



Security Implications of the Nuclear Fuel Cycle

Report of the Monterey Eminent Persons Group

October 2014



JAMES MARTIN CENTER FOR
NONPROLIFERATION STUDIES

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SECURITY IMPLICATIONS OF THE NUCLEAR FUEL CYCLE

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In 2013-2014, the James Martin Center for Nonproliferation Studies (CNS) at the Monterey Institute of International Studies (MIIS) convened a group of distinguished American and Japanese experts on nonproliferation to examine the security implications of the nuclear fuel cycle. The project was made possible by a generous grant from the John D. and Catherine T. MacArthur Foundation.

The participants in the Monterey Group were:

Ambassador Nobuyasu Abe (until February 2014)

Professor Nobumasa Akiyama

Mr. Robert J. Einhorn

Dr. Morton H. Halperin, co-chair

Professor Yoriko Kawaguchi, co-chair

Professor Yusuke Kuno

Professor Janne Nolan

Professor Lawrence Scheinman

Dr. Jeffrey G. Lewis of the Monterey Institute served as the project director.

1. Discussions in Japan about nuclear fuel cycle choices have given insufficient consideration to regional security implications of domestic decisions about uranium enrichment and the civil reprocessing of spent nuclear fuel. Japan began its development of a closed-nuclear fuel cycle in the late 1960s at a time of apparent scarcity of uranium resources and technology optimism about the feasibility of fast reactors. Today, uranium is abundant and policymakers, mindful of the success of the 1970 Nonproliferation Treaty, are more aware of the proliferation risks of plutonium separation. Although a closed-fuel cycle is no longer an urgent task nor necessarily economical, Japan has almost completed the commercial-scale Rokkasho Nuclear Fuel Reprocessing Facility. It is ultimately for the Japanese people to decide what course to take about the fuel cycle.
2. Other countries see the United States and especially Japan as leaders in the civil nuclear energy field. Domestic decisions in both countries provide a technological model for other states. There is a continuing debate about the economic viability of a closed nuclear fuel cycle and the merits of reprocessing to reduce the volume and radiotoxicity of high-level waste. In the absence of a clear consensus on factors such as the cost or feasibility of a closed-fuel cycle, choices made by the United States and Japan may influence other states to follow our technological lead.
3. Civil reprocessing of plutonium from spent nuclear fuel poses some proliferation risks, which may only partly be addressed by international safeguards. Industrial scale reprocessing may result in significant discrepancies in the material balance of plutonium – also known as material unaccounted for (MUF) – due to the uncertainty of measurement system. Assuming 1 percent of the total throughput for a large industrial plant is MUF, this may theoretically be as large as 80 kilograms of plutonium or enough for 10 or more nuclear weapons a year. (The IAEA defines 8 kilograms as a “significant quantity” approximate to the amount of plutonium in a nuclear weapon. US nuclear weapons may have as little as 4 kilograms of plutonium in each weapon, however.)
4. Japan’s Rokkasho Reprocessing Plant has effective and reliable safeguards and material accountancy procedures. Japan has an admirable accountancy record, one that meets the international standard. International safeguards based on Japan’s high quality state system of accounting for and control of nuclear material (SSAC) has been implemented that can help to assure the international community regarding the

non-diversion of plutonium despite irreducible quantitative uncertainties. Such measures include design information verification (DIV), frequent interim inventory verification (IIV) combined with near real time accountancy (NRTA), and the presence of a joint Japan-IAEA On-Site-Laboratory (OSL). In addition, a number of process monitoring systems and unattended verification systems have been introduced along the nuclear material flow path in order to ensure non-diversion of plutonium, given the sensitivity and complexity of accepted technologies as well as the inherent inaccessibility of nuclear materials within the plant. The system of integrated safeguards based on the Additional Protocol, together with state-level approach, provides high confidence that Japan's nuclear activities are for peaceful purposes.

5. Japan has also undertaken a number of important confidence building measures. In 1994, the Japan Atomic Energy Commission (JAEC) officially adopted a policy of “no surplus plutonium”, i.e. Japan does not have any plutonium that does not have specific purpose for its eventual use. And, since 2003, JAEC has expected utilities to submit an annual plutonium usage plan before the separation of plutonium. During the most recent Nuclear Security Summit, Japanese Prime Minister Shinzo Abe reaffirmed the Japanese policy by stating, “we will firmly maintain our policy that we should possess no plutonium reserves without specified purposes. In order to effectively carry out this policy, we do pay due consideration to the balance between supply and demand of plutonium.”¹

6. Since 1994, as a transparency measure, JAEC has published statistics showing Japan's plutonium stockpile. Notwithstanding the “no surplus plutonium” policy, Japan has accumulated more than 9 tons of civil unirradiated plutonium (see table.) The JAEC *Technical Subcommittee on Nuclear Power, Nuclear Fuel Cycle, etc.* has further recommended that Japan's plutonium stockpile be reduced regardless of the fuel cycle options chosen in the future.²

¹ Summary Statement by Prime Minister Shinzo Abe, March 24, 2014. Available at: <http://www.mofa.go.jp/dns/n_s_ne/page22e_000341.html>.

² Japan Atomic Energy Committee, Technical Subcommittee on Nuclear Power, Nuclear Fuel Cycle, etc., 核燃料サイクル政策の選択肢に関する検討結果について [“Assessment of Nuclear Fuel Cycle Policy Options”] June 5, 2012. Available at: <<http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryu2012/siryu22/siryu1-1.pdf>>.

Table: Holdings of Civil Unirradiated Plutonium in Japan

As of 31 December 2013. (Previous year's figure in brackets.)		
	2013	(2012)
Rounded to 100 kg plutonium with quantities less than 50 kg reported as such		
1. Unirradiated separated plutonium in product stores at reprocessing plants.	4.4	(4.4)
2. Unirradiated separated plutonium in the course of manufacture or fabrication and plutonium contained in unirradiated semi-fabricated or unfinished products at fuel or other fabricating plants or elsewhere.	2.9	(2.9)
3. Plutonium contained in unirradiated MOX fuel or other fabricated products at reactor sites or elsewhere.	3.1	(1.6)
4. Unirradiated separated plutonium held elsewhere.	0.4	(0.4)
Total holdings of civil unirradiated plutonium in Japan.	10.8	(9.3)
Note (i) Plutonium in lines 1-4 above belonging to foreign bodies.	0	(0)
(ii) Plutonium in any of the forms in lines 1-4 held in locations in other countries and therefore not included above.	36.3	(34.9)
(iii) Plutonium not included in lines 1-4 above which is in international shipment prior to its arrival in the recipient state.	0	(0)
Source: <i>Communication Received from Japan Concerning Its Policies Regarding the Management of Plutonium</i> , INFCIRC/549/Add.1/17, October 10, 2014. Available at: http://www.iaea.org/Publications/Documents/Infircs/2014/infirc549a1-17.pdf . See also: Japan Atomic Energy Commission, <i>The Current Situation of Plutonium Management in Japan</i> , (2013) http://www.aec.go.jp/jicst/NC/sitemap/pdf/130911e.pdf .		

7. The Eminent Persons welcome the recent decision by Prime Minister Abe and President Obama to remove and dispose of all high-enriched uranium and separated plutonium that is beyond reactor grade, from the Fast Critical Assembly (FCA) at the Japan Atomic Energy Agency (JAEA), while also working together to expand research at the FCA on the transmutation and disposition of nuclear waste.

8. There is no concern that Japan would leave the Nuclear Nonproliferation Treaty or seek to build nuclear weapons. The US-Japan alliance remains the cornerstone of

Japan's security policy. There is little support in Japan for replacing the successful alliance with its own nuclear weapons.

9. It is difficult and undesirable to build nuclear weapons with plutonium separated from civil nuclear power plants operated normally, as in Japan. It is not, however, impossible. The United States Department of Energy has stated "a potential proliferating state could build a nuclear weapon from reactor grade plutonium that would have an assured, reliable yield of one or a few kilotons (and a probable yield significantly higher than that.)"³
10. A greater concern is that reprocessing technologies used for civil purposes could be diverted to weapons programs. As the United States Department of Energy noted in its 2008 Nonproliferation Impact Assessment, all reprocessing technologies carry an inherent risk of diversion to a nuclear weapons program.⁴ There are minimal differences for state actors in terms of proliferation resistance among different reprocessing technologies.
11. The nonproliferation regime has worked very well over the decades. It is now at a crucial moment, particularly with regard to nuclear programs in North Korea and Iran. There is some risk of steady proliferation sparked by nuclear weapons programs in North Korea and Iran.
12. The United States is attempting to meet the challenges posed by North Korea and Iran through diplomatic efforts that strengthen our alliances, measures to build support for the Nuclear Nonproliferation Treaty and other legal regimes, and seeking agreements to eliminate North Korea's nuclear weapons and prevent Iran from acquiring them.
13. As a part of its nonproliferation strategy, the United States has encouraged states to rely on existing international markets for fuel services instead of acquiring sensitive nuclear technologies such as enrichment and reprocessing capabilities, particularly

³ United States Department of Energy, *Final Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Excess Plutonium Disposition Alternatives*, January 13, 1997, pages 37-39.

⁴ United States Department of Energy, *Draft Nonproliferation Impact Assessment for the Global Nuclear Energy Partnership Programmatic Alternatives*, December 2008, pages 68-69.

when negotiating peaceful nuclear cooperation agreements (123 Agreements). Many of these countries look to what Japan does in terms of its fuel cycle activities as a model. Japan's policies have a significant impact on these countries. Japan should also play a leadership role in setting the standard for transparency, safeguards and cooperation with the IAEA, while encouraging states to rely on existing international markets for fuel services.

14. It would not be in the interest of the United States or Japan to see the continued spread of national civilian reprocessing programs in Northeast Asia given current regional security dynamics. The United States and Japan should continue to pursue the goal of the denuclearization of the Korean Peninsula, as well as support practical measures in support of the shared goal of President Obama and Prime Minister Abe of "a world free of nuclear weapons."⁵
15. Nor would it be in the interest of the United States or Japan to see the spread of civilian reprocessing programs in other regions, including Southeast Asia and the Middle East. In particular, current efforts to find a negotiated solution to Iran's nuclear programs are in a sensitive period.
16. The Japanese government should give these factors more consideration in what have been largely domestic debates in Japan about the economic and environmental costs and benefits associated with enrichment and the reprocessing of spent nuclear fuel to recover plutonium.
17. Japan and the United States should actively promote further international measures to reduce the demand for national civil reprocessing programs and to develop new measures to strengthen safeguards. One measure that Japan and the United States may consider, as a general matter, is to develop approaches under which they could invite multinational participation in American and Japanese civilian fuel cycle activities. Such an effort might provide further transparency and confidence, while helping to reinforce a norm against conducting sensitive fuel cycle activities on a national basis. Japan and the United States may also cooperate to build support

⁵ Statement by H.E. Mr. Shinzo Abe, Prime Minister of Japan at the Opening Session High-Level Meeting of the General Assembly on Nuclear Disarmament, September 26, 2013. Available at: < http://www.un.org/en/ga/68/meetings/nucleardisarmament/pdf/JP_opening_en.pdf>

within Northeast Asia for the establishment of a multilateral spent fuel and high-level waste storage facility.

18. Japan and the United States should also work to strengthen the International Atomic Energy Agency, particularly to ensure that the Agency has the funding and authority necessary to carry out its mission.