The Asia-Pacific Journal: Japan Focus
n-depth critical analysis of the forces shaping the Asia-Pacific...and the world.

Plutonium and Japan's Nuclear Waste Problem: International Scientists Call for an End to Plutonium Reprocessing and Closing the Rokkasho Plant

Piers Williamson

On 31 May 2012, Professor Mizukami Tetsuo (Institute for Peace and Community Studies, Rikkyo University) hosted two lectures on the problems associated with reprocessing spent nuclear fuel. The speakers were Professor Frank von Hippel[1] (Princeton University), former assistant director for national security in the White House Office of Science and Technology and co-chair of the International Panel on Fissile Materials (IPFM), and Professor Gordon MacKerron,[2] Director and Head of SPRU (Science and Technology Policy Research) at the University of Sussex.

With recent revelations in the Japanese Press[3] that the Japan Atomic Energy Commission (JAEC) had been organizing secret panels, solely comprised of nuclear power advocates, to produce reports recommending a 'concurrent' policy of direct disposal and reprocessing to preserve the Rokkasho fuel reprocessing plant, the lectures were timely. Prof. von Hippel gave the first talk describing the global situation of plutonium reprocessing, whilst Prof. MacKerron outlined the background behind the UK's decision to abandon reprocessing.


Aerial view of Rokkasho plant in Aomori

Prof. von Hippel started his presentation by describing the IPFM[4] and its work. The IPFM was established in 2006 as an independent body dedicated to arms control and nonproliferation. It focuses on the management of nuclear materials. Two types of material pose a particular problem, plutonium and highly enriched uranium. There are 500,000 kilograms of plutonium in existence globally, which is enough for approximately 100,000 nuclear weapons. Half of this was produced during the Cold War in weapons programs, whereas the other half was produced for civilian use in reactors. Civilian-use plutonium was produced in the belief that uranium 235 was scarce and so there was a pressing need to build new reactors that would use uranium more efficiently. These new reactors were the plutonium breeder reactors. About 1% of the waste produced by normal reactors is plutonium.

Breeder reactors were designed to use plutonium-239 (pu-239) as fuel in a process that would convert readily available uranium-238 into pu-239, which could then be used for refueling thereby replacing uranium-235. The plutonium produced by reactors is mostly pu-239 but it also contains heavier plutonium isotopes (e.g. pu-240) caused by neutron capture on pu-239. Prof. von Hippel noted that although power-reactor plutonium contains more pu-240 than weapons-grade plutonium, it is still weapon usable *without* additional processing. In the case of the Nagasaki bomb design, the yield would likely be reduced, but that is not true for modern designs.

Whilst distinctions are, therefore, made between civilian-use and weapons-grade plutonium, Prof. von Hippel pointed out that India used civilian-use plutonium in 1974 for a so-called 'peaceful explosion'. Furthermore, reprocessing technology spread largely due to interest in weapons manufacturing. For example, Argentina, Brazil, South Korea and Taiwan all pursued reprocessing technology due to military objectives. Interest in reprocessing was so great in the 1970s that it was thought that every county would attempt it. The thinking was that nuclear power use would expand and so there would only be enough uranium for 500 GWe (gigawatt electrical) whereas demand would reach 2000 GWe by 2000. But this did not happen and there is no shortage of uranium.

Prof. von Hippel observed that no state has thus far built a successful breeder reactor and there are no commercial breeder reactors running today. Those that do exist are all prototypes. One major problem that has yet to be overcome is that breeder reactors are cooled by liquid sodium which burns if it comes into contact with air and water. Argentina and Brazil eventually abandoned reprocessing when they returned to civilian rule. France continues to use plutonium for fuel but this only saves on uranium use by 25% and is extremely costly. Currently, of the 30 states which possess nuclear technology, only 6 reprocess and only two – Japan and France – do so on a large scale. However, South Korea is interested in acquiring the technology and is negotiating with the US to agree on an arrangement. Prof. von Hippel pointed out that one of the South Korean government's main arguments is that because Japan reprocesses South Korea has a right to reprocess too.

Japan possesses around 40 tons of plutonium, which is enough to make five thousand nuclear warheads. Most of this plutonium is stored in France and Britain.[5]

The Japanese government has plans to expand the use of mixed oxide fuel (MOX)–a mixture of uranium and plutonium oxides–but it is proving very costly, extremely controversial, and essentially involves using weapons material for fuel. Thus far, the Rokkasho reprocessing plant has cost more than two trillion yen. Prof. von Hippel observed that globally states have virtually stopped producing plutonium for weapons; only India, Pakistan and maybe Israel continue. In March 2012, at the Seoul Nuclear Security Summit, Prime Minister Noda called for a treaty to halt the production of weapons-grade plutonium, whilst President Obama called for a halt in the production of civilian-use plutonium.

Given the growing consensus on the need to wean off plutonium and reprocessing, Prof. von Hippel concluded by making four suggestions:

1) Japan should end its breeder reactor programme. Uranium only accounts for 3% of the cost of nuclear power. Most of the cost is due to the capital cost of the reactors. There is an argument that one should not bury plutonium, but Professor von Hippel argues that a U.S. National Academy of Sciences study has concluded that doses to workers today would be increased by plutonium recycle while doses to people in the future would not be large if spent fuel were buried carefully.

2) Reprocessing should end. It is costly and proliferation is a danger. Building, operating and decommissioning Rokkasho would increase Japan's electric energy costs by 10 trillion yen. Stopping operations at Rokkasho would save 4 trillion yen. There would have been a 1 yen per kilowatt hour saving had Rokkasho not been built. Japan only reprocesses because it has a lack of storage for spent fuel.

3) Spent fuel should be stored in dry casks. These were not damaged at Fukushima. Fuel pools are dangerously densely packed and may lose water. Prof. von Hippel recommended storing the fuel in water for the first 5 years and then moving it to dry casks afterwards. If the fuel is put into dry casks then there will be no need for Rokkasho.

4) The Rokkasho MOX fuel plant should also be closed. It is cheaper to dispose of plutonium directly. In place of Rokkasho, the government should launch an R&D programme on plutonium waste disposal. If it does so, then the UK and US may well collaborate with Japan as they each have problems with their

Plutonium storage area, Sellafield, England

plutonium disposal programs. For example, in the US it will cost about 13 billion dollars to produce MOX fuel with excess weapons plutonium which is only worth about 1 billion dollars.

Prof. von Hippel closed his presentation by stating that although some in Japan argue that the financial and political arrangements associated with reprocessing are so complicated that it is impossible to stop, the UK has chosen to do just that. This comment led into Prof. MacKerron's lecture. He opened by noting that Japan assumes that nuclear power production requires reprocessing; however the UK has shown that they are separable. Simply put, the UK plans to build more reactors to add to the eleven online today, but is abandoning reprocessing and so offers a case study of how reprocessing may be halted.

Prof. MacKerron agreed with Prof. von Hippel that the original aim of reprocessing in nuclear weapons states was the production of weapons-grade materials. In the UK in the 1950s, the Windscale and Magnox reactors were used both for producing weapons materials and generating electricity. A reprocessing facility was constructed in 1962 to reprocess metallic oxide fuels but it will close when current reprocessing contracts are completed – currently estimated to be by 2016/17. The UK now requires any new reactors to have on-site storage capacity for their lifetime spent fuel output.

In 1971, British Nuclear Fuels Limited (BNFL) separated the military function from the civilian. They wanted a commercial facility to process oxide fuel, such as is used by water-cooled reactors and tried to use the Magnox reprocessing plant but failed. In 1978, approval was granted for the construction of a new Thermal Oxide Reprocessing Plant (THORP) that was finally completed in 1994. This plant was meant to cater to demand from Japan, which covered the cost. In total, 40% of the fuel reprocessed at THORP comes from Japan. Much of the rest comes from UK Advanced Gas-cooled Reactors (AGRs).

However, British nuclear utilities have long been unenthusiastic about reprocessing because it is too expensive. Prof. MacKerron stated that they only signed reprocessing contracts because they were owned by the state, which forced them to reprocess to keep potential foreign clients interested. When the utilities were privatized in 1996, British Energy, which took ownership of the AGRs, said that reprocessing was too costly and that it wanted to renegotiate contracts to have the option of storage or reprocessing, knowing that storage was far cheaper. In 2004, the Energy Act established the Nuclear Decommissioning Authority (NDA) which is a government-owned organization tasked with cleaning up nuclear waste and retired nuclear plants. In 2007, the UK's top scientific body, the Royal Society, advocated an end to reprocessing on environmental, economic and safety grounds, and when British Energy was taken over by the French company EDF in 2009, EDF also stated that it did not want to reprocess.

As things currently stand, THORP will complete its contracts in 2018. The spent fuel will then be stored in ponds or in dry storage. Closing THORP is the cheapest option, but reprocessing advocates argue that contracts will eventually materialize. Prof. MacKerron deemed that wishful thinking. He noted that some argue that Japan should build a MOX plant. However, Mox production would be uneconomic compared to spent fuel storage. If Japan chose to halt reprocessing and abandoned its MOX plans, then the UK might want to cooperate on finding solutions to managing separated plutonium. No one in the UK currently wants to reprocess and the government now mandates on-site fuel storage.

Overall, two things were made clear at the event. First, spent fuel reprocessing originates from the production of weapons materials and the initial move towards reprocessing was spurred by wishes to gain nuclear capabilities. Although Japan does not possess nuclear weapons, its large plutonium 'stockpile', combined with its advanced technological base, means that it could go nuclear very easily. As Jacques E. C. Hymans has argued, it only takes the arrival of a leader with the psychology of an 'oppositional nationalist' for the nuclear option to be taken irrespective of seemingly rigid constraints.[6] The meaning of Japan's plutonium 'stockpile' should thus be considered carefully by those keen to prevent a nuclear weapons switch as the state maintains its liminal position of potential nuclear contender.

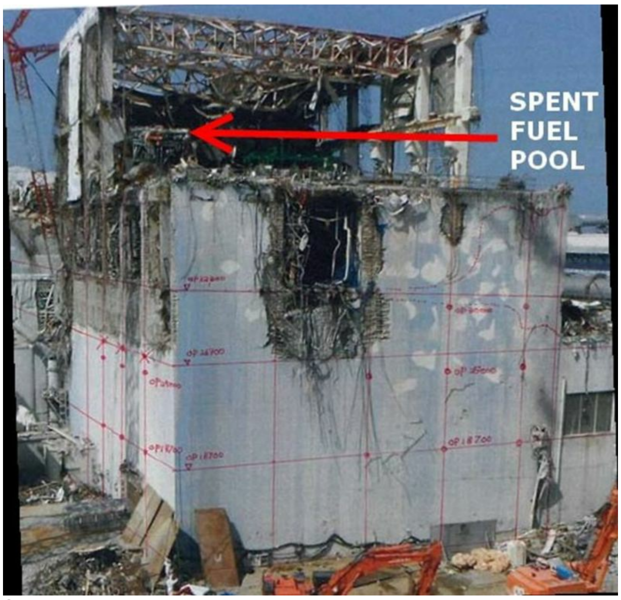
Second, there has been a global move away from plutonium use for nuclear fuel and from civilian reprocessing (plutonium separation). Japan's persistence in reprocessing thus bucks an international trend. Arguments that it is impossible to stop appear flimsy when the global experience and the UK case are taken into account, and Japanese leaders should find Japan's reprocessing as a role model in support of South Korean reprocessing troubling in light of the regional tensions. This is especially so given the lack of any economic benefit to the country as a whole. Put simply, reprocessing is defunct and should be buried with the waste it cannot handle. No one takes Japan's plans to quickly use its 'stockpile', or rather 'surplus', as credible. As Prof. von Hippel has commented elsewhere, 'There is a real credibility problem here.'[7]

The problem of nuclear waste remains critical for Japan. Along with the US, the Japanese government had planned to build a nuclear waste facility in Mongolia unbeknownst to the Mongolian people. The aim was to enable Japan to compete with nuclear states such as France and Russia that offer the acceptance of waste as part of the deal for building facilities, since Japan is unable to take waste. When the plan was made public, the deal collapsed prompting Amano Yukiya, director general of the IAEA, to comment, 'Those who generate radioactive waste must take responsibility for disposing of it. It's unfair to expect someone else to take care of it.'[8] Prof. von Hippel explained that dry cask storage was better than wet storage in the interim, as practiced in Germany and the US, but it is not clear that Japan can move to final underground storage.

Being a small densely populated country devoid of desert expanses and subject to dangerous earthquakes, any burial site is bound to effectively be in somebody's 'back yard'. Whether safe or not, citizens have never been happy about hosting nuclear waste dumps, and support for nuclear power has declined sharply since 3.11 last year. A Mainichi national poll released on 4 June 2012 revealed that 71% of the public see no need to rush the restart of reactors this year, whilst 45% say that a nuclear target of 15% electricity generation in 2030 is desirable. A further 25% want the country to abandon nuclear power altogether.[9]

The problem of spent fuel also runs the risk of a catastrophic climax. The Asia-Pacific Journal has examined the danger posed by reactor Unit 4.[10]

As a consequence of the inability to deal with spent fuel resulting from prolonged delays in the operation of the Rokkasho Reprocessing Plant, the pools at reactors in Japan, as in other countries, are densely packed. Unit 4 contains 1,532 fuel assemblies alone and has been structurally damaged by several explosions, including the blast at Unit 3. A collapse at Unit 4, or even a crack leading to water loss, would cause the fuel to burn. A fuel fire (which could not be put out with water once started and so would have to burn through) may further affect 6,375 fuel assemblies stored at ground level 50 metres away because the area would likely become so radioactive that its ability to maintain water may also be lost. Neither fuel storage area is protected by a containment vessel. The amount of cesium released into the atmosphere should the fuel in Unit 4 catch fire would dwarf that released at Chernobyl, with



Spent fuel pool at reactor # 4 after the blast

experts warning that this would require the evacuation of the Kanto region including Tokyo. Extracting the rods is hugely difficult and TEPCO does not plan to start removal until the end of 2013. Meanwhile, quite apart from frequent aftershocks, scientists from Tohoku University released a study in February 2012 showing that a Magnitude 7 quake is possible right under the plant because the 3.11 shake activated a dormant fault line.[11] The most serious risk the country now faces thus stems directly from the waste problem. With no obvious solution, localized moves towards a green revolution[12] have never been more necessary.

The author would like to thank Frank von Hippel, Gordon McKerron, Andrew DeWit and Mark Selden for their feedback. Thanks also to Azumi Hayakawa for drawing attention to a number of media sources.

Piers Williamson is a research assistant to Professor Andrew DeWit at Rikkyo University. He holds a PhD in East Asian Studies from the University of Sheffield.

Recommended citation: Piers Williamson, 'Plutonium and Japan’s Nuclear Waste Problem: International Scientists Call for an End to Plutonium Reprocessing and Closing the Rokkasho Plant,' The Asia-Pacific Journal, Vol 10, Issue 24, No 4, June 11, 2012.

Articles on related subjects

•Asia-Pacific Journal Feature, The “Black Box” of Japanese Nuclear Power

•Makiko Segawa, After The Media Has Gone: Fukushima, Suicide and the Legacy of 3.11

•Leo Bosner, Can Japan Respond Better to its Next Large Disaster?

•Miguel Quintana, Radiation Decontamination in Fukushima: a critical perspective from the ground - here

•Iwata Wataru interviewed by Nadine and Thierry Ribault, Fukushima: Everything has to be done again for us to stay in the contaminated areas - here

•Paul Jobin, BBC and ZDF Documentaries on Fukushima - here
•Paul Jobin (interview) Fukushima One Year On: Nuclear workers and citizens at risk - here

•Jeff Kingston, Mismanaging Risk and the Fukushima Nuclear Crisis - here

•Koide Hiroaki (interview), Japan's Nightmare Fight Against Radiation in the Wake of the 3.11 Meltdown - here

•Gayle Greene, Science with a Skew: The Nuclear Power Industry After Chernobyl and Fukushima - here

Notes

[1] www.princeton.edu

[2] www.sussex.ac.uk

[3] mainichi.jp

[4] www.fissilematerials.org

[5] timesfreepress.com

[6] Jacques E. C. Hymans (2006), *The Psychology of Nuclear Proliferation*, Cambridge University Press: Cambridge.

[7] timesfreepress.com

[8] mainichi.jp

[9] mainichi.jp

[10] www.japanfocus.org

Also see: www.nytimes.com

For a brief interview with former diplomat Akio Matsumura see here.

For analysis by nuclear expert Arnie Gundersen see here.

[11] blogs.wsj.com

[12] e360.yale.edu