



Guidance Note QGN12

Radiation protection from naturally occurring radioactive materials (NORM) during exploration

*Coal Mining Safety and Health Act 1999
Mining and Quarrying Safety and Health Act 1999*

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Guidance Note – QGN12

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This Guidance Note has been issued by the Mines Inspectorate of the Department of Mines and Energy. It is not a 'Guideline' as defined in the *Coal Mining Safety and Health Act 1999* or the *Mining and Quarrying Safety and Health Act 1999*. In some circumstances, compliance with this Guidance Note may not be sufficient to ensure compliance with the requirements of the legislation.

Guidance Notes may be updated from time to time. To ensure you have the latest version, check the Department of Mines and Energy website

http://www.dme.qld.gov.au/mines/safety_health.html or contact your local Inspector of Mines.

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1. Purpose and scope

This Guidance Note is provided to assist persons to meet their obligations under the Queensland *Coal Mining Safety and Health Act 1999* and the *Mining and Quarrying Safety and Health Act 1999*, to protect the safety and health of mine workers and those affected as a result of exploration. This specifically relates to radiation protection and radioactive waste management on exploration sites. It is not a 'Guideline' as defined in the *Coal Mining Safety and Health Act 1999* or the *Mining and Quarrying Safety and Health Act 1999*. In some circumstances, compliance with this Guidance Note may not be sufficient to ensure compliance with the requirements of the legislation.

Radiation safety in Queensland is regulated under the *Radiation Safety Act 1999* and the Radiation Safety Regulation 1999, administered by the Queensland Department of Health. This legislation is accessible on the internet (see references). On exploration sites, this legislation applies, for example, to the control of man made radioactive substances, such as the isotope sources used in exploration such as bore hole logging. Under this legislation, industry is subject to fees and licensing, obligations when acquiring, storing and disposing of sources, and requirements for radiation safety and radiation protection plans.

Naturally occurring radioactive minerals being mined or processed on mining leases or land the subject of mineral development licences or exploration permits are not regulated by the above radiation legislation. This area is regulated under the *Coal Mining Safety and Health Act 1999* and the *Mining and Quarrying Safety and Health Act 1999*, administered by the Mines Inspectorate, Department of Mines and Energy. It must be noted however, once the aforementioned minerals are no longer within the boundaries of land the subject of a mining lease, mineral development licence or exploration permit within the definitions of the *Mineral Resources Act 1989*, they are regulated by the *Radiation Safety Act 1999*. Under this legislation they are then referred to as "mineral substances".

Under the mining safety and health legislation, (see section 3, referenced legislation), the site senior executive has an obligation to develop and implement a safety and health management system, ensuring that the site controls the risk to an acceptable level. This system must address the scenario of a person in a mine's workings or local environment being exposed to radiation, at above dose limits, from a naturally occurring radioactive mineral at the mine. The Mining and Quarrying Safety and Health Regulation 2001, 'Schedule 5 General exposure limits for hazards' specifies ionising radiation dosage limits. It must be noted that the National Standard for Limiting Occupational Exposure to Ionizing Radiation (republished by ARPANSA in 2002) which can be found at <http://www.arpansa.gov.au/pubs/rps/rps1.pdf> shall be the reference for occupational and public dose limits.

The radiation dose limit for a member of the general public is 1mSv per year above background.

2. Radiation protection and radioactive waste management in exploration.

2.1 The Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)

This code, available at <http://www.arpsa.gov.au/pubs/rps/rps9.pdf>, has been agreed by all states and territories under arrangements made by the Council of Australian Governments (COAG).

The system prepared for the safe management of radiation emanating from minerals during exploration shall comply with the above code, to the extent the provisions are consistent with the Mining Acts and Regulations. This would exclude the following sections of the code:

- Section 2.4 Exemptions
- Requirement for approval by the relevant regulatory authority in Sections 2.7.1, 2.8.1, 2.10.1 (c), 2.10.1 (d),
- Section 2.9 Approvals and Authorisations.

To clarify requirements for exploration, specific guidance material is provided as follows:

2.2 Exploration

2.2.1 Risk assessment

Exploration crews are potentially at risk of radiation exposures. Consequently, all mineral exploration and mining activities need to be assessed to establish whether the amount of radioactivity encountered in the operation will be of concern. This may necessitate a test being performed on the minerals to ensure that the radiation levels are not problematic.

Thorium-232 and uranium-238 are the 'parents' of a series of radioactive elements called 'daughters' which emit alpha (α), beta (β), and gamma (γ) radiation.

According to the Code of Practice, the activity concentration of 1 Bq/g is currently the internationally-accepted level for defining the scope of regulation for naturally occurring materials containing uranium and thorium. For example, if 0.008%, or 80ppm, of uranium ore has an activity concentration of 1 Bq/g then this will be the trigger to conduct further assessment. Where 0.025 % or 250ppm thorium has an activity concentration of 1 Bq/g this will also require further assessment.

At activity concentrations less than 1 Bq/g, these minerals would be considered inherently safe. At higher activity concentrations, the site shall be assessed on a case by case basis and the activities may also be determined as being inherently safe, e.g. if the source of the radionuclides are insoluble or immobile.

Based on results from above, the site shall assess the risk. Where it is likely that the potential dose may exceed the member of the general public dose limit, a comprehensive risk assessment should be carried out and controls be implemented according to the level of risk.

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| | Member of the General Public ¹ | Non-Designated Employee ² | Designated Employee ² |
|------------------------------------|---|--------------------------------------|---|
| Radiation dose limit | 1 mSv per year above background | 5 mSv per year above background | 20 mSv per year above background ³ |
| Dose Rate to reach limit | 0.11 µSv/hr above background | 2.5 µSv/hr | 10 µSv/hr |
| DAC for uranium ore ^{4,5} | N/A | 0.6 adps/m ³ | 2.4 adps/m ³ |
| DAC for thorium ore ⁴ | N/A | 0.2 adps/m ³ | 1.0 adps/m ³ |

Table: Radiation limits and dose rates to reach each limit working 2000 hours per year.

Notes

1. Radiation dose limits for Member of the General Public and Designated Worker adopted from Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), Radiation Protection Series No. 1.
2. "Designated employee" means an employee who works, or may work, under conditions such that the employee's annual effective dose equivalent might exceed 5 mSv. "Non-designated employee" means an employee who is not a designated employee.
(Source: *Western Australia Mines Safety and Inspection Regulations (s.16) 1995*).
3. 50 mSv in any one year and 100 mSv summed over 5-years.
4. DAC – Derived air concentration for 5 and 20 mSv over 2000 hrs of exposure. Workers are typically exposed to both external gamma radiation and dust from the ore.
5. DAC for uranium ore calculated from Table 1 in ARPANSA Radiation Protection Series No. 9.

2.2.2 Specific requirements

Based on the findings from risk assessment, exploration crews may receive radiation exposures from uranium, thorium and associated radioactive decay products in the drill and core cuttings. Although working with NORM from exploration poses a relatively low risk for external gamma exposure, there is potential for significant exposure to radiation from dust that is inhaled or ingested. NORM emits alpha and beta radiation, in addition to gamma radiation. When ingested or inhaled, there can be a ten fold increase in the damage it can cause, compared with gamma radiation. Therefore it is imperative that the site controls these potential exposure routes.

Exploration crews receive radiation exposures from:

- gamma radiation emitted from minerals containing uranium, potassium or thorium;
- the inhalation of radioactive dust;
- the ingestion of radioactive dust.

As discussed, the primary source of radiation exposure for a worker will be from inhaling or ingesting radioactive material. A worker's exposure via inhalation and ingestion is difficult to measure; hence precautions to prevent exposures via these routes shall be taken.

The radiation dose received by exploration crews will depend on:

- the grade of mineralisation;
- the amount of time spent by workers close to the mineralized drill core cuttings;
- the amount of mineralized drill core cuttings in the vicinity;
- the distance between workers and the drill core cuttings;
- the extent of personal exposure to airborne dust.

2.3 Radiation management plan

If the minerals on site contain a level of radioactivity which could pose a health hazard, operators should develop a radiation management plan which outlines procedures for monitoring and minimising radiation exposure to workers, the public and the environment. This plan should identify the specific risks associated with a project and detail how these risks will be managed.

Elements to be incorporated into the plan shall include:

- document control including company name, site, title, number, date, version and signed endorsement by Site Senior Executive
- scope
- introduction
- workforce information
- exposure group information such as hours of work, periods of exposure etc
- sources of potential exposure
- equipment and facilities for controlling exposure and preventative maintenance
- statement of commitment and roles and responsibilities for controlling the risk including implementation of the radiation management plan and ensuring that there is an appropriately trained and qualified radiation safety officer (RSO)
- description of the operational procedures and practices including;
 - designation and control of areas
 - general housekeeping and personal hygiene
 - operation of equipment, calibration, monitoring schedules
 - equipment list and calibration records
 - radiation, airborne dust, airborne uranium, airborne thorium and respirable crystalline silica monitoring program
 - dose assessment
 - standard operating procedures for critical control measures such as dust suppression
 - use of personal protective equipment including clean shaven policy
 - employee, contractor, visitor induction and employee training/contractor requirements
 - environment contamination controls
 - transport of NORM (samples etc)
 - records management and reporting
 - inspection and auditing programs to demonstrate that the plan is fully implemented
 - monitoring and review to evaluate the plans effectiveness.

For specific guidance within each element, refer to the code.

2.4 Radiation safety

Based on the level of risk, determined in 2.2.1, including the degree of radioactive mineralisation, consideration shall be made to assigning a site radiation safety officer. A radiological assessment of the minerals being explored at the site will be a primary indicator of whether radiation is a hazard which needs to be managed at the site. If it is, then the Mining Code shall be followed and the radiation safety officer (RSO) should be appropriately qualified to perform dose estimation, provide technical advice regarding radiation exposure, and control the exposure. The RSO shall also ensure that the radiation plan is fully implemented and also be responsible for reviewing the plan. (Advice on training is available from Queensland Radiation Health refer to <http://www.health.qld.gov.au/radiationhealth/>).

Employees and contractors shall receive general training in radiation safety, be aware of the risks of working with minerals containing elevated levels of radioactivity and the necessary steps to minimise their exposure.

If laboratory testing demonstrates that minerals have elevated levels of radioactivity, a portable radiation monitoring device should be available on site at all times to monitor radiation levels, including gamma and alpha activity, in drill core and dust. It is important that the equipment be properly maintained, calibrated, handled carefully to avoid contamination and only used by trained personnel. Poorly used or understood equipment can provide a false sense of security. If the equipment is not working properly it may indicate that no radioactivity is present when there might be.

Regular monitoring should be conducted and data recorded in a log.

Appropriate dust controls, including dust suppression and localised exhaust ventilation, will reduce the potential of inhaling dust. Where there is potential for exposure to inhalable dust (ie. during core cutting, intersecting ore), respiratory protective equipment (dust masks) shall be used. Dust masks are not required for wet mud drilling. Gloves and appropriate work clothing should be worn when using drilling equipment and handling ore samples to minimise any skin contamination.

Core sheds must be organised to limit the amount of mineralized core stored, and the use of mineralized core boxes as seats or benches is not recommended. Core sheds should be well ventilated.

Good hygiene practices are necessary, including hand washing prior to eating. The measures put in place shall be commensurate with the hazards on site determined in section 2.2.1. Where the hazards are present, consideration shall be made to making the site “clean in” “clean out”, with laundering and shower facilities being provided on site.

Worker exposure can be minimised by locating cores away from occupied areas and drillers assistants not carrying bags of sample close to their bodies.

Where employees are potentially exposed to radiation above 1mSv per annum, then personal exposure monitoring shall be considered. The type of monitoring will be commensurate with the risk assessment determination in 2.2.1. Where radiation monitoring is required, the site shall ensure that resources are available to store

dose records and reports for the appropriate period of time. Records of monitoring results, dose assessments including calculation methods and related information, should be retained in a form that will allow them to be retrieved.

2.5 Solid and liquid wastes

Mud pits should be allowed to dry and then be covered by one metre of compacted soil.

Solid cuttings should be returned to the drill hole. Where this is not possible, individual drill hole solid cuttings and samples should be buried in adjacent mud pits, if available, with at least one metre of compacted soil cover.

Bulk cuttings or samples (i.e. from multiple drill holes) should be mixed with soil to reduce any artificial concentration of the material and buried in a mud pit (or similar) with one metre of compacted soil cover.

Contaminated water shall be contained where there is potential for adverse effects from the water to persons or the environment both within and outside the mining lease.

2.6 Contaminated equipment

It is possible that some equipment may become contaminated with radioactive material and operators should ensure all equipment has been thoroughly cleaned to remove loose material before leaving site.

2.7 Transport

The transport of all radioactive materials to and from site, including radioactive mineral samples, should conform to the Code of Practice for Safe Transport of Radioactive Material 2001.

Sample material may be transported to laboratories or to permanent storage via road. Transport of these materials shall comply with the Code of Practice for Safe Transport of Radioactive Materials 2001, (referenced in the Australian Dangerous Goods Transport Code) and the Queensland Radiation Safety Regulation, which contains licensing requirements. However, licensing is only required if the mineral is deemed to be a radioactive substance as defined in the Queensland Radiation Safety Regulation 1999. For radioactive ores in Queensland this is unlikely.

The Code sets out rules for (i) labelling of packages containing radioactive materials; (ii) placarding of vehicles which transport them, and (iii) issue to driver of Consignor's Certificate describing the material being transported.

2.7.1 Excepted package

For an excepted package, the radiation level at any point on the external surface of an excepted package shall not exceed 5 μ Sv/h.

The measurement shall be taken on the surface of the package.

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Packages shall bear the marking "RADIOACTIVE" on an internal surface in such a manner that a warning of the presence of radioactive material is visible on opening the package.

In the case of minerals being transported, as an excepted package, the load/container will be marked only with 'UN2910'

The "RADIOACTIVE" sign however, is required to be visible when, for example, the tarp is taken from the top of the truck or when a container is opened. The word RADIOACTIVE must be visible upon opening the package.

3. Referenced Legislation

Coal Mining Safety and Health Act 1999

62. Safety and health management system

(3) The safety and health management system must be adequate and effective to achieve an acceptable level of risk by –

- (a) defining the coal mine operator's safety and health management policy; and
- (b) containing a plan to implement the coal mine operator's safety and health management policy; and
- (c) stating how the coal mine operator intends to develop the capabilities and support mechanisms necessary to achieve the policy; and
- (d) including principal hazard management plans and standard operating procedures; and
- (e) containing away of –
 - i) measuring monitoring and evaluating the performance of the safety and health management system; and
 - ii) taking the action necessary to prevent or correct matters that do not conform with the safety and health management system; and
- (f) containing a plan to regularly review and continually improve the safety and health management system so that risk to persons at a coal mine is at an acceptable level; and
- (g) if there is a significant change to the coal mining operations of the coal mine – containing a plan to immediately review the safety and health management system so the risk to persons is at an acceptable level.

Mining and Quarrying Safety and Health Act 1999

55. Safety and health management system

(3) The safety and health management system must be effective to achieve an acceptable level of risk by –

- (a) defining the mine operator's safety and health management policy; and
- (b) containing a plan to implement the mine operator's safety and health management policy; and
- (c) stating how the operator intends to develop the capabilities and support mechanisms necessary to achieve the policy; and
- (d) including procedures for the operations of the mine and standard work instructions
- (e) containing away of –

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- i) measuring monitoring and evaluating the performance of the safety and health management system; and
 - ii) taking the action necessary to prevent or correct matters that do not conform with the safety and health management system; and
- (f) containing a plan to regularly review and continually improve the safety and health management system so that risk to persons at a mine is at an acceptable level; and
- (g) if there is a significant change to the mining operations of the mine – containing a plan to review the safety and health management system so the risk to persons is at an acceptable level.

Mining and Quarrying Safety and Health Regulation 2001

Division 2 Managing risk from exposure to particular hazards

145 Radiation

(1) This section applies if a person in a mine's work or local environment is likely to be exposed, above acceptable limits, to radiation from a naturally occurring radioactive substance at the mine.

(2) The site senior executive must ensure—

- a) the mine has a system to provide for the safe management of the radiation; and
- b) the system is complied with.

Schedule 5 General exposure limits for hazards

schedule 7, definition general exposure limit

| Column 1 Hazard | Column 2 General exposure limit |
|--|--|
| atmospheric contaminant | the exposure standard assigned to the contaminant in NOHSC's document entitled 'Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment [NOHSC:1003]' |
| crystalline silica (cristobalite, quartz, tridymite) | 0.1mg/m ³ ^a |
| inspirable dust | 10mg/m ³ |
| ionising radiation | the dose limit stated in NOHSC's document entitled 'National Standard for Limiting Occupational Exposure to Ionizing Radiation [NOHSC:1013]', schedule 1 |
| noise | a dose limit stated in NOHSC's document entitled 'National Standard for Occupational Noise [NOHSC:1007]' |
| respirable dust | 5mg/m ³ |
| respirable synthetic mineral fibre | 0.5 fibre/mL air |

a) See the 'Amendments to the Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment (Source C Updates) 2004' published in the Commonwealth of Australia Gazette No. GN 49 on 8 December 2004.

Radiation Safety Act 1999

Division 3 Objects

4 Main object of Act and its achievement

(1) The main object of this Act is to protect persons from health risks associated with exposure to particular sources of ionising radiation and harmful non-ionising radiation.

(2) The object is to be achieved mainly by—

- (a) establishing a licensing regime to regulate—
 - (i) the possession and use of radiation sources; and
 - (ii) the transportation of radioactive substances; and
- (b) establishing a legislative framework to ensure radiation sources and the premises at which they are used, and the premises at which radioactive substances are stored, comply with radiation safety standards; and
- (c) imposing restrictions on—
 - (i) the acquisition and relocation of radiation sources; and
 - (ii) the disposal of radiation apparatus and radioactive material; and
- (d) requiring a person who possesses a radiation source for a radiation practice to have an approved radiation safety and protection plan for the practice; and
- (e) ensuring the health and safety of any person are not adversely affected by the carrying out of radiation practices with radiation sources; and
- (f) establishing a legislative framework within which compliance monitoring, and investigative and enforcement activities, may be undertaken; and
- (g) establishing the Radiation Advisory Council.

Schedule 2 (continued)

radioactive material means material that spontaneously emits ionising radiation as a result of the radioactive decay of a radionuclide in it, but does not include a mineral within the meaning of the *Mineral Resources Act 1989* situated within the boundaries of land the subject of a mining lease, mineral development licence or exploration permit within the meaning of that Act.

Mineral Resources Act 1989

6 Meaning of *mineral*

(1) A ***mineral*** is a substance—

- (a) normally occurring naturally as part of the earth's crust; or
- (b) dissolved or suspended in water on or within the earth's crust; or
- (c) that may be extracted from a substance mentioned in paragraph (a) or (b).

(2) Subject to subsection (3), each of the following is a ***mineral***—

- (a) any type of clay;
- (b) foundry sand;
- (c) coal seam gas;³
- (d) limestone;
- (e) marble;
- (f) a product that may be extracted or produced by an underground gasification process for coal or oil shale and another product that may result from the carrying out of the process;

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Example of underground gasification processes—combustion, consumption, heating, leaching and reaction

Example of another product—gas desorbed as a result of an underground gasification process

- (g) peat;
- (h) salt, including brine;
- (i) oil shale;⁴
- (j) silica, including silica sand;
- (k) rock mined in block or slab form for building or monumental purposes.

(3) Despite subsections (1) and (2)—

- (a) clay (other than kaolin and bentonite) is only a mineral if it is mined for use for its ceramic properties; and

Examples of uses of clay for its ceramic properties—

- for brick or tile making
- for pottery making

- (b) limestone, silica and silica sand is only a mineral if it is mined for use for its chemical properties; and

(c) each of the following is not a mineral—

- i) soil, sand, gravel or rock (other than rock mentioned in subsection (2)(k) if it is to be used, or to be supplied for use, as sand, gravel or rock, whether intact or in broken form;
- ii) living matter;
- iii) steam or water.

3) See section 318AC (What is *coal seam gas* and *incidental coal seam gas*).

See also part 7AA, division 8, subdivision 1 (Entitlement to coal seam gas).

4. References

- Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Recommendations for limiting exposure to ionizing radiation (1995) (Guidance note [NOHSC:3022(1995)]) and National standard for limiting occupational exposure to ionizing radiation [NOHSC:1013(1995)] Radiation Protection Series Publication No. 1 Republished March 2002.
<http://www.arpansa.gov.au/pubs/rps/rps1.pdf>
- *Coal Mining Safety and Health Act 1999*
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/C/CoalMinSHA99.pdf>
- *Mining and Quarrying Safety and Health Act 1999*
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/M/MiningQuaSHA99.pdf>
- Mining and Quarrying Safety and Health Regulation 2001
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/M/MiningQuaSHR01.pdf>
- *Mineral Resources Act 1989*
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/M/MineralReA89.pdf>
- *Radiation Safety Act 1999*
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/R/RadiatSafA99.pdf>
- Radiation Safety Regulation 1999
<http://www.legislation.qld.gov.au/LEGISLTN/CURRENT/R/RadiatSafyR99.pdf>
- A Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing <http://www.arpansa.gov.au/pubs/rps/rps9.pdf>

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- Western Australia Mines Safety and Inspection Regulations 1995.
- Code of Practice for the Safe Transport of Radioactive Material - Radiation Protection Series No. 2 ARPANSA
http://www.arpansa.gov.au/trans_code.htm

5. Additional information

Additional information may be obtained from the following:

- Uranium Exploration - Health, Safety and Environmental Management Guideline. Northern Territory Government, Department of Primary Industry, Fisheries and Mines, Minerals and Energy.
http://www.nt.gov.au/dpifm/Minerals_Energy/index.cfm?header=Uranium&newscontainer=1
- Radiation Protection Division – Interim Guidance, Drilling operations in known uranium/thorium deposits 29 June 2006. South Australia EPA Radiation Protection Division.
- Radiation Protection Guidelines for Uranium Exploration. Saskatchewan Labour Occupational Health and Safety.