



A Realistic Approach to Solving Japan's Plutonium Problem

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SUMMARY

There is a serious risk that, within the next few years, Japan will produce more plutonium than it can use. The resulting buildup would set a damaging precedent, exacerbate regional tensions, and increase the likelihood of nuclear terrorism. However, if Japan and its key international partners—the United States most importantly—act now, it is still possible to avert these dangers. Most importantly, this will require Japan to commit to produce only as much plutonium as it can burn in reactors.

Recommendations for Japan and the United States

- The central government should publicly assume responsibility for the plutonium balance.
- The United States and Japan should extend their existing nuclear cooperation agreement in return for a politically binding side agreement on plutonium management, in which Japan should
 - restate and clarify its pledge not to separate excess plutonium;
 - promise to adjust the throughput of its reprocessing plant so it produces only as much plutonium as can be consumed; and
 - pledge not to operate its reprocessing plant until the associated fuel fabrication plant comes online.
- Tokyo should launch formal negotiations with the United Kingdom and informal talks with France about their taking ownership of the Japanese plutonium located in Europe.
- Japan, the United States, and the United Kingdom should cooperate on research into ways to safely dispose of plutonium without burning it in reactors.
- While continuing to reprocess, Tokyo should seriously explore the feasibility of shifting to the once-through fuel cycle. To this end,
 - the Japanese Diet should change the law to allow funds set aside for high-level radioactive waste management to be used for the direct disposal of spent fuel and excess separated plutonium;
 - the requirements for the geological repository that the Japanese government is currently trying to develop should include the direct disposal of spent fuel and excess separated plutonium; and
 - Japan should address its lack of interim storage space for spent fuel by encouraging the sale of existing space and offering greater subsidies.

Managing spent fuel is a challenge for every state with a nuclear power program. Reprocessing the fuel, to separate out the plutonium it contains, is one option—albeit a particularly controversial one since plutonium can be used to fabricate nuclear weapons as well as more nuclear fuel. Accordingly, to reduce the risk of both proliferation and nuclear terrorism, internationally accepted best practice requires states that reprocess to produce no more plutonium than they can actually consume.

As the only non-nuclear-weapon state to have a domestic reprocessing program, Japan is in a unique and delicate position. Tokyo has made strenuous efforts to assure the international community of its peaceful intentions. Its commitment to International Atomic Energy Agency (IAEA) safeguards has been exemplary, and it has promised not to produce excess plutonium both through a series of unilateral pledges and by agreeing to adhere to internationally endorsed IAEA guidelines. Within the next few years, however, there is a serious risk that the country's already substantial stockpile of plutonium will start to grow rapidly. To date, about 47 metric tons of plutonium have been produced from Japanese spent fuel, although roughly three-quarters of this total is still located in Britain and France, where it was separated.

While Japan is highly unlikely to use this material to build nuclear weapons, a plutonium buildup would nonetheless have global ramifications. It would set a precedent that other states that may have an interest in acquiring nuclear weapons could cite to justify accumulating weapon-usable nuclear material. It would exacerbate tensions with Northeast Asian rivals who worry about Japan's intentions. And it would increase the danger of nuclear terrorism.

THE DOMESTIC FACTOR

These risks are *not* the result of a deliberate policy to accumulate plutonium; their primary cause is, in fact, domestic politics. Japan's new nuclear regulator is currently assessing the safety of the industrial-scale Rokkasho Reprocessing Plant (RRP). All future reprocessing of Japanese spent fuel is due to take place at RRP, but it has barely operated as of 2015 because of delays in construction and problems during commissioning. The facility's owner, Japan Nuclear Fuel Limited (JNFL), is confident that, once it gets regulatory approval, it can ramp the facility up to full production over the course of five years. Indeed there is intense domestic pressure to operate RRP as soon as possible. The plant's host communities, Rokkasho Village and Aomori Prefecture, stand to gain financially from its operation. Moreover, if the plant is not restarted, the prefecture in particular is worried that the 3,000 metric tons of spent fuel that are currently stored there, waiting to be reprocessed, will never be removed.

Neither JNFL nor the central government can afford to ignore these concerns. Before spent fuel was first shipped to RRP, Aomori Prefecture and Rokkasho Village were promised that, if reprocessing were abandoned, all the fuel stored there would be removed—an almost unimaginably complex and difficult task. In addition, nuclear waste from Japan's overseas reprocessing contracts with France and the United Kingdom is stored in Rokkasho—and there is more to come. The governor of Aomori has threatened that, if the plant does not reopen, he will forbid the import of this material (which he can do because he controls the prefecture's ports), thus sparking an international incident with two key allies. These pressures were sufficiently

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strong to force the previous Japanese administration of Prime Minister Yoshihiko Noda, which was seriously considering terminating RRP in 2012, into backing down.

Japan's plan is to convert its separated plutonium into so-called MOX (mixed oxide) fuel and burn it in nuclear reactors. However, not only is its facility for fabricating MOX fuel still under construction but, following the 2011 accident at the Fukushima Daiichi Nuclear Power Station, all but one of the country's reactors remain shut down. Moreover, it is likely that only about half of the sixteen to eighteen reactors designated for plutonium consumption will be restarted before RRP reaches full capacity, and finding substitutes for them will be extremely difficult. As a result, the supply of plutonium from RRP is likely to exceed demand.

Domestic politics is, once again, a major cause of the problem. In the aftermath of the Fukushima accident, there is considerable concern about nuclear safety in some of the communities that host reactors, resulting in significant local opposition to reactor restarts and, to a lesser extent, to the use of MOX fuel. Meanwhile, other reactors may not be permitted to operate on safety grounds, including their proximity to fault lines.

HOW JAPAN CAN CHANGE COURSE

It is still possible to navigate around the realities of Japanese domestic politics and avert the risk of a rapidly expanding Japanese plutonium stockpile. To this end, it is critical that the central Japanese government takes action—both on its own and in concert with its key international partners.

OWNERSHIP OF THE PROBLEM

The central government should publicly assume responsibility for the plutonium balance. Tokyo has been generally reluctant to involve itself in reprocessing, arguing that it is a private enterprise conducted by a private company. This description is, however, misleading. Reprocessing was adopted by the government as Japan's national policy for dealing with spent nuclear fuel. Moreover, the funds set aside for spent-fuel management cannot legally be used for the direct disposal of unprocessed spent fuel, so the utilities have no choice but to reprocess. And, because of the proliferation sensitivities associated with separated plutonium, Japan's government has, in fact, pledged not to accumulate more of this material than it can use.

As a result, it is right that the government should take ownership of the problem publicly and institutionalize this pledge. This step is also necessary because any solution will require political and financial support from Tokyo.

U.S.-JAPAN COOPERATIVE STEPS

The United States and Japan should extend their existing nuclear cooperation agreement in return for a politically binding side agreement on plutonium management. Because Japanese reactors and nuclear fuel either were supplied by the United States or use U.S. technology, Tokyo requires Washington's permission to reprocess spent fuel. Their current nuclear cooperation agreement, colloquially known as a 123 agreement, contains blanket approval, in advance, to reprocess spent fuel and is thus highly favorable to Japan (the only other non-nuclear-weapon states to which the United States has given such permission are members of the European Atomic Energy

Community). The initial thirty-year term of the U.S.-Japan 123 agreement expires in July 2018, and the two states must shortly decide whether to allow it to remain in force, which will happen if no action is taken, or to renegotiate it.

Renegotiating the agreement would probably prove complex and would create the possibility that the U.S. Congress might block its entry into force. As a result, it seems likely that Tokyo will want to extend the existing agreement. The United States should agree to this—but, in return, it should ask for a politically binding side agreement to ensure that one of the few states to which the United States has provided advanced reprocessing consent is not misusing that consent to stockpile plutonium.

This side agreement should contain at least three key provisions:

1. **Japan should restate and clarify its pledge not to separate excess plutonium.** Japan has promised not to separate plutonium for which it has no use. As it currently stands, however, this policy places no restriction on the time that can elapse between separation and use. In theory, therefore, plutonium that is due to be consumed in, say, twenty or thirty years is not considered to be excess. As a result, Japan could continue to grow its plutonium stockpile without violating its “no excess” promise. To close this loophole, Japan should pledge that all plutonium separated in the future will be used within an agreed time limit of, say, five years.
2. **Japan should promise to adjust the throughput of RRP so it produces only as much plutonium as can be consumed.** JNFL currently aims to

operate the facility, after an initial ramp-up period, at its maximum throughput of about 8 metric tons of plutonium per year. Japan should, however, agree to operate it at a lower throughput if doing so is necessary to keep the supply and demand of plutonium in balance. The exact formula for how much plutonium Japan would be permitted to separate each year would need to be agreed to in negotiations and should account for both operational considerations and the rate at which plutonium separated abroad is due to be used in Japan. The aim should be to ensure that the total size of Japan’s domestic plutonium stockpile does not grow and, ideally, shrinks gradually.

3. **Japan should pledge not to operate RRP until the associated MOX fabrication plant, J-MOX, comes online.**

Japan cannot make use of separated plutonium without J-MOX, so it should agree not to produce the former until the latter is ready for operations.

This side agreement could be helpful to Japan, too. It could be used to address Japanese concerns about the existing agreement, such as the possibility that the United States might exercise a provision that would, in theory, allow it to terminate the agreement without consultation after the initial thirty-year term expires. Internationally, it would bolster Japan’s nonproliferation credentials.

Some elements of the proposed side agreement could spark significant domestic opposition. Most notably, delaying RRP’s restart until J-MOX comes online could be very controversial because the plants’ host communities would almost certainly interpret the delay as a signal that the government’s

commitment to the project was waning. For similar reasons, operating RRP at a lower throughput would probably also cause considerable, if less intense, concern.

Compensating RRP's host communities financially might help to lessen their opposition. However, even with this concession, prolonged and difficult negotiations would probably be required to gain the understanding of Aomori Prefecture and Rokkasho Village. These negotiations might be easier if Tokyo can point to an international agreement obliging it to operate RRP in a way that avoids a plutonium buildup.

INTERNATIONAL COOPERATION

Tokyo should launch formal negotiations with the United Kingdom and informal talks with France about their taking ownership of the Japanese plutonium located in Europe. Japan's problem is compounded by the need to deal with the plutonium produced by the reprocessing of Japanese spent fuel in France and the United Kingdom. This material is due to be returned to Japan (in fact, some has been sent back already), increasing the total amount of plutonium Japan must burn. It may, however, be possible to reach agreements with London and Paris under which they take ownership of this plutonium, thereby reducing the quantity that Japan must consume.

The British government has already formally offered to take ownership of Japanese plutonium in the United Kingdom, if the two states can come to an agreement on commercial terms. London and Tokyo should, therefore, begin formal negotiations over these terms. France has not made a similar offer to Japan. Nonetheless, Tokyo should seek to start informal talks with Paris over the

possibility of transferring the ownership of Japanese plutonium in France.

Realistically, while it may be possible to reach agreements on transferring Japanese plutonium, both Britain and France would almost certainly insist that Japan continues to be responsible for the nuclear waste produced by reprocessing Japanese spent fuel. The management of these wastes is such a controversial issue domestically that neither government is likely to be willing to accept responsibility for any additional material.

Japan, the United States, and the United Kingdom should cooperate on research into ways to safely dispose of plutonium without burning it in reactors.

All three countries have large plutonium stockpiles with no credible plans to manage them. Working together on research in this area would help them all save costs. Various schemes for direct disposal have been proposed, including mixing the plutonium with nuclear waste (after which it could be managed along with other spent fuel) or immobilizing it and then burying it in deep boreholes (where it would be effectively inaccessible). For Japan in particular, research into the direct disposal of plutonium would help it to develop a "plan B" should efforts to burn it in reactors run into further trouble.

A DUAL-TRACK APPROACH TO SPENT-FUEL MANAGEMENT

While continuing to reprocess, Tokyo should seriously explore the feasibility of shifting to the once-through fuel cycle.

Under such an arrangement, spent nuclear fuel would be disposed of in a geological repository after a period of interim storage.

Nonproliferation is not the only reason for adopting such a dual-track approach; it is also the right decision for ensuring the continued viability of Japan's nuclear energy program over the long term.

Japan started to irradiate MOX fuel before the Fukushima Daiichi accident and intends to burn much more of it in the future. However, for technical reasons, there is no plan to reprocess spent MOX fuel in RRP. Instead, Tokyo intends to reprocess this type of spent fuel in a second reprocessing plant.

Realistically, this plan has a high chance of failure. RRP has, as of 2013, cost about \$22 billion—approximately 175 percent over budget—and is twenty years behind schedule. Moreover, following the Fukushima Daiichi accident, anti-nuclear sentiment is high and likely to remain so. As a result, it could be extremely difficult for the government to persuade all the relevant stakeholders—the Japanese Diet, the utilities, and electricity consumers—to pay for a second reprocessing plant. And, even if funding were secured, it is far from clear that a community willing to accept the plant could be found.

To complicate matters further, Japan's long-term plans for plutonium usage have foundered. Tokyo has only ever viewed burning MOX fuel in conventional nuclear reactors as a stopgap measure. Its original justification for reprocessing was to fuel a fleet of fast breeder reactors that could produce more plutonium than they consumed and hence contribute to energy independence. Only when fast breeder reactor development proceeded much more slowly than originally anticipated was Japan forced into burning plutonium, uneconomically, in its existing reactors. Although Japan remains committed to fast reactors as a matter of policy, its domestic research and development program is in disarray, and there is little evidence from other states that breeders will be commercialized any time soon.

Given the serious difficulty of constructing a second reprocessing plant and uncertainty about the future of fast reactors, it makes sense for Japan to start to explore alternatives to reprocessing.

Exploring alternatives does not mean making a decision now to abandon reprocessing or the continued development of fast reactors. But, it does mean taking the technical and legal steps necessary to create the option of disposing of unprocessed spent fuel in a geological repository in the future. The administration of Prime Minister Shinzo Abe has already made a tentative move in this direction by deciding to support research into direct disposal, but Japan should go further.

The Diet should change the law to allow (but not require) funds set aside for high-level radioactive waste management to be used for the direct disposal of spent fuel and excess separated plutonium.

Currently, such funds can only be used to dispose of reprocessing wastes. While changing the law to permit the direct disposal of spent fuel, Japan should also allow the direct disposal of excess separated plutonium. Further research is necessary to ensure the safety and security of this method, but given the challenges to burning plutonium in reactors, it makes sense to pave the way for alternatives.

The requirements for the geological repository that the Japanese government is currently trying to develop should include the direct disposal of spent fuel and excess separated plutonium.

Tokyo is currently trying to find a site for a geological repository to accommodate reprocessing wastes. If this process is successful, it will be a missed opportunity if the repository is not also designed and licensed to accept spent fuel and excess separated plutonium.

Japan should address its lack of interim storage space for spent fuel by encouraging the sale of existing space and offering greater subsidies.

After nuclear fuel is irradiated, it must be stored underwater in spent-fuel pools that adjoin reactors. Because of the expectation that spent fuel would be reprocessed, Japanese pools were designed with only limited capacities. There is a serious risk that, after reactors have been restarted, some pools may fill up, forcing another round of closures. Without additional storage space, Japan could avert this outcome only by reprocessing spent fuel, hence allowing more to be moved to RRP. Japan's spent-fuel storage problems therefore constitute another barrier to terminating RRP and perhaps even to operating it at a lower rate.

One solution would be to build additional storage facilities—in the form of air-cooled “dry casks”—at reactor sites. After fuel has been cooled underwater for a few years, it can be removed and placed in these casks, where it can be stored safely for decades. Dry casks are used extensively in many countries, including the United States. In Japan, however, their uptake has been very limited. Local communities are often reluctant to accept them because they fear that the spent fuel placed in them might remain on their territory indefinitely.

Japan's only off-site, dry-cask storage facility, located in Mutsu City in Aomori Prefecture, could provide a short-term solution to Japan's spent-fuel management problem. Construction of this facility is now essentially complete, and it could accept fuel in the near future—although the governor of Aomori, who seeks to pressure the central government into operating RRP as soon as possible, has stated that he will not allow it to do so until RRP has been restarted. Ironically, the facility is owned by the two

utilities, the Tokyo Electric Power Company (TEPCO) and the Japan Atomic Power Company (JAPC), that are likely to find it hardest to restart their reactors and so have the least need for additional storage space for spent fuel. Other utilities with more urgent spent-fuel-management challenges do not have access to this facility.

The Japanese government should, therefore, encourage TEPCO and the JAPC to sell spent-fuel storage space at the Mutsu facility to other utilities.

To facilitate a long-term solution, the central government should offer greater subsidies to any prefecture and town or village willing to accept dry-cask storage facilities. The Abe administration has called for the greater use of dry-cask storage, but there is little reason to think that the utilities, by themselves, will have any more success in convincing local communities to accept new storage facilities than they have had in the past. Financial assistance from the central government might, however, make a difference.

AVERTING AN EVEN BIGGER PROBLEM

Both Tokyo and Washington may be inclined to delay addressing Japan's plutonium problem. After all, Japan's nuclear bureaucracy is currently focused on trying to restart the country's fleet of idled reactors and on remediation work in the aftermath of the Fukushima Daiichi accident; by comparison, the plutonium balance may not seem like a pressing issue.

Waiting is, however, only likely to exacerbate the problem. Delaying the restart of RRP until J-MOX comes online and operating it thereafter at a lower throughput—central steps to any credible solution—could prove highly controversial, especially among

the facility's host communities. The longer JNFL talks publicly about restarting the facility as soon as possible and then ramping it up to full capacity within five years, the more resistance there will probably be to a change of plan at a later date.

Japan should, therefore, act now and start to institutionalize its commitment not to produce more plutonium than it can

consume. A politically binding agreement on plutonium management with the United States would be a critical step to this end, not least because it would help Tokyo explain domestically difficult policy changes, such as operating RRP at a lower rate. As such, quick action now could help to forestall even bigger problems later. ■

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The Carnegie Endowment for International Peace is grateful to the John D. and Catherine T. MacArthur Foundation for its generous support of this publication.

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