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

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On Thursday 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 processing, 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, namely 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 as fuel in a process that would convert readily available uranium-238 into pu-239, which could then be used for refueling thereby replacing ur-235. Although pu-239 can be used in weapons, it needs to be processed in a special reactor to remove pu-240, which may cause premature detonations. This cannot be done through commercial reprocessing.

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. Indeed, 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 Japan reprocesses and therefore South Korea also 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 too costly, extremely difficult to extract the plutonium, and essentially involves using weapons material for fuel. Thus far, the Rokkasho reprocessing experiment has cost about two trillion yen. Prof. von Hippel observed that globally states have virtually stopped producing plutonium for weapons; only India, Pakistan and maybe Israel. In 2012, 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 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 amounts to 3% of the cost of nuclear power. Most of the cost goes to the reactors. There is an argument that one should not bury plutonium, but Professor von Hippel argues that a study has shown that doses to workers today are higher than they would be to people in the future if buried carefully.

Plutonium storage area, Sellafield, England

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

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

4) The Rokkasho MOX fuel plant should be closed. It is cheaper to dispose of fuel 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 a vested interest in success. For example, in the US it costs 20 billion dollars to produce reprocessed fuel which is only worth 1 billion dollars.

Prof. von Hippel closed his presentation by stating that although some in Japan argue that reprocessing is too complicated a process 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 includes reprocessing; however the UK has shown that they are quite different. 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 oxide fuels but it will close in 2016/17. The main problem the UK faces is that there is a shortage of dry storage.

In 1971, British Nuclear Fuels Limited (BNFL) separated the military function from the civilian. They wanted a commercial facility and tried to use the Magnox plants but failed. In 1978, approval was granted for the construction of a new Thermal Oxide Reprocessing Plant (THORP) which 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.

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 foreign clients interested. When the utilities were privatized in 1996, British Energy 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 an independent organization tasked with cleaning up nuclear waste and 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 this wishful thinking. He noted that some argue that Japan can build a MOX plant. However, he contends that this would only be feasible if Japan built more reactors. In the present situation this is highly unlikely and so immobilization is better. If Japan chose to halt reprocessing, then the UK could cooperate. 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, nuclear power 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 and from reprocessing. 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 de facto operation 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 use its 'stockpile', or rather 'surplus', seriously. 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] Whilst Prof. von Hippel explained that dry cask storage was better than wet storage, it is not clear that Japan can even pursue that policy. Being a small densely populated county 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 June 4, 2012 reveals that 71% of Japanese see no need to rush the restart of reactors this year, whilst 45% say that a nuclear target of 15% electricity generation is desirable, and 25% want the country to abandon nuclear power altogether.[9]

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

Spent fuel pool at reactor # 4 after the blast

As a consequence of the inability to deal with spent fuel, the pools at reactors in Japan, as in other countries, are densely packed. Unit 4 contains 1,532 fuel rods alone and a collapse will also affect 6,375 fuel rods stored 50 metres away. Neither is protected by a containment vessel. The amount of cesium released into the atmosphere would dwarf that released at Chernobyl with 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, in February 2012, scientists from Tohoku University released a study 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 have never been more necessary.12

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Notes

[1] http://www.princeton.edu/step/people/faculty/frank-n.-von-hippel/

[2] http://www.sussex.ac.uk/Professoriles/1676

[3] http://mainichi.jp/english/english/newsselect/news/20120524p2a00m0na014000c.html; http://mainichi.jp/english/english/newsselect/news/20120526p2a00m0na007000c.html; http://mainichi.jp/english/english/newsselect/news/20120525p2a00m0na020000c.html

[4] http://www.fissilematerials.org/

[5] http://timesfreepress.com/news/2012/jun/02/japan-make-more-plutonium-despite-big-stockpile/?breakingnews

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

[7] http://timesfreepress.com/news/2012/jun/02/japan-make-more-plutonium-despite-big-stockpile/?breakingnews

[8] http://mainichi.jp/english/english/perspectives/news/20120313p2a00m0na003000c.html

[9] http://mainichi.jp/select/news/20120604k0000m010087000c.html

[10] http://www.japanfocus.org/-Murata-Mitsuhei/3742

Also see:

http://www.nytimes.com/2012/05/27/world/asia/concerns-grow-about-spent-fuel-rods-at-damaged-nuclear-plant-in-japan.html

For a brief interview with former diplomat Akio Matsumura see:

http://www.youtube.com/watch?v=KwCfAY4iyPQ

For analysis by nuclear expert Arnie Gundersen see:

http://fairewinds.com/content/fukushima-daiichi-truth-and-future

[11] http://blogs.wsj.com/japanrealtime/2012/02/15/could-fukushima-daiichi-be-ground-zero-for-the-next-big-one/

12 http://e360.yale.edu/feature/a_crossroads_for_japan_revive_nuclear_or_go_green/2534/