

New U.S.-ROK Peaceful Nuclear Cooperation Agreement:

A Precedent for a New Global Nuclear Architecture



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For decades, the United States and the Republic of Korea (ROK) have enjoyed extensive and mutually beneficial cooperation in the peaceful use of nuclear energy. In 2014, however, the current U.S.-ROK peaceful nuclear cooperation agreement will expire. Soon, the two countries must begin to negotiate a replacement agreement. This new U.S.-ROK civil nuclear trade accord could serve as an important vehicle for enhancing the peaceful nuclear programs of both countries, while simultaneously establishing effective nonproliferation conditions and controls to govern such programs.

More Stable Cooperation and More Rigorous Nonproliferation Controls

The U.S. Nuclear Non-Proliferation Act (NNPA) of 1978 requires that all new peaceful nuclear cooperation agreements contain rigorous nonproliferation and assurances on exports of U.S. nuclear equipment and nuclear materials, including peaceful, non-explosive use assurances, international safeguards, physical protection and the right of the U.S. to approve various sensitive nuclear activities such as reprocessing. The U.S. has since concluded agreements with 20 countries and two international organizations, the European Atomic Energy Agency (EURATOM) and the International Atomic Energy Agency (IAEA). Each agreement contains these nonproliferation controls, which are far more extensive than those contained in the existing U.S.-ROK agreement signed in 1974.

Under the NNPA, after the President submits the proposed text of a new peaceful nuclear cooperation agreement to Congress, it will undergo 90 days of continuous session unless Congress enacts legislation to disapprove it. However, if a proposed new peaceful nuclear cooperation agreement lacks any of the NNPA requirements, its approval requires the enactment of a resolution of approval by both Houses of the U.S. Congress. Given these legal and political realities, U.S. negotiators will undoubtedly press for including all NNPA-specified conditions in any new peaceful nuclear cooperation agreement with the ROK.

A new U.S.-ROK accord could have clear benefits for both countries. It could provide a stable basis for peaceful nuclear trade and cooperation for the future, while also establishing a model for strict nonproliferation controls that South Korea might include in its own bilateral nuclear cooperation agreements with other countries. Unlike the existing U.S.-ROK accord, the U.S. intends to make the new agreement reciprocal in nature and impose the same conditions on ROK exports of nuclear materials and

equipment to the United States as it does on U.S. exports of nuclear supplies to South Korea. In this respect, the agreement offers opportunities to strengthen nonproliferation controls on civil nuclear trade and to lessen the one-sided nature of past nuclear cooperation between the two countries.

Additionally, the two countries could enhance their contribution to the nonproliferation regime by setting forth in the agreement itself—or in a side document—their shared views on nonproliferation and their specific intentions and commitments to strengthen both civil nuclear cooperation and nonproliferation. This would include pledges to:

- promote the peaceful uses of nuclear energy in each country and avoid hampering, hindering, interfering with, or delaying the peaceful nuclear activities of either party;
- support the Non-Proliferation Treaty (NPT);
- strengthen the IAEA safeguards system, including increased financial and technical support;
- ensure effective controls on their nuclear exports and assist other countries in establishing strong export control systems;
- support restraint in the export of sensitive nuclear technology;
- promote the application of the most effective physical protection techniques;
- conduct R&D on the proliferation-resistance of nuclear fuel cycle activities, including both technical and institutional barriers to diversion;
- work together to urge countries to adopt the universal entry into force of the Additional Protocol to IAEA safeguards agreements, the conclusion of a verifiable Fissile Material Cut-Off Treaty (FMCT), and the entry into force of the Comprehensive Test Ban Treaty (CTBT).

The new agreement could also give formal recognition to, and elevate the status of, the Joint Standing Committee on Nuclear Energy Cooperation (JSCNE). In 1980, the U.S. and the ROK established the JSCNEC, a bilateral agency that meets formally at least once a year. The JSCNEC has become the central forum for exchanging views on a wide range of technical and policy matters, including environmental and waste management, nuclear energy research and development (R&D), nuclear safety, nuclear fuel cycle issues, safeguards, the NPT, nuclear export controls, nuclear supply assurances, regional proliferation concerns, nuclear smuggling, and nuclear cooperation with other countries.

Differences Over the Nuclear Fuel Cycle

Most likely to complicate the negotiation of a new U.S.-ROK peaceful nuclear cooperation agreement is the implementation of a U.S. right to consent to South Korea's reprocessing of used nuclear fuel from its nuclear program.¹

¹ There have also been reports that the ROK may also consider the acquisition of enrichment technology, a step that could also conflict with U.S. nonproliferation policy. See "Seoul considering options to improve energy efficiency" *Korean Herald*, July 8, 2009.

About two-thirds of South Korea's used power reactor fuel has been produced from nuclear material supplied under the 1974 U.S.-ROK peaceful nuclear cooperation agreement. This existing agreement provides that nuclear material supplied to South Korea may be reprocessed only in facilities acceptable to both parties upon a joint determination that IAEA safeguards may be effectively applied. With the 1978 NNPA, U.S. nonproliferation legislation now requires that new agreements contain an expanded U.S. consent right to include not only nuclear material supplied by the U.S., but also all nuclear material that has been used in a U.S.-supplied reactor. To date, the U.S. has not consented to any reprocessing—or to the alteration in form of content—of U.S.-supplied used nuclear fuel in Korea.

South Korea's used nuclear fuel problem. South Korea is heavily dependent on nuclear power; by 2030, it will account for 59 percent of South Korean electricity generation. However, South Korea faces serious challenges in managing and storing its used nuclear fuel.²

The lack of adequate used fuel storage capacity could lead to a shut down of the existing reactors and be one of the biggest stumbling blocks for South Korea's plans to generate more nuclear power.³ In the longer term, the ROK must find a place to dispose of its high-level nuclear waste. In early 2009, the government established the Korea Radioactive Waste Management Co. Ltd (KRWM) as an umbrella organization designed to resolve South Korea's waste management disposition—and to forge a national consensus on high-level wastes. However, the ROK has not yet raised the issue of site selection for the disposal of high-level waste, an issue that will undoubtedly spark considerable controversy. In 2007, the government began construction on South Korea's first repository for mid- and low-level nuclear waste, but only after 20 years of highly contentious debate. The government promised to donate USD\$300 million to the local community in Gyungjoo, the host city of the final repository, and to financially support the community with USD\$4 billion.

South Korea currently has 20 reactors in operation, six under construction, and plans to increase nuclear capacity to 38 reactors by 2030. These reactors will produce more than 100,000 tons of used nuclear fuel by 2100. South Korea wants to establish a capability to minimize the accumulation of used nuclear fuel discharged from its nuclear power plants and, potentially, to recycle it by using the transuranic elements in fast reactors.

South Korea must find both short and long-term solutions to managing the back end of its nuclear fuel cycle. In the short-term, the only realistic answer is the interim storage of spent fuel either at reactors at a central storage facility, or at multiple, regional facilities.

² At the end of 2007, South Korea had a combined storage capacity of 12,561 tons of used nuclear fuel that is discharged from its 20 nuclear reactors currently in operation. The total spent fuel inventory stored at reactor sites in the ROK now exceeds 10,000 metric tons. Officials at Korea Hydro & Nuclear Power Co. KHNP recently revealed that the spent fuel pools for Korea's 16 pressurized power reactors (PWRs) at three existing sites will be full as of 2016. ROK aims to forge a stakeholder consensus by 2016 on how it will manage its growing inventory of spent power reactor fuel.

³ "Lack of Storage Capacity Clouds Nuclear Power Plan," *Korea Times*, December 2, 2007.

However, these alternatives are likely to encounter strong public opposition. For the long-term, some in the ROK government and the R&D community believe that a certain form of reprocessing, referred to as *pyroprocessing*, is the most sensible solution to managing South Korea's nuclear waste. The final disposal of used nuclear fuel, they believe, would be a formidable task: South Korea's population density is among the world's highest and its present infrastructure makes impossible the road transport of used nuclear fuel, as its transport canister weighs more than 110 tons. For the South Koreans, these factors put a premium on minimizing nuclear waste.

Pyroprocessing and Proliferation Risks. In negotiating a new agreement with the United States, South Korea will likely aim to obtain advance, long-term U.S. consent on both reprocessing or pyroprocessing of used nuclear fuel, subject to the agreement, and U.S. consent to South Korea's use of recovered plutonium and other transuranics in fast reactors.

However, because reprocessing technology poses several proliferation risks, the U.S. has long approached the reprocessing issue with great caution. Classic PUREX reprocessing separates plutonium from all fission products. This separated plutonium may be used as fuel in civil nuclear reactors, but it is also directly usable in nuclear weapons. A state, which possesses such material, could abrogate its nonproliferation commitments and produce a nuclear weapon within a short period of time. Reprocessing plants are also challenging and costly to safeguard, while separated plutonium offers a tempting target to non-state actors.

International attention towards the proliferation risks posed by reprocessing has focused on two different strategies. The first strategy, the so-called once-through fuel cycle, eschews reprocessing and disposes of used nuclear fuel as waste. Proponents of this approach have argued that reprocessing is more costly than the once-through fuel cycle strategy and presents far greater proliferation risks. The United States has long promoted this strategy, dating back to the 1970s Ford and Carter administrations. The second strategy focuses on the development of new and increased "proliferation-resistant" technologies, which do not separate pure plutonium. As part of its Global Nuclear Energy Partnership (GNEP), the George W. Bush Administration placed considerable emphasis on "proliferation-resistant" fuel cycle development. The U.S. Department of Energy (DOE) has therefore studied a range of reprocessing technologies, virtually all of which are in the research stage and have not demonstrated commercial viability.

One of these reprocessing technologies is pyroprocessing, the technology in which South Korea is particularly interested. The U.S. has engaged ROK scientists on joint pyroprocessing experiments involving used nuclear fuel at U.S. laboratories. However, the U.S. has agreed to such cooperation on the R&D level only on a case-by-case basis. In addition, South Korea scientists have been restricted to using natural uranium, which does not contain plutonium.⁴ The United States has also not allowed any "hot"

⁴ The plutonium product of pyroprocessing is not pure but is mixed with uranium, some rare-earth fission products (notably cerium-144), and the other transuranic elements, namely americium, curium, and neptunium.

processing of used nuclear fuel subject to the existing U.S.-ROK nuclear cooperation agreement.

Pyroprocessing has been under development in the DOE's Argonne National Laboratory. In 2005, South Korea built a laboratory-scale Advanced Conditioning Processing Facility (ACPF) in the Irradiated Material Examination Facility of the Korea Atomic Energy Research Institute (KAERI). On December 23, 2007, the Korean Ministry of Science and Technology announced a civil nuclear energy plan that aims to build a functioning, next-generation fast reactor and a pyroprocessing—or pyrorecycling—fuel cycle by 2028. The plan is to first begin construction of a *pilot* pyroprocessing facility by 2012, which will be completed by 2016. The Ministry also envisages a semi-commercial facility in place by 2025.⁵

Observers both within and outside the U.S. government have argued that pyroprocessing and pyrorecycling is not “proliferation-resistant” because technology separates most fission products from the plutonium, therefore removing the major technical barriers to its use in nuclear weapons. In addition, the draft Nonproliferation Impact Assessment (NPIA) of the GNEP Programmatic Alternatives, which was developed by the DOE, reached the preliminary conclusion that the candidate reprocessing technologies under study, including pyroprocessing, suggest only modest improvements in reducing proliferation risk over existing PUREX technologies, and these would reduce the risks that non-state actors, not states, would be able to gain access to the plutonium.⁶

Over several decades, U.S. policy toward reprocessing in other countries has exhibited a striking continuity of approach. The U.S. has granted consent to reprocessing only in countries that already have advanced nuclear programs, including reprocessing and enrichment plants, and excellent nonproliferation credentials. Also, the U.S. grants consent to countries with no proliferation risk or are located in areas of only limited proliferation danger. To date, the U.S. has approved the reprocessing of U.S.-obligated used nuclear fuel only in EURATOM and Japan—and has agreed to consent to such reprocessing in a future Indian reprocessing facility. For all other countries, U.S. administrations from President Gerald Ford to President George W. Bush have sought to restrict the spread of reprocessing and have declined to give consent to reprocessing of U.S.-obligated spent fuel. Recently, the U.S. Congress underlined its support for this policy in the United States-India Nuclear Cooperation Approval and Nonproliferation

⁵Lee Joon-seung, “S. Korea's aims to develop a functioning fast reactor, advanced fuel cycle by 2028,” *Yonhap News*, December 23, 2007.

⁶ With respect to pyroprocessing, the NPIA stated that the compact and batch nature of pyroprocesses favors co-locating a fuel recycle facility with a group of advanced burner reactors thus reducing the need for a large centralized processing facility and possibly reducing transportation of separated transuranic material, including the plutonium, and the attendant physical protection concerns. Pyroprocessing remains an experimental process not yet deployed on a production scale. Misuse could take longer than estimated if there are complications in modifying or scaling up the process. On the other hand, development of new pyroprocessing methods could allow for misuse scenarios that take less time to complete. It also states that pyroprocessing poses challenges for material accountancy and would require significant safeguards technology and system development before effective safeguards systems could be implemented even for engineering-scale facilities. An effective safeguards approach for such facilities should be designed to detect both misuse of the facility and diversion of nuclear material.

Enhancement Act of 2008, which required the President to certify that it is, “the policy of the United States to work with members of the Nuclear Suppliers Group (NSG), individually and collectively, to agree to further restrict the transfers of equipment and technology related to the enrichment of uranium and reprocessing of spent nuclear fuel” (Section 104 (a)).

The Obama Administration, the U.S.-ROK Peaceful Nuclear Agreement, and Reprocessing. The Obama Administration’s approach to reprocessing in South Korea was addressed in written answers that Ellen Tauscher provided to Senator Richard Lugar, ranking minority member of the Senate Foreign Relations Committee, in connection with her nomination hearings for the position of Under Secretary of State for Arms Control and International Security. Senator Lugar asked:

“Does the Administration contemplate any changes in existing nuclear cooperation agreements, in particular those with Taiwan and the Republic of South Korea, to allow reprocessing of US-origin materials in those nations?”

Tauscher’s written answer was:

“Pursuant to the requirements of the Atomic Energy Act of 1954, as amended, all U.S. nuclear cooperation agreements with partner countries require that the United States give its consent to reprocessing of spent fuel containing U.S.-origin nuclear material by those countries. The agreements with EURATOM, India and Japan provide programmatic consent⁷ for reprocessing within the European Union, India and Japan. The Administration does not believe that such programmatic consent to reprocessing is *necessarily appropriate* (highlighting added for emphasis) in other cases, including Taiwan and the Republic of Korea.”

Tauscher’s use of the words “necessarily appropriate” in reference to the possibility of U.S. programmatic consent to reprocessing is ambiguous. It would appear to leave open, at least, the possibility of such U.S. approval of reprocessing in both places. However, Senator Lugar also asked:

“Do you believe that an agreement that allowed any form of reprocessing to take place in South Korea would violate the 1992 Joint Declaration, in particular its clear statement that “The South and the North shall not possess nuclear reprocessing and uranium enrichment facilities”?”

Tauscher’s answer appears to close the door to the reprocessing of U.S.-obligated used nuclear fuel in South Korea:

“I believe that the existence of a reprocessing plant in the Republic of

⁷ Programmatic consent means advance, long-term U.S. consent to reprocessing and the use of plutonium in the peaceful nuclear programs in these countries under specified safeguards and physical protection measures.

Korea would be inconsistent with the commitments made in the 1992 Joint Declaration.”⁸

Washington has regarded the 1992 North and South Korean Joint Declaration on the Denuclearization of the Korean Peninsula, in which both parties agreed to forego possession of enrichment and reprocessing facilities, as a key component of realizing nuclear stability on the Korean Peninsula. The U.S. has feared that any South Korean pyroprocessing program would undermine the 1992 North-South denuclearization agreement at a sensitive time in U.S. efforts to dismantle North Korea’s nuclear program.

Points of Contention: the United States. The U.S. will find it difficult to consent to pyroprocessing in Korea for a number of reasons:

1. As noted above, it will be extremely difficult for the U.S. to consent to any kind of reprocessing on the Korean Peninsula, if Washington perceives that such a decision would jeopardize the satisfactory resolution of the nuclear issue in the North, including a nuclear-weapon-free Korean Peninsula.
2. Finding a rationale for making an exception for South Korea to its long-standing policy of preventing the spread of sensitive nuclear facilities will be challenging. To date, the only exceptions have been Japan and EURATOM and, more recently, a promise to give India advance consent to reprocessing.
3. The ROK differs from Japan and EURATOM in that it has neither built nor operated reprocessing facilities and is, therefore, not in a position to argue that its existing programs should be grandfathered like those in Japan and EURATOM.
4. Most members of the arms control and nonproliferation community in the United States will oppose any kind of reprocessing and will lobby the Executive Branch and the Congress against any arrangements allowing reprocessing or pyroprocessing in South Korea.
5. A growing international consensus has emerged favoring a halt to the further spread of national enrichment and reprocessing capabilities.⁹

⁸ Pre-Hearing Questions for the Record, Senator Richard Lugar Nomination of Helen M. Tauscher to be Under Secretary of State for Arms Control and International Security.

⁹ For example, Dr. Mohamed El Baradei, Director General of the IAEA, has urged countries to agree to a moratorium on the construction of new enrichment and reprocessing facilities in return for their receiving guarantees of delivery of nuclear fuel for peaceful production of electricity. He has also advocated placing all enrichment and reprocessing plants under some form of international auspices or control. In December 2005 the High-Level UN Panel on Threats, Challenges and Change issued a report that called for a limited moratorium on the construction of any further enrichment or reprocessing facilities, with a commitment to the moratorium matched by a guarantee of the supply of fissile materials by the current suppliers at market rates. The members of the Group of Eight (G-8) have also issued statements in which they said, “it is important to develop and implement mechanisms assuring access to nuclear fuel related services to states as an alternative to pursuing enrichment and reprocessing activities.”

6. The NSG has been examining ways to strengthen its guidelines on transferring enrichment and reprocessing technologies.
7. Acceptance of South Korean pursuit of pyroprocessing would not only be controversial in America, but may also raise regional and global nonproliferation concerns.

Points of Contention: South Korea. As mentioned earlier, the ROK will press the United States hard for advance, long-term consent to reprocess—or pyroprocess—used nuclear fuel subject to the bilateral agreement for a number of their own reasons.

1. As a sovereign state and as a party to the NPT, the ROK will argue that it has the right to engage in reprocessing as long as it is abiding by its NPT obligations. Seoul will point to the wording of Article IV of the NPT, which negotiators will cite as the legal basis in resisting any notion that the ROK should be denied a reprocessing or pyroprocessing capability. The Article states, “Nothing in this Treaty shall be interpreted as affecting the inalienable right of all the Parties to the Treaty to develop research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of this Treaty.”
2. North Korean reprocessing, and its conduct of a nuclear test, both constitute a violation of the two countries’ 1992 denuclearization agreement. This, they will argue, renders null and void the South Korean commitment in that agreement not to possess enrichment or reprocessing capabilities.
3. South Korea finds it discriminatory that the United States has given India, Japan and EURATOM advance, long-term consent to reprocessing and to the use of plutonium while refusing the ROK the same treatment, even though South Korea has a major nuclear power and R&D program. Seoul sees the U.S.-Japan civil nuclear cooperation agreement, in particular, as the benchmark for a new U.S.-ROK agreement.
4. South Koreans disagree with their U.S. counterparts about reprocessing and have asserted that the pyroprocessing technology they have developed is not reprocessing because no plutonium is separated from other transuranics when they are separated from uranium. South Koreans also argue that the technology is proliferation resistant¹⁰ and that any concerns about their pyroprocessing R&D program can be put to rest by effective safeguards.¹¹

¹⁰ Daniel Horner and Mark Hibbs, ““US debating whether pyroprocessing qualifies as reprocessing for Korea” *Nuclear Fuel*, June 2, 2008

¹¹ Mark Hibbs, “Pyroprocessing proliferation issues can be solved, Korean experts say,” *Nuclear Fuel*, June 13, 2008.

5. The United States cannot deny the ROK consent to reprocessing after it has given preferential treatment to India, a non-NPT party.¹² In its recently concluded peaceful nuclear cooperation with India, the U.S. has promised to advance, long-term consent to reprocessing in India. Specifically, paragraphs iii and iv of Article 6 of that agreement provides that:

“...the Parties grant each other consent to reprocess or otherwise alter in form or content nuclear material transferred pursuant to this Agreement and nuclear material and by-product material used in or produced through the use of nuclear material, non-nuclear material, or equipment so transferred. To bring these rights into effect, India will establish a new national reprocessing facility dedicated to reprocessing safeguarded nuclear material under IAEA safeguards and the Parties will agree on arrangements and procedures under which such reprocessing or other alteration in form or content will take place in this new facility. Consultations on arrangements and procedures will begin within six months of a request by either Party and will be concluded within one year.”

The U.S. and India have already begun consultations on the arrangements and procedures for safeguarding the proposed Indian reprocessing plant, with the intention of completing them by August 2010, as required by the terms of the agreement. The U.S.-Indian agreement has given the South Koreans the argument that the U.S. should be prepared to grant the ROK the same treatment with respect to pyroprocessing of U.S.-obligated spent fuel as it has accorded India with respect to reprocessing. The ROK will argue that they have assumed all the obligations and burdens of an NPT party whereas India has not and that they have a close alliance and a security treaty with the United States, which India does not. In addition, the Korean Peninsula is a region that is no more politically unstable than South Asia.

Options for the United States and South Korea

Given the positions that the U.S. and ROK have on reprocessing and pyroprocessing/recycling, is a resolution of this issue possible? Below are several options.

Just Say ‘No’. The U.S. could adopt the position it has taken with the vast majority of its cooperating partners and simply decline to give advance, long-term consent to pyroprocessing in South Korea. Under this option, the U.S. could offer to explore with the ROK options on interim storage of used nuclear fuel either in the ROK or offshore. The U.S. could then consider any future requests to pyroprocess U.S.-obligated used

¹² Until recently the United States required that all non-nuclear-weapon states (India is a non-nuclear-weapon state under international law) accept comprehensive safeguards as a condition of significant nuclear cooperation. The Bush Administration departed significantly from this principle when it persuaded the U.S. Congress to change the U.S. Atomic Energy Act and the members of the NSG to revise its international guidelines in order to enable nuclear cooperation with India by exempting India from the requirement for accepting comprehensive IAEA safeguards.

nuclear fuel on a case-by-case basis. South Korea would then have to store its used fuel indefinitely and possibly consider disposing of it as waste. This stance would be fully consistent with long-standing U.S. policy and would be supportive of Washington's efforts to prevent the spread of reprocessing capabilities. It would encounter no opposition from the nonproliferation, arms control and environmental communities in the United States and would most likely receive a positive reception in the U.S. Congress. The South Koreans, however, would find this outcome highly unsatisfactory, particularly in light of the fact that the U.S. had been cooperating with the ROK on research into pyroprocessing and thereby had encouraged Seoul to pursue this technology—not to mention that the U.S. has given consent to other countries with major nuclear programs. South Korea would find it difficult to proceed with its plans to develop and deploy commercial pyroprocessing technology in the face of an uncertain U.S. response to a ROK request to future pyroprocessing or to make plans for the long-term disposition of its used nuclear fuel.

International Storage or Disposal Facilities. South Korea could explore the option of establishing an international (or regional) storage or waste disposal facility. While this idea has generated a great deal of support and enthusiasm for many years, and despite the potential value of such a facility, no country has yet to come forward to agree to host one. For the foreseeable future, this is a not a realistic option for South Korea or for any other country.

Domestic Storage. One short-term possibility is to establish a dry cask storage at reactor sites or to construct central storage, or regional storage, sites. South Korea is likely to face some political obstacles with this approach, but interim dry cask storage would provide near-term and mid-term relief to the utility industry and would not raise any nonproliferation concerns. However, this does not address the long-term problem.

Reprocessing abroad. Another option would be for the U.S. to permit the ROK to transfer some or all U.S.-obligated spent fuel to Europe for reprocessing. There are indications that the U.S. government might be willing to take this approach, as long as there is no return of the separated plutonium to South Korea. However, South Korea would view such a U.S. position as severely discriminatory because the U.S. has granted Japan consent to reprocessing and the use of plutonium in Japanese nuclear facilities, this includes the return of Japanese plutonium recovered from overseas reprocessing.¹³ In addition, without the option of returning the recovered plutonium to South Korea, Korean utilities would have to pay for the indefinite storage of their recovered plutonium in Europe. Since there is no real market for this material, they are unlikely to find acceptable customers for such plutonium.

Pyroprocessing. Secretary Tauscher's response to Senator Lugar's question that "the existence of a reprocessing plant in the Republic of Korea would be inconsistent with the commitments made in the 1992 Joint Declaration" would seem to allow the possibility of U.S. consent to reprocessing in the ROK, but only under very limited circumstances, if at

¹³ Mark Hibbs, "US might permit offshore reprocessing but not return of South Korean plutonium," *Nuclear Fuel*, September 21, 2009.

all. At a minimum, it is difficult to imagine that the United States would agree to South Korean pyroprocessing until the North Korean nuclear issue reaches a satisfactory resolution. The United States has attached considerable importance to the ROK-DPRK joint declaration of 1992. Moreover, all of the countries involved in six-party talks would likely have to accept the idea of South Korean pyroprocessing. A consensus on this question may be difficult to achieve since it is questionable whether the DPRK would agree to forego sensitive nuclear activities unless the ROK agreed to the same kind of restraint. If the North Korean problem were to be satisfactorily resolved, the U.S. might be prepared to agree to some form of pyroprocessing under strict nonproliferation conditions. There are a few possibilities under which pyroprocessing could be allowed, as listed below.

1. The 1992 North Korean-South Korean declaration could be replaced in the future by some broader understanding that contemplates some form of reprocessing and enrichment under special controls, restraints and conditions on the Korean Peninsula. Under the present circumstances, however, such a development seems highly uncertain.
2. The United States could also determine that pyroprocessing is not, in fact, reprocessing. At the moment, this question is still under review by the U.S. government, but it is fair to say that the U.S. generally regards pyroprocessing as reprocessing since this technology has been developed to the point where the plutonium product is quite pure. However, there may be some room to maneuver for electro-reduction as opposed to electro-refining, since the former leaves a product that contains mostly uranium and some fission products and that, therefore, is less proliferation-prone than electro-refining.
3. The U.S. could make a commitment to approve long-term pyroprocessing in South Korea along the lines similar to the arrangements that the U.S. has made with India and Japan. In other words, the U.S. could agree in principle to consent to pyroprocessing and pyrorecycling of U.S.-obligated nuclear fuel in a facility that South Korea might construct in the future—provided that it was designed, managed, and operated under mutually acceptable nonproliferation conditions and met agreed safeguards criteria.¹⁴ The U.S. would grant such consent only when it is satisfied that pyroprocessing/recycling in South Korea would not exacerbate the risk of proliferation on the Korean Peninsula.
4. The ROK and the U.S. could make a joint commitment to work with each other on the development of proliferation-resistant pyroprocessing technology; and they could both work with the IAEA on related advanced safeguards techniques. The ROK R&D facility could become a test bed for the development of such pyroprocessing and safeguards technologies. Simultaneously, the facility could be

¹⁴ In the 1988 U.S.-Japan peaceful nuclear cooperation agreement, the U.S. agreed to the future reprocessing of U.S.-obligated spent fuel at the then-yet-to-be built Rokkasho facility, provided that Japan agreed to allow the IAEA to apply safeguards in accordance with a safeguards concept that had been agreed to in advance by the U.S. and Japan.

utilized to design high levels of safeguards into new nuclear systems and facilities from the outset, including both the inherent technical characteristics of the process and the safeguards measures to be taken. Joint U.S.-ROK R&D would be aimed at designing a commercial facility that would restrict the ability to adjust the technical parameters to produce separated plutonium, in addition to developing safeguards systems that could be designed to provide timely detection of any alteration of parameters. The two states could agree that ROK would move toward the establishment of a commercial capability only on a step-by-step basis—and only when both the U.S. and the ROK have jointly agreed that pyroprocessing in the ROK is sufficiently “proliferation-resistant” and may be effectively safeguarded. One element of this step-by-step approach would be to continue to restrict “hot” processing to the United States until the two sides reach an agreement on proliferation-resistance and safeguards’ effectiveness, at which point some “hot” processing R&D would take place in the ROK.

5. Seoul could take additional steps to make South Korean pyroprocessing activities more palatable to Washington. For example, the ROK could make a legally binding commitment in the new ROK-U.S. peaceful nuclear cooperation agreement to refrain from possessing a PUREX reprocessing capability. This would make it easier to obtain a purer and more easily handled product than one from a pyroprocessing plant, as the pyroprocessing facility would contain a mixture of plutonium, uranium and fission products and would require substantial further reprocessing. Seoul could also agree to co-locate all pyroprocessing, fuel fabrication, and advanced burner reactors as part of the future South Korean nuclear program, thus minimizing the risk of theft.¹⁵ Whether the United States would agree to this kind of arrangement, however, is questionable. It would conflict with long-standing U.S. opposition to the spread of reprocessing and the use of plutonium, and it is questionable whether any pyroprocessing can be made to be sufficiently proliferation-resistant to make the plutonium product unusable in nuclear weapons. Also, this kind of arrangement would encounter serious opposition in the United States nonproliferation community and the U.S. Congress.
6. The U.S. and South Korea could consider a joint venture or multinational entity, which would establish strengthened barriers to proliferation and avoid national control of this sensitive technology. Seoul could commit to making any pyroprocessing facility in South Korea a joint venture that would entail U.S. and/or multinational participation in the management and/or operation of the facility. The enterprise could possibly involve the IAEA in the policy-making or management of the plant. Given the potential political, economic and

¹⁵ The Nonproliferation Impact Assessment of GNEP Alternatives stated that, “The compact and batch nature of pyroprocesses favors co-locating a fuel recycle facility with a group of advanced burner reactors thus reducing the need for a large centralized processing facility and possibly reducing transportation of separated transuranic material, including the plutonium, and the attendant physical protection concerns.”

management complexities of any such endeavor, the establishment of a joint venture or multinational R&D pyroprocessing facility might be a prudent first step. This option would have several advantages. First, it would help the United States maintain its position of opposing the spread of sensitive nuclear facilities because the ROK pyroprocessing facility would constitute an alternative to nationally controlled facilities. Second, a plant with U.S. or multinational involvement could establish additional barriers, through greater transparency, to the diversion of nuclear materials to non-peaceful purposes and thus serve as an important complement to international safeguards and physical protection. Third, the presence of a multinational staff would place participants under a greater degree of scrutiny by partners and may also constitute an additional obstacle against a breakout by the ROK. Finally, it offers a less discriminatory approach than a regime that allows a few states to continue their national programs while strongly discouraging most states from acquiring such technologies.

Whether such additional commitments and restrictions would be acceptable to the United States remains to be seen. In evaluating these and possibly other options, the negotiators will face challenges in trying to design a new U.S.-ROK agreement that is tailored to the ROK program and simultaneously avoids setting a precedent for other states to acquire their own sensitive nuclear facilities. Regardless of whether South Korea accepts the once-through fuel cycle as the U.S. would prefer—or some form of pyroprocessing under enhanced safeguards and some form of joint or multinational control—the two countries need to resolve this issue in a way that will establish a positive model for reconciling the nuclear fuel cycle aspirations of an advanced nuclear power such as South Korea, with global concerns about the proliferation risks of reprocessing.