a) Knowledge of the origin and characteristics of the waste being considered;

   b) Knowledge of the processes giving rise to the potential contamination of materials;

   c) The design of the facility;

   d) The operating rules of the facility;

   e) The history of the facility; and

   f) Occurrence of incidents.

5) Further handling of non-process waste falls outside the scope of this document. The justification for this is that, subject to NNR acceptance of this segregation, as applicable to a given waste type, there will be no radiological restrictions on the handling or disposal of such waste.

6) Hence it is foreseen that the segregation and acceptance of a particular waste stream as non-process waste will assist in reducing the quantities of material requiring radiological monitoring prior to disposal or storage.

7) Process waste would apply to any waste failing the segregation and motivation as given above. Hence the potential exists that the waste may have become radioactively contaminated, either directly, through being involved in a process known for the presence of radioactivity, or indirectly, by being in close proximity to known or potentially radioactively contaminated waste.

8) At this point the possibility still exists that the waste may be demonstrated to be not radioactively contaminated. However, such demonstration must necessarily involve an NNR approved protocol of radioactivity monitoring.

9) Waste is either homogeneous process waste such as slimes material, calcine, pyrite and baddeleyite or discrete process waste such as waste rock, scrap metal, timber, etc.

10) Process waste should be classified as either NORM-L or NORM-E in accordance with Attachment A.

11) The waste classification should be based upon an approved sampling and radioactivity analysis programme.

8 GUIDANCE ON THE MANAGEMENT OF NORM TAILINGS

8.1 Waste Avoidance and Minimisation

1) A primary concern in terms of the protection of persons, the environment and damage to property is not to generate waste of any nature. However, due to mining and milling activities of minerals and metals, waste is invariably generated in the process. Due to the radioactive content of the waste, it is imperative that regulatory oversight is exercised in all processes of the management and disposal of the waste. Waste or unnecessary waste should be avoided by all means and where possible, minimisation thereof should be of utmost importance.

2) Processes, procedures, design measures and operator intervention should be identified and implemented to avoid generation of unnecessary NORM waste. In doing so, the controls would be introduced to minimise and avoid waste at the planning and production phases.

   It is during the planning phase for the minimisation of the waste that measures should be identified that could be implemented to reduce the amount of activity concentrations of the NORM radionuclides. Suitable disposal options should then be investigated for the radioactive content removed from the waste during this phase.

8.2 Reuse, Reprocessing and Recycling

1) In cases where waste generation cannot be avoided, material that is classified as radioactive waste can be reused, reprocessed or recycled as a means to control the amounts and the risk in the spread of the material.

2) Reusing the material would be possible in the authorised processes such as backfilling a worked-out area in an underground mine with slurry/tailings or using the water collected from containment ponds from tailings storage facilities in the metallurgical plants.

3) NORM residue such as phosphogypsum is also increasingly coming into the focus of international companies who reuse it in other industries, such as brick making or in construction where the phosphogypsum is used to fabricate drywall or ceilings. Since this is NORM residue as per the classification of radioactive waste, these materials can only be reused or recycled to go into the public domain if it fulfils the exemption criteria as per the regulations.

4) Reprocessing NORM residue is increasingly becoming more feasible with newer technology and extraction techniques of sought-after minerals or metals. The reprocessing of old gold tailings in South Africa is becoming an industry on its own relative to conventional underground mining to recover metals that could not be extracted efficiently decades ago. An advantage of reprocessing old TSFs is that companies are removing a source of NORM residue from a number of locations and processing the material. The “new” residue is deposited on newly designed TSFs constructed with the latest technology and best practices.

5) The Radioactive Waste Management Plan should therefore include considerations on the implementation of the reuse, recycling and reprocessing of NORM waste.

8.3 Storage

1) Storage in terms of NORM residues refers to the placement of the radioactive waste in a facility where appropriate isolation and monitoring can be provided so that the material can be accessed at some point in the future to reuse, reprocess, recycle or for final disposal thereof [11].

2) The storage of NORM residue in terms of TSFs should therefore be included in the Radioactive Waste Management Plan so that the risks at the storage facility is minimised and controlled.

3) The major design considerations for the management and storage of NORM residue and waste are proper containment and isolation.

4) The design of such a storage facility should take cognisance of the principle of preventing undue burden and liability for future generations by:

   a) Minimising waste;

   b) Reusing and recycling of materials;

   c) Minimising the use of fresh water;

   d) Minimising the TSF footprint; and

   e) Minimising its potential impacts on the surrounding surface environment and groundwater resources.

5) The storage facility should account for the development of a cost-effective residue management strategy that involves evaluating the options for:

   a) Siting;

   b) Design and construction;

   c) Operation;

   d) Management of waste streams (e.g. treatment, conditioning, recycling); and

   e) Decommissioning.

f) Other factors include benefits, costs, detriments and any regulatory limits, constraints and reference levels.

6) The reduction of NORM residue from the processing of minerals would also influence the size of the storage facility, therefore these aspects should be considered in the planning phase of the facility.

7) In South Africa, slurry is transported by means of pipelines almost exclusively from the metallurgical plants to the TSFs or from the tailings reclamation sites to the plants. The pipelines are positioned on the surface and due to old infrastructure or accidents involving the pipelines; spillages are often reported to the NNR.

8) To reduce the risk of pipe failure and the spread of NORM residue, it is important that holders of nuclear authorisations that operate and intend to operate TSFs with the necessary pipeline infrastructure to establish a NORM Pipeline Maintenance Programme.

9) The programme should cover the following:

a) Measures to reduce the risk of pipe failures;

b) Optimal utilisation of available resources;

c) Measures to identify pipe bursts through measurement of flow rates, etc.;

d) Measures to identify areas at risk and mitigatory actions in response thereof, e.g. bunded areas, emergency control ponds for sensitive areas or where the pipeline crosses a river, etc.;

e) Clearly identify responsibilities at every level for the transport of the slurry; and

f) Monitoring and inspecting the pipelines regularly.

8.4 Conditioning and Final Disposal

1) The conditioning of NORM residue involves operations that transform it into a form suitable for handling, transportation, storage and long-term management. Of importance to NORM residue and the storage facilities, is stabilisation of the residue which includes dewatering of the material.

2) The final disposal options of NORM residue is very much influenced and determined by the safety assessments to be performed in the selection of the site and the environmental impacts thereof.

3) In addition to the points listed in Section 8.3 (5) for storage facilities, the final disposal site should account for the following [11]:

a) Site characteristics;

b) Residue characteristics including volume, chemical, physical and radiological properties;

c) Waste volumes including contingencies (including foreseeable accident scenarios) to ensure that sufficient space will be available during the operation, closure and decommissioning periods;

d) Potential for retrieval of residues either for relocation or reprocessing for further resource extraction;

e) Drainage and liquids management including seepage collection and treatment;

f) Acid generating potential of the residues and controls thereof;

g) Radiation protection measures which may include shielding, containment, as well as radon and dust control;

h) Site access control;

i) Permeability of any cover and base, and the permeability criteria that are acceptable given the site and residue characterisations – including intrusion and leaking of liquids, and emanation of radon;

j) Environmental monitoring of the facility including, but not limited to, groundwater, surface water and air sampling stations downstream of any effluent or airborne releases;

k) Revegetation;

l) Long-term stability and erosion control (e.g. dams, berms, slopes, covers) in relation to natural weathering processes and extreme natural events (e.g. flooding); and

m) Control of inadvertent intrusion by people or animals.

4) The management options for waste are listed in Attachment A.

5) The disposal and storage options for process waste are provided in Attachment B.

8.5 Monitoring and Surveillance

1) The operator of the authorised site should establish and implement a Monitoring and Surveillance Programme, subject to NNR approval. The programme should form the basis of monitoring and surveillance before operation, during operation and during long-term management of the facility. The aim of the project is also to evaluate and verify the impact on human health and the environment by assessing the following parameters:

a) Radiological impacts;

b) Environmental impacts; and

c) Facility engineering and safety related impacts.

2) The storage and management of NORM residue on a long-term basis go hand in hand with effective institutional controls. The institutional controls must be put in place to prevent unauthorised entry onto the facilities. This will be confirmed by monitoring the site through various means and maintaining surveillance to manage the risks at the site.

3) The controls should include: monitoring, surveillance, remedial work (if necessary), water diversion and treatment, maintenance of fences, controlling land use and erecting signpostings and warnings.

4) The Monitoring and Surveillance Programme should be reviewed periodically. The necessary records and documentation produced as part of the quality assurance of the programme must also be maintained to form part of the institutional controls.

5) The programme should also specify the parameters to be monitored, the locations and frequencies for sampling, the procedures for analysis and reporting, including the setting of appropriate action levels that would trigger specified actions.

9 GUIDANCE ON THE MANAGEMENT OF WASTE ROCK

1) In addition to the guidance already provided, the following guidance is applicable to other waste types, such as waste rock:

   a) Other solid and liquid wastes that are generated in the mining and milling of ores and which should be managed throughout the lifetime of the mining and milling facilities include: sludges, contaminated materials, waste rock, mineralised waste rock, process water, leaching fluids, seepage and runoff. Of these wastes, waste rock and mineralised waste rock are generally the more difficult to manage.

   b) While the radiological hazards associated with waste rock and mineralised waste rock are usually much less significant than those for tailings, non-radiological hazards will remain and should be recognised as often being among the more important matters to be considered in the selection and optimisation of management options. There are many possible options for managing waste rock and mineralised waste rock. Whichever management option represents the optimum one will depend on the particular mineralogy, radioactivity and chemical reactivity of these wastes.

   c) Of the different residues produced by NORM activities, large bulk residues represent the greatest challenge despite their relatively low specific activity. This is due to the large volumes produced and the presence of very long-lived radionuclides and often other hazardous substances, such as heavy metals.

   d) Options for managing waste rock and mineralised waste rock include their use as backfill materials in open pits and in underground mines, and for construction purposes at the mine site. The need to cover mineralised waste rock with inert waste rock should be taken into account.

   e) As with tailings, consideration should be given to the extent to which the various options will help ensure that, when managed on the surface, piles of waste rock and mineralised waste rock are stable and resistant to erosion and rainwater infiltration, and do not result in unacceptable environmental impacts on the water catchment area.

   f) Co-placement of waste rock with tailings is a procedure that can be considered for both underground and above ground management options in mining situations, however chemical compatibility of the comingled material should be considered.

   g) Subject to regulatory authorisation, some residues may be suitable for reincorporation into the original environment, possibly including dilution or selective mixing to reduce activity concentrations.

   h) For NORM residues that might be recycled or disposed, inadvertently or intentionally, and become entrained in construction material, or impact drinking water, food and feed, the clearance criteria as stipulated in regulation 4 of Part TWO: Scope of Regulatory Control applies.

   i) Clearance may be granted for specific situations on the basis of the criteria specified, with account taken of the physical or chemical form of the radioactive material, and its use or the means of its management.

   j) The management options for process waste are listed in Attachments A and B.

10 SAFETY CONSIDERATIONS IN DIFFERENT PHASES OF AUTHORISATION

10.1 Siting

1) The siting and design of waste management facilities should provide for the effective collection and containment of waste and should prevent the diversion of waste from the site other than by means of authorised discharges or by the authorised removal from regulatory control.

2) A preliminary evaluation of site characteristics should be made so as to identify any restrictions in terms of radiological and environmental factors at each proposed location, and to allow the selection of a small number of locations and possible preliminary design concepts for which the impacts can then be evaluated in detail.

3) The final optimised choice of site, obtained using the conceptual design for waste management, should be assessed and the resulting safety assessment submitted to the regulatory body for review.

4) In selecting the site for waste management facilities, the important considerations in the optimisation process that should be taken into account, particularly in reducing the need for long-term institutional controls after closure, include the following:

   a) Local land management process;

   b) Climatology and meteorology;

   c) Geography, geomorphology, demography and land use;

   d) Structural geology and seismology;

   e) Geochemistry;

   f) Mineralogy;

   g) Surface water and groundwater hydrology;

   h) Flora and fauna, including protected and endangered species;

   i) Archaeological and heritage issues;

   j) Natural background levels of radiation; and

   k) Public acceptance issues.

5) In selecting a site for large volumes of residues and waste, the need for, and dependence on, active institutional controls should be minimised.

10.2 Design and Construction

1) The design should be supported, where appropriate, by fieldwork and laboratory or pilot plant studies and by radiological and environmental impact assessments. The design should include a waste management plan covering the management of tailings and waste rock, effluent treatment, seepage controls and operational monitoring.

2) The design and construction of waste management facilities should be undertaken within the framework of the quality assurance programme and should include quality control procedures.

3) Good mining practice should be followed to the practicable extent and consistently with the requirements for radiological protection, so that the design of the waste management facilities:
   a) Maximises the use of natural materials for containment;
   b) Maximises the placement of waste material below ground level, or in some cases under water;
   c) Minimises the impact on the surrounding environment during operations and after closure;
   d) Minimises the need to retrieve or relocate the waste at closure; and
   e) Minimises the need for surveillance and maintenance during operations and for institutional controls after closure.
4) A preliminary closure plan should be prepared during the design of the facilities, which, at a conceptual level, identifies and ranks the available options for their closure according to the results of the safety assessment and the optimisation of protection.
5) It should also specify the financial provisions necessary for the preferred option. The preliminary closure plan should be submitted to the regulatory body for approval.

10.3 Operation

1) The waste management facilities should be operated in accordance with the waste management strategy, the safety assessment, the authorisation, and a waste management plan. This plan should describe in detail all aspects of the management of the waste.
2) In addition, the plan should be consistent with the quality management programme and thus should include provision for:
   a) Detailed and documented procedures for operation, maintenance, monitoring, quality assurance and safety;
   b) Training of personnel in the implementation of the procedures;
   c) Adequate surveillance and maintenance of all the structures, systems and components of the waste management facility that are important to safety;
   d) A system of controlled and supervised areas and clearance procedures for materials removed from the site;
   e) Timely submissions to the regulatory body of inspection reports, monitoring results and reports on unusual occurrences; and
   f) The development and exercise, where appropriate, of contingency plans for failures of the waste management facilities that may result in a significant reduction in the protection of human health or the environment.
3) Measures should be taken during operations, and consistently with the safety assessment, to limit the rates of release to the environment of contaminants in liquid and airborne effluents. Measures should be used to ensure that solid waste remains under proper control so that the misuse of tailings is avoided. Releases of radon or radioactive dusts into the atmosphere and of radium and other radionuclides into surface water and groundwater by surface runoff or leaching from solid waste should be minimised.

10.4 Closure

1) The preliminary closure plans should be revised periodically during the operation of the waste management facilities to reflect significant operational changes, technological advances and regulatory requirements. The financial mechanism(s) guaranteeing that funds will be available to fulfil the requirements for closure and post-closure should be updated as necessary. Updated plans and financial mechanisms should be submitted to the NNR.
2) Once any part of the waste management facilities is no longer needed, it should be closed to the practicable extent during operations (e.g. closure of a waste rock pile).

11 REFERENCES

The following references were consulted during the compilation of this document:

[1] Draft NNR Regulations – General Nuclear Safety Regulations (pending)

[2] National Nuclear Regulator Act (Act No. 47 of 1999)

[3] Regulations in terms of section 36, read with section 47 of the National Nuclear Regulator Act, 1999 (Act No. 47 of 1999), on Safety Standards and Regulatory Practices (2006)

[4] IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection: 2007 edition – Vienna: International Atomic Energy Agency, Definition of NORM Residue (2007)

[5] International Atomic Energy Agency (IAEA) Safety Standards Series No. WS-G-1.2, Management of Radioactive Waste from the Mining and Milling of Ores, Vienna, Austria (2002)

[6] Management of Uranium Mine Waste Rock and Mill Tailings – Regulatory Document RD/GD-370: Canadian Nuclear Safety Commission (2012)

[7] European Commission, Reference Document on Best Available Techniques for Management of Tailings and Waste Rock in Mining Activities, Seville, Spain (2009)

[8] International Atomic Energy Agency Technical Document – Exposure of the Public from Large Deposits of Mineral Residues, Vienna, Austria (2011)

[9] Department of Mineral Resources – Guideline for the Compilation of a Mandatory Code of Practice on Mine Residue Deposits, Pretoria, South Africa (2000)

[10] Department of Mineral Resources, Mine Health and Safety Act, 1996 (Act No. 29 of 1996)

[11] International Atomic Energy Agency Draft Safety Guide No. DS 459, Management of Radioactive Residues from Uranium Production and other NORM Related Activities, Vienna Austria

[12] International Atomic Energy Agency Technical Document Safety Report Series No. 27 – Monitoring and Surveillance of Residues from the Mining and Milling of Uranium and Thorium, Vienna, Austria (2002)

[13] Department of Environmental Affairs, National Environmental Management: Waste Act (Act No. 59 of 2008)

[14] Department of Environmental Affairs, National Environmental Management: Waste Amendment Act (Act No. 26 of 2014)

ATTACHMENT A: EXTRACT FROM ANNEXURE 5 OF DRAFT REGULATIONS

Waste Class	Waste Description	Waste Type/Origin	Waste Criteria	Generic Waste Treatment/ Conditioning Requirements	Disposal/Management Options
5 NORM-L (low activity)	Potential radioactive waste containing low concentrations of NORM.	Mining and minerals processing. Fossil fuel electricity generation. Bulk waste – unirradiated uranium (nuclear fuel production).	1 Long-lived radio nuclide concentration: <100 Bq/g.	Unpackaged waste in a miscible form.	1. Reuse as underground backfill material in an underground area. 2. Extraction of any economically recoverable minerals followed by disposal in any mine tailings dam or other sufficiently confined surface impoundment. 3. Authorised disposal. 4. Clearance.
6 NORM-E (enhanced activity)	Radioactive waste containing enhanced concentrations of NORM.	Scales. Soils contaminated with scales.	1 Long-lived radio nuclide concentration: >100 Bq/g.	Packaged or unpackaged waste in a miscible or solid form with additional characteristics for a specific repository.	1. Reuse as underground backfill material in an identified underground area. 2. Extraction of any economically recoverable minerals followed by disposal in any mine tailings dam or other sufficiently confined surface impoundment. 3. Regulated deep or medium depth disposal.

ATTACHMENT B: SUMMARY OF WASTE CLASSES, LIMITS AND CONDITIONS FOR PROCESS WASTE

Waste Type and Typical Waste Description	Waste Class	Limits	Disposal/Storage Options
Homogenous Process Waste • Slimes material • Calcine • Pyrite • Baddeleyite	NORM-L	Long-lived radio nuclide concentration: <100 Bq/g.	• May be released to an authorised facility. • May be stored on site. • May be placed directly on slimes dams/waste rock piles, etc. • Deposition into mine void(s) left from mining operations, provided a safety assessment proves this is a viable option and controls are engineered or put in place to prevent contamination of the environment.
	NORM-E	Long-lived radio nuclide concentration: >100 Bq/g But: <1000 Bq/g.	• May be released to an authorised facility. • May be stored on site. • May be placed on slimes dams/waste rock piles, etc. following a process of dilution of at least 1:10.
		Long-lived radio nuclide concentration: >1000 Bq/g.	• Must be stored on an authorised site in approved storage facility.

(Note: The waste type and typical waste description in the above table is intended as guidance depicting the type of information required in submissions.)