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# understanding uranium & health

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Olympic Dam Uranium Mine, Roxby Downs, South Australia- Photo: Jessie Boylan

This information booklet has been put together with information from the research of Doctors, Scientists and Engineers from around Australia. This booklet has been made to provide factual information about the health risks associated with uranium mining. If you would like more information, other educational resources or confidential advice and referal please call Mia Pepper Nuclear Free Campaigner at the Conservation Council of WA on (08) 9420 7209 or email at mia.pepper@conservationwa.asn.au.

In September 2008 Federal Resources Minister Martin Ferguson promised the establishment of a National Radiation Dose Register for uranium mine workers. The Register is not operational and is being developed within “yet to be agreed timeframes”.

# what is uranium ?

Uranium is a very dense radioactive metallic element. Uranium in nature is made up of three atoms – uranium-238, uranium-235, and uranium 234. Uranium-235 is a fissile isotope – it has the ability to cause a fission chain reaction creating energy.

To get fuel for nuclear power, the concentration of uranium-235 must be increased from 0.7% in natural ores to 3-5%. This concentrating process is called enrichment and the waste by-product is called depleted uranium or DU. Depleted uranium has military uses for defensive armour plating, armour piercing projectiles and munitions.

Australia has the world’s largest reserves of uranium, which is used as fuel for nuclear power or research reactors and as the feedstock to produce fissile (explosive) material for nuclear weapons (highly-enriched uranium or plutonium).

# uranium mining & you

Uranium mining is different from other forms of mining because of the radioactive nature of the mineral and the release of radon gas and its breakdown products during the mining and milling process.

We all live with background levels of radiation from the sun and the earth. The dose from background sources is typically about 2 millisieverts (mSv) per year. Increased radiation exposure – whether from granite in homes, uranium mining or other nuclear fuel cycle processes or from other sources – increases the risk of cell damage and various diseases, including cancers.

Uranium mine workers are exposed to radiation from the ore itself and from the inhalation of radioative radon gas. The association with uranium mining and lung cancer is unequivocal, and is due to radon gas exposure. Recent evidence and the determination by the International Comission on Radiological Protection (2009) indicates that radiation from radon gas exposure is twice as hazardous as originally claimed.

The waste and tailings (waste rock and slurry) from uranium mining remain an on-site radioactive legacy. These wastes pose a public health hazard well into the future beyond the lifetime of any government or mining company.

# what is ionising radiation?

Ionising radiation is classified as a Class 1 carcinogen by the International Agency for Research in Cancer of the World Health Organisation, this means that we know that ionising radiation can cause cancer with the highest level of certainty.

The carcinogenicity of ionising radiation is well established. The Committee on the Biological Effects of Ionizing Radiation (BEIR) assigns a risk factor of 5% per Sv, or roughly 1:25,000 chance of contracting cancer per mSv dose. Thus:

Over a lifetime, a dose of 1mSv creates an excess risk of cancer of approximately 1 in 10,000

A dose of 100mSv would cause 1 in 100 people to develop cancer

For a website calculator to determine the health risk associated with any radiation dose, visit: www.wise-uranium.org/rdcri.html

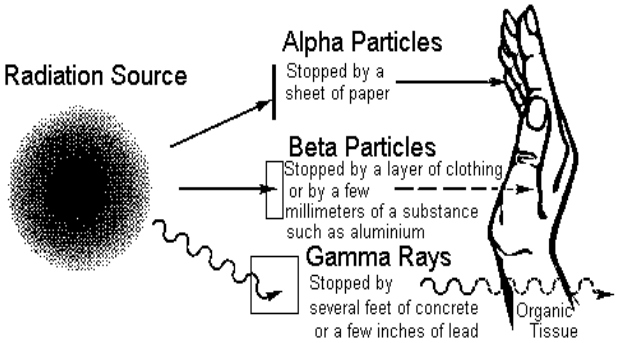
# what is ionising radiation?

Ionising radiation consists of subatomic particles or electromagnetic waves that are energetic enough to detach electrons from atoms or molecules, ionising them. The most important types of ionising radiation are alpha, beta and gamma radiation:

☢ Alpha particles (two neutrons and two protons) are relatively heavy and lose their energy quickly. Their penetration through solid obstacles is very low and hence deposit large amounts of energy in small volumes e.g. in the lining of the airways and the gut. Alpha-emitting radioactive particles are particularly dangerous if you swallow or breathe them in which is how rad gas deposits it's radiation in the body

☢ Beta particles (electrons) are smaller, faster moving and are more penetrating than alpha particles. Beta particles can pass through 1-2 cm of matter such as human skin.

☢ Gamma rays are high energy waves, similar to light, and are highly penetrating.




## How radiation damages us:

☢ All humans are made of cells

☢ Every cell contains DNA

☢ DNA carries the 'story' for the cell

☢ Radiation breaks the DNA

☢ The broken DNA-story can spread to other cells and can be passed on to your children

## Ionising radiation causes adverse health effects by:

☢ Transferring energy to atoms in biological tissue which then becomes electrically charged

☢ Leads to the formation of free radicals which damage the cell's DNA and lead to genetic mutations

☢ Direct DNA disruption along the track the ionising radiation traverses through the cell's nucleus

# effects of ionising radiation

## Delayed Effects:

When a small dose is received there will be no obvious signs or symptoms but the ionising radiation may still be affecting DNA, cells and genes. This may show up as many as 40 years after exposure, and in the next generations. Workers from uranium mines or processing plants can leave work and later in life develop radiation related symptoms and problems, but cannot prove how they were exposed to ionising radiation.

## Prompt Effects:

When a high dose is delivered within a short period of time the effects can include blood component changes, fatigue, diarrhoea, nausea, radiation burns and death. These effects will develop within hours, days or weeks, depending on the dose. This type of dose is likely when waste material or contaminated water is ingested. Although not frequent, intense exposures have occurred by accident, e.g. at the Three Mile Island and Chernobyl (power station melt downs) or by design Hiroshima, Nagasaki, (nuclear weapons explosions) and nuclear weapons tests around the world.

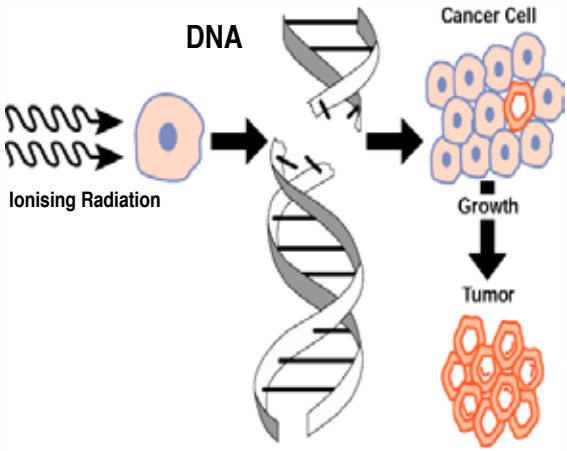



Figure 1. Development of cancer from mutation produced by ionizing radiation.

## Reproductive Effects:

Rapidly proliferating and differentiating tissues are most sensitive to radiation damage. Radiation exposure can produce developmental problems, particularly in the developing brain, when a foetus is exposed in the womb. The developmental conditions most commonly associated with prenatal radiation exposure include low birth weight, microcephaly, mental retardation and other neurological problems.

## Genetic effects:

If the damage to the DNA code occurs in a reproductive cell (egg or sperm), the coding error may be passed on to offspring. This can cause birth defects and cancers in children.

If DNA abnormalities are passed on to subsequent generations of cells the abnormal coding can lead to tissue abnormalities, including cancers. Cancer development is a multi-stage process and is similar for radiation-associated cancers as for spontaneous cancers, or those associated with exposure to other carcinogens.

Low-dose radiation appears to mainly act on the early stages of cancer initiation, whereas high dose effects later stages of cancer promotion and progression are also likely. International cancer incidence and mortality data demonstrate statistically significant links between radiation and all solid tumours as a group, as well as for cancers of the stomach, colon, liver, lung, breast, ovary, bladder, thyroid and for non-melanoma skin cancers and most types of leukaemia.

It may take several decades before cancers are detected as the delay can range from five years (for leukaemia) to 40 years. Dr Bill Williams states: “The delay enables polluters to avoid responsibility for the disease-promoting properties of radiation. This avoidance is amplified by the fact that leukaemia and other cancers induced by radiation are indistinguishable from those that result from other causes.”

It should be noted that these are average risks and that the risks faced by vulnerable groups of the population may be considerably higher. The BEIR Committee assessed women as having about twice the radiation risk for solid cancer incidence as men, and 38% higher cancer mortality risk than men. Children are at even greater risk - radiation during infancy for boys results in three to four times the cancer risk as between 20 to 50 years of age, and female infants have double the risk of boys.

A study of Namibian uranium mine workers found increases in chromosome aberrations leading to risks to their future children of leukaemia and genetic abnormalities (Zaire et al., 1997).

# radiation at olympic dam ura

Olympic Dam Uranium Mine tailings - Photo: Jessie Boylan

ADELAIDE'S INDEPENDENT WEEKLY NEWSPAPER REPORTED ON 4 JUNE 2010:

Mining giant BHP Billiton is risking the lives of its staff and employees at Olympic Dam in South Australia by exposing them to unsafe levels of radiation, according to a company whistleblower.

Documents received by The Independent Weekly say BHP Billiton has been warned about the risks, and has chosen to take no action.

The documents show BHP Billiton uses manipulated averages and distorted sampling to ensure its "official" figures slip under the maximum exposure levels set by government. "The commitments to worker safety in the expanded Olympic EIS are unrealistic and won't be achieved," the BHPB whistleblower said. "Assertions of safety of workers made by BHPB are not credible because they rely on assumptions rather than, for example, blood sampling and, crucially, an assumption that all workers wear a respirator when exposed to highly radioactive polonium dust in the smelter.

www.independentweekly.com.au/news/local/news/general/roxbys-radioactive-risk/1849823.aspx

NUCLEAR RADIOLOGIST DR PETER KARAMOSKOS STATES:

Uranium miners are also exposed to ionising radiation directly from gamma radiation and the dose from this is cumulative to that from radon. At the Olympic Dam underground uranium mine, the total dose per miner is approximately 6mSv, of which 2-4 mSv (allowing for the new International Council Radiation Protection dose coefficients) are due to radon and the balance due to gamma radiation.

Most modern uranium mines have air extraction systems and monitored ambient measures of radon concentrations to ensure (exposure) levels remain low. Current levels of radon in underground uranium mines are only a fraction of mines over one hundred years ago. Furthermore, miners are given personal protective equipment (PPE) including masks to filter out the radioactive particulate matter. However, many underground miners find the masks extremely uncomfortable, especially in the hot underground environment they must contend with.

It is estimated that up to 50% of underground uranium miners in Australia do not use their masks, and thus drastically increase their risk of lung cancer, whilst underestimating their actual radiation dose (since this is calculated assuming PPE's are used).

The average miner at Olympic Dam is in his twenties and stays on average five years at the site. A typical calculation using the linear no threshold model and the latest BEIR-VII figures of radiation carcinogenesis risks indicates miners at Olympic Dam therefore have a 1:420 chance of contracting cancer, most likely lung cancer. Note that the research demonstrates that the risk of developing lung cancer is greater for younger workers.

## Exposure limits:

Radiation health authorities set "permissible limits" for ionising radiation exposure.

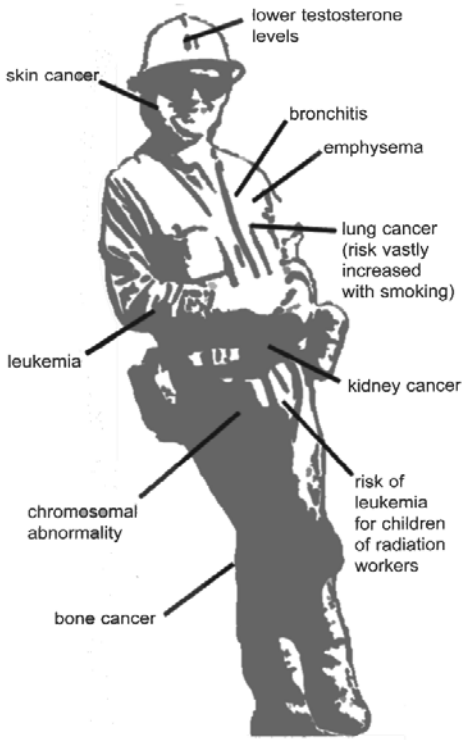
The recommended maximum exposures for the public and the workforce has steadily been reduced – levels once regarded as "safe" are now known to be associated with cancers, bone marrow malignancies and genetic effects.

**For workers, the permitted dose has decreased by a factor of 25:**

- In 1934 the dose was 500 mSv p.a.
- In 1946 the dose was reduced to 150 mSv p.a.
- In 1956 the dose was reduced to 50 mSv p.a.
- In 1991 the dose was reduced to 20 mSv p.a. (averaged over 5 years)
- In Australia, the maximum permitted dose for members of the public is 1 mSv, but for a mine worker the maximum permitted dose is 20 mSv p.a.

## Radon:

- Is a gas, so it can be breathed into the body
- Is the only gas in the uranium decay series
- Releases the most harmful type of radiation – alpha particles
- Progeny (decay products) are highly reactive elements that can connect to airborne particles, such as aerosols, and then lodge in lung tissue



## Radon:

Radon gas is the second biggest cause of lung cancer (after smoking) according to the World Health Organisation.

The link between uranium mining and lung cancer has long been established. Radon is a radioactive gas and alpha emitter. It was identified as a proven cause of lung cancer in the 1950s. Studies of underground miners, especially those exposed to high concentrations of radon, have consistently demonstrated the development of lung cancer.

In 2009 the International Commission on Radiological Protection (ICRP) stated that radon gas delivers twice the absorbed radiation dose to humans as originally thought and it is now reassessing the permissible levels.

The BEIR Committee reviewed eleven cohort studies of 60,000 underground miners with 2,600 deaths from lung cancer, eight of which were uranium mines in Europe, North America, Asia and Australia. These found a progressively increasing frequency of lung cancer in miners directly proportional to the cumulative amount of radon exposure in a linear fashion. As expected, Smokers had the highest incidence of lung cancer however the greatest increase in lung cancer was noted in non-smokers. The highest percentage increase in lung cancer was noted 5-14 years after exposure and in the youngest miners.

The Electrical Trades Union has advised its members in Queensland and the Northern Territory against working in uranium mines, nuclear power stations or any workplace that is part of the nuclear fuel cycle.

"Uranium is the new asbestos in the workplace. We are sending a clear message to the industry and the wider community that vested interests in the uranium and nuclear industries are trying to hoodwink us about this dangerous product and industry. Corporate interests and their political supporters in the Labor and Coalition parties are trying to buy working families off with high wages, while denying the true short-term and long-term health risks of such jobs"
Queensland state secretary of the ETU, Peter Simpson.


“They (industry supporters) assert a record of “good management” in the Australian nuclear industry to date: a clear misrepresentation in view of hundreds of instances of mismanagement (leaks, spills, contamination, regulatory breaches) at Ranger, Olympic Dam and Beverly and the total failure of either industry or regulators to monitor health impacts in local populations despite known distribution of radio-toxins into habitat and food chain.”

Dr Bill Williams,
President of the Medical Association for the Prevention of War

The difficulty of definatively proving health impacts from low-level radiation exposure is used by nuclear proponents as the basis for an endless stream of self-serving, disingenuous and scientifically-indefensible statements – not least the claim from uranium mining companies that radiation exposure below permitted limits is 'safe'.

The overwhelming weight of scientific opinion holds that there is no 'safe' dose of radiation let alone a beneficial dose. The BEIR Committee notes that: "There is a linear dose-response relationship between exposure to ionizing radiation and the development of solid cancers in humans. It is unlikely that there is a threshold below which cancers are not induced."

Prof. Richard Monson, Chair of the BEIR Committee and Professor of e Epidemiology at the Harvard School of Public Health, said: "The scientific research base shows that there is no threshold of exposure below which low levels of ionizing radiation can be demonstrated to be harmless or beneficial. The health risks - particularly the development of solid cancers in organs - rise proportionally with exposure."

# ion is a safe dose

Authorities and mine operators acknowledge that there has been contamination from (uranium) mining activity but argue that even though there have been hundreds of incidents, the number is not significant and that, in any case, environmental damage has not been proved.

It is the case however that a pattern of underperformance and non-compliance can be shown. The Committee also identified many gaps in knowledge and found an absence of reliable data on which to measure the extent of contamination or its impact on the environment.

Uranium mining at Ranger and Jabiluka in the NT raised different sociological, geophysical and operationsal issues and environmental challenges from Honeymoon and Beverly mines in South Australia. However, the shortcomings in the operations of all four mines suggests that short-term considerations have been given greater weight than the potential for permanent damage to the environment.

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# acknowledgements

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ccwa

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