RADIATION AND ITS MANAGEMENT

08
Fact Sheet

Overview

Rare earths are a collection of elements that naturally occur in close association with the radioactive elements uranium and thorium. Rare earths themselves are not radioactive.

In Central Australia, the level of radioactivity in water and minerals is often higher than other regions because of naturally occurring uranium and thorium in the rocks. At the Nolans Bore Mine we also have higher levels of uranium and thorium in the ground. Similarly, background radiation levels become elevated in areas where there are large granite rock deposits. When geologists run a 'scintillometer' (an instrument that measures radioactivity) over ground containing elevated levels of uranium and thorium, compared to natural background, it clicks a lot.

For more information on rare earths refer to Fact Sheet 03 - Our Products.

The Nolans Bore rare earths deposit contains relatively low concentrations of uranium (0.017%) and thorium (0.27%). It would not be economic to mine the Nolans Bore resource just for uranium as such concentrations are too low. As the rare earths minerals contain these elements, Arafura will operate at all times within the strict Australian, State and Territory regulatory frameworks that govern the safe handling, transportation, management and storage of radioactive materials.

We understand people's concerns about radiation so this Fact Sheet provides information and background on the subject. It contains information primarily referencing uranium as this is the best source of available data and people are familiar with this mineral. **It must be stressed, however, that the Nolans Bore Mine is not a uranium mine.**

What is radioactivity?

Radioactivity is energy produced by rays that range from:

- the high frequency ionising radiation (the energy produced as atoms decay) such as cosmic, gamma and X-rays that are beneficial or potentially harmful to humans
- the mid-frequency range, such as ultra violet and visible light rays
- or at the low frequency end of the energy spectrum, the infra red, microwave or radio frequencies.

Examples of ionising particles include:

- **alpha particles** which can penetrate the skin but are blocked by paper. Alpha rays are dangerous to the lungs, so it is important to avoid inhaling radioactive dust
- **beta particles** which can penetrate the body but are blocked by as little as a sheet of aluminium foil
- **gamma rays** which can go right through the body and require thick lead, concrete or water to stop them – however, they also occur naturally in the environment and at low levels are not harmful.

Radioactivity of some natural and other materials

	Radioactivity (becquerels Bq)		Radiation dose (millisieverts mSv)
1 kg coffee	1,000 Bq	Dental X-ray (bitewing)	0.02 mSv
1 kg granite	1,000 Bq	30 return flights Darwin-Adelaide	1 mSv
1 kg superphosphate fertiliser	5,000 Bq	Mammogram	1-2 mSv
Adult human	7,000 Bq	Household smoke detector (with americium)	1-6.7 mSv
1 kg uranium ore (0.3% U)	500,000 Bq	CT scan (chest or pelvis)	4-8 mSv

Rare earths are a collection of elements that naturally occur in close association with the radioactive elements uranium and thorium.

Putting risk in perspective

Every day, every Australian is exposed to radiation. If it reaches harmful levels, we manage it. The same applies to mining, where occupational and public exposure to radiation is highly regulated.

Radioactivity is measured in becquerels (Bq). Just about everything emits a degree of radiation including human beings. A kilo of coffee or granite can emit 1,000 Bq, the potassium in an adult human body emits 7,000 Bq and low-level radioactive hospital waste emits one million Bq. A kilo of uranium ore emits 500,000 Bq.

Why doesn't the term becquerel scare us? Because we don't have an emotional reaction to the word becquerel, whereas years of association with a handful of high profile nuclear incidents means the word 'uranium' generates fear out of all proportion to the risk.

Most Australians are exposed to another form of radiation daily: from the sun's rays. Exposure to sunlight helps our body to produce vitamin D which keeps us healthy; however too much exposure can lead to sunburn and ultimately skin cancer later in life. We control our exposure to these ultraviolet rays (and skin cancers) with hats, clothes and sunscreen. Most of us have learnt to live sensibly with this radiation risk despite the fact that about 1,700 Australians die from skin cancers each year. (Source: Cancer Council Australia)

Nuclear medicine can save lives but over-exposure to radiation can cause cancer and kidney damage. Keeping the risk in perspective, nuclear scientists, doctors and dentists take sensible precautions to limit patients' doses, and their own exposure, to chemotherapy and X-rays.

Similarly, uranium mining companies are professional and responsible about managing risk. They are legally required to provide safe working environments so the risks are minimised and managed successfully. They ensure that staff don't inhale radioactive dust and that personal exposure to radionuclides is constantly monitored to ensure no one suffers ill-effects from long-term exposure.

No worker at a uranium mine in Australia or Canada, two countries that together account for over 35 per cent of the world's uranium production, is known to have become seriously ill, let alone died, from exposure to workplace radiation.

Let's put the risks from radioactivity in perspective. Unless you were to lie under an X-ray machine all day or sit next to a nuclear 'hot rod', it's many times easier to die from sun-baking or hereditary cancers than exposure to what is known as 'ionising' radiation – or radiation from the naturally occurring decaying uranium and thorium atoms that bombard us every day.

How radioactive is uranium?

Soil naturally contains a variety of radioactive materials – uranium, thorium, radium and the radioactive gas radon which is continually escaping into the atmosphere. The tailings at an average uranium mine are only 10 times more radioactive than many granites used in city buildings. Even living permanently on top of a uranium tailings dam would only double a person's normal radiation dose.

To put it another way, the average Australian is exposed to about 2-3 millisieverts a year (mSv/yr) of background radiation (a millisievert is a measure of radiation dose). Of this, about 85% is naturally occurring (42% is radon gases from the earth's surface, 11% from drinking water, 14% from the sun's rays and 18% from buildings and the soil). Nearly all of the remainder is from medical equipment (14%) while only 1% is from the nuclear industry.

The average uranium mine worker is exposed to an additional 2-3 mSv of radiation each year. In order to accumulate an equivalent level of exposure from an everyday activity like aircraft travel, it would take more than 50 return Adelaide-Darwin flights. In fact much larger doses are used to kill bacteria in food and to sterilise medical equipment.

In order to produce saleable rare earth products from its Nolans Project, Arafura has developed a chemical process to remove the uranium. As a consequence, about 150 tonnes of uranium oxide will be produced annually at Arafura's Rare Earths Complex in Whyalla. In comparison, current production of uranium oxide from the Olympic Dam operation in South Australia is about 4,500 tonnes a year.

Thorium

Thorium has the potential to be the nuclear fuel of the future. It is more abundant than uranium in the earth's crust and can produce nuclear power. However, unlike uranium, the thorium nuclear reaction is not self-sustaining and so it cannot be used in weapons. There has been limited commercialisation of thorium as a nuclear fuel; however, experimental reactors are now operating in several countries.

The Nolans Bore deposit contains about 0.27 per cent thorium. Like uranium, thorium from the Nolans Bore Mine will also be removed as part of the chemical process used to produce rare earth products. About 20,000 tonnes of thorium-containing process residues will be recovered at the Whyalla Rare Earths Complex each year. The residue will be stored securely at an approved location for possible future sale or reprocessing.

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Arafura has received interest from parties who are looking to build thorium-based reactors for power generation. While this is not a short-term opportunity, Arafura certainly hopes to develop a future market for its thorium.

Work safety in uranium mines

Radiation is a weak carcinogen, but high exposure can certainly increase health risks. This is why there are many precautionary regulations covering all radioactive material including the mining and transport of uranium, thorium, and even mineral sands.

In Australia, radiation protection standards are set by the International Commission on Radiological Protection (ICRP) and monitored by a number of State and Australian government agencies. Scientific evidence does not indicate any cancer risk or immediate health effects at doses below 50 mSv/yr. However, as a precautionary measure, the ICRP recommends that additional doses above natural background should be limited to 1 mSv/yr for members of the public and 20 mSv/yr averaged over five years for radiation workers. Workers classified as radiation workers are subjected to continuous monitoring of their exposure to radiation in the workplace.

The best protection is:

- continual monitoring of radiation exposure levels
- maintaining safe handling practices
- limiting the time and proximity of people exposed to radiation controlling dust, which is the main source of radiation exposure in an open cut mine
- ensuring adequate ventilation to remove radon gas (at Ranger Uranium Mine in the Northern Territory, the radon gas seldom exceeds one percent of the levels allowable for continuous occupational exposure)
- ensuring strict hygiene standards, including respiratory protection.

Work safety at Nolans Bore Mine

Arafura's Nolans Project will mine phosphate and rare earths. However, because there is also thorium and uranium in the ore, Arafura will be bound by the same safety regulations that apply to uranium mines even though the quantities of uranium are much less at the Nolans Bore Mine compared to stand alone uranium mines. The level of radioactivity from the Nolans Bore Mine will be similar to the level of radioactivity at Ranger, or Olympic Dam, or at some beach sand mining operations in Western Australia.

Long-term exposure to radioactivity will be reduced at the Nolans Bore Mine by complying with all relevant regulations and having strict procedures such as:

- managing dust to prevent inhalation
- measuring the exposure of all staff to radiation
- using appropriate personal protective equipment
- daily laundering of work clothes for people working at the mine
- washing haul trucks to limit the build up of surface radiation
- transporting ore in purpose-built sealed containers designed to eliminate radiation exposure risk
- ensuring all equipment transferring ore material operates in a negative pressure environment.

Detailed measures will be documented in Arafura Resources' Radiation Management Plan. Staff and supervisors will receive comprehensive radiation management training and radiation safety personnel will be employed.

Work safety at Whyalla Rare Earths Complex

Radiation management at Arafura's Whyalla Rare Earths Complex has been a key consideration in its engineering design. From receipt of mineral concentrate from Nolans Bore through to final products, Arafura will comply with all relevant regulations and will apply the 'ALARA' principle (As Low As Reasonably Achievable) to minimise all potential exposure to radiation.

Mineral concentrate rich in rare earth and phosphate minerals, and containing radioactive elements uranium and thorium, will be transported by rail in sealed containers from the Nolans Bore Mine in Central Australia to the Whyalla Rare Earths Complex. Arafura will use a chemical process at Whyalla that separates, isolates and recovers by-products of uranium oxide (150 tonnes per year) and thorium (20,000 tonnes per year). Arafura intends to commercialise the uranium oxide. The thorium residue will be taken to an approved location for safe and secure long-term storage.

Conclusion

There is a level of risk to everything we do in life. What's important is how we manage risk. No technology is absolutely safe, but the safety record of uranium mining is excellent and its environmental impacts bear no comparison with emissions from a coal-fired power station.

This fact sheet is just an introduction to radiation. You will find comprehensive information at any of the websites listed below, which were the sources of much of the above information.

There is a level of risk to everything we do in life. What's important is how we manage risk.

Minerals Council of Australia	**www.minerals.org.au**
Australian Uranium Association	**www.aua.org.au**
World Nuclear Organisation	**www.world-nuclear.org**
Australian Radiation Protection & Nuclear Safety (ARPANSA)	**www.arpansa.gov.au**
Australian Nuclear Science and Technology Organisation (ANSTO)	**www.ansto.gov.au**
US Environmental Protection Agency (US EPA)	**www.epa.gov/radiation/understand**
Energy Resources of Australia (ERA)	**www.energyres.com.au**
Heathgate Resources	**www.heathgateresources.com.au**
Uranium SA (BHP, Heathgate, Uranium One and the SA Chamber of Mines and Energy)	**www.uraniumsa.org**

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