**Managing naturally occurring radioactive material (NORM) in mining and mineral processing**

**Guide**

**NORM-II**

**Radiation management plans**

**Incorporating the appointment of radiation safety officers**

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# Foreword

This Guide provides practical advice on how to comply with the requirements of the *Work Health and Safety Act 2020* (WHS Act) and the Work Health and Safety (Mines) Regulations 2022 (WHS Mines Regulations).

The work health and safety (WHS) legislative framework embraces a risk-based approach to minimising harm arising from exposure to workplace hazards, including the ionising radiation emitted from naturally occurring radioactive materials (NORM).

The purpose of this Guide is to provide mine operators with guidance on the legislative requirement to develop and implement an appropriate radiation management plan (RMP) to minimise the potential exposure of Western Australian mine workers and members of the public from naturally occurring radionuclides (NORs).

Specifically this Guide reflects the provisions of Part 10.2, Division 3, Subdivision 3B – Radiation in mines of the WHS Mines Regulations.

This Guide replaces the former:

* *NORM 1 Applying the system of radiation protection to mining operations: Guideline*,Appendix B (Radiation Safety Officer requirements)
* *NORM 2.1 Preparation of a radiation management plan – exploration: Guideline*
* *NORM 2.2 Preparation of a radiation management plan – mining and processing: Guideline.*

## National uniformity

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) *National directory for radiation protection* (2nd Edition, 2021) (NDRP) provides an agreed regulatory framework for radiation safety across the Australian Commonwealth, states and territories.

The NDRP requires jurisdictions to ensure their radiation protection legislation is consistent with the applicable requirements of the International Atomic Energy Agency’s (IAEA) *Governmental, legal and regulatory framework for safety: General safety requirements* (Rev.1, 2016) (GSR Part 1).

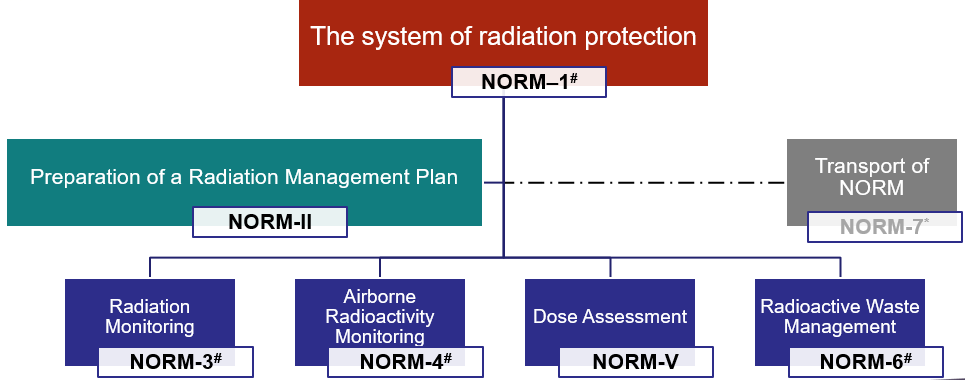
The WHS Mines Regulations reflect the regulatory framework outlined in the NDRP, so far as is reasonably practicable. This includes the adoption and implementation of the ARPANSA *Radiation Protection Series 9 - Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (2005)(RPS-9).

Where discrepancies occur between expectations of the regulator and those outlined in RPS-9, directions issued by the regulator have precedence.

## Relationship to other NORM guides

The diagram below illustrates the relationship of NORM-II with the suite of NORM guides.

The remaining guides will be renumbered using a Roman numeral format as they are published.



# under review at time of publication of NORM-II

\* under consideration for development

Figure 1: Relationship of NORM guides

## **How to use this Guide**

This Guide includes references to legal requirements under the WHS Act and WHS Mines Regulations. These are included for convenience only and should not be relied on in place of the full text of the WHS Act or WHS Regulations. The words ‘must’, ‘requires’ or ‘mandatory’ indicate a legal requirement exists that must be complied with. The word ‘should’ is used in this Guide to indicate a recommended course of action, while ‘may’ is used to indicate an optional course of action.

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# Introduction

**WHS Mines Regulations r. 5B**

Meaning of mining operations

**WHS Mines Regulations r. 641K**

Meaning of radioactive material

**WHS Mines Regulations r. 641L**

Application of subdivision

**WHS Mines Regulations pt. 11.2**

Exemptions

This Guide applies to all exploration, mining and mineral processing operations in Western Australia that use or handle naturally occurring radioactive material (NORM) and come within the scope of the regulation 641L of the WHS Mines Regulations.

This Guide provides guidance to mine operators on the development of a suitably detailed radiation management plan (RMP) that includes the:

* identification of potential sources of radioactive materials on mining (including exploration) operations
* implementation of control measures to minimise radiation exposures to workers, members of the community and the environment
* methods deployed to verify and confirm the effectiveness of controls via a robust monitoring program.

## 1.1 Radioactive material

The WHS Mines Regulations define **radioactive material** as materials that have an activity concentration that exceeds 1 Becquerel per gram (Bqg-1), and:

* exhibit radioactivity
* emit ionising radiation particles
* contain naturally occurring radionuclides (NORs).

The most significant NORs in the Western Australian mining industry are:

* members of the decay series of
  + thorium-232 (232Th)
  + uranium-235 (235U)
  + uranium-238 (238U)
* potassium-40 (40K)
* rubidium-87 (87Rb).

The activity concentration criteria can be met by a single NOR or a combination of the contributions from two or more NORs.

If secular equilibrium is assumed among all members of the 232Th, 238U or 235U decay series only the activity concentration of the head-of-chain is considered. However, if secular equilibrium has been disturbed, the contribution by individual radionuclides in a decay series requires evaluation against the 1 Bqg-1 criteria, regardless of higher exemption limits published in other statutes.

## 1.2 Relevant mines

Part 10.2, Division 3, Subdivision 3B applies to the mines specified in regulation 641L. The WHS Mines Regulations defines these mines as **relevant mines**. A mine is a relevant mine if minerals or radioactive materials with an activity concentration criteria of 1 Bqg -1 or more are mined or are present at the mine, and annual doses of radiation from the mining operations are likely to exceed either:

* 1 millisievert (mSv) for workers
* 0.5 mSv for members of the public at, or in the vicinity of the mine.

## 1.3 Mining operations that do not meet the relevant mine criteria

Under regulation 690, if a mining operations does not meet the criteria of a relevant mine, the mine operator may apply to the regulator for an exemption from all, or specified parts of, Part 10.2, Division 3, Subdivision 3B. The mine operator must demonstrate, with verifiable data, that the mine does not meet the criteria of a relevant mine.

The regulator will consider the matters outlined in regulation 685 before making a decision, and may impose conditions on the exemption under regulation 691. The regulator may apply the condition that the mine operator must provide the regulator with regular updates that confirm the conditions on the mine have not changed, and the criteria of a relevant mine are not met or exceeded. The mine operator must comply with the conditions of the exemption.

An application for an exemption can be refused, and an exemption may be amended or cancelled.

## 1.4 Relationship with other legislative requirements

Some processing plants are not classified as mining operations and are regulated by different legislation. However, if the activity concentration of waste materials increases above the 1 Bqg -1 criteria as a result of mineral processing operations the WHS Mines Regulations cover the disposal of these radioactive wastes if it occurs at a mining operation.

The licence for the site issued by the Department of Water and Environmental Regulation may contain specific conditions and requirements for discharges and contaminated sites.

If irradiating apparatus such as x-ray fluorescence instruments or density gauges are in use on a mining operation, their licensing and use will fall within the remit of the *Radiation Safety Act 1975* (Radiation Safety Act) and Regulations, and will require a separate, specific radiation management plan (RMP) that meets the requirements of the Radiological Council of WA, and:

* a reference to the RMP for irradiating apparatus should be made in the health management plan for the mining operation
* for guidance on reporting incidents involving irradiating apparatus to the regulator, refer to Section 2.8.

An RMP developed in accordance with this Guide should be cross referenced against other applicable legislation to ensure it meets those requirements.

# 2 General Guidance

**WHS Act s. 17**

Management of risks

**WHS Act s. 19**

Primary duty of care

**WHS Mines Regulations ch. 10 pt. 10.2 div. 1 sub-div. 2**

Mine safety management system

**WHS Mines Regulations r. 641M**

Pre-operational monitoring program

**WHS Mines Regulations r. 641N**

Radiation management plan

**WHS Mines Regulations r. 641O**

Radiation waste management plan

**WHS Mines Regulations r. 641Q**

Assessment of doses

## 2.1 Duties

The mine operator and each person conducting a business or undertaking (PCBU) has a duty to consider the health and safety of workers, members of the public, and the protection of the environment at all stages in the design, planning, construction, operation, decommissioning and closure of a mining operation.

Each mine operator or PCBU at an exploration, mining or mineral processing operation that meets the relevant mine criteria must ensure that adequate measures are taken to control the exposure of workers, members of the public and the environment to radiation arising from NORs in the lithology (rock formations), hydrogeology (groundwater), ore being mined and processed, products, residues or wastes.

The measures to be implemented are submitted for consideration by the regulator in the form of an RMP. The RMP is to be supplemented by a radioactive waste management plan (RWMP) which is detailed in the *NORM-VI Radioactive waste management: Guide*.

## 2.2 Pre-operational monitoring program

A pre-operational monitoring program that monitors radiation levels and dose levels at the mine must be developed. Before mining operations commence at a site, the:

* pre-operational monitoring program must
  + be submitted to the regulator by the mine operator
  + be approved by the regulator
* mine operator must provide the regulator with the results of the program.

The pre-operational monitoring program establishes the baseline radiological parameters to be met by the mine operator when seeking relinquishment of the mining lease. The pre-operational monitoring program may also be used to determine the background radiation exposure of members of the public before mining operations commenced.

A pre-operational monitoring programfor exploration operations may be submitted as part of the RMP.

The regulator may approve a pre-operational monitoring programif it is appropriate, and meets the conditions of this Guide.

The results of a pre-operational monitoring programmust be submitted to the regulator, at times agreed with the regulator.

## 2.3 RMP: regulatory requirements

The mine operator of a relevant mine must ensure that an approved RMP is in place before mining operations commence. The RMP must comply with clause 2.7.2(b) of RPS-9, and include:

* a plan for monitoring workers’ radiation exposure under clause 2.7.2(b) of RPS-9
* a plan for discharges of radioactive waste
* the incidents that the mine operator will report to the regulator.

2.4 RMP to be part of the mine safety management system

The RMP is part of the mine safety management system for the mine.

This inclusion ensures that radiation protection is integrated into the overall hazard and risk management of the mining operation (including exploration).

2.5 RMP to be approved before mining operations commence

The mine operator of a relevant mine must ensure that a mining operation does not commence unless:

* an RMP has been submitted to the regulator
* the regulator has approved the RMP.

Before the RMP is approved, the regulator may allow peripheral activities that do not disturb the mineral-bearing lithology, such as installing fence lines or constructing access roads or airstrips.

If a mining operation has commenced, and is subsequently determined to meet the criteria of a relevant mine, an RMP must be submitted to the regulator for approval as soon as is practicable.

Penalties exist where mining operations commence before an approved RMP is in place, and other regulatory interventions such as prohibitions may be applied.

## 2.6 Alignment with RPS-9

To comply with the WHS Mines Regulations, an RMP must incorporate the requirements of RPS-9 clause 2.7.2 (supplemented by RPS-9 section 3.8). This aligns the WHS Mines Regulations with ARPANSA’s radiation regulatory framework and minimises duplication with conditions of the Radiation Safety Act.

The *NORM-V Dose assessment: Guide* has been declared an approved procedure by the regulator under regulation 641Q(2) and therefore all dose assessments should be made in accordance with *NORM-V*, rendering Section 3.8.1(d) of RPS-9 redundant.

Section 4 contains further information on the requirements of Clause 2.7.2 of RPS-9.

2.7 Plan for discharges of radioactive waste

The ARPANSA *Management of naturally occurring radiative materials (NORM): Safety guide, RPS-15* (p. 29) states the ‘processing of NORM materials gives rise to products, wastes and residues’ and further defines residues as materials that have the ‘potential for utilisation’. This is expanded on in *NORM-VI Radioactive waste management: Guide*.

The RMP must include a plan for the discharge of radioactive waste. This should integrate with the RWMP. The RMP should detail the temporary storage of residues, including proposed periods of storage, and justify why the residues should not be construed as wastes.

2.8 Incidents to be notified to the regulator

The RMP must include the types of incidents that must be reported to the regulator by the mine operator.

RPS-9 (p. 43) defines an incident as:

An event which causes, or has the potential to cause, abnormal exposure of employees or members of the public and which requires investigation of its causes and consequences. Such an event may require corrective action within the program for control of radiation, but is not of such scale as to be classified as an accident.

An accident is defined by RPS-9 (p. 43) as:

An unintended event which causes, or has the potential to cause, employees or members of the public to be exposed to radiation from which the individual doses or collective doses received do not lie within the range of variation which is acceptable for normal operation. An accident may result from human error, equipment failure or other mishap; it may require emergency action to save life or to safeguard health, property or the environment. An accident requires investigation of its causes and consequences and, possibly, corrective action within the program for control of radiation, and it may require remedial action to mitigate the consequences.

The intention of regulation 641N(2)(a)(iii) is to ensure that the regulator is made aware of **all** events that may lead to abnormal exposure of workers or members of the public, and as such, the term ‘incidents’ should be interpreted as ‘accidents and incidents’, as defined in RPS-9.

Accidents, unexpected events and malicious acts that result in radiation exposure and require immediate action are also considered reportable incidents, as stated in the *emergency exposure situation* definition in the IAEA *Radiation protection and safety of radiation sources – International basic safety standards: General safety requirements part 3* (GSR Part 3) (pp 8-9).

Inadvertent exposure to radiation is a dangerous incident under section 37 of the WHS Act, and should be included as an ‘accident or incident’ to be reported to the regulator. While outside the scope of this Guide, it is highlighted that the incorrect use, loss or theft of irradiating apparatus used on a mining operation may expose persons to radiation and should be assessed to determine whether the event constitutes a dangerous incident.

The *Incident notification: Interpretive guideline* contains further information about reporting dangerous incidents.

## 2.9 Review of the RMP

An approved RMP forms part of the mine safety management system (MSMS) for the mining operation, and must be reviewed at least every three years.

The RMP must be submitted to, and approved by, the regulator every three years. A review will be triggered earlier if there is a change in the radiation risk profile of the operation.

More information about triggers for review can be found in the *Mine safety management system: Code of practice.*

# 3. Risk-based radiation management plans

The GSR Part 1 establishes the responsibilities and functions of regulatory bodies in Chapter 4. The performance of regulatory functions should correspond with the radiation risks associated with the mining operation, and outlines a *graded* approach, where:

Safety is optimized [*sic*], the balance between operational benefits and potential consequences for people and the environment being taken into account (GSR Part 1, Clause 4.3(a), p. 18).

As a result, the depth and scope of the RMP for an exploration or mining operation should correspond with the radiation risks associated with the activities proposed to be conducted on the site.

Some exploration and mining operations encounter NORs in concentrations that are elevated, but do not meet the 1 Bqg-1 criteria, so are not considered relevant mines, such as:

* mineral exploration operations where the lithology is not initially expected to be classified as ‘radioactive’, that is, not be above 1 Bqg-1, e.g. exploration for heavy mineral sands, rare earths, phosphate or lithium
* underground mines, where exposure of workers may arise from the inhalation of isotopes of radon and radon progeny. There is potential for exposure via this pathway in all underground mines, independent of the mineral or material being mined.

In line with this graded approach the regulator may:

* exempt mining operations with a low radiation risk from some requirements of Subdivision 3B – Radiation in mines, where appropriate (see Section 1.3)
* scrutinise mining operations with high radiation risks before and after approvals or authorisations are granted.

Processing operations or underground mines may require data collection and assessment to demonstrate that the operation does not meet the criteria specified in regulation 641L and is not a relevant mine. The regulator can require the mine operator to supply this information in accordance with section 155(2) of the WHS Act.

An RMP is not required if the assessment indicates that:

* it is very unlikely that any radioactive materials will be encountered at **any part** of the mining operation
* the exposures of workers and the members of the public are expected to be significantly below the relevant mines criteria, and
* the generation of wastes is minimised resulting in an undetectable of negligible impact on the environment.

A generic risk assessment and a commitment to periodically review the concentrations of NORs, potential doses to workers and critical groups, and impacts upon the environment will be sufficient. A critical group is defined in RPS-9 as a ‘group of members of the public comprising individuals who are relatively homogenous with regard to age, diet, and those behavioural characteristics that affect the doses received and who receive the highest radiation doses from a particular practice’.

### Greenfield exploration operations

The *Mining Act 1978* requires proponents for exploration operations to submit a [programme of work](https://dmp.wa.gov.au/Environment/Programmes-of-Work-5966.aspx) for environmental approval before exploration activities commence. If the exploration activities encounter lithology that contains NORs, proponents must indicate the occurrence.

The WHS Mines Regulations require the prospective mine operator [notify the regulator before exploration operations commence](https://www.wa.gov.au/government/publications/notification-of-commencement-of-exploration-operations#:~:text=The%20Work%20Health%20and%20Safety%20%28Mines%29%20Regulations%202022,notice%20of%20the%20commencement%20of%20the%20exploration%20operations.). The risk assessment submitted with the exploration operation notification (EON) should contain information on the presence of NORs. When the regulator has been notified of the exploration, discussions relating to the requirement to submit an RMP may commence.

Risk assessments included in an EON for activities associated with greenfield exploration, such as ground or airborne surveying, collection of rock-chip samples, shallow augering, or where there is minimal ground disturbance, should indicate the steps the exploration manager proposes to use to ensure risks to workers (including those third parties that may be analyse samples that potentially contain NORs) and the environment due to the potential presence of NORs are as low as reasonably achievable.

During this phase of exploration an RMP is not required, and a radiation safety officer (RSO) does not need to be appointed – the risk assessment will suffice.

### Risk based approach to RMP

The graded approach adopted by the regulator embraces a five-tiered approach according to the risk of exposure to NORs:

Tier 1: Very low radiation exposure risk

Tier 2: Low radiation exposure risk

Tier 3: Restricted radiation exposure risk

Tier 4: Moderate radiation exposure risk

Tier 5: Elevated radiation exposure risk.

In all cases, the RMP needs to satisfy the regulator that the proposed operating principles are sufficient, and that the application:

* demonstrates the safety of the exploration or mining operation, and that radiation safety is optimised
* is accurate and shows compliance with regulatory requirements
* provides sufficient radiation protection, and assumptions used in the RMP have been proven through testing or experience
* reduces radiation risks associated with normal operation to as low as reasonably achievable
* anticipates incidents and accidents as defined in Section 2.8 (including those with a very low probability of occurrence), before activities commence, and throughout the lifetime of the operation.

## 3.1 Tier 1: Very low radiation exposure risk operations

### Advanced exploration operations

During advanced exploration operations, it is assumed that geochemical analyses are complete, information about the lithology composition and mineral characteristics has been assessed, and plans to evaluate the potential resource are under development.

When the concentration of the radionuclides (thorium and uranium) in the lithology and mineral characteristics are assessed, if any results meet the definition of radioactive material (i.e. exceed the 1 Bqg-1 criteria), a Tier 1 RMP, as outlined in Section 4.2, must be submitted to the regulator for consideration for approval.

If drilling, bulk sampling or costeaning activities are proposed, the RMP must include a plan to monitor potential worker radiation exposure, including the inhalation of dust that contains NORs during drilling, exposure to gamma rays from bulk samples, or the potential for internal doses from radon and radon progeny in deep excavations (greater than three metres).

The RMP must include a commitment to return the disturbed area of the operation to pre-existing radiological conditions, including the disposal of samples returned to the site.

A radiation safety officer (RSO) (exploration) must be appointed for an advanced exploration operation as outlined in Section 5.4.

### Brownfields exploration

Brownfields exploration activities must be included in the RMP for the mining operation.

In the event that an RMP has not been previously submitted and approved, the requirements of Section 3.1 apply, and an RSO must be appointed as outlined in Section 5.3.

### Exploration operations that progress to mine development

**WHS Mines Regulations r. 675UC**

Information about commencement of non-exploration mining operations

If exploration operations transition to development of a mining operation, the WHS Mines Regulations require the prospective mine operator to provide the regulator with a mining commencement notice in a [*Notice of information about non-exploration mining operation* form](https://www.wa.gov.au/government/publications/notice-of-information-about-non-exploration-mining-operations) (MON-2).

If the criteria for radioactive materialsand relevant mines are met, the risk of encountering NORs must be indicated on the mining commencement notice (MON‑2) in Part E: Information about the management of risk.

In many cases the concentrations of NORs will increase as a result of mining and mineral processing activities, and may differ significantly from those in the untreated lithology. An additional assessment will be required and the development of a formal RMP, based on the radiation exposure risk, will be necessary.

## 3.2 Tier 2: Low radiation exposure risk operations

A low radiation exposure risk operation is one in which secular equilibrium of the thorium and/or uranium decay series has been preserved, and:

* radioactive materials are encountered in products or at one or more of the mining, mineral processing, or residue and waste management operations
* radiation doses are generally less than the relevant mine criteria, but a worst-case exposure scenario indicates annual doses to
  + one or more cohorts of workers can approach 2 mSv, or
  + critical groups exceed 0.5 mSv.

The contents of an RMP for low radiation risk exposure mining operations are outlined in Section 4.3.

A radiation safety officer (restricted) is to be appointed for a low radiation exposure risk mining operation as is outlined in Section 5.5.

## 3.3 Tier 3: Restricted radiation exposure risk operations

A restricted radiation exposure risk operation is one in which secular equilibrium of the thorium and uranium decay series **has been disturbed**, and distinct practises of the mining operations have the potential to concentrate NORs such that:

* radioactive materials are present in known and specific sections of the mining operation, and
* radiation doses to the majority of the workforce are less than the relevant mine criteria, but a worst-case exposure scenario indicates that workers involved in the distinct practisemay receive an annual dose that exceeds 1 mSv.

Examples of distinct practises include water treatment and reverse osmosis plants, accumulation of radionuclides in waste streams, and deposition of radioactive scale inside processing vessels.

The parts of the mining operation in which radioactive materials are not present may be subject to an exemption. As outlined in Section 1.3, the onus is on the mine operator to demonstrate that Part 10.2, Division 3, Subdivision 3B should not apply.

The RMP requirements for a restricted radiation exposure risk operation are outlined in Section 4.4.

The RMP for a restricted radiation exposure risk mining operation will be limited to the specific section(s) of the mining operation affected by the distinct practise,and will not apply to sections of the mining operation where radioactive materials are not present. The onus is on the mine operator to demonstrate that Part 10.2, Division 3, Subdivision 3B should not apply (see Section 1.3).

A radiation safety officer (restricted) is to be appointed for a restricted radiation exposure risk mining operation as is outlined in Section 5.5.

If radioactive materials that are not related to a distinct practise are present in the mining operation, a more complex RMP and the appointment of an RSO (relevant mine) will be required.

## 3.4 Tier 4: Moderate radiation exposure risk operations

A moderate radiation exposure risk operation is one in which radioactive materials are encountered in products or at one or more of the mining, mineral processing, or residue and waste management operations, and either:

* annual radiation doses to most workers are generally less than 2 mSv, but a worst-case exposure scenario indicates annual doses to
  + one or more cohorts of workers can approach 5 mSv, or
  + critical groups exceed 0.5 mSv
* bulk residues or wastes generated by the mining operations do not exceed an activity concentration of 10 Bqg-1.

It is important that the state of secular equilibrium of the thorium and uranium decay series for all products and at each stage of the mining, mineral processing, or residue and waste management operation is stated, and has been considered in the dose assessment process.

The contents of an RMP for moderate radiation risk exposure mining operations are outlined in Section 4.5.

## 3.5 Tier 5: Elevated radiation exposure risk mining operations

An elevated radiation exposure risk operation is one in which radioactive materials are encountered in products or at one or more of the mining, mineral processing, or residue and waste management operations, and:

* annual radiation doses to most of the workforce are generally less than 5 mSv, but a worst-case exposure scenario indicates annual doses to
  + one or more cohorts of workers can exceed 5 mSv, or
  + critical groups approach or exceed 1 mSv, and
* bulk residues or wastes generated by the mining operations exceed an activity concentration of 10 Bqg-1.

The contents of a RMP for elevated radiation risk exposure mining operations are outlined in Section 4.6.

## 3.6 Decision matrix

The radiation risk-based decision process to determine which tier of RMP is required is illustrated in Appendix 3.

# 4 Detail required in the radiation management plan

**WHS Mines Regulations r. 641N**

Radiation management plan

**WHS Mines Regulations r. 641O**

Radioactive waste management plan

The level of detail an RMP should include depends on the activity concentration of the NORs, the identified or estimated risk of potential radiation exposures or impact on the environment, and the expected difficulty of controlling exposures.

For example, a greenfield exploration project’s RMP is not expected to be as detailed as one for a mining and mineral processing operation.

As outlined in Section 2.1, where applicable, the RMP must be supplemented by a separate RWMP that complies with Clause 2.8.2 of RPS-9:

* Tier 4 and Tier 5 radiation risk exposure operations will require the submission and approval of an applicable RWMP
* Lower Tier operations may require the submission and approval of an RWMP, as directed by the regulator.

The RMP should be a ‘controlled’ document, allocated a specific document identifier (unique reference number relevant to the operation) and submitted to the regulator by the exploration manager for an exploration operation or the site senior executive (on behalf of the mine operator) for a mining operation.

## 4.1 Common details required in all RMPs

Regardless of the radiation exposure risk associated with an exploration or mining operation, all RMPs must comply with Section 2.3, and must include:

* a cover sheet with
  + the document title
  + the date of submission to the regulator
  + the name of the company and operation
  + the Safety Regulation System (SRS) site group reference
  + the operation’s EON or MON-2 reference number
  + if applicable, the previous RMP the current submission replaces
  + the revision history of the document
  + signed endorsement by the exploration manager or site senior executive (on behalf of the mine operator) and the person (nominally the RSO) who compiled the RMP
* a table of contents
* the name and address of the mine operator
* the name and email address of the company representative the Department should correspond with
* the scope of the RMP, including
  + the reference of the applicable lease(s), tenement(s) or other land title(s)
  + the project’s location, including the shire and distance to the nearest town and critical group
  + the specific operations/facilities described in the document, for example exploration, surface mining, underground mining, mineral processing, smelting, refining or waste disposal
* a brief history of the site’s ownership (e.g. lease, tenement)
* a statement including the sources of radiation exposure, and the risk level (Tier 1 to 5, see Section 3), the proponent forecasts, and the basis for the judgement.

### Initial RMP submission

If the RMP is the first to be submitted for a specific mining operation, it must also include commitments to:

* conduct a baseline monitoring program, and provide the required information to the regulator before mining operations commence
* develop and submit an RWMP to the regulator for approval
* review the radiation exposure risk as the results of the annual monitoring plan become available.

## 4.2 Details required in an advanced exploration RMP (Tier 1)

The RMP for a Tier 1 operation must include:

* the details as listed in Section 4.1
* the expected duration and nature of the exploration operations
* the size of the workforce and the anticipated periods of exposure
* the appointment of a radiation safety officer (exploration)
* the average and maximum concentration of NORs encountered to date on the site (e.g. lease, tenement)
* a commitment to perform a baseline gamma survey (including the name and type of survey instrument) and provide the results to the regulator
* an estimate of average and maximum worker external doses from gamma radiation exposure
* methods used to minimise worker exposure to gamma radiation
* a commitment to inform third party analytical laboratories that samples from the exploration operation may contain NORs
* a commitment to return the gamma radiation levels at the site(s) of exploration activities to baseline levels.

If drilling or costeaning activities are scheduled to occur, the RMP must also include:

* an estimate of average and maximum internal doses arising from inhalation of dust at concentrations of 1 milligram per cubic metre (mg/m3) and 3 mg/m3
* an estimate of internal dose from radon, thoron and their progeny from costeaning operations and sample storage areas
* an estimate of effective dose arising from the applicable exposure pathways.

The radiological risk assessment will be quite straightforward and can be based upon time and motion studies rather than personal sampling conducted on workers.

If the exploration campaign will extend past six months, the RMP should consider the allocation of personal monitors for gamma exposure to the potentially most exposed workers.

## 4.3 Details required in a low radiation exposure risk mining RMP (Tier 2)

The RMP for a Tier 2 operation must include:

* the details listed in Section 4.1
* the nature of the mining operation/s (e.g. dredging, open pit, underground, processing plants, tailings storage)
* the size of the workforce, the allocation of workers to similar exposure groups, and the average and maximum annual working hours
* identification of the cohort(s) of workers most likely to receive the maximum radiation dose
* the appointment of a radiation safety officer (restricted)
* the average and maximum concentration of NORs encountered in products or the mining, mineral processing, or residue and waste management operations (as applicable)
* a radionuclide by mass balance for the inputs, products, residues and waste streams associated with the mining operations
* data that verifies that secular equilibrium of the NORs has been maintained
* estimates of the average and maximum worker effective doses from applicable pathways for each similar exposure group that include
  + a summary of the contribution from each exposure pathway
  + a statement as to how the doses were calculated
* an annual monitoring program that includes sufficient representative personal samples to make a statistically valid estimate of the doses received by the most exposed cohort(s) of workers, supplemented by sufficient monitoring to make evidence-based estimates of doses to the remainder of the workforce, based upon time and motion studies, and
  + details of the equipment to be used and the minimum detection levels of the equipment where applicable
  + a commitment to comply with the manufacturer’s instructions and any applicable Australian Standards
  + identify any third party that will analyse samples collected in the monitoring plan, and verify their credentials to provide the service
* methods used to minimise worker radiation exposures, including
  + identification of supervised and controlled areas
  + a commitment to train workers and contractors required to perform tasks in supervised or controlled areas
  + site inductions that include measures workers and others can implement to minimise their radiation exposures
* identification of critical groups, their location in relation to the mining operations and the potential annual effective doses, including the contribution from each exposure pathway.

## 4.4 Details required in a restricted radiation exposure risk mining RMP (Tier 3)

The RMP for a Tier 3 operation must include:

* the details listed in Section 4.1
* the nature of the mining operation
* the distinct practises that require the submission of the RMP
* data that verifies secular equilibrium of the NORs has been disturbed
* a radionuclide by mass balance for each distinct practise
* identification of the radionuclide(s) that are the most likely source of exposure, their concentration, and their potential behaviour in the environment in case of planned or accidental release
* exposure pathways (if inhalation or ingestion are potential sources of exposure, cite the applicable dose coefficients[[1]](#footnote-2))
* demographics of the cohort of workers involved in the distinct practise(s) (number of workers, estimated hours of exposure, applicable similar exposure group)
* appointment of a radiation safety officer (restricted)
* an annual monitoring program designed to ensure, or verify that, doses received by the most exposed cohort(s) of workers in each distinct practise are as low as reasonably achievable
* methods to ensure that the doses to workers conducting the distinct practise, and others, are minimised, including
  + identify the areas in which the distinct practises occurs
  + provide training to workers and contractors required to perform tasks in the distinct practise
  + site inductions that include measures workers and others can implement to minimise their radiation exposures
  + specific safe work procedures describing all measures associated with the management of the radiological hazards.

If disposal of potentially contaminated items of plant, equipment or wastes is proposed, a separate RMP addressing the removal, clearance levels, storage, transport and disposal of the materials must also be submitted to the regulator for approval. This will have the format and content of a Tier 4 or Tier 5 RMP, dependent on the radiation exposure risk of the disposal process.

## 4.5 Details required in a moderate radiation exposure risk mining RMP (Tier 4)

An RMP for a Tier 4 operation must include:

* the details listed in Sections 4.1 and 4.3
* a radionuclide by mass balance that clearly identifies the radiological properties of the various streams of inputs, intermediate and final products, residues and wastes
* a marked-up diagram, map or aerial photograph of the mining operation that identifies areas with potential for elevated exposure, using the radionuclide by mass (or volume) balance
* identification of any parts of the mining operation that are designated as supervised or controlled areas
* identification of the cohort of workers that may potentially receive annual effective doses greater than 5 mSv and personal identification of any worker whose annual exposure may exceed 10 mSv
* the appointment of an RSO (relevant mine)
  + If a new appointment is proposed, supply the candidate’s credentials in an appendix
  + if the candidate has been previously approved by the regulator, supply a copy of the formal approval issued by the regulator (or their predecessor) in the appendix
* an annual monitoring program, with the requirements of Section 4.3 expanded to ensure sufficient personal monitoring data is collected on all designated workers (workers with potential exposures greater than 5 mSv), to support a statistically valid estimate of personal doses
* a communication strategy to advise all designated workers
  + that their potential dose places them into the designated worker category
  + of the methods they can use to minimise their exposure
* details of the equipment used in the monitoring program, including calibration status, and method of calibration
* identification of any areas of the mining operation (if any) in which secular equilibrium has potentially been disturbed
* a commitment to apply a dose assessment procedure approved by the regulator as per r. 641Q (2)
* the dose conversion factors applied to the calculation of internal dose arising from inhalation of dust, including
  + for any areas in which secular equilibrium has been disturbed
  + the input parameters to the derivation of the dose conversion factors
* the dose coefficient for inhalation of isotopes of radon and their progeny, including the equilibrium factor used
* a monitoring program to calculate potential doses to critical groups, and if required, exposure controls to ensure compliance with the annual public dose limit
* links to the RWMP for the operation
* details about the induction and training course in radiation protection and exposure minimisation provided to workers (including contractors) and other people at the mining operation
* an overview of the systems used for record keeping, implementation and evaluation of exposure controls, calculation of doses, and reporting to workers and the regulator
* a commitment to verifying the effectiveness of the implementation of the RMP.
* an appendix listing the commitments made in the RMP.

As in Section 4.4, if the disposal of potentially contaminated items of plant, equipment and wastes is proposed, a separate RMP specifically addressing the removal, clearance levels, storage, transport and disposal of the materials must be submitted to the regulator for approval

## 4.6 Details required in an elevated radiation exposure risk mining RMP (Tier 5)

An RMP for a Tier 5 operation must include:

* all details outlined in Sections 4.1, 4.3 and 4.5
* an annual monitoring program that meets the requirements of Section 4.5, expanded to ensure sufficient personal monitoring data is collected on all workers with potential exposures of 3 - 5 mSv to support a statistically valid estimate of personal doses, and allow for trend analysis and intervention to ensure doses remain as low as reasonably achievable
* identification of all workers whose annual effective dose will potentially exceed 10 mSv, and the details of the personal monitoring program to effectively assess their dose
* detailed procedures designed to ensure workers whose doses potentially exceed 5 mSv are maintained as low as reasonably achievable
* evidence of the application of the hierarchy of control to minimise exposures to workers, especially those with the potential to exceed an annual effective dose of 5 mSv (refer to the [*How to manage work health and safety risks: Code of practice*](https://www.commerce.wa.gov.au/publications/code-practice-how-manage-work-health-and-safety-risks))
* evidence of the application of best practicable technology in the design of plant and equipment, and controls to maintain exposures to as low as reasonably achievable
* nomination of investigation levels which, if exceeded, will trigger an investigation into a source of exposure or reported dose
* use of instantaneous readout detection equipment in areas of the mine with the potential for elevated radiation exposures.

# 5 Radiation safety officers (RSOs)

**WHS Mines Regulations r. 641N**

Radiation management plan

**WHS Mines Regulations r. 675ZZK**

Regulator may approve courses for particular statutory positions

**WHS Mines Regulations Sch. 26 cl. 1**

Radiation safety officers

Protection of workers, members of the public and the environment from the potentially harmful effects of ionising radiation requires the application of principles drawn from several disciplines, including physics, chemistry, mathematics, biology, engineering, physiology, toxicology and environmental science. Because an RSO will work in mining, mineral processing or residue and waste management activities, an understanding of the principles of mining and mineral processing and experience in applying radiation protection to these sectors is considered essential.

Clause 2.7.2 (a) of RPS-9 states that the RMP must include ‘demonstrated access to appropriate professional expertise in radiation protection’. This requirement is elaborated in Clause 2.10.1 (d) of RPS-9 which requires the mine operator to:

ensure that appropriate expertise in the fields of radiation protection and radioactive waste management is available, and appoint a Radiation Safety Officer who has qualifications and experience acceptable to the relevant regulatory authority

Therefore, an RMP will only be approved by the regulator if a suitably qualified, experienced and competent RSO is appointed. If the RSO for a site changes, the relevant sections of the RMP must be resubmitted to the regulator for approval.

## 5.1 Appropriate expertise

The mine operator must ensure that appropriate expertise in radiation protection is available, and appoint an RSO who has qualifications and experience acceptable to the regulator.

The requirements in terms of appropriate expertise will be different for each exploration, mining or mineral processing operation, according to the scale of the operation and accompanying risks of radiation exposure.

This approach is reflected in Clause 3.10.1 of RPS-9, which states:

The operator has the responsibility to appoint an appropriately qualified Radiation Safety Officer (RSO). The requirements will change depending on the scale of the operation and concomitant risks of radiation exposure. Normally, an RSO is expected to have a degree in physical sciences or equivalent and some years of experience in radiation protection, preferably in the mining industry. The RSO is responsible for advising the operator on all matters relating to radiation protection of employees, members of the public and the environment, and for implementing the radiation management plan.

See Appendix 10 for further information on appropriate expertise.

## 5.2 A risk-based approach

The appropriate expertise required for an RSO will depend on the radiation exposure risk as outlined in Section 3.

There are three categories of roles related to radiation protection activities that apply to Western Australian mining operations with the potential for workers or members of the public to be exposed to NORs:

* radiation safety officer (exploration)
* radiation safety officer (restricted)
* radiation safety officer (relevant mine).

Two common requirements apply to all three categories:

* an undergraduate degree in an applicable science-based discipline
* successful completion of a course about radiation protection from naturally-occurring radioactive material the regulator considers is suitable for RSOs.

Each category of role related to radiation protection activities has additional requirements, as outlined in the following Sections.

## 5.3 Conditions of appointment

As has been outlined in this Section, the appointment of RSOs depends on the radiation exposure risk profile of a specific advanced exploration or mining operation.

It is a requirement that the mine operator, site senior executive or exploration manager nominates appropriate RSO in the RMP. However, if the radiation exposure risk profile of the operation changes the RMP must be revised, and a review of the nominated RSO will occur as a result.

Approval as the RSO at one mining operation will not constitute approval at another mining operation.

The person appointed to an RSO role must attain necessary licences as required under the Radiation Safety Act. Approval under Part 10.2, Division 3, Subdivision 3B does not necessarily constitute approval under the Radiation Safety Act.

If the appointment is rescinded for any reason, the site senior executive or exploration manager and the appointed individual performing the RSO role must advise the regulator as soon as practicable.

## 5.4 Radiation safety officer (exploration)

The role of RSO (exploration) applies to those advanced exploration operations which present Tier 1 and 2 (very low and low) radiation exposure potential as outlined in Section 3.

Generally, the conditions on Tier 1 and 2 advanced exploration operations are such that if radioactive materials are encountered, exposure periods are often of relatively short duration and doses to workers and members of the public are unlikely to exceed the 1 mSv criteria to be defined as a relevant mine.

The functions of the role are focussed on verifying and implementing simple dose minimisation controls such as the application of shielding, time and distance, and the effective use of dust controls.

Monitoring of exposure to external gamma radiation is expected, however estimates of internal dose are encouraged, but not mandated, unless directed by the regulator. If a direction is issued by the regulator, specialist assistance may be required for the collection and analysis of applicable representative samples.

A candidate for consideration will be required to demonstrate they have attained:

* an undergraduate degree in science, technology, engineering, mathematics, geology, geophysics or earth science
* a relevant Licence for use of X-ray Equipment and/or Electronic Products issued by an appropriate authority[[2]](#footnote-3)
* successful completion of an approved course for RSOs (exploration).

An approved RSO (relevant mine) or radiation safety officer (restricted) may be considered for the role of RSO (exploration) if they have attained the relevant Licence for use of X-ray Equipment and/or Electronic Products.

## 5.5 Radiation safety officer (restricted)

The role of radiation safety officer (restricted) applies to those mining operations which present low or restricted radiation exposure potential (Tier 2 or 3) as outlined in Section 3.

Because the radiological conditions on a Tier 2 or 3 mining operation may potentially meet the relevant mine criteria, the functions of the role is on verifying exposure controls are implemented and validating that they are effective. Dose assessments (when conducted) will be based upon similar exposure groups and will apply default parameters for the assessment of internal dose.

A candidate for consideration will be required to demonstrate they have attained:

* an undergraduate degree in science, technology, engineering, or mathematics; or occupational hygiene, workplace health and safety or similar with a curriculum that includes a significant component of hazard and risk management
* a relevant Licence for use of Radioactive Substances issued by an appropriate authority [[3]](#footnote-4)
* attainment of the competencies of a mine air quality officer
* successful completion of an approved course for radiation safety officer (restricted)
* completion of a professional development program in radiation protection in mining supervised and authenticated by an RSO (relevant mine).

Where a radiation safety officer (restricted) has been appointed, the RMP must nominate an appropriate person to provide them with specialist radiation protection. It is highly recommended that the appropriate person is, or is eligible for appointment as, an RSO (relevant mine).

## 5.6 Radiation safety officer (relevant mine)

**WHS Mines Regulations Sch. 6 cl. 1**

Radiation safety officers

As is explicitly required under Schedule 26 1(1) an RSO is required to be appointed for a relevant mine (any exploration or mining operation to which Part 10.2 Division 3 Subdivision 3B applies). The relevant mine criteria refers to moderate and elevated radiation exposure risk mining operations (Tiers 4 and 5).

The functions of appointed RSOs (relevant mine) include:

* advising the site senior executive or exploration manager of precautions to be taken to control the radiation doses people receive at the mine
* monitoring sources of radiation exposure
* assessing doses of radiation received by people (workers and members of the public) because of mining operations carried out at the mine.

To be considered for appointment as an RSO (relevant mine), the candidate must:

* have an undergraduate degree in science, technology, engineering or mathematics
* meet the eligibility requirements for a mine air quality officer outlined in Schedule 26 clause 4(3)
* have successfully completed a course about radiation protection from naturally-occurring radioactive material that is approved by the regulator
* have worked for at least 12 months under the supervision of an RSO
* have successfully completed an approved WHS risk management unit for RSOs
* have passed an applicable legislation examination for RSOs.

## 5.7 Appointment of part-time radiation safety officer

The time an RSO requires to fulfil their role will depend on the radiation exposure risk of the mining or exploration operation.

The radiological conditions on Tiers 1, 2 and 3 radiation exposure risk mining or advanced exploration operations may not warrant the appointment of a full-time RSO. An appropriately qualified and experienced person can be employed on a part time basis.

However, as the radiation exposure risk of the mining operation increases, the time commitment of the RSO will increase, to the point where a Tier 5 elevated radiation exposure risk mining operation may require the appointment of a full-time RSO (relevant mine).

Details of the time allocated to fulfil the radiation protection duties must be included in the RMP. The allocation may be expressed as a percentage of fulltime worker, hours or days per month, or another measure that officially commits time and resources to the mining and mineral processing operation.

## 5.8 Appointment of a contracted radiation safety officer

**WHS Act s. 26A**

Duty of persons conducting businesses or undertakings that provide services relating to work health and safety

In some circumstances it may not be reasonably practicable for a Tier 1, 2, 3 or 4 advanced exploration or mining operation to employ the requisite RSO as a member of its permanent workforce. In these cases, it may be appropriate for the regulator to approve the appointment of an appropriately qualified, skilled and experienced person from outside the organisation to provide the services under contract.

The mine operator, the site senior executive or exploration manager responsible for the appointment of the RSO must be conscious of their key functions, including:

advising the operator on all matters relating to radiation protection of employees, members of the public and the environment, and for implementing the radiation management plan (RPS-9, Clause 3.10.1).

The contract must be constructed in such a way as to allow the RSO to put the RMP into effect, whilst also performing the relevant functions as outlined in Schedule 26 cl. 1(2).

In practical terms the mine operator must ensure:

* the RSO is directly accountable to the site senior executive or exploration manager (whichever is applicable)
* sufficient time and resources are allocated to RSO to evaluate the effectiveness of measures to control radiation exposures, monitor sources of exposure and assess doses
* the development, implementation, revision and verification of the effectiveness of the RMP and any supporting procedures, such as
  + induction training
  + safe working procedures
  + methods for collecting and analysing samples and recording the results
  + assessment of doses to workers and members of the public
* annual radiation reports are prepared and submitted as required by the regulator
* compliance with Part 10.2, Division 3, Subdivision 3B.

The RMP must include details of the proposed time allocated to fulfil the radiation protection duties by the contracted RSO. This time commitment must provide the regulator with confidence that the RMP will be effectively implemented.

When considering an RMP that proposes the appointment of a contracted RSO, the regulator will evaluate the radiation exposure risk profile of the advanced exploration or mining operation and whether the time proposed to be allocated in the contract is sufficient to put the RMP into effect, while also being able to perform the relevant functions as outlined in Schedule 26 clause 1(2).

### Appointment of contracted radiation safety officers to relevant mines

Unless exceptional circumstances apply, such as the need for a short-term (less than 3 months) interim appointment due to an unforeseen absence of the approved RSO (relevant mine), the regulator will not approve an external contractor to the role RSO (relevant mine) for a Tier 5 mining operation.

An external contractor may be appointed as an RSO (relevant mine) to a Tier 4 mining operation, however if any worker annual dose is reported as exceeding 4 mSv, or an annual dose to a member of the public exceeds 0.5 mSv in the three-year period covered by the most current version of the RMP, the appointment must be revoked at the expiry of the three-year period, or at the direction of the regulator. An external contractor may be appointed to a maximum of two Tier 4 mining operations simultaneously.

### Conditions on the appointment of contracted radiation protection personnel

External contractors appointed to the RSO roles outlined in this Guide are to be appointed individually, and not as a representative of a company. The individual who is appointed to the statutory position, and is expected to implement the RMP, while also performing the relevant functions of an RSO.

The external contractor may engage the services of other people to collect samples or conduct analyses, however the individual external contractor and their PCBU (or the organisation they represent) are accountable for the performance of any other people they engage.

The external contractor may be appointed simultaneously in a radiation protection role for up to four mining operations, as defined by their site group status in SRS (or successors to SRS), and:

* + the appointments must be comply with the limit of two tier 4 mining operations
  + each nomination for appointment is to be made in an operation‑specific RMP submitted to the regulator for approval
  + each proposal for appointment will be considered on its own merits. A prior appointment to a radiation protection role as outlined in this document is persuasive to an additional appointment, but does not bind the regulator.

Individuals appointed as external contractors, and their PCBU (or the organisation they represent) are PCBUs that provide services relating to work health and safety, and the provisions of section 26A apply to the services they provide.

All correspondence, including RMPs and annual reports, between the external contractor and the regulator must be authorised in writing by the site senior executive or exploration manager.

# Appendix 1 – Glossary

|  |  |
| --- | --- |
| Term | Description |
|  |  |
| ARPANSA | Australian Radiation Protection and Nuclear Safety Agency |
| Control measure | In relation to a risk to health and safety, a measure to eliminate or minimise the risk. |
| Critical group | Defined in RPS-9 as ‘a group of members of the public comprising individuals who are relatively homogenous with regard to age, diet, and those behavioural characteristics that affect the doses received and who receive the highest radiation doses from a particular practice’ |
| Designated worker | A worker that works, or may work, under conditions so that the effective dose of radiation the worker receives may exceed 5 millisievert per year |
| Distinct practise(s) | Distinct practises of mining operations have the potential to concentrate NORs such that:   * radioactive materials are present in known and specific sections of the mining operation, and * radiation doses to the majority of the workforce are less than the relevant mine criteria, but a worst-case exposure scenario indicates that workers involved in the distinct practise may receive an annual dose that exceeds 1 mSv.   Examples of distinct practises include water treatment and reverse osmosis plants, accumulation of radionuclides in waste streams, and deposition of radioactive scale inside processing vessels. |
| EON (exploration operation notification) | The notification used by the prospective mine operator to [notify the regulator before exploration operations commence](https://www.wa.gov.au/government/publications/notification-of-commencement-of-exploration-operations#:~:text=The%20Work%20Health%20and%20Safety%20%28Mines%29%20Regulations%202022,notice%20of%20the%20commencement%20of%20the%20exploration%20operations.) |
| Exploration manager | A person appointed under r. 675ZM |
| GSR Part 1 | International Atomic Energy Agency’s (IAEA) *Governmental, legal and regulatory framework for safety: General safety requirements* (Rev.1, 2016) |
| Hazard | A situation or thing that has the potential to harm a person. Hazards at work may include: noisy machinery, a moving forklift, chemicals, electricity, working at heights, a repetitive job, bullying and violence at the workplace. |
| IAEA | International Atomic Energy Agency |
| MON-2 | Mining operational notice 2 - Notice of information about non-exploration mining operations |
| May | ‘May’ indicates an optional course of action. |
| Mine | A place at which mining operations are carried out. |
| Mine air quality officer | A person appointed to the statutory position set out in Schedule 26 clause 4 |
| Mining operations | Any method of working by which the earth or any rock structure, coal seam, stone, fluid, or mineral bearing substance is disturbed, removed, washed, sifted, crushed, leached, roasted, floated, distilled, evaporated, smelted, refined, sintered, pelletised, or dealt with for the purpose of obtaining any mineral or rock from it for commercial purposes or for subsequent use in industry, whether it has been previously disturbed or not; and includes exploration operations and developmental and construction work associated with opening up or operating a mine – see WHS Mines Regulations r. 5B for full definition and exclusions. |
| Mine operator | A person (including a partnership, syndicate or other association of persons) who:   * in relation to a mine where only exploration operations are being carried out, has overall control and supervision of the exploration operations at the mine and the exploration manager appointed for those operations   otherwise is the proprietor, lessee, or occupier of a mine and who has overall control and supervision of the mine and mining operations at the mine. |
| MSMS | Mine safety management system. |
| Must | ‘Must’ indicates a legal requirement exists that must be complied with. |
| NDRP | The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) *National directory for radiation protection* (2nd Edition, 2021) |
| NOR | Naturally occurring radionuclides |
| NORM | Naturally occurring radioactive material |
| Person conducting a business or undertaking (PCBU) | A PCBU is an umbrella concept, which intends to capture all types of working arrangements or relationships. A PCBU includes a:   * company * unincorporated body or association * WHS service provider * sole trader or self-employed person.   A reference to a PCBU in the WHS Regulations is deemed to be a reference to a mine operator where it is relevant.  Individuals who are in a partnership that is conducting a business will individually and collectively be a PCBU.  A volunteer association (defined under the WHS Act) or elected members of a local authority will not be a PCBU. |
| RSO | Radiation safety officer |
| RMP | Radiation management plan. |
| RPS-9 | ARPANSA *Radiation Protection Series 9 - Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (2005) |
| RWMP | Radioactive waste management plan. |
| Radioactive material | Materials that have an activity concentration that exceeds 1 Becquerel per gram (Bqg-1), and:   * exhibit radioactivity * emit ionising radiation particles * contain NORs. |
| Regulator | WorkSafe Commissioner |
| Relevant mine | A mine is a relevant mine if minerals or radioactive materials with an activity concentration criteria of 1 Bqg -1 or more are mined at the mine, and annual doses of radiation from the mining operations are likely to exceed either:  • 1 millisievert (mSv) for workers  • 0.5 mSv for members of the public at, or in the vicinity of the mine. |
| Risk | The possibility harm (death, injury or illness) might occur when exposed to a hazard. |
| SRS | Safety Regulation System |
| Should | ‘Should’ indicates a recommended course of action. |
| Similar exposure group | A cohort of workers with similar expected exposure profiles to NORs.  A similar exposure group can be defined based on duties, hazards to which the workers are exposed, the duration and concentration of exposure and controls in place to manage hazards |
| Statutory positions | Schedule 26 of the WHS Mines Regulations provides the requirement for the following statutory positions, where applicable:   * radiation safety officers * noise officers * statutory supervisors * mine air quality officers * electrical supervisors * high voltage operators * underground managers * underground supervisors * underground ventilation officers * authorised mine surveyors (underground & quarry operation) * winding engine drivers * quarry managers. |
| Worker | Any person who carries out work for a person conducting a business or undertaking, including work as an employee, contractor or subcontractor (or their employee), self-employed person, outworker, apprentice or trainee, work experience student, employee of a labour hire company placed with a 'host employer' or a volunteer. |
| Workplace | Any place where work is carried out for a business or undertaking and includes any place where a worker goes, or is likely to be, while at work. This may include offices, factories, shops, construction sites, vehicles, ships, aircraft or other mobile structures on land or water. |

# Appendix 2 – Developing an RMP

The information and checklists in the following appendices can assist to determine which Tier of radiation management plan applies to an exploration or mining operation, the relevant details to be included, and the skills and experience required to be an RSO for the operation.

In order to expedite the review process by regulator, submit the checklist and record the relevant page number within the RMP.

Ensure that where a combination of checklists are required, all relevant details have been completed.

Please note that additional site-specific issues may need to be included in the RMP. These will be considered on an as-needs basis by the regulator.

# 

# Appendix 3 – Decision matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Tier** | **Descriptor** | **Annual Dose Range (mSv)** | | **Secular**  **equilibrium** | **Conditions** | **Typical activities** |
| **Mean** | **Worst case** |
| - | Greenfields exploration | < 0.5 | < 1.0 | Assumed intact | Mineral sands, tantalite rare earths or uranium exploration | * Rock chipping * Small volume field samples |
| 1 | Very low risk | < 1 | ~ 1 | Assumed intact | * Radioactive materials may be encountered, but unlikely * Risk assessment attached to EON * Commitment to periodic review of NOR concentrations | * Brownfield exploration if RMP not required on established operations * Wet gravity concentration * Ports shipping < 10 B |
| 2 | Low risk | < 1 | 1–2 | Assumed intact | Relevant mine criteria met, but majority of doses are less than, but may approach 1 mSv | * Advanced exploration * Hard rock spodumene mining * Lithium processing * Garnet milling * Metallurgical laboratories * Ports shipping < 10 Bqg-1 minerals |
| 3 | Restricted | < 1 | 1–2 | Disturbed | * Relevant mine criteria met as a result of distinct practises * Majority of doses are less than, but may approach 1 mSv | * Reverse osmosis plants * Underground mines with radium‑contaminated steel parts * Mineral ‘finishing’ plants * Steel components in acid leach circuits |
| 4 | Moderate risk | < 2 | 1–5 | Confirmed intact or disturbed | * Relevant mine criteria met * Bulk residues < 10 Bqg-1 * Wastes < 10 Bqg-1 | * Mineral sands plants with low monazite content * Tantalum extraction * Ports shipping enhanced radionuclide minerals (e.g. zircon, monazite, xenotime) * In-situ uranium leaching * Zircon processing * Synthetic rutile production * Underground mines with radium-enriched waters (radon exposure) |
| 5 | Elevated risk | < 5 | > 5 | Confirmed intact or disturbed | * Relevant mine criteria met * Bulk residues > 10 Bqg-1 * Wastes > 10 Bqg-1 | * Monazite or xenotime production * Rare earth separation * Uranium mining and processing |

# Appendix 4 – Checklist for common elements and initial RMP submissions

## Common details

|  |  |  |
| --- | --- | --- |
| **Information required** | **Completed** | **Page #** |
| 1. A cover sheet that includes the: |  |  |
| * document title | 🞏 |  |
| * date of submission to the regulator | 🞏 |  |
| * name of the company and the operation | 🞏 |  |
| * SRS site group reference |  |  |
| * operation’s EON or MON reference number | 🞏 |  |
| * previous RMP the current submission replaces (if applicable) | 🞏 |  |
| * revision history of the document | 🞏 |  |
| * signed endorsement by exploration manager or site senior executive and the person (nominally the RSO) who compiled the RMP | 🞏 |  |
| 1. A table of contents | 🞏 |  |
| 1. The name and address of the mine operator, and name and email address of the company representative the Department should correspond with | 🞏 |  |
| 1. Scope of the radiation management plan, including the: |  |  |
| * reference of the applicable lease(s), tenement(s) or other land title(s) | 🞏 |  |
| * project’s location, including the shire and distance to the nearest town and critical group | 🞏 |  |
| * specific operations/facilities described in the document, for example exploration, surface mining, underground mining, mineral processing, smelting, refining or waste disposal. | 🞏 |  |
| 1. A brief history of the site’s ownership (e.g. lease, tenement) | 🞏 |  |
| 1. A statement including the sources of radiation exposure, and the risk level (Tier 1 to 5, see Section 3), the proponent forecasts, and the basis for the judgement | 🞏 |  |

## Initial RMP submission

|  |  |  |
| --- | --- | --- |
| **Commitments required** | **Completed** | **Page #** |
| 1. A plan for dealing with, and reporting incidents to, the regulator |  |  |
| 1. Conduct a baseline monitoring program, and providing the required information to the regulator before mining operations commence | 🞏 |  |
| 1. Develop and submit an appropriate RWMP to the regulator for approval | 🞏 |  |
| 1. Review the radiation exposure risk as the results of the annual monitoring plan become available | 🞏 |  |

# Appendix 5 – Checklist for an advanced exploration RMP (Tier 1)

These requirements are in addition to Appendix 4

|  |  |  |
| --- | --- | --- |
| **Information required** | **Completed** | **Page #** |
| 1. The expected duration and nature of the exploration operations | 🞏 |  |
| 1. The size of the workforce, and the anticipated periods of exposure | 🞏 |  |
| 1. The appointment of an RSO (exploration) | 🞏 |  |
| 1. The average and maximum concentration of NORs encountered (to date) on the site (e.g. lease, tenement) | 🞏 |  |
| 1. A commitment to perform a baseline gamma survey (including the name and type of survey instrument) and provide the results to the regulator | 🞏 |  |
| 1. An estimate of average and maximum worker external doses from gamma radiation | 🞏 |  |
| 1. Methods deployed to minimise worker exposure to gamma radiation | 🞏 |  |
| 1. A commitment to ensuring that third party analytical laboratories are informed that samples from the exploration operation may contain NORs | 🞏 |  |
| 1. A commitment to return the gamma radiation levels at the site(s) of exploration activities to baseline levels | 🞏 |  |
| **If drilling or costeaning activities are scheduled to occur, the RMP must also include:** | | |
| 1. An estimate of average and maximum internal dose arising from inhalation of dust at concentrations of 1 mg/m-3 and 3mg/m-3 | 🞏 |  |
| 1. An estimate of internal dose from radon, thoron and their progeny from costeaning operations and sample storage areas | 🞏 |  |
| 1. An estimate of effective dose arising from the applicable exposure pathways | 🞏 |  |

# Appendix 6 – Checklist for a low radiation exposure risk mining RMP (Tier 2)

These requirements are in addition to Appendix 4

|  |  |  |
| --- | --- | --- |
| **Information required** | **Completed** | **Page #** |
| 1. The nature of the mining operation/s (e.g. dredging, open pit, underground, processing plants, tailings storage) | 🞏 |  |
| 1. The size of the workforce, the allocation to similar exposure groups, and the average and maximum annual working hours | 🞏 |  |
| 1. Identification of the cohort(s) of workers most likely to receive the maximum radiation dose | 🞏 |  |
| 1. Appointment of a radiation safety officer (restricted) | 🞏 |  |
| 1. The average and maximum concentration of NORs encountered in the products or mining, mineral processing, or residue and waste management operations (as applicable) | 🞏 |  |
| 1. A radionuclide by mass balance for the inputs, products, residues and waste streams associated with the mining operations | 🞏 |  |
| 1. Data that verifies that secular equilibrium of the NORs has been maintained | 🞏 |  |
| 1. Estimates of the average and maximum worker effective doses from applicable pathways for each similar exposure group. The estimates to include: | 🞏 |  |
| * a summary of the contribution from each exposure pathway | 🞏 |  |
| * a statement as to how the doses were calculated | 🞏 |  |
| 1. An annual monitoring program that includes sufficient representative personal samples to make a statistically valid estimate of the doses received by the most exposed cohort(s) of workers; supplemented by sufficient monitoring to make evidence-based estimates of doses to the remainder of the workforce, based on time and motion studies, and | 🞏 |  |
| * details of the equipment to be used, and the minimum detection levels of the equipment where applicable | 🞏 |  |
| * a commitment to comply with the manufacturer’s instructions and any applicable Australian Standards |  |  |
| * identify any third party that will analyse samples collected in the monitoring plan, and verify their credentials to provide the service | 🞏 |  |
| 1. Methods used to minimise worker radiation exposures, including: | 🞏 |  |
| * identification of supervised and controlled areas | 🞏 |  |
| * a commitment to train workers and contractors required to perform tasks in supervised or controlled areas | 🞏 |  |
| * site inductions that include measures workers and others can implement to minimise their radiation exposures | 🞏 |  |
| 1. Identification of critical groups, their location in relation to the mining operations and the potential annual effective doses, including the contribution from each exposure pathway | 🞏 |  |

# Appendix 7 – Checklist for a restricted radiation exposure risk mining RMP (Tier 3)

These requirements are in addition to Appendix 4

|  |  |  |
| --- | --- | --- |
| **Information required** | **Completed** | **Page #** |
| 1. The nature of the mining operation/s | 🞏 |  |
| 1. The distinct practises that require the submission of the RMP | 🞏 |  |
| 1. Data that verifies secular equilibrium of the NORs has been disturbed | 🞏 |  |
| 1. A radionuclide by mass balance for each distinct practise | 🞏 |  |
| 1. Identification of the radionuclide(s) that are the most likely source of exposure and their concentration | 🞏 |  |
| 1. Exposure pathways (if inhalation or ingestion are potential sources of exposure, cite the applicable dose coefficients) | 🞏 |  |
| 1. Demographics of the cohort of workers involved in the distinct practise(s) (i.e. number of workers, estimated hours of exposure, applicable similar exposure group) | 🞏 |  |
| 1. Appointment of a radiation safety officer (restricted) | 🞏 |  |
| 1. An annual monitoring program designed to ensure doses received by the most exposed cohort(s) of workers in each distinct practise are as low as reasonably achievable | 🞏 |  |
| 1. Methods to ensure that the doses to workers conducting the distinct practise, and others, are minimised, including: | 🞏 |  |
| * identify the areas in which the distinct practise occurs | 🞏 |  |
| * provide training to workers and contractors required to perform tasks in the distinct practise(s) | 🞏 |  |
| * site inductions that include measures workers and others can implement to minimise their radiation exposures | 🞏 |  |
| * specific safe work procedures describing all measures associated with the management of the radiological hazards | 🞏 |  |

# Appendix 8 – Checklist for a moderate radiation exposure risk mining RMP (Tier 4)

These requirements are in addition to Appendix 4

| **Information required** | **Completed** | **Page #** |
| --- | --- | --- |
| 1. A radionuclide-by-mass balance that clearly identifies the radiological properties of the various streams of inputs, intermediate and final products, residues and wastes | 🞏 |  |
| 1. A marked-up diagram, map or aerial photograph of the mining operation that identifies areas with potential for elevated exposure, using the radionuclide by mass (or volume) balance | 🞏 |  |
| 1. Identification of any parts of the mining operation that are designated as supervised or controlled areas | 🞏 |  |
| 1. Identification of the cohort of workers that may potentially receive annual effective doses greater than 5 mSv and personal identification of any worker whose annual exposure may exceed 10 mSv | 🞏 |  |
| 1. Appointment of an RSO (relevant mine): | 🞏 |  |
| if a new appointment is proposed, supply the candidate’s credentials in an appendix | 🞏 |  |
| if the candidate has been previously approved by the regulator, supply a copy of the formal approval issued by the regulator (or their predecessor) in the appendix | 🞏 |  |
| 1. An annual monitoring program, with the requirements of Section 4.3 expanded to ensure sufficient personal monitoring data is collected on all designated workers (workers with potential exposures greater than 5 mSv), to support a statistically valid estimate of personal doses | 🞏 |  |
| 1. A communication strategy to advise all designated workers | 🞏 |  |
| * that their potential dose places them into the designated worker category |  |  |
| * of the methods they can use to minimise their exposure |  |  |
| 1. Details of the equipment used in the monitoring program, including calibration status, and method of calibration | 🞏 |  |
| 1. Identification of any areas of the mining operation (if any) in which secular equilibrium has potentially been disturbed | 🞏 |  |
| 1. A commitment to apply a dose assessment procedure approved by the regulator as per r.641Q(2) | 🞏 |  |
| 1. The dose conversion factors applied to the calculation of internal dose arising from inhalation of dust, including: | 🞏 |  |
| * for any areas in which secular equilibrium has been disturbed | 🞏 |  |
| * the input parameters to the derivation of the dose conversion factors | 🞏 |  |
| 1. The dose coefficient for inhalation of isotopes of radon and their progeny, including the equilibrium factor used | 🞏 |  |
| 1. A monitoring program to calculate potential doses to critical groups, and if required, exposure controls to assure compliance with the annual public dose limit | 🞏 |  |
| 1. Links to the RWMP for the operation | 🞏 |  |
| 1. Details about the induction and training course in radiation protection and exposure minimisation provided to the workforce (including contractors) and other people at the mining operation | 🞏 |  |
| 1. An overview of the system used for record keeping, implementation and evaluation of exposure controls, calculation of doses, and reporting to workers and the regulator | 🞏 |  |
| 1. A commitment to verifying the effectiveness of the implementation of the RMP | 🞏 |  |
| 1. An appendix listing the commitments made in the RMP | 🞏 |  |

# Appendix 9 – Checklist for an elevated radiation exposure risk mining RMP (Tier 5)

These requirements are in addition to Appendix 4

|  |  |  |
| --- | --- | --- |
| **Information required** | **Completed** | **Page #** |
| 1. An annual monitoring program that meets the requirements of Section 4.5, expanded to ensure sufficient personal monitoring data is collected on all workers with potential exposures of 3 - 5 mSv to support a statistically valid estimate of personal doses, and allow for trend analysis and intervention to ensure doses remain as low as reasonably achievable | 🞏 |  |
| 1. Identification of all workers whose annual effective dose will potentially exceed 10 mSv, and the details of the personal monitoring program to effectively assess their dose | 🞏 |  |
| 1. Detailed procedures designed to ensure workers whose doses potentially exceed 5 mSv are maintained as low as reasonably achievable | 🞏 |  |
| 1. Evidence of the application of the hierarchy of control to minimise exposures to workers, especially those with the potential to exceed an annual effective dose of 5 mSv | 🞏 |  |
| 1. Evidence of the application of best practicable technology in the design of plant and equipment, and controls to maintain exposures as low as reasonably achievable; | 🞏 |  |
| 1. Nomination of investigation levels which, if exceeded, will trigger an investigation into a source of exposure or reported dose | 🞏 |  |
| 1. Use of instantaneous readout detection equipment in areas of the mine with the potential for elevated radiation exposures | 🞏 |  |

# Appendix 10 – Radiation safety officer (RSO) requirements

The RMP should describe the management and reporting structure for the particular site, and the duties and qualifications of relevant personal and, in particular, the RSOs performing radiation protection duties.

The RMP should also include a clear commitment to provide adequate staff with appropriate qualifications and experience, and availability to collect the data required to perform dose assessments, evaluate exposure controls and advise the site senior executive or exploration manager on all aspects of radiation protection on the site.

## Qualifications

A prerequisite to formal approval as an RSO for a mining and/or minerals processing operation that uses or handles NORM is (as a minimum) the successful completion of an undergraduate degree in a relevant technical discipline that has, at its core, physics, chemistry, mathematics, environmental science or engineering.

To perform the complex calculations required to compile dose assessments, the RSO must have a firm grasp of advanced mathematical principles. As an exploration operation *may* have a reduced requirement for high level mathematics, is not always necessary for the RSO to be able to perform all the calculations expected of an RSO (relevant mine). This reduced requirement is entirely dependent on the hazard and risk profile of the exploration operation.

All categories of RSO are required to successfully complete a course about radiation protection from naturally-occurring radioactive material that is approved by the regulator under regulation 675ZZK (1)(a) of the WHS Mines Regulations.

Because internal dose from long-lived alpha emitting radionuclides in dust is an important exposure pathway, the RSO (relevant mine) must have attained the pre-requisite criteria to be appointed as a mine air quality officer.

It is advisable that the individual attends and successfully completes the ‘Fixed Radiation Gauges’ training course and initially becomes the RSO for fixed gauges.

## Experience

There are two principal aspects of experience, which an RSO must possess. These are technical experience and relevant background:

**Technical experience**

An RSO must be thoroughly conversant with the various radiation monitoring and recording techniques approved by the regulator, as well as with the appropriate reporting protocols.

As per Schedule 26 clause 1(3)(d), a nominee for the role of RSO (relevant mine) must have 12 months’ practical experience in radiation protection activities under the direct supervision of an existing approved RSO (relevant mine). Although not mandatory, it is deemed best practice for the mine operator to nominate the candidate for appointment, and provide a learning and development program to the regulator.

For potential new RSOs with exceptional qualifications and/or experience in radiation safety, the supervision period may be revised to less than 12 months if the appointment is to be made to a Tier 1, 2 or 3 operation.

In other circumstances, particularly if the nominee is to be appointed as an RSO (relevant mine) at a Tier 5 operation, the supervision period may be extended beyond the 12 month period nominated in Schedule 26 clause 1(3)(d).

**Relevant background**

Protection of workers, public and the environment from potentially harmful effects of ionising radiation requires an understanding of many disciplines.

In the case of mining and mineral processing in Western Australia, technical areas such as physics, metallurgy and process control are required for the theoretical planning and implementation phase of the RMP.

Once operations commence, a skill set in occupational hygiene complemented by general understanding of other relevant disciplines is considered ideal for the monitoring, data analysis and reporting of radiation monitoring data.

It is highly recommended that the RSO has previous employment history and/or experience in an exploration, mining and/or processing environment.

**Legislative framework(s)**

It is expected that all categories of RSO are conversant with all Western Australian legislation, and national documents that are cited in, or influence, the State’s legislative framework for radiation safety in mining and mineral processing operations.

Where applicable, the RSO should also be able to demonstrate familiarity with international publications, especially those from the International Commission for Radiological Protection and IAEA that are cited in, or influence the Australian radiation protection legislative framework.

Approved/authorised RSO’s from jurisdictions outside Western Australia are required to demonstrate that they are conversant with the Western Australian framework and methodologies enshrined in the series of NORM guides.

## Continuous professional development

It is strongly recommended that an RSO (relevant mine) commits to continuously update their skills and knowledge, for example, as:

* regulatory documents, including applicable national and international guides, are reviewed and amended
* new radiation monitoring equipment becomes available
* new monitoring methods are proposed and implemented
* dose conversion factors for assessments of internal radiation exposures change based on the latest research
* new software for assessment of radiological impact on the environment becomes available and is updated.

## Appropriate resources

The RMP should also list the resources required to implement the sampling and monitoring program, including the:

* make and model of sampling and monitoring equipment
* calibration methods, frequency, and traceability to a primary standard
* maintenance and replacement schedule
* examples of warning signs used on site and their locations.

# Appendix 11 – Information for radiation safety officers appointed under the *Mines Safety and Inspection Act 1994*

Under the former Mines Safety and Inspection Regulations 1995, specifically r.16.9(2), radiation safety officers were required to have qualifications and experience satisfactory to the State mining engineer. If candidates nominated for the role of RSO met the criteria as listed in Appendix B of NORM Guideline 1, they were approved by the State mining engineer.

New and updated titles

The title radiation safety officer (exploration) was inferred in the previous approval process, but was not widely applied. Inclusion in this Guide formalises recognition of the title.

The title radiation safety officer (restricted) is an addition to the previous approval process, and reflects the risk based approach.

Under the *Mines Safety and Inspection Act 1994* and Regulations, a candidate who met the criteria outlined in Appendix B of *NORM Guideline 1: Applying the system of radiation* *protection to mining operations*, and received approval from the State mining engineer in accordance with regulation 16.9 was deemed as a Radiation Safety Officer (NORM). The title radiation safety officer (relevant mine) replaces the title Radiation Safety Officer (NORM)

# Appendix 12 – References

1. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) *National directory for radiation protection* (2nd Edition, 2021) (NDRP)
2. Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) *Radiation Protection Series 9 - Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing* (2005)(RPS-9)
3. International Atomic Energy Agency (IAEA) *Governmental, legal and regulatory framework for safety: General safety requirements* (Rev.1, 2016) (GSR Part 1)
4. International Atomic Energy Agency (IAEA) *Radiation protection and safety of radiation sources: International basic safety standards* (GSR Part 3)

1. Refer to NORM-V for applicable dose coefficients [↑](#footnote-ref-2)
2. In Western Australia this is the Western Australian Radiological Council [↑](#footnote-ref-3)
3. In Western Australia this is the Western Australian Radiological Council [↑](#footnote-ref-4)