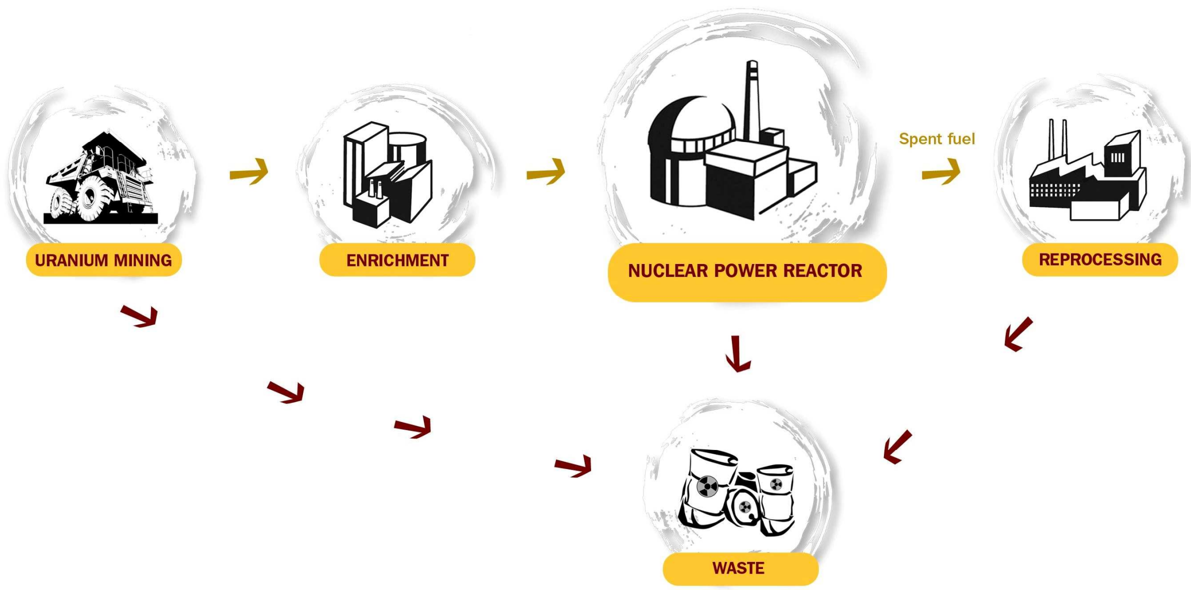
RADIOACTIVE WASTE

Choose Nuclear Free www.choosenuclearfree.net
An initiative of the Medical Association for Prevention of War www.mapw.org.au
the International Campaign to Abolish Nuclear Weapons www.icanw.org.au
and Friends of the Earth, Australia http://www.foe.org.au/anti-nuclear

November 2010



1. INTRODUCTION

Key Points:
* Hazardous radioactive wastes are generated at every stage of the nuclear fuel cycle.
* No country has established a repository for high level nuclear waste from nuclear power.
* Some waste streams have military potential – depleted uranium is used in munitions, and spent nuclear fuel from reactors contains weapons-useable plutonium.

According to the International Atomic Energy Agency (2010), radioactive waste is any material that contains a concentration of radioactive particles greater than those deemed safe by national authorities, and for which no use is foreseen.

Radioactive wastes can be solid, liquid or gaseous and are produced at every stage of the nuclear fuel cycle:
* Underground and open pit uranium mines generate large volumes of long lived, low level waste which is kept on site.
* In situ leach uranium mines pollute groundwater with radioactive particles, heavy metals and acid.
* Enrichment plants generate large volumes of depleted uranium waste.
* Reactors produce high level radioactive waste in the form of spent nuclear fuel.
* Reactors and other nuclear fuel cycle facilities discharge radioactive emissions to air and water.
* Reprocessing plants generate a high level radioactive waste stream.

Waste categories are determined by the concentration and type of radioactive particles and heat generation. In terms of management options, industry and governments generally consider that shallow repositories are the preferred method of disposal for low level and short lived intermediate level waste, and deep repositories are the preferred method of disposal for long lived intermediate level and high level waste.

Low level waste and short lived intermediate level waste:
Includes a wide range of materials that may be lightly contaminated, such as paper, glassware, tools and clothing. Typically requires isolation for a period of several hundred years. Most of this waste is either disposed of in shallow repositories and is stored pending disposal in a repository. Some low level waste is disposed of in landfill or emitted to air or water.
Long lived intermediate level waste:
Includes reactor components, chemical residues, sealed radioactive sources from medicine and industry and used metal fuel cladding. Requires special handling and shielding of radioactivity, but not cooling. Destined for disposal in deep geological repositories but no such repositories exist (except a military repository, the Waste Isolation Pilot Plant in the US)
High level waste:
Includes spent nuclear fuel intended for disposal and the waste stream from reprocessing spent nuclear fuel. Contains high concentrations of radioactivity and requires cooling and special shielding, handling and storage. Contains both short lived and long lived radionuclides (some with half lives of many thousands of years). Most countries with high level waste envisage disposal in a deep geological repository but no such repositories exist. Some countries reprocess spent nuclear fuel, but this still leaves a high level waste stream.

2. URANIUM MINING WASTE

By far the greatest component of nuclear fuel cycle waste is low level waste from the mining and milling of uranium ores. The most significant wastes are tailings (finely crushed, solid residues from ore processing), liquid waste from processing the ore, and radon gas.

After mining ceases, uranium tailings retain about 80% of the radioactivity of the original ore body. Tailings emit radioactivity to the environment for tens of thousands of years. Before mining the 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 with many recorded examples of leaks, spills and dam collapses (WISE, 2010).

Olympic Dam

Tailings are stored above ground at the Olympic Dam (Roxby Downs) copper/uranium mine in South Australia. The tailings dump amounts to about 100 million tonnes, growing at 10 million tonnes annually. If the mine expansion proceeds as planned, tailings production will increase to 68 million tonnes annually. BHP Billiton plans a tailings 'storage' facility that would cover an area of up to 44 square kms to a height of up to 65 metres.

Serious questions over the long-term management of these tailings remain unanswered. On March 10, 2006, The Australian newspaper reported on documents obtained under Freedom of Information legislation. The documents, written by scientific consultants to BHP, state that the mine needs urgent improvements in radioactive waste management and monitoring. They call on government regulators to "encourage" changes to the tailings management, noting that radioactive slurry was deposited "partially off" a lined area of a storage pond thereby contributing to greater seepage and rising ground water levels.

In 2009, an Olympic Dam mine worker provided the media with photos of multiple leaks in a tailings dam at Olympic Dam. BHP Billiton's response was to threaten "disciplinary action" against any worker caught taking photos of the mine site. The Olympic Dam mine is not required to fully comply with the SA Freedom of Information Act.

(More information: <www.foe.org.au/anti-nuclear/issues/oz/u/roxby>)

Ranger

The Ranger uranium mine in the Northern Territory (NT) is operated by Energy Resources of Australia (ERA), majority owned by Rio Tinto. Since it was established in the 1980s, the mine has been plagued with recurring water and tailings management problems. Contaminated water regularly leaks into Kakadu National Park. Hundreds of spills, leaks and license breaches have been recorded. A recent Australian Government report indicated that the Ranger tailings dam is probably seeping at a rate of 150,000 litres daily. In April 2010, contaminated water was detected downstream of the mine in Magela Creek near where 40 people live. ERA acknowledged that mine was the source of the contamination. In December 2008, a dam burst sending six million litres of contaminated water into the National Park.

Ranger is located in an excised area amongst Kakadu's extensive wetlands − a system of floodplains, swamps, estuaries, mangroves and mudflats. Seasonal flooding underlines concerns about leaks and spills into waterways still used as a traditional food source. In the 1998-99 wet season, high uranium concentrations in water discharged into the Coonjimba and Magela Creeks was discovered. Contaminated water was released into the creeks for three subsequent seasons before the problem was addressed.

ERA is developing plans to expand its Ranger operations by introducing heap leach mining, which involves spraying sulphuric acid onto piles of low grade ore and collecting the slurry for processing to extract the uranium. Mirarr Traditional Owners are fighting to prevent the expansion of the mine (www.mirarr.net).

Beverley − in-situ leach (ISL) mining

ISL uranium mining is used at the Beverley uranium mine in South Australia and it is the mining method proposed for Beverley Four Mile, Oban and Honeymoon.

ISL mining involves pumping an acidic solution into an aquifer, dissolving the uranium and other heavy metals and pumping the solution back to the surface. After the uranium has been separated, liquid radioactive waste is simply dumped in the aquifer. This liquid waste contains radioactive materials, heavy metals and acid.

Isolation and containment of the pollutants would not be difficult or expensive, but mining companies take the cheaper option of polluting groundwater. Proponents of ISL mining claim that "attenuation" will occur over time − that the groundwater will return to its pre-mining state. However, there is considerable scientific uncertainty about the future of ISL-polluted groundwater. A 2003 Senate References and Legislation Committee report recommended banning the discharge of radioactive liquid mine waste to groundwater.

Spills and leaks are common at ISL mines. The SA Department of Primary Industry and Resources lists 59 spills at Beverley from 1998 to 2007, some involving many thousands of litres of liquid radioactive waste.

3. WASTE GENERATED OVERSEAS FROM AUSTRALIA'S URANIUM EXPORTS

Australia's annual uranium exports averaged 8100 tonnes from 2000−2009 (WNA, 2010). When processed in nuclear plants overseas, 8100 tonnes of uranium gives rise to:
* 1134 tonnes of enriched uranium
* 7000 tonnes of depleted uranium waste
* 1134 tonnes of spent nuclear fuel containing 8.9 tonnes of plutonium

The Australian Safeguards and Non-proliferation Office provides the following information on 'Australian Obligated Nuclear Materials' (arising from Australia's uranium exports) held overseas as at 31 December 2008 (ASNO, 2008-09):
* depleted uranium − 93,618 tonnes − held in the EU, Japan, South Korea, US.
* plutonium − 121.4 tonnes − held in Canada, EU, Japan, Mexico, South Korea, Switzerland, US.

4. URANIUM ENRICHMENT AND DEPLETED URANIUM

Natural uranium contains 0.7% of the uranium-235 isotope and 99.3% of the uranium-238 isotope (with traces of other uranium isotopes). Enrichment increases the percentage of uranium-235 to 3-5% which makes it suitable for use as fuel in most of the world's nuclear power reactors.

The enrichment technologies commercially available at present are the gaseous diffusion process and the centrifuge process. Both of them require the prior conversion of the uranium to gaseous uranium hexafluoride (UF6).

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. When natural uranium is enriched, one-seventh of the original amount becomes enriched uranium fuel; the other six-sevenths becomes DU waste.

Thus very large stockpiles of DU waste have been created, estimated at 1.5 million tonnes at the start of 2005 (IAEA, 2006).

Peter Diehl (2010) from the World Information Service on Energy summarises storage and disposal issues: "Most of the depleted uranium produced to date is being stored as UF_6 in steel cylinders in the open air in so-called cylinder yards located adjacent to the enrichment plants. ... Chemically, UF_6 is very reactive: with water it forms the extremely corrosive hydrofluoric acid and the highly toxic uranyl fluoride (UO_2F_2). The hydrofluoric acid causes skin burns, and, after inhalation, damages the lungs. Further health hazards result from the chemical toxicity of the uranium to the kidneys, and from the radiation of the uranium (an alpha emitter). In the storage yards, the cylinders are subject to corrosion. The integrity of the cylinders must therefore be monitored and the painting must be refreshed from time to time. This maintenance work requires moving of the cylinders, causing further hazards from breaching of corroded cylinders, and from handling errors. ... For long-term storage or disposal, the depleted UF_6 must be converted to a less reactive chemical form: candidates are UF_4, U_3O_8, and UO_2."

DU has military uses:
* It is used in munitions (e.g. missile nose cones) used to pierce armour plating. It has been used in munitions used by the US and NATO in Iraq, the Balkans and Afghanistan. This has generated controversy because of the long-term public health and environmental risks associated with DU.
* 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.
* Enrichment plants are of military significance since they can produce not only low enriched uranium for use as reactor fuel, but also highly enriched uranium which can be used as the fissile (explosive) material in nuclear weapons.

There are also civil uses of DU. It can be re-enriched to provide more fuel for reactors. It is sometimes used as a radiation shield or as ballast (because of its weight). It can also be used to provide fuel for fast neutron reactors although very few of these reactors exist.

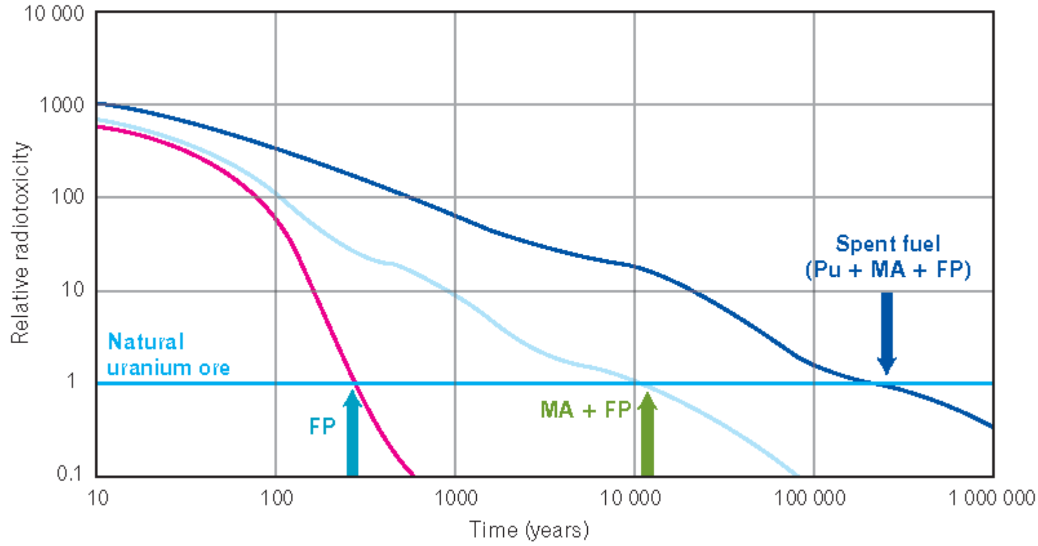
(For more information on DU and enrichment plants see Makhijani and Smith, 2005.)

5. NUCLEAR REACTORS AND SPENT NUCLEAR FUEL

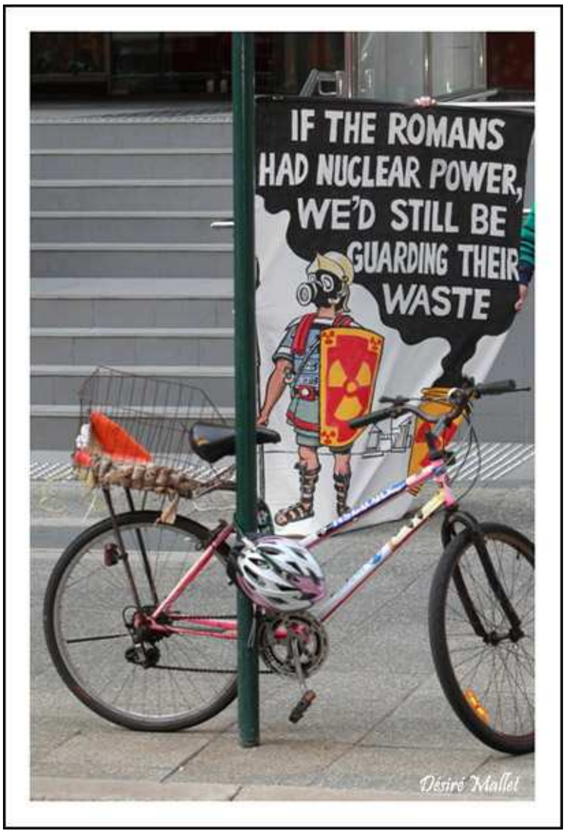
The waste produced in nuclear reactors − called spent nuclear fuel − is orders of magnitude more radioactive than fresh uranium fuel. This is because irradiation of uranium produces many types of radioactive particles.

It takes about 200,000 years for the radioactivity of spent fuel to decline to that of the original uranium ore body because of the time required for decay of transuranics and long lived fission products in the fuel. Transuranics or actinides are elements such as plutonium, which are heavier than uranium. Fission products are uranium break-up products; they are elements lighter than uranium.

For the high level waste stream from reprocessing (from which plutonium and uranium have been removed), it takes about 10,000 years for the radioactivity to decline to that of the uranium ore body. (Switkowski Report, 2006.)



FP = fission products; MA = minor actinides; Pu = plutonium



A typical power reactor produces about 30 tonnes (10 m3) of spent nuclear fuel annually, as well as 300 m3 of low and intermediate level waste. (Switkowski Report, 2006.)

Annually, nuclear power plants around the world produce 12,000 to 14,000 tonnes of spent fuel, and about 200,000 m3 of low and intermediate level waste.

About 340,000 tonnes of spent fuel have been produced in power reactors around the world. About one third of that amount has been reprocessed and the remainder is stored.

These are small amounts of waste compared to the mass or volume of wastes generated by coal-fired electricity plants. However, there are very large waste streams generated across the nuclear fuel cycle, not least many millions of tonnes of uranium mine tailings wastes. Moreover it is not the volume or mass of spent fuel that is of concern but its extreme toxicity, longevity, heat generation, and the fact that it contains plutonium which can be extracted for use in nuclear weapons.

Storage of spent fuel in reactor cooling ponds for several years after its removal from the reactor is necessary to allow residual heat to decline to levels that facilitate handling. This is usually followed by longer term storage away from the reactor, pending reprocessing or eventual disposal.

6. NUCLEAR POWER IN AUSTRALIA − HOW MUCH WASTE?

Former Chair of the Board of the Australian Nuclear Science and Technology Organisation, Ziggy Switkowski (2009b), has been promoting the construction of 50 nuclear power reactors in Australia. Each year, 50 reactors would:
* be responsible for 36 million tonnes of low level radioactive tailings waste (assuming the uranium came from Olympic Dam).
* be responsible for 8600 tonnes of depleted uranium waste.
* produce 1500 tonnes of high level nuclear waste (approx. 500 m3).
* produce 15,000 cubic metres of low level waste and intermediate level waste.
* produce 15 tonnes of plutonium, enough for 1500 nuclear weapons assuming 10 kgs of 'reactor grade' plutonium for one weapon.

Over a 50-year lifespan, 50 reactors would:
* be responsible for 1.8 billion tonnes of low level radioactive tailings waste (assuming the uranium came from Olympic Dam).
* be responsible for 430,000 tonnes of depleted uranium waste.
* produce 75,000 tonnes of high level nuclear waste (approx. 25,000 cubic metres).
* produce 750,000 cubic metres of low level waste and intermediate level waste.
* produce 750 tonnes of plutonium, enough for 75,000 nuclear weapons.

To give some sense of scale, successive Australian governments have attempted − to date without success − to establish a repository for low and intermediate level waste stockpiles which now amount to 4000 cubic metres. Thirteen reactors in Australia would produce that volume of low and intermediate level waste each year, in addition to the spent fuel they would produce and the much larger volumes of tailings waste and depleted uranium they would be responsible for.

As the Switkowski Report (2006) noted: "Establishing a nuclear power industry would substantially increase the volume of radioactive waste to be managed in Australia and require management of significant quantities of HLW [high level waste]."

The Switkowski Report (2006) states that with a nuclear power industry in Australia, a repository would be required for the more voluminous low level wastes soon after start-up. The smaller volumes of long lived intermediate and high level waste could be managed initially through interim storage, followed by deep geological disposal.

Former Liberal Party Senator Nick Minchin has commented on the difficulty of managing wastes from a nuclear power program: "My experience with dealing with just low level radioactive waste from our research reactor tells me it would be impossible to get any sort of consensus in this country around the management of the high level waste a nuclear reactor would produce."

7. REPOSITORIES

"The greatest minds in the nuclear establishment have been searching for an answer to the radioactive waste problem for fifty years, and they've finally got one: haul it down a dirt road and dump it on an Indian reservation".

-- Winona LaDuke, Indigenous World Uranium Summit, 2006

Not a single repository exists anywhere in the world for the disposal of high level waste from nuclear power reactors. 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 as former IAEA Director-General Mohamed El Baradei (2000, 2003) notes, these plans face significant obstacles including lack of public acceptance, cost, lack of expertise and lack of suitable sites.

A 2006 survey of 39 countries with civil nuclear power or other significant sources of radioactive waste found that 19 have decided in favour of deep geological disposal and 10 have expressed a preference for this approach (Sustainable Development Commission, 2006).

The Massachusetts Institute of Technology (MIT) Interdisciplinary Study into the future of nuclear power notes that if global nuclear output was increased almost three-fold to 1000 GWe, and assuming direct disposal rather than reprocessing, new repository storage capacity equal to the legal limit established for Yucca Mountain (70,000 tonnes) would have to be created somewhere in the world "roughly every three or four years". With a ten-fold increase in nuclear power, new repository storage capacity equal to the legal limit for Yucca Mountain would have to be created somewhere in the world every year. The MIT Interdisciplinary Study notes that "the organizational and political challenges of siting will surely be formidable." (Ansolabehere et al., 2003.)

Former Chair of the Board of the Australian Nuclear Science and Technology Organisation, Ziggy Switkowski (2009), claims that "critics are correct in noting that no such [high level waste] repository is in place, though several will open in the next decade." However it is unlikely that a single high level nuclear waste repository will open anywhere in the world in the next decade. According to World Nuclear Association web-papers, Sweden plans to have a repository operational in 2023; Finland is working on plans for a repository "with a view to operation from 2020"; and France has a target date of 2025 (http://world-nuclear.org/infomap.aspx).

Plans for a high level waste repository at Yucca Mountain in Nevada, USA, were abandoned in 2009. Over 20 years of work was put into the repository plan, and over A$10 billion spent. The repository plan was controversial and subject to occasional scandals. These included a scandal involving the falsification of safety data in relation to groundwater modeling. 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 also generated controversy.

Shallow repositories for low and short-lived intermediate level waste have been established in over 30 countries. Many have experienced problems. Three repositories in the USA have been closed because of environmental problems. Farmers in the Champagne region of France have taken legal action in relation to a leaking radioactive waste dump. In Asse, Germany, all 126,000 barrels of waste already placed in a repository are being removed because of large-scale water infiltration over a period of two decades.

8. REPROCESSING SPENT NUCLEAR FUEL

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 (Sellafield) and France (La Hague). There are smaller plants in India, Russia and Japan. Japan plans to begin large-scale reprocessing at the Rokkasho plant. (In addition, a number of countries have military reprocessing plants.)

Reprocessing is arguably the most dangerous and dirty phase of the nuclear fuel chain. Reprocessing generates large waste streams with no management solution and it separates weapons-useable plutonium from spent fuel.

Proponents of reprocessing give the following four justifications:

1. 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. Steve Kidd (2004) 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."

2. 'Recycling' uranium to reduce reliance on natural reserves.

However, only an improbably large expansion of nuclear power would result in any problems with uranium supply this century. A very large majority of the uranium separated from spent fuel at reprocessing plants is not reused, but is stockpiled. Uranium from reprocessing is used only in France and Russia and accounts for only 1% of global uranium usage (IAEA, 2006). It contains isotopes such as uranium-232 which complicate its use as a reactor fuel.

3. Separating plutonium for use as nuclear fuel.

However there is very little demand for plutonium as a nuclear fuel. It is used in 'MOX' reactor fuel (mixed uranium-plutonium oxide), which accounts for 2−5% of worldwide nuclear fuel, and in a small number of fast neutron reactors.

4. Using plutonium as a fuel so that it can no longer be used in nuclear weapons.

However, reactors which can use plutonium as fuel can produce more plutonium than they consume. Moreover, since there is so little demand for plutonium as a reactor fuel, stockpiles of separated plutonium continually grow and now amount to about 250 tonnes (enough for 25,000 nuclear weapons). Reprocessing has clearly worsened rather than reduced proliferation risks. Addressing the problem of growing stockpiles of separated plutonium could hardly be simpler – it only requires that reprocessing be slowed, suspended, or stopped altogether.

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 and unnecessary 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. 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.

None of this is logical or justifiable on non-proliferation, environmental, public health or economic grounds but it suits the short-term political and commercial objectives of those involved.

(See Friends of the Earth, 2008, for more information on reprocessing.)

9. TRANSMUTATION AND OTHER NOVEL TECHNOLOGIES

Transmutation is a technological 'solution' sometimes proposed to deal with high level, long lived waste. The aim is to use reactors, spallation technology or particle accelerators to generate beams of neutrons or charged particles to transform long lived radionuclides into shorter lived or stable isotopes. For example, neutron bombardment of radioactive iodine-129 results (indirectly) in its conversion to stable, non-radioactive xenon. And neutron bombardment of plutonium and neptunium leads to their fission which converts them into shorter-lived radionuclides.

Problems with transmutation include the following (Zerriffi and Makhijani, 2000; Ansolabehere et al., 2003):
* The technology is immature and its future is uncertain.
* It is useful only for certain types and forms of waste. It does not do away with the need for long-term management (storage or disposal) of the resulting wastes.
* It may require the use of reactors (with the attendant proliferation, public health and environmental risks).
* It may require reprocessing (with the attendant proliferation, public health and environmental risks) to separate waste streams prior to selective treatment. Failure to separate/partition can lead to unwanted outcomes such as conversion of stable isotopes into radioactive isotopes.

The MIT Interdisciplinary Study concludes that: "Decisions about partitioning and transmutation must ... consider the incremental economic costs and safety, environmental, and proliferation risks of introducing the additional fuel cycle stages and facilities necessary for the task. These activities will be a source of additional risk to those working in the plants, as well as the general public, and will also generate considerable volumes of non-high-level waste contaminated with significant quantities of transuranics. Much of this waste, because of its long toxic lifetime, will ultimately need to be disposed of in high-level waste repositories. Moreover, even the most economical partitioning and transmutation schemes are likely to add significantly to the cost of the once-through fuel cycle." (Ansolabehere et al., 2003.)

Another novel technology is 'pyroprocessing', which would be used on conjunction with fast neutron reactors (but could not be used in conjunction with conventional reactors). Spent fuel is dissolved in a chemical bath, electrodes are inserted to selectively concentrate plutonium and other transuranics which can then be recycled as fast reactor fuel. This process is preferable to conventional reprocessing as it does not involve plutonium separation, and the mix of transuranics (including plutonium) could not be used in weapons (unless it was further processed to separate the plutonium). The waste stream of fast reactors coupled with pyroprocessing would be fission products, most of which are short-lived. (Hannum et al., 2009.)

Pyroprocessing has been demonstrated on a pilot scale but considerable further work needs to be done. In 2009, South Korea announced its intention to embark on a R&D program to assess the viability of operating reactors in conjunction with pyroprocessing by the year 2028. That is almost 20 years − just to assess the viability of the concept.

10. RADIOACTIVE WASTE IN AUSTRALIA

In addition to uranium mine wastes, Australia has a stockpile of about 4000 m3 of low and intermediate level waste, increasing at the rate of 50 m3 each year. By volume, about half of this is very low level waste (contaminated soil from the processing of ores by the CSIRO) stored at Woomera in South Australia, and most of the remainder is stored at ANSTO's Lucas Heights facility. Measured by radioactivity, ANSTO accounts for a large majority of the waste.

Radioactive waste stored at Lucas Heights.

The former Coalition government planned to establish a national radioactive waste dump in South Australia but abandoned the plan in the face of public opposition in July 2004. Plans to dump the waste an unspecified Pacific island were pursued for the following 12 months. In July 2005 the government announced plans to establish a repository in the Northern Territory. That process has also been pursued by the Labor government since it was elected in November 2007. Just one site is under active consideration − Muckaty, 120 kms north of Tennant Creek. If built the repository will accept low and short lived intermediate level waste.

The proposed repository at Muckaty is controversial. It is opposed by the NT government. The NT Parliament has passed legislation banning the imposition of radioactive waste dumps but the federal government plans to ignore or override the NT legislation.

Resources Minister Martin Ferguson claims that Muckaty Traditional Owners support the nomination of the site. However Mr Ferguson has received a letter opposing the dump signed by 57 Muckaty Traditional Owners. Moreover, Senior Traditional Owners have initiated legal action in the Federal Court challenging the nomination of the Muckaty site. Mr Ferguson has refused countless requests to meet with Traditional Owners opposed to the dump, stating that consultation will take place after decisions have been made.

The NT Labor Party has called on the federal government to exclude Muckaty on the grounds that the nomination "was not made with the full and informed consent of all Traditional Owners and affected people and as such does not comply with the Aboriginal Land Rights Act".

The federal Labor government has put the National Radioactive Waste Management Bill (NRWMB) before Parliament. The NRWMB is draconian, overriding all state/territory laws which could in any way impede the repository plan. The Bill limits the application of federal environmental protection legislation, Aboriginal heritage protection legislation, and appeal rights. Labor's promise to handle this issue in an open, transparent and fair manner has not been met.

No progress has been made towards the establishment of a deep geological repository for long lived intermediate level waste in Australia. Spent fuel from Lucas Heights is sent overseas for reprocessing.

Some reprocessing waste will be returned from the UK and France. The government plans to store this long lived intermediate level reprocessing waste above ground at the proposed repository site in the NT.

The Western Australian government operates a low level waste disposal facility at Mount Walton East in the Goldfields. The Queensland government operates a purpose-built store at Esk while other states store radioactive waste, usually at the point of production.

11. AUSTRALIA AS THE WORLD'S NUCLEAR WASTE DUMP?

Some argue that Australia should establish a deep geological repository and accept high level nuclear waste from overseas. A variation of the argument is that Australia should accept high level waste arising from the processing of Australian uranium.

It is argued that Australia would be making a contribution to global non-proliferation efforts by accepting nuclear waste from overseas. However it is not clear that non-proliferation efforts would be advanced. It would depend on many factors, not least whether the waste contains weapons-useable plutonium. Spent fuel contains plutonium, but the high level waste stream from reprocessing does not. Globally, power reactors have produced about 2000 tonnes of plutonium (enough for 200,000 weapons). Australia's uranium exports have produced over 120 tonnes of plutonium (enough for 12,000 weapons).

It is argued that Australia has a responsibility to accept waste arising from the processing of uranium exports. However the larger share of the responsibility lies with the countries that make use of Australian uranium. Moreover, while uranium mining companies arguably ought to take some responsibility for the waste arising from their exports, it is not clear that responsibility lies with Australia as a whole. One plausible scenario is uranium being mined on Aboriginal land regardless of Aboriginal opposition, and high level waste being dumped on Aboriginal land, again without consent.

The argument that Australia should accept high level nuclear waste imports rests on the questionable assumption that it would be carefully and responsibly managed in Australia. To give a fairly recent example of mismanagement of radioactive waste in Australia, the 'clean up' of the Maralinga nuclear test site in the late 1990s was botched. Even after the 'clean up', tonnes of plutonium contaminated waste remain buried in shallow, unlined pits in totally unsuitable geology. As nuclear engineer Alan Parkinson said of the 'clean-up' on ABC radio on August 5, 2002: "What was done at Maralinga was a cheap and nasty solution that wouldn't be adopted on white-fellas land." Nuclear physicist Professor Peter Johnston noted that "there were ... very large expenditures and significant hazards resulting from the deficient management of the project by [the Department of Education, Science and Training]."

There are serious environmental and public health risks associated with high level nuclear waste. Professor John Veevers (1999) states: "[T]onnes of enormously dangerous radioactive waste in the northern hemisphere, 20,000 kms from its destined dump in Australia where it must remain intact for at least 10,000 years. These magnitudes − of tonnage, lethality, distance of transport, and time − entail great inherent risk."

Dr Mike Sandiford (2009) from School of Earth Sciences at University of Melbourne writes: "Australia is relatively stable but not tectonically inert, and appears to be less stable than a number of other continental regions. Some places in Australia are surprisingly geologically active. We occasionally get big earthquakes in Australia (up to about magnitude 7) and the big ones have tended to occur in somewhat unexpected places like Tennant Creek. The occurrences of such earthquakes imply that we still have much to learn about our earthquake activity. From the point of view of long-term waste disposal this is very important, since prior to the 1988 (M 6.8) quake, Tennant Creek might have been viewed as one of the most appropriate parts of the continent for a storage facility.

Australia is not the most stable of continental regions, although the levels of earthquake risk are low by global standards. To the extent that past earthquake activity provides a guide to future tectonic activity, Australia would not appear to provide the most tectonically stable environments for long-term waste facilities. However, earthquake risk is just one of the 'geologic' factors relevant to evaluating long-term integrity of waste storage facilities, and other factors such as the groundwater conditions, need to be evaluated in any comprehensive assessment of risk."

12. WHAT TO DO WITH RADIOACTIVE WASTE?

A common-sense approach to radioactive waste involves the following three steps:
1. Minimising the production of radioactive waste;
2. Thoroughly assessing all options for the management of radioactive waste; and
3. Using scientific and environmental siting criteria rather than choosing politically 'soft' targets.

Public involvement in decision making, and informed consent to proposals, is also essential if an equitable outcome is to be achieved. Involvement and informed consent are also desirable from a practical point of view. There is a long history of communities successfully mobilising to force the abandonment of nuclear dump proposals. The UK Committee on Radioactive Wast Management emphasises two key principles of "voluntarism and partnership between communities and implementers". <www.corwm.org.uk>

Before producing radioactive waste, it needs to be demonstrated that the benefits outweigh the risks. Unfortunately, waste minimisation principles are too often honoured in the breach. For example, the plan for a new reactor at Lucas Heights was not subject to thorough, independent analysis under the Howard government.

Much of the debate on waste management options assumes the 'need' for off-site stores or dumps. But the option of storing waste where it is produced needs serious consideration:
* Even if centralised facilities exist, waste is inevitably stored at the site of production, often for long periods. On-site storage facilities must be adequately constructed and regulated whether or not centralised, off-site waste management facilities exist. With adequate on-site storage facilities, the case for centralised facilities is weakened, especially considering the progressive decline of the radioactivity and toxicity of radioactive waste.
* Storage at the site of production avoids altogether the risks of transportation.
* It is by far the best (and perhaps the only) way to get radioactive waste producers to get serious about minimising waste production. Conversely, the provision of an out-of-sight-out-of-mind disposal option, as with the federal government's planned nuclear waste facility in the NT, is likely to lead to more profligate waste production.
* Organisations producing waste must have the expertise to manage it. Conversely, there is no radioactive waste management expertise in the Tennant Creek / Muckaty area of the NT.

In the case of the Lucas Heights research reactor plant, operated by the Australian Nuclear Science and Technology Organisation (ANSTO), it is difficult to see why ANSTO cannot continue to store its waste rather than the current push to dump it in the NT – albeit the case that improved waste management systems and greater transparency are required at ANSTO. All relevant organisations − including ANSTO, the regulator ARPANSA, the Australian Nuclear Association and even Martin Ferguson's own department − have acknowledged that ongoing storage at Lucas Heights is a viable option.

If a site selection process is required for a waste store or repository, it ought to be based on scientific and environmental criteria, as well as on the principle of community consent. When the federal Bureau of Resource Sciences conducted a preliminary site selection study in the 1990s, based on environmental and scientific criteria, the Muckaty area did not even make the short-list as a "suitable" site for a nuclear dump, yet Muckaty is the only site now under consideration.

13. REFERENCES

Ansolabehere, Stephen, et al., 2003, "The Future of Nuclear Power: An Interdisciplinary MIT Study", <web.mit.edu/nuclearpower>.

El Baradei, Mohamed, 2000, "Signs of progress: IAEA perspectives on radioactive waste management", IAEA Bulletin, 42/3/2000.

El Baradei, Mohamed, 2003, "Geological Repositories: The Last Nuclear Frontier", Statement to International Conference on Geological Repositories: Political and Technical Progress, 8-10 December 2003, Stockholm, Sweden, <www.iaea.org/NewsCenter/Statements/2003/ebsp2003n028.html>.

ASNO − Australian Safeguards and Non-proliferation Office, 2008-09, Annual Report, <www.asno.dfat.gov.au/annual_reports.html>

Diehl, Peter, 'Depleted Uranium: a by-product of the Nuclear Chain', <www.wise-uranium.org/dhap991.html>. [Accessed November 2010.]

Friends of the Earth, 2008, 'Spent nuclear fuel: reprocessing and repositories', <www.foe.org.au/anti-nuclear/issues/nfc/waste>

Hannum, William H., Gerald E. Marsh and George S. Stanford, 26 January 2009, 'Smarter Use of Nuclear Waste', Scientific American (online), <www.sciam.com/article.cfm?id=smarter-use-of-nuclear-waste>.

IAEA − International Atomic Energy Agency, 2006, "Nuclear Technology Review 2006", <www.iaea.org/OurWork/ST/NE/Pess/assets/ntr2006.pdf>.

IAEA − International Atomic Energy Agrency, 'Managing Radioactive Waste', <www.iaea.org/Publications/Factsheets/English/manradwa.html> [Accessed November 2010.]

Johnston, Peter, 2004, Second round submission to ARPANSA regarding proposed repository in South Australia.

Makhijani, Arjun, and Brice Smith, 2005, 'Costs and Risks of Management and Disposal of Depleted Uranium', <www.ieer.org/reports/du/LESprfeb05.html>

Sandiford, Mike, <www.abc.net.au/science/expert/realexpert/nuclearpower/08.htm>. [Accessed 2009.]

Sustainable Development Commission (UK), 2006, The role of nuclear power in a low carbon economy. Paper 5: Waste and decommissioning, <www.sd-commission.org.uk/publications.php?id=340>

Switkowski Report, 2006, Uranium Mining, Processing and Nuclear Energy Review, <http://pandora.nla.gov.au/tep/66043>

Switkowski, Ziggy, 18 December 2009, 'A clean and green way to fuel the nation', The Australian, <www.theaustralian.com.au/news/opinion/a-clean-and-green-way-to-fuel-the-nation/story-e6frg6zo-1225811526701>

Switkowski, Ziggy, 3 December 2009, 'Australia must add a dash of nuclear ambition to its energy agenda', <www.smh.com.au/opinion/politics/australia-must-add-a-dash-of-nuclear-ambition-to-its-energy-agenda-20091201-k3pq.html>

Veevers, J.J., 1999, 'Disposal of British RADwaste at home and in antipodean Australia', Australian Geologist <www.es.mq.edu.au/geology/media/veevers1.htm>

WNA − World Nuclear Association, November 2010, 'Australia's uranium, <www.world-nuclear.org/info/inf48.html>

WISE − World Information Service on Energy, Uranium Project, 2010, Chronology of uranium tailings dam failures, <www.wise-uranium.org/mdafu.html>

Zerriffi, Hisham and Annie Makhijani, May 2000, 'Nuclear Alchemy Gamble: An Assessment of Transmutation as a Nuclear Waste Management Strategy', <www.ieer.org/reports/transm/summary.html>

14. FURTHER READING

'Radwaste' information portal <www.radwaste.org>

Country and regional briefings <http://world-nuclear.org/infomap.aspx>

Plan for Commonwealth repository in NT

Beyond Nuclear Initiative <www.beyondnuclearinitiative.wordpress.com>

Friends of the Earth <www.foe.org.au/anti-nuclear/issues/oz/nontdump> and <www.nuclearfreeways.org.au>

Federal government: <www.radioactivewaste.gov.au>

NSW Inquiry into Nuclear Waste Management 2003-04, Joint Select Committee into the Transportation and Storage of Nuclear Waste, 2004 <www.parliament.nsw.gov.au/nuclearwaste>

Successful campaign against a proposed dump in South Australia: Kupa Piti Kungka Tjuta, Irati Wanti campaign <http://web.archive.org/web/20080718193150/www.iratiwanti.org/home.php3>

Australia as the world's nuclear waste dump

Veevers, J.J., 1999, 'Disposal of British RADwaste at home and in antipodean Australia', Australian Geologist <www.es.mq.edu.au/geology/media/veevers1.htm>

Nuclear Fuel Leasing Group, Submission to UMPNER, 18 August 2006: <http://web.archive.org/web/20070830182528/http://www.pmc.gov.au/umpner/submissions/134_sub_umpner.pdf>

Association for Regional and International Underground Storage <www.arius-world.org>