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MINISTRY OF HEALTH
MANATŪ HAUORA

Compliance Guide: Management of Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Extraction

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1 Purpose

The purpose of this *Compliance Guide: Management of Naturally Occurring Radioactive Material (NORM) in Mining and Mineral Extraction* (the guide) is to provide information on how to manage risks associated with naturally occurring radioactive material (NORM) in mining and minerals industries in Aotearoa New Zealand to comply with the Radiation Safety Act 2016 (the Act). This guide covers activities related to exploration for mineral resources, mining operations and mineral processing plants.

Section 5 of the Act defines 'radioactive material', which includes any naturally occurring radioactive material.

NORM, including uranium and thorium, may present risks to health, property, and the environment. Similar to any other hazard at a mine or mineral processing plant, this hazard and its associated risks must be managed.

The guide sets out a risk management approach and requirements for NORM management planning that a mining or minerals facility should include in its overall site health, safety, and environment management plan.

The guide applies to all operations associated with exploration, mining and processing of materials containing NORM. These operations include:

- exploration activities such as taking soil or water samples, geophysical surveys, test drilling, storing core samples, bulk sampling, excavation, and seismic surveying using explosives
- mining activities such as drilling, blasting, loading, transporting, crushing, screening and stockpiling
- processing activities such as concentrating, smelting, leaching, storing, and handling concentrate product
- disposal of waste products
- construction, commissioning, decommissioning and remediation activities.

This guide is consistent with the approach that the International Atomic Energy Agency (IAEA) outlines in its publication GSR Part 3 (IAEA 2014) and other NORM-related standards and guidance.

2 NORM and its hazards

Naturally occurring radioactive material refers to substances of natural origin found in the environment that emit radiation and gradually transform into other radioactive elements called radionuclides. Radionuclides are present in varying concentrations throughout Earth's crust. People can come across them when exploring, extracting, or processing mineral resources.

The activity concentrations of the radionuclides in rocks and soil found in nature are generally low. However, certain minerals, including some that are commercially exploited, contain uranium, thorium, or potassium at elevated concentrations. Each radionuclide has its own distinctive type of radiation emission and unique chemical and hazardous properties.

The presence of these radionuclides becomes significant when industrial processes disturb them, potentially creating an exposure risk to workers and the public. It is essential to properly characterise radionuclides present in NORM in order to effectively assess and manage their risk.

In the mining and minerals industry, NORM may be contained within host rock, ores, concentrates, samples and waste materials.

The internationally accepted level for defining the scope of regulatory oversight for NORM containing uranium and thorium (and their decay products) is 1 becquerel per gram (Bq/g). At activity concentrations below 1 Bq/g, these materials are considered inherently safe.

NORM is an ionising radiation hazard that may present a potential long-term health risk to people who are exposed to it on a regular, ongoing basis. NORM emits alpha, beta and gamma radiation. The main hazards are from exposure to alpha radiation when materials containing NORM are taken into the body (internal hazard) and from exposure to gamma radiation outside the body (external hazard).

2.1 Internal hazard

The internal hazard arises when someone inhales or ingests NORM. Known routes of exposure include:

- inhaling airborne dust containing NORM
- inhaling the decay products of radon emanating from NORM-containing materials in confined spaces or buildings
- inhaling fumes containing NORM in smelting operations

- ingesting NORM via dust on skin (which is transferred to the mouth when eating, drinking and/or smoking).

2.2 External hazard

The external hazard arises from whole-body exposure to gamma radiation from sources where NORM may be concentrated. Sources may include:

- tailings
- stockpiles
- samples
- radium scale deposits.

3 Risk management

3.1 Safety assessment

All exploration, mining and processing activities must be assessed for their potential to encounter NORM during operations.

Representative sampling and analysis of the site and operations must be conducted to determine if NORM is present at levels that may make controls necessary.

If the analysis determines that NORM activity concentrations will not exceed 1 Bq/g, no special controls are indicated, and the operations are not of regulatory concern.

If the analysis determines that NORM activity concentrations may exceed 1 Bq/g, then the Director for Radiation Safety (the Director) should be notified and a comprehensive assessment carried out to determine the risk. If the results of this show:

- the material above 1 Bq/g would give doses less than 1 millisieverts (mSv) per year, then the assessment should be provided to the Director, and no further regulatory action is required
- activity concentrations may exceed 10 Bq/g and/or it is likely the potential dose to people arising from the operations may exceed 1 mSv per year, operations may be subject to licensing under the Act. Under these circumstances, an application for a source licence under the Act should be made to the Director before operations start.

Assessments should be carried out a number of times throughout the life cycle of the operation as radiological conditions could change as operations change. Typical occasions for assessments are:

- before exploring, or after discovering NORM during exploration activities
- while planning mining and processing operations
- after starting operations or after discovering NORM following the start of operations
- as directed by the Director for Radiation Safety
- when significant changes occur or every five years, whichever is sooner
- during decommissioning before abandoning the site.

The safety assessment should include and consider where appropriate:

- radionuclides, activity concentrations and quantities
- the nature of proposed operations and activities
- radiological conditions in different plant areas
- routes of exposure, including inhalation of particulates and radon, and ingestion of and exposure to external gamma radiation
- dose assessments or estimates for workers and public

- existing controls and possible additional controls
- changes to plant, processes, or materials at the site.

Assessing radiation doses from exposure to NORM is complex. It may involve air sampling in different areas to measure particulate airborne radioactivity, water sampling to assess radionuclide concentrations in surface water, groundwater and process water, radon monitoring, surface contamination, gamma dose rate and individual dose monitoring. A qualified expert (such as a health physicist) should devise and carry out the monitoring programme and assess the results. The safety assessment should consider all information relevant to the hazard and controls. The report on the assessment should include details of the people involved in preparing and reviewing the assessment, including their job description, qualifications, and experience. A copy of the safety assessment report should be kept at the site for as long as the hazard exists.

3.2 Control measures

To ensure radiation exposures to NORM do not exceed dose limits specified in Schedule 3 of the Act and all doses are as low as reasonably achievable (ALARA), controls should be applied in the following hierarchy:

- engineering controls
- administrative controls
- personal protective equipment.

This section describes possible control measures that should be considered to minimise radiological risks. The measures covered are not exhaustive and should be tailored to the specific site and activities.

3.2.1 Facility and process plant design

Reducing risks from NORM starts at the site planning phase. Design of the facilities can have a significant impact on the extent to which workers and the public are exposed to these risks. For example:

- consider prevailing winds and weather conditions to reduce dust
- locate high-occupancy areas such as the control room, workshops, and staff facilities away from processing plant and stockpile areas
- enclose dust sites
- design in ways that make spillage clean-up easier.

3.2.2 Dust suppression and extraction

Effective dust suppression and extraction will reduce exposure to NORM through inhalation. It is important to identify all areas and activities that generate dust such as drilling, excavation, roads, stockpiles, and process operations. Examples of control measures include:

- watering roads, stockpiles and other areas that generate dust
- covering stockpiles with sheets and tarpaulins
- controlling spillage and, where spills happen, cleaning up as soon as practicable
- having enclosed local extraction ventilation containment systems to control dust generated during drilling, crushing and processing
- installing dust suppression on crushing, screening, and conveyor systems
- disposing of captured dust appropriately.

3.2.3 Ventilation

Ventilation can significantly dilute radon and particulate airborne radionuclides to an acceptable level before it enters the breathing zone of workers. Ventilation of enclosed spaces where dust and radon can build up is particularly important. Note that filters on ventilation plant will concentrate dust containing NORM and additional precautions will be required when maintaining ventilation plant and when handling and disposing of used filters.

3.2.4 Maintenance

Poorly maintained plant may compromise control measures designed to mitigate NORM exposures. The maintenance schedule should ensure appropriate maintenance and servicing are carried out and exposures for maintenance personnel are considered and controlled.

3.2.5 Separating people from NORM

The distance over which people are separated from NORM will directly affect their level of exposure to gamma radiation from NORM. In plant areas with enhanced gamma dose rates, controls should be put in place to minimise the time personnel spend in those areas and restrict access to essential operations only.

3.2.6 Shielding

Shielding may be an effective control for reducing the external radiation hazard. Examples of shielding are storing known 'hot' samples in the middle of other samples, using concrete-walled bunkers to store stockpile materials, and burying NORM-containing material under 1 metre of compacted soil (subject to consent conditions).

3.2.7 Procedures and local rules

Examples of procedures and local rules that can reduce NORM exposure include:

- access control and signage requirements for areas where NORM is present
- pre-start checks to establish that dust control, suppression, extraction, and ventilation systems are operating and effective

- hygiene rules such as no cooking, eating, drinking, and smoking and washing/showering after work in certain plant areas
- personal protective equipment requirements, including for its selection, use, maintenance and disposal
- decontamination of equipment before leaving the site or before maintenance
- sample handling, transfer, and storage procedures
- product storage and transport procedures (note that transport of NORM off site must comply with ORS Code C6 (Ministry of Health 2019), which incorporates by reference the IAEA transport regulations – see Section 5.1)
- housekeeping, runoff and waste management, and spill response procedures
- radiological monitoring procedures, including calibration of instruments.

3.2.8 Training and competency

All operators who may perform duties in areas with risks from NORM should receive radiation safety training and regular refresher training. That training should cover:

- basic principles of radiation protection
- hazards of NORM
- control and protective measures
- monitoring and dose assessment
- overview of the NORM management plan.

A radiation safety officer (RSO) should be appointed to oversee the NORM management plan, including the training of all relevant personnel. The RSO should have a higher level of training and knowledge in radiation safety, similar to an RSO in general industrial applications of radiation sources.

3.2.9 Personal protective equipment

Personal protective equipment (PPE) is the lowest-order control in the hierarchy of control measures. It is only effective if it is appropriate, correctly fitted and used properly. Therefore, when PPE is used, workers should be trained in its correct use, and their compliance should be supervised and enforced.

Respiratory protective equipment (RPE) should only be used as a temporary or interim measure. Every effort should be made to reduce airborne NORM concentrations to levels that do not require the use of RPE.

Additional PPE may include coveralls, safety glasses and gloves. Procedures should be established for selecting and using PPE and as well as for its storage, inspection, and disposal. Procedures should also cover undressing and washing to prevent cross-contamination and generation of airborne dust when removing PPE.

Note the use of PPE will only provide protection from the internal hazard. It will not reduce external gamma radiation exposures.

3.3 Radiological monitoring programme

Radiological monitoring should be carried out on a routine basis throughout the life cycle of the facility as well as when changes occur that can affect the radiological risk at the site.

The objectives of monitoring are to:

- assess radiation doses to workers and the public
- verify the effectiveness of implemented controls
- identify potential sources of radioactivity.

In the context of NORM, radiological monitoring may include, but is not limited to:

- using thermoluminescent dosimeter (TLD) badges (to measure gamma dose)
- monitoring personal exposure to dust
- monitoring environmental dust (particulate airborne radioactivity concentration)
- monitoring radon levels
- conducting gamma dose rate surveys
- monitoring surface contamination
- undertaking radionuclide analysis of samples (eg, gamma spectrometry).

The radiological monitoring programme should be developed in consultation with a qualified expert and overseen by the RSO.

The results of the monitoring programme should be used to assess the radiation exposures to personnel, taking account of all exposure pathways (external and internal doses).

Workers who may be occupationally exposed to more than 5 mSv per year should have their own individual dose monitoring and assessment programme.

A facility should maintain monitoring records for its lifetime and for 30 years after that. These records include dose assessments, calculation methods and radiological survey reports.

4 NORM management plan

For operations where the safety assessment indicates activity concentrations may exceed 10 Bq/g and/or it is likely that, due to the operations, people may potentially receive a dose above 1 mSv per year, a NORM management plan should be developed as part of an overall site health, safety, and environment management plan.

The NORM management plan should typically include the following sections:

- Purpose – description of NORM, hazards on site and how this fits in with all hazards approach
- Scope – overview of key processes where NORM may exist, including waste management
- Organisational arrangements – responsibilities and competencies in radiation safety, NORM control measures, supervision
- Safety assessment – routes and risks of exposure to radiation, sources and quantities of NORM, internal and external hazards, controls
- Engineering controls – list of engineering controls implemented to reduce exposures, such as details of testing and maintenance
- Administrative controls – local rules and procedures
- PPE – list of PPE, procedures for servicing and testing it
- Training and competency – radiation safety training requirements for RSO, operators and other personnel, including details of refresher training
- Radiological monitoring programme – details of routine workplace monitoring and individual dose monitoring, list of monitoring equipment, calibration and service records, dose records and assessments
- Waste management – procedures for assessment, handling, storage, and disposal of waste containing NORM
- Emergency arrangements – addressing any impact that NORM may have on the site's emergency preparedness and response arrangements
- Review and audit – procedures for periodically reviewing, auditing, and revising the NORM management plan.

5 Transport of NORM

5.1 IAEA transport regulations

Carriers, consignees, and consignors must comply with the Code of Practice for the Safe Transport of Radioactive Material ORS Code C6 (Ministry of Health 2019). This incorporates by reference the IAEA Regulations for the Safe Transport of Radioactive Material (IAEA SSR-6), also known as the IAEA transport regulations. New Zealand implements these regulations through ORS Code C6 and the applicable dangerous goods frameworks for each mode of transport (land, sea, and air).

The purpose of the IAEA transport regulations is to protect people, property, and the environment when radioactive materials are being transported, by containing radioactive material and controlling external radiation levels.

NORM falls within the definition of radioactive material. However, not all NORM is subject to the requirements of the IAEA transport regulations.

Whether the IAEA transport regulations apply to NORM depends on:

- radionuclide(s) present
- activity concentrations
- total activity.

Depending on the nature of the radioactive material, its transport may:

- be exempt from the regulations
- be excepted from the regulations due to their particular circumstances
- require full application of the regulations.

NORM can fall into any of these categories depending on its radionuclides, activity concentrations and total activity.

5.2 Exempt

The regulations do not apply to nuclear materials and ores containing NORM, in secular equilibrium, which may have been processed, provided the activity concentration is no more than 10 times the basic radionuclide value in the appendix of the IAEA transport regulations. For natural uranium and natural thorium, this threshold equates to 10 Bq/g. Therefore, ores or processed materials may be exempt if, for example, the product contained natural uranium with an activity concentration below 10 Bq/g.

A product to be transported would also be exempt if its total activity was less than the activity limit for an exempt consignment. For example, the exempt activity level for natural uranium and natural thorium is below 1 kilobecquerel.

For most NORM, the activity concentration rather than the total activity is likely to be the deciding factor as to whether they are exempt. This is because usually the volume of material involved in NORM shipments is relatively large, with the result that they exceed the limits on total activity.

5.3 Excepted

Excepted packages are packages that contain limited quantities of radioactive material, or are contained in instruments or manufactured articles, or empty packages that previously contained radioactive material. They are designed to withstand normal handling conditions during transport, but not accidents.

The radioactive content that the IAEA transport regulations permit in excepted packages is very limited. For this reason, if these packages are damaged, the radiological hazard is minimal.

The dose rate on the surface of the transport package must be less than 5 microsieverts per hour.

The packaging for excepted packages must be designed to meet IAEA requirements and be marked with the UN number (UN 2910) but does not need a transport category label. A transport document (consignment note) is also required and must include the UN number. However, the Office of Radiation Safety considers that, provided they comply with these requirements, excepted packages are not a significant risk during transport.

Consequently, in line with 1.2(3) of the Dangerous Goods Rule (Waka Kotahi NZ Transport Agency 2005), the Office of Radiation Safety has declared that excepted packages complying with IAEA requirements do not need to be transported as dangerous goods on land in New Zealand. This declaration means that, during transport of these excepted packages:

- vehicles do not have to display placards
- a Shipper's Declaration is not required
- drivers do not require a dangerous goods endorsement on their driver licence and drivers do not need to be authorised to use radiation sources under the Act.

5.4 Full application (low specific activity material and surface contaminated objects)

NORM shipments that are not exempt or within the excepted package limitations will normally be transported as low specific activity material (LSA) or a surface contaminated object (SCO).

5.4.1 Low specific activity material

LSA can be classified as LSA-I, LSA-II or LSA-III, depending on the activity concentration and other characteristics. The LSA classification determines the specific requirements for transport, such as packaging and labelling. NORM LSA is typically transported in industrial packages such as standard 200-litre drums and International Organization for Standardization (ISO) freight containers.

5.4.2 Surface contaminated objects

An SCO is a solid object that is not radioactive in itself, but that has radioactive material distributed on its surfaces. Typical examples include pipework and vessels where scale containing NORM has plated out on surfaces.

An SCO that is subject to the IAEA transport regulations could be classified as SCO-I or SCO-II, depending on its surface activity levels, the radionuclides involved and whether the contamination is fixed or non-fixed (dispersible).

Contamination is defined as the presence of a radioactive substance on a surface in amounts above:

- 0.4 Bq/cm^2 for beta, gamma, and low-toxicity alpha emitters
- 0.04 Bq/cm^2 for all other alpha emitters.

Low-toxicity alpha emitters include natural uranium and thorium when these materials are contained in ores or physical and chemical concentrates. The more restrictive limit would apply to radium.

The packaging must be suitable to contain the radioactive material and prevent the spread of radioactive contamination under 'routine conditions of transport'. These routine conditions include transport incidents other than severe accidents.

The type of package that is suitable depends on the activity, the radionuclides present and the form of the material (solid, liquid or gas).

A suitable package is not necessarily a rigid box. For example, pipes with internal surface contamination only could be transported with secure caps closing off their ends.

5.5 Marking, labelling and placarding

The transport packages must be labelled with the appropriate UN number, proper shipping name, category labels and contact details for both the consignor and consignee.

The vehicle must display Class 7 placards at its front and rear. ISO freight containers must have placards on all sides.

The UN numbers and proper shipping names relevant to NORM are:

- UN 2910 Radioactive Material, Excepted Package – Limited Quantity of Material
- UN 2912 Radioactive Material, Low Specific Activity (LSA-I)
- UN 3321 Radioactive Material, Low Specific Activity (LSA-II)
- UN 3322 Radioactive Material, Low Specific Activity (LSA-III)
- UN 2913 Radioactive Material, Surface Contaminated Objects (SCO-I or SCO-II).

5.6 Additional guidance for transport

For more guidance for consignors, carriers and consignees, see: Ministry of Health. 2025. *Quick Reference Guide: Road transport of radioactive material*. URL: **www.health.govt.nz/regulation-legislation/radiation/additional-information-and-guidance/road-transport** (accessed 10 April 2026).

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