34,000 tonnes

The radioactive waste creation and effects on rehabilitation of mining 34,000 tonnes of uranium oxide at the proposed Ranger 3 Deeps underground mine, Kakadu, Northern Territory.

December 2012

A report by the Environment Centre NT
Compiled by Cat Beaton and Justin Tutty

With contributions:
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The Ranger uranium mine is operated by Rio Tinto subsidiary Energy Resources of Australia (ERA) and has been operating on the traditional lands of the Mirarr people, wholly surrounded by the World Heritage listed Kakadu National Park in Australia's Northern Territory for three decades.

In this report the Environment Centre NT examines the implications of this new mining proposal and highlights the importance of comprehensive Northern Territory and federal scrutiny of the current and proposed operations and potential impacts on the surrounding area.

In May 2012 ERA commenced work on an underground uranium mine plan. The underground mine proposal – known as Ranger 3 Deeps (R3D) – is focused on an estimated deposit of 34,000 tonne uranium oxide (or 'yellowcake'). ERA have never before used underground mining at Ranger.

This report identifies the far-reaching costs of the Ranger 3 Deeps development. It highlights what mining 10 million tonnes of rock and selling 30,260 tonnes of U_3O_8 (uranium oxide, or yellowcake)[1] means in relation to tailings production and storage, rehabilitation, nuclear weapons proliferation and reactor use in the shadow of Fukushima.

The Ranger mill recovers around 89% of the uranium in the host rock. At this recovery rate the estimated 34,000 tonnes U_3O_8 would become around 30,260 t of commercial U_3O_8. The other 3,740 t U_3O_8 would end up in the tailings. In this report the calculated impacts of R3D production of uranium for sale are based on a predicted production of 30,260 tonnes.

This report details that the R3 Deeps project - should it proceed - would create about 10 million tonnes of uranium mine tailings requiring storage on site in isolation for at least 10,000 years.[2] The Ranger 3 Deeps project would see the creation of 21,990 tonnes of depleted uranium waste, 3,850 tonnes of high level nuclear waste and enough plutonium to build 3900 nuclear weapons.

This report highlights the ongoing environmental risks of uranium mining, It further highlight the fact that decisions made in Jabiru, Darwin and Canberra will have significant, lasting and negative impacts in Australia and beyond.

Ranger Uranium Mine – a porous project

Open cut mining operations at the Ranger Pit #3 ceased in December 2012. From this time onwards the mill will process stockpiled ore. The remaining uranium-bearing ore at Ranger is estimated to be about 140 million tonnes, but these stockpiles are considerably lower in grade than normal ore processed in the mill. Annual production using stockpile sources will be reduced from 5,000 tonnes per annum to around 1,500 t U_3O_8. This is forecast to occur at precisely the time when additional funds for substantial rehabilitation projects and ongoing operational remediation works are needed.

The significant problems and risks regarding water management for an open-cut uranium mine in the wet/ dry tropics have consistently plagued Ranger's operations.

The Supervising Scientist from the federal government's Supervising Scientist Division (SSD) indicated during Senate Estimates in February 2009, that Ranger's Tailing Storage Facility is seeping contaminated water at a rate of around 100,000 litres per day.[3] A modeling study by CSIRO commissioned by ERA estimated seepage from the TSF could reach 150,000 l/day.[4]

In the 2010-11 Wet season, water management problems caused ERA to halt both uranium mining and processing at Ranger on 29th January 2011 - a shutdown which lasted five months and led to a company loss due to lost production and shutdown costs.

The Tailings Storage Facility (TSF) was so full that a lift of the wet season Maximum Operating Limit (MOL) was explicitly approved by the Department of Resources so that ERA would not be in breach of its operating guidelines. Process water reached up to 0.5 metres below the maximum operating level of the dam and contingency plans were put in place to pump process water from the TSF into the currently operational Pit 3 in the event of further rainfall.[5]

The Environment Centre NT is firmly of the view that ERAs track record must be considered when assessing the future Ranger 3 Deeps underground mine proposal.

Rehabilitation of the existing project

The rehabilitation of the Ranger Project Area is currently scheduled to occur from January 2021 to January 2026, when the lease must be surrendered. ERA's legal obligation is that:

> "… the company must rehabilitate the Ranger Project Area to establish an environment similar to the adjacent areas of Kakadu National Park such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated area could be incorporated into the Kakadu National Park."
>
> *(Clause 2.1, Environmental Requirements, Section 41 Authority).*

If commercial mining was to occur at Ranger 3 Deeps, it would appear virtually inevitable that ERA would seek to extend production beyond 2021 – delaying final rehabilitation of the whole site and exacerbating risks associated with tailings and water management. These profound site specific impacts would occur prior to the wider concerns raised by the export of any uranium and its potential to fuel another Fukushima disaster.

The Ranger 3 Deeps deposit

ERA now estimates that the 'Ranger 3 Deeps' deposit holds some 34,000 tonnes U_3O_8. In August 2011 the company revealed that the size of the deposit was thought to be about 10 million tonnes of ore at an average grade of around 0.34% U_3O_8.[6]

To further explore and access the deposit ERA are currently constructing a tunnel to allow more drilling, to better model and understand the ore zones. Construction of the 3 Deeps box cut decline began on 1 May 2012 and will tunnel for 2 kilometres down to a depth of 350 metres under the Magela Creek and floodplain.

The Environment Centre NT maintains that the R3D exploration decline tunnel is part of the infrastructure needed for commercial mining of the 3 Deeps deposit, and should be assessed accordingly.

The Federal Government has come under heavy criticism for allowing 'mining dressed as exploration' to occur with no environmental assessment. There is a compelling case that construction of the decline should be recognised as mining activity under the NT Mining Management Act. On a Federal level the Ranger 3 Deeps decline should have been recognised as a nuclear action and triggered the Environment Protection and Biodiversity and Conservation Act (EPBC) for detailed assessment before construction was approved and commenced.

The 3 Deeps decline is a tunnel big enough to drive a truck into and is well beyond anything ever previously considered for authorisation for exploration.

This 'exploration' project will take over 18 months of construction before drilling can be undertaken. With the current Ranger uranium mine lease due to expire in 2021, there is much speculation over the company's mid to long term intentions and CEO Robert Atkinson has said publicly that the company would like to continue mining beyond 2021.[7]

The Environment Centre NT and the Australian Conservation Foundation have called for a federal review on the decline project and the highest level of federal assessment and scrutiny of any future mining application by ERA.[8]

Nuclear power and waste

The calculations for nuclear waste creation are based on:

- an 89% recovery of 34,000 tonnes = 30,260t U308 with the remaining 11% lost to tailings
- a uranium content of 25,660 tonnes
- the assumption that six sevenths of enrichment feedstock becomes Depleted Uranium waste (and the remainder is low-enriched uranium for use in reactors)
- a 1 GW reactor uses 200 tonnes uranium per year, thus 25,660 tonnes equates to 128.3 reactor-years
- a 1 GW reactor generates 30 tonnes of spent fuel each year
- 30 tonnes of spent fuel contains 300 kgs plutonium, sufficient for 30 nuclear weapons (10 kgs / weapons)

Based on the above calculations and assumptions, export from the Ranger 3 Deeps project would create the following waste across the nuclear fuel cycle:

- about 10 million tonnes of uranium mine tailings waste (long lived low-level radioactive waste);
- 21,990 tonnes of depleted uranium waste;
- 3,850 tonnes of high level nuclear waste (in the form of spent nuclear fuel) containing approximately 39 tonnes of plutonium (enough for 3900 nuclear weapons)

Mine (tailings) waste

Exports from 34,000 tonnes of Ranger 3 Deeps uranium oxide would generate about 10 million tonnes of uranium mine tailings waste.

This long-lived low-level radioactive waste would be stored in perpetuity on the mine site.

Despite the fact that '34,000 tonnes' of uranium oxide would be removed from the ore body, further chemicals about equal in mass are also added.

The tailings also significantly decrease in dry density from crystalline rock to pulverised, ground tailings – from about 3 tonnes per cubic metre as in situ rock to about 1.4 t/m3 as tailings – meaning that 10 million tonnes of ore would become about 7.1 million cubic metres of tailings after processing.

It is also expected that there would be additional waste rock and low grade ore from R3D – and based on typical ratios for these in underground mining, we could assume another 1-2 million tonnes of waste rock and low grade ore bought to the surface from underground mining.

Environmental Requirements[12] attached to the authorisation for Ranger mine specify that the tailings should be managed in such a way as to ensure that:

(i) the tailings are physically isolated from the environment for at least 10,000 years; and

(ii) any contaminants arising from the tailings will not result in any detrimental environmental impacts for at least 10,000 years'.

While such an undertaking is plainly beyond the scope of human and technical capacity, it reflects the long-lived and toxic nature of radioactive mine waste.

DEPLETED URANIUM WASTE

Exports from 34,000 tonnes (30,260 t U_3O_8 as sold) of Ranger 3 Deeps uranium oxide would generate 21,990 tonnes of depleted uranium waste.

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.

A major concern with enrichment plants is that they can be used to produce uranium sufficiently enriched in the uranium-235 isotope to be used directly in a nuclear weapon (such as the weapon that destroyed Hiroshima).

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 globally, estimated at 1.5 million tonnes in 2005.[11]

"Most of the depleted uranium produced to date is being stored as UF_6 (uranium hexa-fluoride) 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). 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). The storage cylinders are subject to corrosion. The integrity of the cylinders must therefore be monitored and 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 UF6 must be converted to a less reactive chemical form: candidates are UF4, U_3O_8, and UO_2."[12]

DU also 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.

As mentioned, enrichment plants can produce highly enriched uranium which can be used as the fissile (explosive) material in nuclear weapons.

For more information on DU and enrichment plants see Makhijani, Arjun, and Brice Smith, 2005, '*Costs and Risks of Management and Disposal of Depleted Uranium',* www.ieer.org/reports/du/LESprfeb05.html

HIGH LEVEL NUCLEAR WASTE AND REPROCESSING

Export of 30,260 tonnes uranium oxide (from 34,000 t U_3O_8 in mined ore at 90% recovery) would generate 3560 tonnes of high level nuclear waste. This would be in the form of spent nuclear fuel, and contain approximately 36 tonnes of plutonium.

The waste that comes out a reactor is called 'spent fuel'. This is not a helpful term as this spent fuel is several orders of magnitude more radioactive than the original uranium fuel – a better term would be 'irradiated fuel'.

One (1GW) reactor in one year produces 30 tonnes of high level nuclear waste in the form of spent fuel. About 340,000 tonnes of spent fuel have been produced in power reactors around the world.

About one third of that amount is reprocessed. The remainder is stored, often on site at the reactor complex.

Reprocessing involves dissolving irradiated fuel in acid and separating it into three streams:

- 1% plutonium,
- 3% waste products, and
- 96% unused uranium.

Most commercial reprocessing takes place in the UK (Sellafield) and France (La Hague). There are smaller plants in India, Russia and Japan.

Reprocessing results in considerable releases of radioactive materials.[13]
It has been described as "environmentally dirty" by the Deputy Director General of the World Nuclear Association.[14]

A major concern with reprocessing is that once the plutonium has been separated from irradiated fuel, it can be used directly in nuclear weapons.

Another significant concern is how long these materials remain highly radioactive.

It takes about 200,000 years for the radioactivity of spent fuel to decline to that of the original uranium ore body and about 10,000 years for products of the high level waste stream from reprocessing (from which plutonium and uranium have been removed).[15]

PLUTONIUM AND PROLIFERATION

Exports from the extraction of 34,000 tonnes of Ranger 3 Deeps uranium oxide would generate 39 tonnes plutonium.

This 39 tonnes of plutonium is sufficient to produce 3900 nuclear weapons (10kg/weapon).

Nuclear industry advocates sometimes claim that the 'reactor grade' plutonium produced in power reactors cannot be used in nuclear weapons. This claim is false. 'Reactor grade' plutonium can be and has been used in weapons. An expert committee drawn from the major US nuclear laboratories concludes that:

"Although weapons-grade plutonium is preferable for the development and fabrication of nuclear weapons and nuclear explosive devices, reactor grade plutonium can be used."

Many other experts and expert committees have reached the same conclusion.

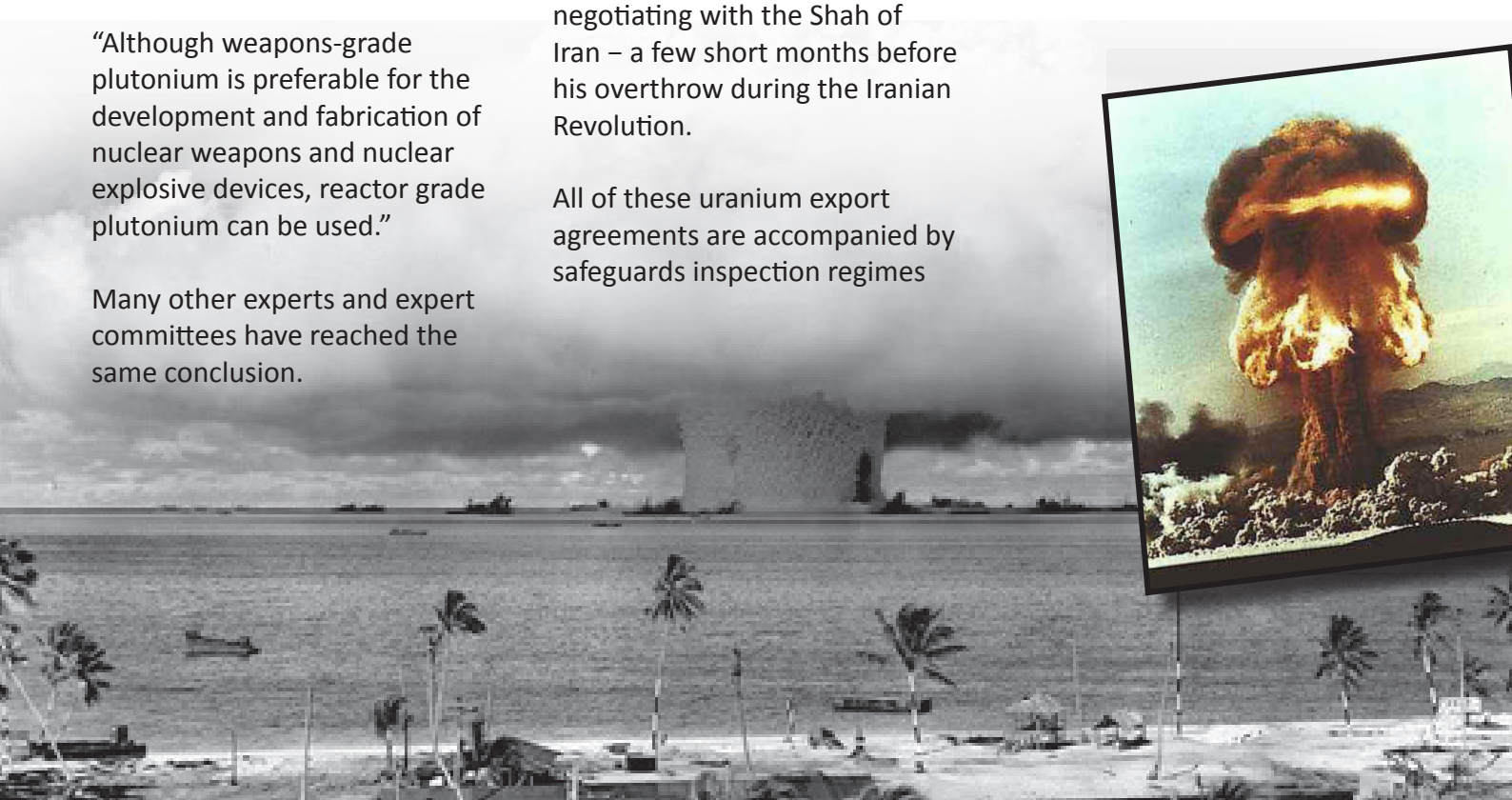
Moreover reactors can be operated on a shorter irradiation cycle to produce weapon grade plutonium.

Australia has uranium export agreements with nuclear weapons states with no intention of meeting their Nuclear Non-Proliferation Treaty (NPT) disarmament obligations; countries that are not NPT signatories with a history of secret nuclear weapons research; countries that refuse to sign and ratify the Comprehensive Test Ban Treaty; countries blocking progress on the proposed Fissile Material Cut-Off Treaty and undemocratic, secretive states with poor human rights records.

The Federal Government is now planning uranium sales to a non-democratic Middle Eastern state – the United Arab Emirates.
The last time Australia planned uranium sales to a Middle Eastern state was in 1979 when the Fraser government was negotiating with the Shah of Iran – a few short months before his overthrow during the Iranian Revolution.

All of these uranium export agreements are accompanied by safeguards inspection regimes that are at best modest, sometimes tokenistic (e.g. China) and sometimes all but non-existent (e.g. Russia).
ERA is expected to soon move to export uranium oxide to Russia.

The former Direct or General of the International Atomic Energy Agency, Dr. Mohamed El Baradei, has noted that the International Atomic Energy Agency's basic rights of inspection are "fairly limited", that the safeguards system suffers from "vulnerabilities" and it "clearly needs reinforcement", that efforts to improve the system have been "half-hearted", and that the safeguards system operates on a "shoestring budget ... comparable to that of a local police department ".



NUCLEAR POWER DISASTERS

"The Fukushima Daiichi accident is one of the most serious and complex disasters which human beings have ever had to deal with."

– International Atomic Energy Agency Director-General Yukiya Amano, 27 July 2011.

In March 2011 an earthquake and tsunami devastated Japan causing extensive damage to the Fukushima Daiichi nuclear power plant.

Electricity for the plant was cut off, the back up generators failed and the reactors were left without any method of being cooled. The Fukushima crisis was rated a Level 7 on the 7-point International Nuclear Events Scale – on par with Chernobyl.

Four of the six reactors were seriously damaged, suffering fires and explosions. Fuel rods were melting due to the lack of cooling and there was damage to the reactor core and spent fuel rod stores.[16]

More than 150,000 people have been displaced as a result of the crippled power plant. The crisis will remain for many years.

"No less than 99 nuclear accidents (defined as incidents that either resulted in the loss of human life or more than US$500,000 of property damage ...), totalling US$20.5 billion in damages, have occurred worldwide from 1952 to 2009"

– Benjamin Sovacool, August 2012 [17]

"We can confirm that Australian obligated nuclear material was at the Fukushima Daiichi site and in each of the reactors"

- Dr Floyd, Director-General of the Australian Safeguards and Non-Proliferation Office.

Environment Centre NT

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The Environment Centre NT strongly opposes the development of the Ranger 3 Deeps uranium mine. The creation of radioactive waste at the Ranger Project Area and through the wider nuclear cycle is detrimental to a healthy environment. The Environment Centre NT maintains that a full Environmental Impact Statement is required should ERA proceed with any application to mine Ranger 3 Deeps.

The Environment Centre NT urges Energy Resources of Australia to consider the wider impacts of the uranium industry. Post-Fukushima, there will be growing pressure on Energy Resources of Australia to assume full responsibility for the product it sells, the waste it creates and the disasters it may cause both here in Australia and overseas.

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1. 30,260 t U3O8 based on around 89% recovery during milling from ore containing 34,000 t U3O8, based on production data taken from ERA Annual Reports, 1981-2011
2. Atomic Energy Act 1953 Clause 2.1, Environmental Requirements, Section 41 Authority
3. Commonwealth of Australia, Environment, Communications and the Arts Standing Committee, Hansard, 24/02/09, p32
4. M. G. Trefry, 14 November 2008. Ranger Tailings Storage Facility: Review of hydrogeological issues for a wall lift to RL+54m. Report to Energy Resources of Australia Ltd, CSIRO, Canberra.
5. Supervising Scientist Annual Report 2010-2011. 2.2 Ranger. P. 7-9
6. Energy Resource of Australia Ltd, ASX Announcement, Ranger 3 Deeps Exploration Decline (August 25, 2011)
7. ABC News online. 'ERA keen to keep uranium mine open beyond 2021' (April 22, 2009)
8. Australian Conservation Foundation News and Media, May Day! Kakadu uranium miner expanding by stealth (May 1, 2012)
9. The 2006 Switkowski Report notes that a typical power reactor produces about 30 tonnes of spent nuclear fuel annually, as well as 300 m3 of low and intermediate level waste. (Uranium Mining, Processing and Nuclear Energy Review)
10. Ranger Uranium Mine, Environmental Requirements, clause 11.3
11. IAEA – International Atomic Energy Agency, 2006, "Nuclear Technology Review 2006", www.iaea.org/OurWork/ST/NE/Pess/assets/ntr2006.pdf
12. Diehl, Peter, 'Depleted Uranium: a by-product of the Nuclear Chain', www.wise-uranium.org/dhap991.html
13. http://www.ucsusa.org/nuclear_weapons_and_global_security/nuclear_terrorism/technical_issues /reprocessing-and-nuclear .html
14. http://www.neimagazine.com/story.asp?sectionCode=147&storyCode=2023239
15. Switkowski Report, 2006. Uranium Mining, Processing and Nuclear Energy Review, <http://pandora.nla.gov.au/tep/66043
16. Let the Facts Speak: Page 15. No. 12, Fukushima, Japan
17. Sovacool , B. 'A Critical Evaluation of Nuclear Power and Renewable Electricity in Asia', Journal of Contemporary Asia, Vol. 40 No.3, pp.369–400