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Questioning the Rationality of the Rokkasho Reprocessing Plant

A Call for a Reassessment and a Transparent Debate on the Future of the Plant

No to a Fake "Completion"

Despite the more than 30 years since construction by Japan Nuclear Fuel Limited (JNFL) began, the Rokkasho Reprocessing Plant in Aomori Prefecture, remains unfinished. The primary technical obstacle is the vitrification (solidification) of high-level liquid waste containing fission products. This waste emits extremely intense radiation and heat; in its liquid state, it is particularly vulnerable to earthquake tremors and physical impact, such as from an aircraft collision, as well as posing a significant risk of a hydrogen explosion if cooling ceases due to a loss of power supply during an earthquake. Prompt solidification is therefore essential for safety. One of the significant factors in the repeated delays in the plant's completion is the continued failure to successfully implement the vitrification process.

In an apparent attempt to claim "completion" despite the inadequacy of the vitrification process, JNFL announced last December that vitrification tests using actual liquid waste would be conducted only after the plant is declared finished.[1] The objective is to reach a nominal completion by the end of fiscal year 2026 (March 2027).

However, if operations commence under these conditions and vitrification fails to proceed as planned, the liquid waste tanks will soon reach capacity, forcing an inevitable plant shutdown. "Reprocessing" is an integrated sequence of processes consisting of the chemical processing of spent nuclear fuel to extract plutonium and uranium, followed by the vitrification of the remaining high-level liquid waste. Vitrification is not a secondary task but an essential component of the process, without which the facility cannot function normally. Furthermore, storing high-level waste in liquid form poses an unacceptable safety risk for Japan, a country that experiences high levels of seismic activity.

Attempting to bypass vitrification tests to stage a superficial "completion" not only indicates a disregard for safety but also lacks operational logic from the perspective of the smooth operation of a reprocessing plant. The Nuclear Regulation Authority (NRA) must not approve this deceptive approach in its ongoing safety examination of the JNFL application.

The Uncertainty of Plutonium Utilization Plans

As of late 2024, Japan, domestically and overseas, holds nearly 45 tons of plutonium that has no specific or predetermined destination for its use.[2] Since this amount of plutonium is sufficient to produce more than 5,500 nuclear warheads, it has drawn concern from the international community, including the United States.

Japan has pursued the "nuclear fuel cycle" as national policy since the early stages of nuclear development. The nuclear fuel cycle is meaningful only if the cycle—plutonium extracted via reprocessing is "bred" in fast breeder reactors (FBRs) and then reused in FBRs—is repeated. However, the prototype FBR "Monju"—the principal component of Japan's plutonium utilization program—became inoperable after a sodium fire accident in 1995. Japan's nuclear fuel cycle effectively collapsed at that point.To maintain the appearance of policy continuity, the government shifted the focus to "pluthermal"—the use of mixed oxide (MOX) fuel in conventional light-water reactors (LWRs). However, since LWRs are designed for uranium fuel, using MOX fuel reduces safety margins (e.g., by decreasing control rod effectiveness) and increases the risk of accidents.

While electric power companies have planned to implement pluthermal in at least 12 LWR units by 2030, pluthermal has been implemented in only four reactors thus far.[3] Of those, only two are currently generating power using MOX fuel, with a combined annual plutonium consumption of just 0.7 tons. The construction of Ohma Nuclear Power Plant, designed as a "full-MOX" reactor and seen as a major outlet for plutonium, has been delayed with no clear completion date.[4] Furthermore, the development of a "fast reactor" demonstration unit—the proposed successor to the failed breeder reactor—is targeted for the 2040s, but its commercial viability remains entirely speculative. The international community's stern vigilance regarding Japan's plutonium stockpile is based on two primary reasons: First, it risks setting a precedent that other nations could use to justify holding weapons-usable material, as demonstrated by Iran's recurrent citations of Japan's stockpile at Nuclear Non-Proliferation Treaty (NPT) Review Conferences; and second, persistent concerns remain regarding Japan's latent capability and potential for future military diversion.

In 2018, the Japanese government set out a policy to reduce its plutonium stockpile and to permit reprocessing only in the volumes required for actual pluthermal implementation, thereby not allowing the stockpile to exceed the current level at the time (approximately 47 tons).[5]

The Rokkasho plant has a maximum reprocessing capacity of 800 tons per year. If this policy is strictly adhered to, however, its throughput will be capped by the actual pace of plutonium reduction. Given the struggles of the pluthermal program, the plant now faces the prospect of being "open for business but with no work to do." Furthermore, as the completion of the MOX fuel fabrication plant under construction in Rokkasho Village has also been repeatedly postponed, the pluthermal program remains riddled with numerous uncertainties. Hence, **it is difficult to find any rational justification for rushing into full-scale operation of the reprocessing plant under such questionable circumstances.**

The Utmost Priority is the Reduction of the Plutonium Stockpile

Japan's national policy has been "full reprocessing," under which all spent nuclear fuel is to be reprocessed. The small-scale Tokai Reprocessing Plant in Ibaraki Prefecture (decommissioned in 2014) could handle only a small fraction of the spent fuel produced, resulting in Japan paying vast sums to the UK and France to outsource reprocessing while constructing its own large-scale reprocessing plant in Rokkasho Village.

Reprocessing plants also serve as storage facilities for spent fuel. When spent fuel is removed from a reactor, it is cooled in on-site pools before being transported to a reprocessing facility. If spent fuel is not removed from the reactor core, fresh fuel cannot be loaded, leading to little option but to shut down the reactor. Indeed, it is only the ability to ship spent fuel to the UK and France that has enabled Japanese power companies to continue to operate their nuclear power plants.

While reprocessing Japan's spent fuel proceeded overseas, the failure of Monju and the stagnation of the pluthermal program led to the amassing of a huge stockpile of extracted plutonium. Currently, 80% of Japan's plutonium is stored in the UK and France.

Since 1999, Japanese plutonium stored in France has been fabricated into MOX fuel and shipped back to Japan at a pace consistent with Japan's pluthermal program. The remaining amount is currently about 14 tons. Returning it to Japan in MOX form is necessary because transporting pure plutonium poses grave concerns for accidents and terrorism.[6]

Plutonium stored in the UK now amounts to approximately 22 tons. As the UK has closed its MOX fuel plant, the extracted plutonium is effectively "stranded" there. In 2025, from the viewpoints of security and non-proliferation, the UK government made a decision to dispose of the UK-owned civil plutonium stockpile (over 100 tons) by immobilizing and placing it deep underground. This indicates that the UK regards plutonium as de-facto "waste." The UK has also offered to undertake disposal of the Japanese portion.[7]

Attempting to bring the Rokkasho Reprocessing Plant online while holding this excessive plutonium stockpile is unlikely to gain consent from the international community. **Japan must go beyond merely maintaining the plutonium stockpile below a self-imposed limit (about 47 tons); it must prioritize reduction of the stockpile toward an eventual zero.** Any decision to start operation of the plant should be contingent on this. To reduce the plutonium stockpile, in addition to pluthermal, Japan should examine a geological disposal option similar to that of the UK. Regarding the stranded plutonium stored in the UK, the Japanese government must indicate a clear policy for a solution rather than continue to push it off onto the back burner.

The Economic Irrationality of Pluthermal

While the exact price of French-fabricated MOX fuel is not made public, trade statistics from the Ministry of Finance suggest it costs nearly 10 times more than conventional uranium fuel.[8] This figure only covers

fabrication; the total cost would be even higher if the price of plutonium extraction (reprocessing) were included. Domestically-produced MOX fuel from the Rokkasho fabrication plant is expected to be even more expensive, with one estimate suggesting it could cost up to 50 times more than uranium fuel.[9]

While spent MOX fuel contains plutonium, its isotopic composition makes it unsuitable for efficient power generation and thus there is no point in re-extracting it at high cost. Furthermore, as recycling through pluthermal is thought to be feasible at most only once or twice, its uranium-saving effect is negligible. In addition, as spent MOX fuel is more radioactive and generates more heat than spent uranium fuel, it requires longer cooling periods and more storage space. Thus, in fact, rather than a resource-saving measure, pluthermal effectively makes waste disposal more complex and costly.

Despite this, the government has decided on a policy of reprocessing spent MOX fuel as well as spent uranium fuel. Japan, however, possesses neither the necessary technology nor the facilities to implement this, resulting in electric power companies opting to outsource demonstration research for this process to France. [10] Such stop-gap measures are likely to complicate and expand the problem further, in a very similar manner to the previous outsourcing of reprocessing to the UK and France.

Japan's nuclear fuel cycle collapsed long ago. The Japanese government must acknowledge this reality and refrain from piling up fallacy upon fallacy in policy making. **The pluthermal program, which is both hazardous and economically irrational, should be discontinued except in unavoidable circumstances.[11] The plan to reprocess spent MOX fuel must also be canceled immediately.**

Underestimated Seismic Risks and Concerns about Seismic Resistance

In December 2025, an earthquake with a maximum intensity of 6+ on the Japanese seismic intensity scale occurred off the eastern coast of Aomori Prefecture.

Three major fault lines run along the eastern Shimokita Peninsula, where the Rokkasho Reprocessing Plant is located: The “Shelf-edge fault,” the “Rokkasho fault,” and the “Detoseiho fault” (Fig. 1). JNFL’s seismic assessment only accounted for the Detoseiho fault, dismissing the Shelf-edge fault as inactive and entirely ignoring the Rokkasho fault.

Studies by geological experts, on the other hand, show that there is an undeniable probability of the latter two being active. The Rokkasho fault, an inland branch of the Shelf-edge fault discovered in 2008, actually crosses the site of the Rokkasho Nuclear Fuel Cycle Facilities that include the reprocessing plant. While JNFL continues to ignore it, the Rokkasho flexure (fault) is clearly documented in the 2021 maps published by the Geological Survey of Japan (GSJ) of the National Institute of Advanced Industrial Science and Technology (AIST), a public organization that conducts geological surveys and research. [12]

As these faults were excluded from JNFL's magnitude assumptions, the plant's seismic design may be insufficient. Should a simultaneous rupture occur along the 150-kilometer-long Shelf-edge fault and Rokkasho fault, the resulting ground motion could far exceed JNFL's projections, casting serious doubt on the plant's ability to withstand the impact.

Drawing on the lessons learned from the Niigata Chuetsu-Oki earthquake (2007) and the Great East Japan Earthquake (2011), seismic reinforcement work has progressed at nuclear facilities across the country, but the Rokkasho plant poses a severe challenge. During "active tests" using actual spent fuel conducted since 2006, the main reprocessing lines became contaminated with high-level radiation. This has resulted in certain sections being designated "red cells"—no-go areas sealed off behind thick concrete walls.

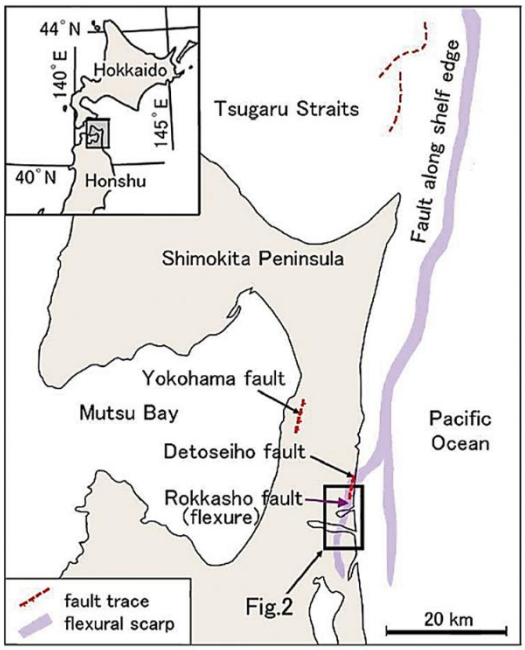

Fig.1 Map showing the study area (square) and active faults in around the eastern part of the Shimokita peninsula.
Note. From "Flexural deformation of marine terrace surfaces and geomorphic development around the Rokkasho fault, Aomori Japan", Mitsuhisa Watanabe, 2016, *Active Fault Reaerch,* No.44, pp.1-8.

At the Rokkasho Reprocessing Plant, far from implementing reinforcement work, there are more than 5,000 pieces of equipment that cannot be reached—or even approached for visual or physical inspection—making it nearly impossible to address accidents or malfunctions.[13] Should the facility be struck by an earthquake of a magnitude greater than that assumed, the likelihood that this could lead to a severe accident is high. **For a plant that handles vast quantities of highly radioactive material, the fact that its major equipment can neither be inspected nor reinforced for seismic safety is dangerous in the extreme.** Before the Rokkasho Reprocessing Plant enters full-scale operation, the Japanese government should very seriously consider the option of closing the facility down. Indeed, there have been a number of precedents around the world where nuclear facilities that were nearly complete were cancelled or frozen after a re-examination of their economic and social costs.[14]

Burgeoning Reprocessing Costs

Construction costs for the Rokkasho Reprocessing Plant have ballooned. Originally estimated at 760 billion yen in 1989, the figure reached 3.74 trillion yen by 2025—nearly five times the initial budget. When 40 years of operation and eventual decommissioning are included, the total project cost is estimated at 15.62 trillion yen. Adding the costs of the MOX fuel plant brings the total to over 18 trillion yen (as of 2025).[15]

When construction began in 1993, the plant was scheduled be completed in four years. However, plagued by a series of troubles, the completion date has thus far been postponed 27 times. Even while idle, the facility incurs maintenance and security costs exceeding 110 billion yen per year—roughly 300 million yen per day.[16]

Delays at the Rokkasho Reprocessing Plant are also disrupting the operation of nuclear reactors nationwide due to the inability to ship spent nuclear fuel out from the reactor sites. This logistical bottleneck is likely a major reason why the government and electric power companies are rushing to bring the plant online. However, even if the facility is completed, its processing volume will be strictly capped by the pace of plutonium reduction, meaning that the acceptance of spent fuel from power plants will remain severely limited.

Anticipating this deadlock in the reprocessing program, the government decided to introduce "interim storage" as a buffer between the reactors and the reprocessing plant. The intent is to allow reactors to continue to operate without being constrained by the progress in reprocessing or the limited capacity of on-site spent fuel cooling pools. To this end, an interim storage facility funded by Tokyo Electric Power Company (TEPCO) and the Japan Atomic Power Company has already opened in Mutsu City, Aomori Prefecture. Meanwhile, Kansai Electric and Chugoku Electric Companies are planning a facility in Kaminoseki Town, Yamaguchi Prefecture, and other companies such as Shikoku Electric are constructing, or are considering the construction of storage facilities either inside or outside their plant sites.

It must be noted that interim storage is an "after-the-fact" addition, not part of the original nuclear fuel cycle plan. Every additional stage in the process inherently increases costs and leads to greater generation of radioactive waste, higher risks of contamination, and increased radiation exposure. Furthermore, it necessitates extra expenditures for transportation between facilities, security, and counter-terrorism measures.

The entire spectrum of costs associated with reprocessing—including the construction of the Rokkasho plant, overseas outsourcing, the pluthermal program, the MOX fuel fabrication plant, interim storage, the final disposal of high-level waste, and so on—is structured to be borne by current and future electricity consumers through their electricity bills. **The government and electric companies must provide full financial transparency to the public, disclosing the total costs invested to date in the development and maintenance of the nuclear fuel cycle program, as well as all projected future costs. Based on this disclosure, a rigorous reassessment must be conducted to compare the economic and social costs of reprocessing against other alternatives, including direct disposal of spent fuel.**

We Call for an Independent Reassessment and a Transparent Debate

Comprehensive assessments of the nuclear fuel cycle, including reprocessing, have been conducted only twice by the Japan Atomic Energy Commission (JAEC); in 2004–2005 and 2011–2012.

In the 2004–2005 assessment, various options were compared by the "New Framework Planning Committee" established under the JAEC. The committee consisted of more than 30 members from various sectors of society, but its composition lacked fairness and impartiality; it was overwhelmingly dominated by pro-nuclear proponents, with only a few cautious voices and a single member in clear opposition.

The committee's deliberations resulted in a consensus that "direct disposal of spent nuclear fuel is the least expensive option, while reprocessing is the most costly." However, the argument subsequently emerged that halting reprocessing would incur significant "policy change costs." By factoring in these speculative costs, the committee concluded that a full-reprocessing route "could not necessarily be deemed inferior," effectively justifying its continuation.[17] With this official endorsement, JNFL went ahead with "active tests" in 2006. As previously noted, it is precisely this step that has made subsequent seismic reinforcement work so difficult due to radioactive contamination.

Following the Fukushima Daiichi nuclear accident, nuclear policy underwent a "zero-based review," leading to another comprehensive assessment of the nuclear fuel cycle in 2011–2012. A subcommittee of seven experts organized by the JAEC examined three options based on various perspectives, including economic efficiency, nuclear non-proliferation and security, environmental impact, and waste disposal. Their findings reconfirmed that "direct disposal" was the superior option. Considering future uncertainties, the subcommittee proposed a "coexistence" model that would allow for direct disposal alongside reprocessing.[18] However, this recommendation was never reflected in national policy, and the "full reprocessing" mandate remained unchanged.

More than a decade has passed since then, and the landscape surrounding reprocessing has changed drastically. A stark example is the decision by the United Kingdom—a pioneer in reprocessing—to reclassify its plutonium as waste for disposal. The UK has already exited the reprocessing business and shuttered its facilities, leaving behind a vast legacy of radioactive waste and contamination.

Taking the UK's experience as a cautionary lesson, we must fundamentally question whether reprocessing is truly necessary for Japan's energy policy. **The Japanese government should freeze the Rokkasho Reprocessing Plant until plutonium stockpiles approach zero and create a new forum to reassess the rationality of reprocessing based on the latest data and information.**

In conducting the reassessment, an independent third-party body should be established, for which **the selection of members must be guaranteed to be fair and impartial, without bias toward any particular stakeholder or position.**

Furthermore, **alongside this reassessment, the government should implement citizen-participatory "deliberative discussions" for each key theme.** Engaging researchers and experts specializing in deliberative democracy to plan and manage these sessions would facilitate a more open and transparent debate. Such citizen-led deliberations on nuclear and energy policy have already been implemented in Taiwan and South Korea; Japan itself conducted "deliberative polling" in 2012 regarding Japan's reliance on nuclear power.

There have been ample opportunities to review the reprocessing mandate in the past. Yet, the Japanese government has insisted on the nuclear fuel cycle, either by putting off decisions or by making policy choices that have only exacerbated the situation. As a result, costs continue to snowball, the nation is burdened by excessive plutonium, and the already daunting task of radioactive waste disposal has become even more complex.

The Rokkasho Reprocessing Plant has not yet entered full-scale operation. To avoid leaving a disastrous legacy for future generations, the Japanese government must exhaust all avenues of debate regarding the rationality of reprocessing to finally reach a sound, evidence-based decision.

Endnote

[1] Nuclear Regulation Authority (NRA) N-ADRES, Japan Nuclear Fuel Limited (JNFL), "III. Policy for Correspondence Regarding Pre-service Operator Inspections," https://www.da.nra.go.jp/view/NRA100014881?contents=NRA100014881-002-038#pdf=NRA100014881-002-038, accessed April 14, 2026.

[2] Office of Atomic Energy Policy, Cabinet Office, "The Status of Plutonium Management in Japan in 2024," August 5, 2025, https://www.aec.go.jp/bunya/04/plutonium/20250805.pdf, accessed April 13, 2026.

[3] The Federation of Electric Power Companies of Japan (FEPC), "Regarding the Plutonium Utilization Plan," February 14, 2025, https://www.aec.go.jp/kaigi/teirei/2025/siryo07/1-1_haifu.pdf, accessed April 13, 2026.

[4] Aomori Asahi Broadcasting, "Ohma Nuclear Power Plant 2030 Operation Start Target: 'Must say it is extremely difficult'," March 6, 2026, https://www.aba-net.com/news/news-175932.html, accessed April 13, 2026.

[5] Japan Atomic Energy Commission (JAEC), "The Basic Philosophy of Plutonium Utilization in Japan," July 31, 2018, https://www.aec.go.jp/kettei/kettei/20180731_2.pdf, accessed April 13, 2026.

[6] In January 1993, powdered plutonium was shipped back to Japan from France. Countries along the transport route expressed opposition due to risks of terrorism and concerns regarding Japan's potential

nuclear armament. Following a series of statements refusing passage through territorial waters, the Japanese government decided to have plutonium converted to MOX fuel form for all subsequent shipments.

[7] UK Parliament, "Plutonium Disposition Strategy," January 24, 2025, https://questions-statements.parliament.uk/written-statements/detail/2025-01-24/hcws388, accessed April 13, 2026.

[8] Asahi Shimbun, "Imported MOX Fuel Revealed to Cost 1.2 Billion Yen per Unit: 10 Times the Price of Uranium, says Kansai Electric Power," July 8, 2023, https://digital.asahi.com/articles/ASR7805QSR6YPISC00N.html, accessed April 13, 2026.

[9] Citizens' Nuclear Information Center (CNIC), "How much is the cost of MOX fuel?", https://cnic.jp/rep/?p=1257, accessed April 13, 2026.

[10] The Federation of Electric Power Companies of Japan (FEPC), "Regarding Demonstration Research on the Reprocessing of Spent MOX Fuel," May 19, 2023, https://www.fepc.or.jp/pr/news/oshirase/__icsFiles/afieldfile/2023/05/19/press_20230519-1.pdf, accessed April 13, 2026.

[11] From the perspective of nuclear non-proliferation, pluthermal is conducted to "pollute" the plutonium (change its isotopic composition), making it more difficult to divert to the production of nuclear weapons. Storing MOX fuel returned from France without utilizing it would pose a significant issue for global nuclear non-proliferation efforts.

[12] Preparatory Document 212, "The 'Rokkasho Flexure' (Rokkasho Fault) Recognized by AIST," September 27, 2024, https://1mangenkoku.org/wp-content/uploads/2024/09/212_rokkasho_active_fault.pdf, accessed April 13, 2026.

[13] Chihiro Kamisawa (2021), "Rokkasho Reprocessing Plant: Contaminated Equipment Lacks Seismic Strength but Cannot Undergo Reinforcement," CNIC Newsletter, No. 565, Citizens' Nuclear Information Center.

[14] Examples of nuclear facilities cancelled or frozen after completion include the Wackersdorf reprocessing plant in the former West Germany, the Zwentendorf nuclear power plant in Austria, and the Lungmen Nuclear Power Plant (Fourth Nuclear Power Plant) in Taiwan.

[15] Asahi Shimbun, "Rokkasho Village Reprocessing Plant Total Project Cost Increases by 530 Billion Yen to 15.62 Trillion Yen," June 24, 2025, https://digital.asahi.com/articles/AST6R3SR6T6RUNHB008M.html, accessed April 13, 2026.

[16] Tokyo Shimbun, "110 Billion Yen per Year for Reprocessing Plant Maintenance Even Without Operation: More than 5 Times the Cost of 'Monju' in the Nuclear Fuel Cycle Project," May 14, 2012, https://www.tokyo-np.co.jp/article/236495, accessed April 13, 2026.

[17] Hideyuki Ban (2006), Critique of the Framework for Nuclear Energy Policy: From the Frontlines of the Planning Committee, Nanatsumori Shokan, p. 160.

[18] Atomic Energy Commission Subcommittee on Study of Nuclear Power and Nuclear Fuel Cycle Technology, etc., "Regarding the Results of the Study on Nuclear Fuel Cycle Policy Options," June 5, 2012, https://www.aec.go.jp/kaigi/senmon/hatukaku/kentou_1.pdf, accessed April 13, 2026.