Wasting the Future

fact sheet
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Radioactive waste presents long-term public health and environmental risks, and some forms also represent a proliferation risk because they contain fissile material such as plutonium.

There is not a single permanent repository for high-level nuclear waste anywhere on Earth, and the most advanced project, Yucca Mountain in the USA, has been a $10 billion fiasco that is 19 years behind schedule.

- All nuclear activities generate radioactive waste.
- Radioactive waste poses unique difficulties because of the extensive time it remains a hazardous.
- No nation on Earth has a permanent disposal facility for high-level nuclear waste.

Radioactive wastes can be solid, liquid or gaseous and pose unique and fundamental management challenges and human and environmental risks. These wastes are produced at every stage of the nuclear fuel cycle, from uranium mining and enrichment to reactor operation and the reprocessing of spent nuclear fuel. Much of this material remains hazardous for many thousands of years.

The nuclear industry began before there were clear plans on how to best handle these long-lived wastes and six decades later not much has changed. There are no permanent disposal facilities for high-level radioactive waste anywhere around the globe, waste stockpiles continue to grow and there is no proven and assured way to isolate radioactive waste from people and the environment for the time needed.

Uranium mining waste

The discharge of radioactive waste into the environment begins with uranium mining. Mining operations produce huge volumes of lower level radioactive wastes (tailings) that are left behind at abandoned mining sites. After mining ceases uranium tailings retain about 80 per cent of the radioactivity of the original ore body and contain over a dozen radioactive materials that pose a significant health hazard including thorium-230, radium-226 and radon gas. These materials can emit radioactivity to the environment for tens of thousands of years.

Before mining these radioactive elements are generally locked in an impervious rock cocoon so little radioactivity reaches the wider environment. After mining radioactive elements can escape into waterways and the atmosphere. Tailings are finely ground and the radon escapes many thousands of times faster than it otherwise would from the ore body. Wind and water provide a variety of pathways for the spread of this waste.

Tailings dams have a poor track record and waterways have been polluted by radium after a sudden collapse or by constant erosion. Radon gas and radioactive dust are also mobilized and carried in wind. Since many radioactive decay products persist for over 100,000 years the hazard and the threats will be effectively endless and a short term mining operation creates a long term human and environmental hazard.

Depleted uranium

Depleted uranium (DU) is a radioactive by-product of the uranium enrichment process. It gets its name from the fact that much of the uranium-235 has been extracted from it. Despite this it remains toxic and around 60% as radioactive as naturally occurring uranium. For every gram of enriched uranium that is used in nuclear reactors or weapons around 7 grams of depleted uranium are produced.

DU has military uses and has been used in munitions used by US and NATO in Iraq, the Balkans and Afghanistan. Because DU is rich in uranium-238 it is ideal for producing fissile plutonium-239 for use in nuclear weapons. This can be done by inserting a ‘blanket’ or target into a reactor. One of South Korea’s nuclear weapons research experiments involved irradiating DU and separating the plutonium.

There are also civil uses of DU – it can be re-enriched for use in reactors and used as a radiation shield or as ballast.

Most DU is stored and the current global stockpile of ‘civil’ DU is 1.3-1.5 million tonnes.

(For more information on DU and enrichment plants see Makhijani and Smith.[1])

Routine emissions to air and water

Routine emissions of radionuclides to air and water from any particular nuclear plant over a short period of time are almost negligible, but the cumulative impact of many facilities operating for many years is significant.

The United Nations Scientific Committee on the Effects of Atomic Radiation has estimated the collective effective dose to the world population over a 50-year period of operation of nuclear power reactors and associated nuclear facilities to be two million person-Sieverts.[2] If we apply the standard risk estimate (0.04 cancer deaths / Sievert) we get an estimated toll of 80,000 cancer deaths. If we allow for a margin of error of a factor of two in either direction

- as recommended by the UN Committee on the Biological Effects of Ionizing Radiation - the estimated death toll is 40,000 to 160,000.[3]

Most of these routine emissions arise not from reactors but from reprocessing plants.

High-level nuclear waste

Unwanted radioactive materials created by the nuclear industry are classified into several categories for regulatory purposes. These classifications relate to the concentration of radioactivity, not necessarily by the potential hazard to humans and other life forms, e.g. the plutonium in low-level reactor waste is stored under much less strict control than the same type of plutonium in high-level waste.

Low level waste: includes contaminated paper, rags, tools, clothing and filters. Some low level waste is created by hospitals, industry and research units, but most comes from nuclear reactors. This waste is hazardous for up to 30 years and requires confinement and isolation for up to 300 years.

Intermediate level waste: requires shielding when handled and is typically comprised of resins, chemical sludges and metal fuel cladding as well as contaminated materials from decommissioned nuclear reactors.

High-level waste: arises from the use of uranium fuel in a nuclear reactor. The high-level waste accounts for over 95% of the total radioactivity produced in the process of nuclear electricity generation. The other 5% is made up of the larger volumes of low and intermediate level waste. High level waste includes spent nuclear fuel and material from the reprocessing of spent nuclear fuel. These wastes contain elements that decay slowly and remain intensely radioactive for many hundreds or thousands of years.

A typical power reactor (1000 MWe, light water type) produces 25-30 tonnes of spent nuclear fuel annually. Nuclear power reactors produce about 12,000-14,000 tonnes of spent fuel around the world each year. Over 250,000 tonnes of spent fuel have been produced in power reactors around the world, about one third of which has been reprocessed.

Technologies exist to encapsulate or immobilise radionuclides to a greater or lesser degree, but encapsulated nuclear waste still represents a potential public health and environmental threat for millennia. Synroc – the ceramic immobilisation technology developed in Australia – seems destined to be a permanently 'promising' technology. As nuclear advocate Leslie Kemeny notes, Synroc "showed great early promise but so far its international marketing and commercialisation agendas have failed".[4]

A range of alternative technologies (e.g. transmutation or changing the nuclear structure of elements) or options (e.g. sea-bed or space disposal) have been discussed for decades. However, all are seen to be non-starters for economic, technological or political reasons. Given this the nuclear industry has a general 'international consensus' towards placing high-level waste in deep underground repositories.

Despite this industry bias not a single repository exists anywhere in the world for the disposal of high-level waste from nuclear power reactors and only a few countries have identified a repository site. Plans are being advanced in several countries to build deep underground repositories for high-level waste, but these plans face significant obstacles including lack of public acceptance, cost, lack of expertise and the lack of suitable sites.

The US, Sweden and Finland are said to be the most advanced countries in relation to high-level waste disposal. The US Yucca Mountain project is the most advanced but it continues to encounter cost and timeline blowouts, significant community and political obstacles and unresolved technical issues.
Sweden has yet to decide on a location for a permanent repository.
Finland will shortly begin studies on a site which may or may not prove to be suitable for a permanent repository.

Yucca Mountain

The US government has been working on a project to build a deep underground repository at Yucca Mountain in

Nevada since 1987. The intention was to have the repository accepting waste by 1998, but the current earliest date for the repository to be operational is 2017 - a slippage of 19 years. The Yucca Mountain project has so far cost around US$8-10 billion.

In March 2005 a scandal emerged involving the falsification of safety data between 1998 and 2000 in relation to groundwater modeling. Evidence of the falsification of data was found in emails and the US Department of Energy is now trawling through 14 million emails to see if it can uncover further problems.

Studies found that Yucca Mountain could not meet the existing radiation protection standards in the long term and subsequent moves by the US Environmental Protection Agency to weaken radiation protection standards have been rejected by a US federal court.

More information on Yucca Mountain:

- US Government Accountability Office, "Yucca Mountain: Quality Assurance Needs Increased Management Attention", March 2006, <http://www.gao.gov/htext/d06313.html>
- US government Department of Energy: Yucca Mountain project: <www.ymp.gov>
- State of Nevada: <www.state.nv.us/nucwaste>

Finland
In Finland spent fuel is stored at reactor sites. Work is proceeding on what is described as a an "underground research facility" at Olkiluoto and it is hoped that this site will prove suitable for a permanent repository. The actual rock characterisation research is scheduled to take place from 2007-2011. If the site is found to be suitable a separate licensing process would be required before the repository could be built. The cost of the final repository is estimated at three billion Euros.

Finland has four operating power reactors and one under construction – as such it has far less spent fuel to deal with than countries operating a much greater number of reactors such as the US, the UK, Japan, France, Russia, and South Korea.

More information: <www.posiva.fi/englanti>

Sweden
An interim repository for spent fuel has been operating since 1985 at Oskarshamn. Its 5,000 tonne capacity is being expanded to 8,000 tonnes to cater for all the spent fuel from current reactors. Two municipalities are now being considered as locations for a permanent deep geological repository for spent fuel.

More information: <www.uic.com.au/nip39.htm>

Reprocessing

Reprocessing involves dissolving spent nuclear fuel in acid and separating the unused uranium (about 96% of the mass), plutonium (1%) and high-level wastes (3%). Most commercial reprocessing takes place in the UK and France. There are smaller plants in India, Russia and Japan. Japan plans to begin large-scale reprocessing at the Rokkasho plant in 2007.

Over 80,000 tonnes of spent fuel from commercial power reactors has been reprocessed – about one third of all the spent fuel generated in power reactors.

Proponents of reprocessing give the following justifications for this controversial and contaminating activity.

- Reducing the volume and facilitating the management of high-level radioactive waste. However reprocessing does nothing to reduce radioactivity or toxicity, and the overall waste volume, including low- and intermediate-level waste, is increased by reprocessing.
- 'Recycling' uranium to reduce reliance on natural reserves. Only an improbably large expansion of nuclear power would result in any problems with uranium supply this century. Much of the uranium separated from spent fuel at reprocessing plants is not reused, but is stockpiled. Uranium from reprocessing accounts for only 1% of global uranium usage.
- Separating plutonium for use as nuclear fuel. Plutonium 'breeder' reactors have proven to pose significant nuclear proliferation risks. The stockpile of separated plutonium amounts to 270 tonnes and is continuing to grow.

- Fissioning plutonium in the process of using it as nuclear fuel, so it is no longer available for use in nuclear weapons. Unfortunately, reactors can be used to 'breed' plutonium as well as to 'burn' it.

The main reason reprocessing proceeds is that reprocessing plants act as long-term de facto storage facilities for spent nuclear fuel. Unfortunately this sets up a series of events which has been likened to the old woman who swallowed a fly – every solution is worse than the problem it was supposed to solve:

1. The perceived need to do something about growing spent fuel stockpiles at reactor sites (not least to maintain or obtain reactor operating licences) coupled with the lack of repositories for permanent disposal, encourages nuclear utilities to send spent fuel to commercial reprocessing plants, which act as long-term, de facto storage sites.
2. Eventually the spent fuel must be reprocessed, which brings with it serious proliferation, public health and environmental risks.
3. Reprocessing has led to a large and growing stockpile of separated plutonium, which is an unacceptable proliferation risk.
4. Reprocessing creates the 'need' to develop mixed uranium-plutonium fuel (MOX) or fast neutron reactors to make use of the plutonium separated by reprocessing.
5. And all of the above necessitates a global pattern of transportation of spent fuel, high-level waste, separated plutonium and MOX, with the attendant risks of accidents, terrorist strikes and theft leading to the production of nuclear weapons.

Despite claims by the nuclear industry none of this is justifiable on non-proliferation, environmental, public health or economic grounds.

Reprocessing plants are designated as 'sensitive' nuclear facilities because they are used to separate plutonium. The production of vast amounts of plutonium in power reactors – over 1,600 tonnes to date, enough for about 160,000 weapons – is problem enough, but the problem is greatly exacerbated by the separation of plutonium in reprocessing plants. Whereas separation of plutonium from spent fuel requires a reprocessing capability and is potentially hazardous because of the radioactivity of spent fuel, the use of separated plutonium for weapons production is far less complicated.

Civil reprocessing releases significant quantities of radioactive wastes into the sea and gaseous discharges into the air. Cogema's reprocessing plant at La Hague in France and the reprocessing plant at Sellafield in the UK, are the largest source of radioactive pollution in the European environment. The radioactive contamination from these facilities can be traced through the Irish Sea, the North Sea, along the Norwegian coast into the Arctic and Atlantic Oceans and gives rise to elevated contamination levels in biota.

Steve Kidd from the World Nuclear Association states: "It is true that the current Purex reprocessing technology (used at Sellafield and La Hague) is less than satisfactory. Environmentally dirty, it produces significant quantities of lower level wastes." [5]

The hazards associated with reprocessing were highlighted in April 2005 with the revelation of an accident at the THORP reprocessing plant at Sellafield in the UK. A broken pipe led to 83,000 litres of nitric acid containing dissolved spent fuel leaking into a containment structure. This incident attracted much public attention and a fine of 2.5 million Pounds.

An environmental approach to radioactive waste:

The following approach should be adopted for radioactive waste:

- Radioactive waste is a long-lived and serious environmental hazard and its production should be minimised or halted. As a society we need to move from an unrealistic concept of "disposal" towards a sense of stewardship and long-term isolation and management of existing radioactive waste.
- A fundamental principle in dealing with dangerous industrial wastes is reduction at source – it's time to turn off the toxic tap.
- Open and inclusive processes to develop an effective approach to radioactive waste management are urgently required. This approach would be based on the adoption of best international standards and practise, waste minimisation and the non-imposition of transport or storage of radioactive waste.
- Any sense of an "out of sight - out of mind" culture in relation to the management of radioactive waste should be actively challenged.

- Existing facilities, records and documentation regarding radioactive waste should be reviewed and upgraded if needed.
- Nuclear waste should be stored above ground in a dry, monitored and retrievable fashion at or near the site of creation of the waste to reduce transport risks.
- Radioactive waste storage facilities and practices should be the focus of regular independent audits and public review to increase transparency and ensure compliance with international best practise.
- The development of an Australian national radioactive waste management strategy should be informed by a dedicated public Inquiry based on the principles of international best practise, waste minimisation and the non-imposition of radioactive waste transport or storage. This Inquiry would identify the full inventory of radioactive waste in Australia - what it is, where it is, who has jurisdiction and options for long-term management.

Why nuclear waste should be stored above-ground and on-site:

- The waste must be carefully monitored and accessible such that problems can be addressed. This becomes difficult or impossible if the waste is buried. The nuclear industry in recent years has been moving towards acceptance of this principle of 'retrievability'.
- It greatly reduces the risk of transport accidents and contamination.
- It encourages waste minimisation. On-site storage encourages best practice waste minimisation strategies whilst burial can foster an "out of sight, out of mind" disposal culture and profligate waste production.
- It will be close to the experts. Burial makes it difficult for experts to monitor the site. To keep the waste safely isolated from the environment it is necessary for expert monitoring to be in effect for the duration of toxicity.

Statement by traditional Aboriginal landowners

A meeting of traditional landowners for both the Alcoota/Harts Range site and the Mt Everard site in the Northern Territory - both short-listed for a national nuclear waste dump - was held on country on Thursday 20 October 2005. At that meeting traditional landowners agreed to send the following message to Prime Minister John Howard:

We are the traditional landowners of the country where your Government wants to build a nuclear waste dump.

We do not want your nuclear waste dumped on our country.

You and others in Canberra might think that our country is an empty place, that no people live here. We are telling you that there are communities and outstations close to the proposed sites – this is our home and unlike you we cannot move to another place.

We live on this country, we use it for hunting kangaroo and getting bush tucker like honey ants and bush bananas. Our country is alive – there are sacred sites and our law and ceremonies are strong.

We don't believe that this poisonous waste can be kept safely for thousand of years. You will be gone but our grandchildren will be left to worry. Can you tell us why we should be the ones to live with this risk? Why should Aboriginal people be dumped with this problem?

We know you have experts in Sydney. You should leave the waste safely there instead of bringing it here out of your sight. We will not let you turn our country into a waste land.

You talk a lot about economic development – telling us we should make money from our country. We run a successful cattle business on Alcoota station, and now you want to put this dump in the middle of it. Do you think people will still buy our beef if the nuclear waste dump is built here? We have ideas for tourism too – but tourists wont come to our country if we have a waste dump.

Your Government tells us to manage and care for our country. Putting this waste on our country is not caring for country, it might take a long time but one day it will poison our country.

We call on you, as the Prime Minister of Australia, to respect our law and culture, to respect our views as traditional landowners and to listen to our voice. We call on you to stop your plans to impose a nuclear waste dump on our country.

More information on the proposed national nuclear waste dump:

- Friend of the Earth, Northern Territory nuclear duymp briefing paper, <www.foe.org.au/download/NT-dump-infosheet.doc>.
- NT Central Land Council <www.clc.org.au>

Further Reading:

www.corwm.org.uk - the Committee on Radioactive Waste Management is an independent body commissioned by UK Government ministers to advise on radioactive waste issues. Has a good links page.

www.antenna.nl/wise - the Amsterdam based World Information Service on Energy has teamed up with the US Nuclear Information and Resource Service to provide useful information and an extensive links page.

www.iaea.org/inis - the UN's International Atomic Energy Agency's international nuclear information system is a detailed database of nuclear research and discourse.

www.radwaste.org - US based site with lots of information and useful links.

References:

1 Makhijani, Arjun and Brice Smith, 2005, "Costs and Risks of Management and Disposal of Depleted Uranium", <www.ieer.org/reports/du/LESprfeb05.html>.)
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3 UN Committee on the Biological Effects of Ionizing Radiation, 2005, "Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII – Phase 2)", www.nap.edu/books/030909156X/html.
4 Kemeny, Leslie, April 15, 2005, "Power to the People", The Australian Financial Review, www.uic.com.au/KemenyAFR.htm
5 Kidd, Steve, May 11, 2004, "Achilles heel or own goal?", Nuclear Engineering International, www.neimagazine.com/story.asp?sectionCode=147&storyCode=2023239

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About our organisation:

energyscience.org.au is a co-operative production by a group of concerned scientists, engineers and policy experts that seek to promote a balanced and informed discussion on the future energy options for Australia.
With increasing concern over the looming impact of global climate change the community needs to be aware of the issues involved. energyscience aims to provide reliable and evidence based information to our whole community

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