Multinational Storage of Spent Nuclear Fuel and Other High-Level Nuclear Waste

A Roadmap for Moving Forward

Robert D. Sloan

AMERICAN ACADEMY OF ARTS & SCIENCES

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Cover image: The dry-cask storage hall of the Zwilag radioactive waste interim storage facility in Würenlingen, Switzerland. The hall is used to store high-level radioactive waste and spent-fuel elements. © Zwilag Zwischenlager Würenlingen AG.

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Contents

Foreword

The Academy's work in its Global Nuclear Future project on the back-end of the nuclear fuel cycle has focused on identifying and developing nuclear waste solutions that are feasible and adoptable by legacy countries as well as by nuclear newcomers. The project acknowledges the fact that nuclear waste is a national responsibility for all countries that have, or are in the process of building, nuclear power plants. However, for many of these countries, domestic nuclear waste solutions (such as interim storage facilities and final repositories[1]) might be difficult to establish—obstacles can include challenging economics for nations with small nuclear fleets (nuclear power, like most other energy technologies, profits from scale), unsuitable geophysical conditions, and public opposition. Furthermore, there is a lack of international consensus on the importance of spent nuclear fuel. Those who value spent nuclear fuel see it as a potential feedstock, as part of a closed nuclear fuel cycle; others view it as an unattractive nuisance or worse because it contains fissile plutonium, a potential source of material for weapons, and therefore they wish to dispose of it in a permanent, nonretrievable repository. As a result, attempts to fashion a multilateral nuclear waste repository that can respond to these needs have not been successful. The partners or customers of such a permanent facility would have to agree to the nature of this storage: would it allow for retrievable spent fuel or not, and would all agree to the conditions under which such fuel would be permanently stored?

This situation has led some potential nuclear newcomers to consider an alternative that does not require them to deal with the spent fuel at all. This is the essence of the "build-own-operate" model offered by the Russian nuclear supplier ROSATOM. Here, the supplier of the nuclear power plant builds, owns, and operates the power plant—and because the operator also supplies the fresh nuclear fuel, it removes the spent nuclear fuel. In this case, the host country of the nuclear power plant is only obligated to pay for the negotiated price of the electric power produced. While this business proposition resolves the nuclear waste storage for the host country, it also sharply restricts its freedom of action. Since it does not own or operate the power plant, its ability to negotiate fresh fuel prices is hamstrung—there is only one fuel supplier, and in any case, it is doubtful whether the owner/operator would accept spent fuel that was bought "fresh" on the open commercial market: that is, was not its own fuel. Furthermore, there are many complex issues related to safety and security—and the rights of the national nuclear regulatory body to regulate operations of a foreign facility—that remain opaque and potentially politically charged. Finally, the owner/operator becomes de facto a monopoly energy supplier, and thus

1. In our discussion, we define repositories as ultimate storage facilities for spent nuclear fuel.

the host country's negotiating position after the power plant comes on line is severely compromised. The operator can always resort to the "nuclear option" of simply ceasing operations, which in a highly integrated national electric grid can have catastrophic consequences.

The obvious question is then: is there another alternative? We believe there is. Our opinion is that the current disagreement regarding the ultimate disposal of spent nuclear fuel is in large part driven by different views regarding the future evolution of reprocessing technologies, and that over the next fifty to one hundred years, the commercial value, safety, and security of reprocessing will be clarified. In the meantime, we need to deal with the accumulating spent fuel—and this strongly suggests the establishment of multilateral consolidated interim storage facilities capable of holding the spent fuel safely and securely.

Why interim storage? Because we know that technology is in hand that allows for the safe and secure storage of spent nuclear fuel for periods of fifty to sixty years without repackaging. This technology is based on the use of dry storage casks, which use passive cooling, and thus do not require any external source of electric power.

Why consolidated? Why multilateral? Because consolidation of the spent nuclear fuel allows for more effective supervision from the perspective of safety and safeguards of the spent fuel than allowing the spent fuel to reside in a multitude of reactor storage sites. A multilateral arrangement, based on contractual agreements between a host nation of the facility and the customer nations, ensures that this supervision satisfies international standards for safe and secure storage of nuclear materials. Finally, precisely because costs in things related to energy technologies depend inversely on the scale of operations, consolidation is expected to be more economically efficient than scattered site storage. Thus,

1. **Multilateral interim storage allows countries to generate a narrative of collective nuclear responsibilities**. The fact that these countries can identify other countries in the region facing similar challenges in harnessing civilian nuclear power for peaceful purposes—in a safe and sustainable way—may well make them feel less isolated both domestically and internationally.

2. **Economically**, as we have noted several times, multilateral interim storage is viable both for the host country and the customer. It also has several other economic advantages. It includes a research and development option that could spark interesting regional collaborations, and because it allows countries to retrieve their nuclear waste, it does not force them to make decisions regarding the permanent storage of spent fuel before they are either technically or politically ready to do so.

3. **Strategically**, it preserves the freedom of participants of this multilateral interim storage scheme to chose fuel suppliers, a freedom that is lost if, for example, the nuclear waste challenge is met by agreeing to solutions

of the kind offered by Russia's ROSATOM, namely, the "build-own-operate" model discussed earlier.

4. **Regionally**, it offers a new avenue for scientific and technological cooperation—and in a way, also serves as a mechanism for regional confidence and trust building.
5. **It provides higher standards of safety and security for the whole region** (including for countries that do not have active nuclear power programs): regional interim storage would allow countries to consolidate nuclear waste in one specific facility and avoid dispersion of material around the region. This option for consolidation offers greater guarantees to countries that might harbor doubts of the ability of certain nuclear countries to operate and store nuclear waste in a responsible manner.

In a series of Occasional Papers published under the auspices of the American Academy's Global Nuclear Future project,[2] we have developed a number of aspects of such multilateral storage arrangements, and discussed the technical and governance issues one encounters as well as the business case necessary to make such a facility economically viable. The last, missing aspect has been a discussion of exactly how the contractual arrangements for such a multilateral interim storage facility would need to be worked out. This Occasional Paper addresses precisely this question. We are fortunate to have engaged Robert D. Sloan, Esq., former chief legal counsel of Entergy Corporation, who has considerable experience in the realm of international legal issues related to nuclear power and weapons, to deal with this crucial aspect of establishing a multilateral interim spent fuel storage facility.

We would like to thank Scott Sagan of Stanford University and Steven Miller of Harvard University, who eight years ago had the vision to launch an Academy initiative on the Global Nuclear Future. The project has led us to engage actively with nuclear power countries and nuclear newcomers on the topics of nuclear safety, security, and nonproliferation. Many of these discussions have been conducted under Chatham House Rule and all have been convened with the purpose of exchanging and sharing knowledge and building friendships and scholarly collaborations. We are thankful to all our partners and friends in Southeast Asia and the Middle East for their involvement in our work.

Finally, we are grateful to Carnegie Corporation of New York, The William and Flora Hewlett Foundation, The John D. and Catherine T. MacArthur Foundation, The Alfred P. Sloan Foundation, The Flora Family Foundation, and The Kavli Foundation for their support of the Academy's Global Nuclear

2. See *The Back-End of the Nuclear Fuel Cycle: An Innovative Storage Concept*, by Stephen M. Goldberg, Robert Rosner, and James P. Malone (Cambridge, Mass.: American Academy of Arts and Sciences, 2012); and *The Back-End of the Nuclear Fuel Cycle: Establishing a Viable Roadmap for a Multilateral Interim Storage Facility*, by Robert Rosner, Lenka Kollar, and James P. Malone (Cambridge, Mass.: American Academy of Arts and Sciences, 2015).

Future project. We would especially like to thank Carl Robichaud at Carnegie Corporation of New York and Emma Belcher at The John D. and Catherine T. MacArthur Foundation for participating and contributing to the design and implementation of our initiatives. Their deep knowledge of the nuclear field has helped us to think strategically and effectively about the many challenges that the global nuclear order faces as well as the unlimited possibilities that can emerge when we pursue international collaborations and rigorous scholarship for the greater global good.

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Section 1
Introduction

Nuclear power can continue to provide at least some of the greenhouse gas–free electricity that the world economy increasingly needs to support a growing population[1] and economic expansion in a sustainable, environmentally sound fashion. The civilian nuclear power option can remain in play in a major way through the further construction and safe operation of advanced large-scale nuclear reactors that can power upward of a million homes working off a traditional electric transmission grid or small-scale modular reactors that could supply electricity through strategically sited and operated micro-grids.[2] While nuclear power presents an array of advantages over both fossil-based power generation and variable generating renewable resources, it is at the same time associated with drawbacks that have hindered its commercial development and present serious long-term challenges.

Certain of these drawbacks are tied to site selection challenges and others to nuclear power plant construction costs, including the issue of massive construction cost overruns. The lack of concrete, viable "interim" storage, and long-term disposal programs for a large percentage of existing and anticipated spent nuclear fuel and other high-level radioactive waste remains another significant barrier to the further development and, in some cases, even the continued use of this highly reliable base load energy resource.[3] Some nations have opted for the chemical reprocessing of spent nuclear fuel, whereby the used products are dissolved and the recovered uranium and plutonium can be used to fabricate mixed oxide (MOX) fuel for further power generation. What is crucial is that the "waste" byproduct resulting from both straightforward nuclear power generation and from the chemical spent fuel reprocessing generates a similar requirement for well-designed interim storage and ultimate long-term disposal

1. Roughly 1.2 billion persons in the world are estimated to have no regular access to electricity.

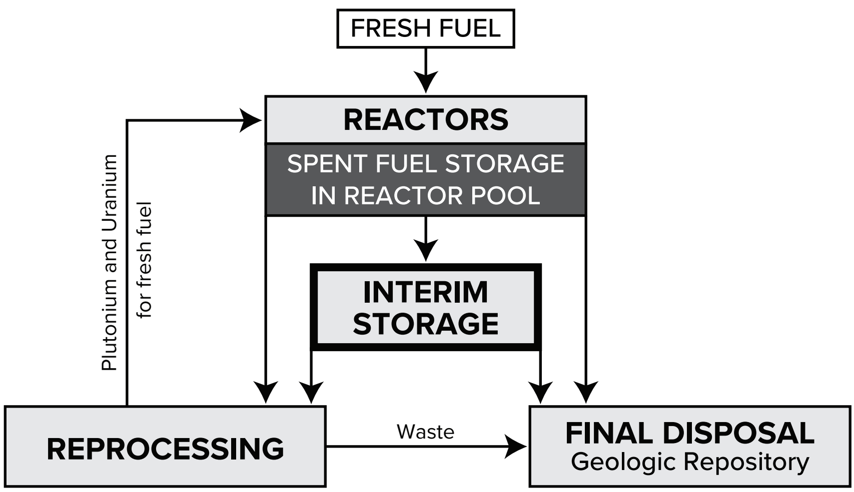
2. Most nuclear power plants are fueled with "enriched uranium oxide," in which the concentration of the fissionable isotope uranium 235 has been increased above levels found in nature.

3. As of October 2016, 450 nuclear power reactors were in operation around the world, with a total generating capacity of 391.6 gigawatts (electrical) (GW(E)). Another 60 reactors are under construction. See International Atomic Energy Agency (IAEA), Power Reactor Information System (PRIS) database, https://www.iaea.org/PRIS.

facilities.[4] These facilities should guarantee not only safe plant operations and radioactivity management but the absence of illegal diversions of radioactive nuclear material for nuclear explosive device or “dirty bomb” development, as well as any related activities.[5]

To unlock the long-term potential of nuclear power on an international level and to do so in a safe, economical, and rigorously proliferation-resistant fashion, multinational spent fuel storage operations must be made a reality at

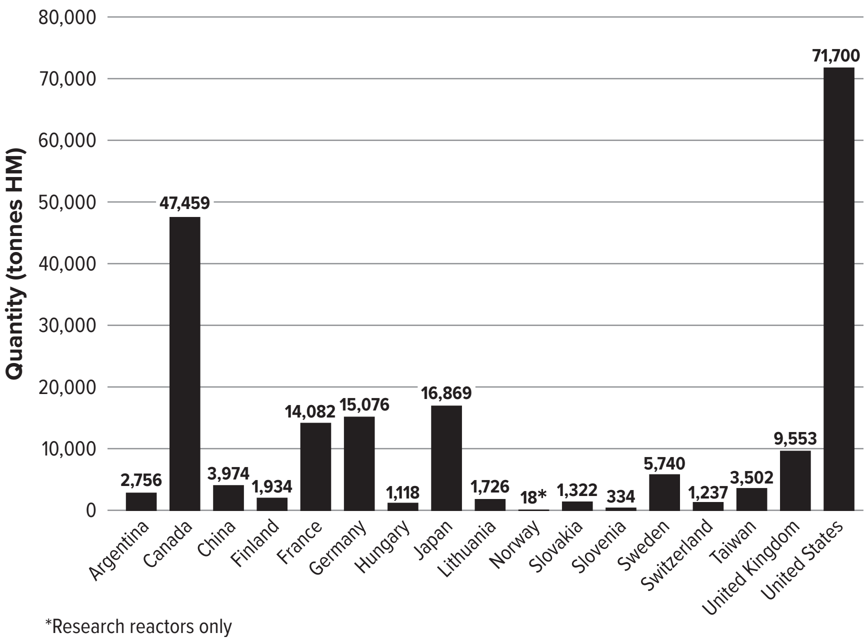
4. The diagram below illustrates one possible fuel cycle technology that would include the option of relying on mixed oxide (MOX) fuel. Other fuel cycle options using different technologies exist. Interim storage of spent nuclear fuel is likely to be a central aspect of either a once-through nuclear fuel cycle designed in part around the reprocessing and recycling of these materials or a fuel cycle focusing from the beginning on interim storage and, later in the process, final long-term disposal. Interim storage is a necessary complement to the long-term repository approaches that will form a crucial part of managing and optimizing the overall operation of the nuclear fuel cycle.



See Matthew Bunn, John P. Holdren, Allison Macfarlane, Susan E. Pickett, Atsuyuki Suzuki, Tatsujiro Suzuki, and Jennifer Weeks, *Interim Storage of Spent Nuclear Fuel: A Safe, Flexible, and Cost-Effective Near-Term Approach to Spent Fuel Management (A Joint Report from the Harvard University Project on Managing the Atom and the University of Tokyo Project on Sociotechnics of Nuclear Energy)* (Cambridge, Mass.: Harvard University; Tokyo: University of Tokyo, 2001), 2. See as well International Panel on Fissile Materials (IPFM), *Managing Spent Fuel from Nuclear Power Reactors: Experience and Lessons from Around the World*, ed. Harold Feiveson, Zia Mian, M. V. Ramana, and Frank von Hippel (Princeton, N.J.: IPFM, 2011), 3.

5. A radiological dispersal device (often referred to as a “dirty bomb”) is a radiological weapon combining radiological material with the use of conventional explosives. The purpose of such a weapon would be to contaminate and make unusable the area where the weapon is deployed and to spread panic. Such a device is not to be confused with a nuclear explosion, such as a fission-based bomb that creates destructive effects and radiological material dispersal of much greater orders of magnitude. See U.S. Nuclear Regulatory Commission, “Fact Sheet on Dirty Bombs,” December 2012, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/fs-dirty-bombs.html.

Selected Spent Nuclear Fuel Inventories

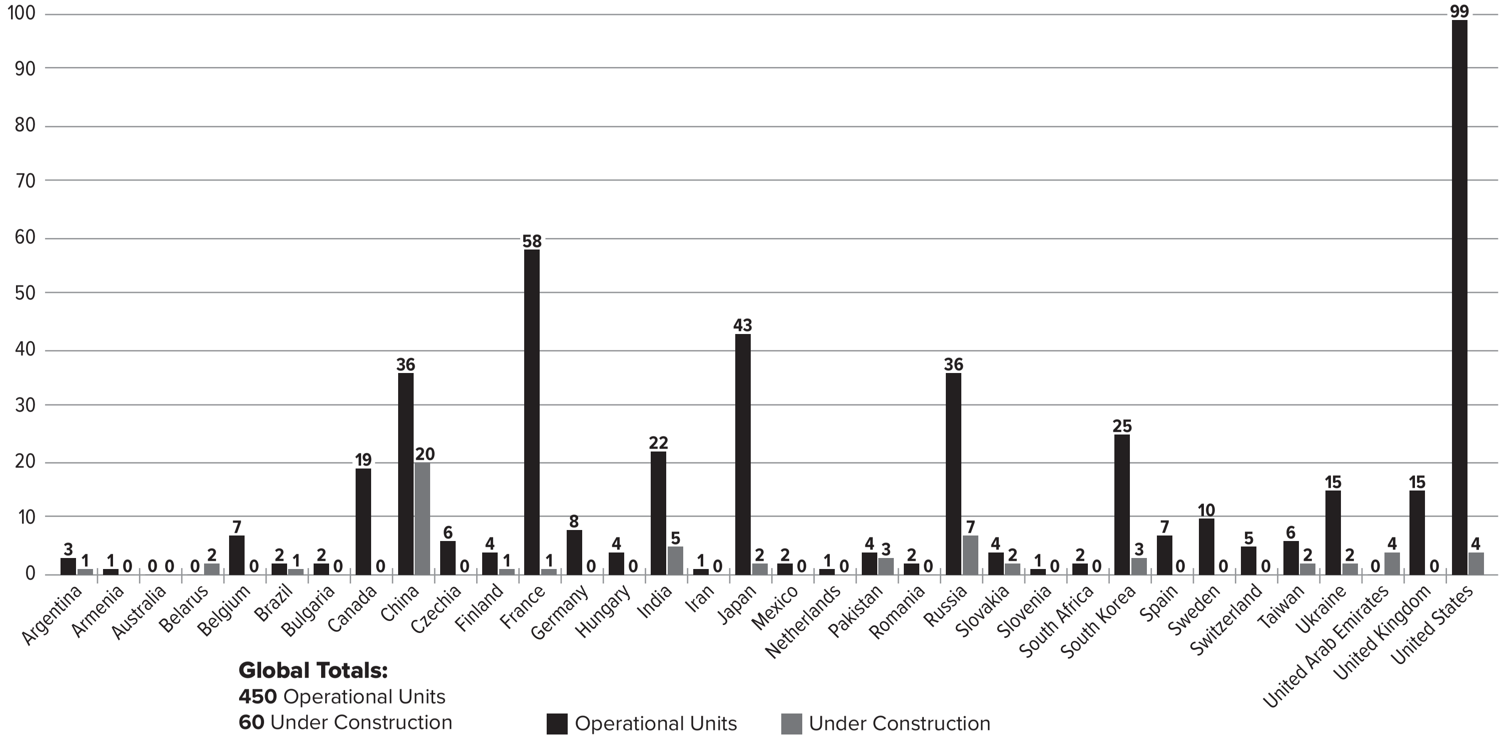


Based on individual country estimates of the contracting parties to the "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" (May 2015).

one or several strategically placed locations.[6] Nations currently operating relatively small civilian nuclear power programs (or with plans to launch such a program in the near term) could benefit enormously from a multinational approach to spent nuclear fuel storage. First, participating in the financing of a large-scale spent fuel storage facility rather than taking on the entire cost of building and operating a world-class facility to be used exclusively for domestic purposes would seem to be highly attractive from a purely economic perspective. Second, use of such a multinational facility by several Customer States could also offer the advantages of ensuring spent fuel storage at a safe and secure site abroad with all required international safeguards and physical protection standards in place. Therefore, financial factors aside, such an approach could reassure the public in smaller Customer States that their own spent nuclear fuel and related high-level waste will be safely and securely managed.

6. Spent nuclear fuel and other high-level waste are most commonly stored at reactor sites in spent fuel ponds for relatively short-term cooling purposes and then stored in massive concrete, steel-reinforced dry cask storage canisters. Although skepticism abounds among some, this form of interim storage has been subject to rigorous analysis and review and has met with widespread scientific approval. As only one example of this sentiment, the U.S. Nuclear Regulatory Commission has through successive interpretations of its Waste Confidence Rule expressed growing confidence in this form of "interim storage" of spent nuclear fuel and other high-level waste from a technical and radiological safety perspective.

Global Civilian Nuclear Reactor Count



Updated as of October 2016, IAEA Power Reactor Information System (PRIS) database, https://www.iaea.org/PRIS/.

For political, financial, legal, and national security purposes, key conditions will have to be met. A multinational approach to spent fuel storage and management will have to ensure that spent nuclear fuel storage services are supplied based on explicit contractual terms and conditions. Such an approach will also have to ensure compliance with core international nonproliferation norms.

In excess of 371,000 metric tons of spent nuclear fuel were in storage worldwide at the end of 2014.[7] This amount grows by over 12,000 metric tons per year.[8] The charts on the previous pages and on the following page present current data on spent nuclear fuel inventories in key civilian nuclear power nations, a summary of the global nuclear power reactor count, and the share of electricity generation derived from nuclear power plant operations in a broad range of nations.

Numerous attempts have been made over a long period to develop multinational spent nuclear fuel storage and final disposal options in support of civilian nuclear power programs.[9] Despite great diligence and good intentions on the part of many, along with potential benefits flowing to a range of concerned parties, these efforts, with few exceptions, have largely been unsuccessful.[10] They have foundered based on technical, legal, governance, safeguard, and political factors, as well as, at least in part, on nonnuclear weapons states' uneasiness concerning the equitable application of nuclear nonproliferation standards. Questions have consistently been raised about how the operation of a multinational storage

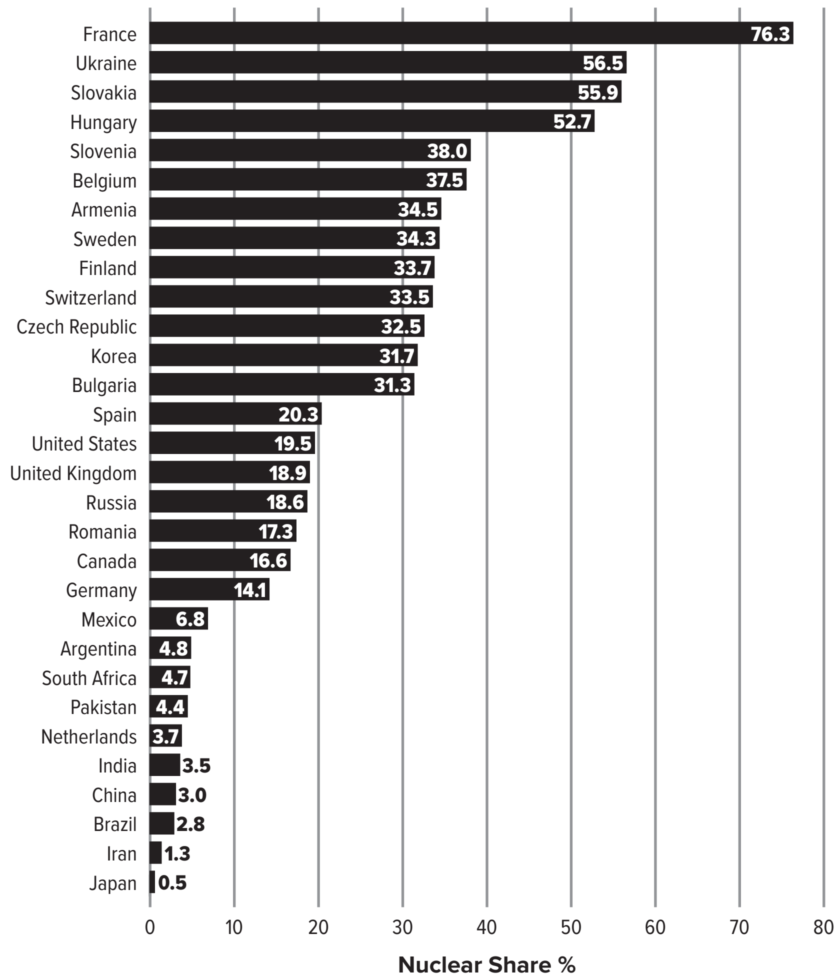
7. IAEA, *Spent Fuel Performance Assessment and Research*, IAEA-TECDOC-1771 (Vienna: IAEA, 2015), http://www-pub.iaea.org/MTCD/Publications/PDF/TE-1771_web.pdf.

8. "Radioactive Waste Management," World Nuclear Association, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx (updated October 2016).

9. See IAEA, *Final Report of the Expert Group on International Spent Fuel Management* (Vienna: IAEA, 1982). Subgroup A covers "Technical Economic Considerations" (October 1981) and Subgroup B deals with "Institutional, Legal and Procedural Considerations" (May 1982). Rudolf Romesch of Switzerland served as chair of the Expert Group and Alan Hanson of the IAEA served as scientific secretary. Subgroup appendices A and B were prepared under the chairmanship of Cyril Buck of the United Kingdom and Franz Marcus of Denmark, respectively. IAEA leadership has endorsed a multinational approach in "certain circumstances" and reiterated this position in 2003. In May 2016, the South Australian Royal Commission investigating the nuclear fuel cycle recommended that South Australia would be a prime location for a multinational spent fuel storage facility. See "International Nuclear Waste Disposal Concepts," World Nuclear Association, http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/international-nuclear-waste-disposal-concepts.aspx (updated November 2016).

10. See IAEA, *Multinational Approaches to the Nuclear Fuel Cycle: Expert Group Report Submitted to the Director General of the International Atomic Energy Agency*, INFCIRC/640 (Vienna: IAEA, 2005). Two additional significant private efforts have been undertaken to develop an interim spent nuclear fuel storage facility to serve the interests of the civilian power industry. One is the Private Fuel Storage (PFS) project, a consortium of eleven private utility companies headed by Northern States Power Company in the United States. Their original plan was to build a private interim spent fuel storage facility with a 40,000-ton capacity. The necessary land for this project was to be leased from the Skull Valley Goshute Tribe in the state of Utah. Another private project with some characteristics in common with the PFS initiative was proposed at Owl Creek in Wyoming by Nuclear Energy West Corporation. Neither of these U.S.-based efforts met with success for a variety of local and financial reasons. See Bunn et al., *Interim Storage of Spent Nuclear Fuel*, 51–53.

Nuclear Share of Electricity Generation in 2015



Data taken from the IAEA's Power Reactor Information Systems (PRIS) database. Last update on November 9, 2016.

facility could affect the basic political bargain underlying the Nuclear Non-Proliferation Treaty (NPT) of 1970.

In particular, certain countries with civilian nuclear programs—or those with ambitions to develop such a program in the near term—are concerned that participation in a multinational spent fuel storage regime could undermine their "inalienable right . . . to develop[ment] research, production and use of nuclear energy for peaceful purposes without discrimination and in conformity with Articles I and II of the Treaty" that deals with the NPT's core nonproliferation objectives. Article IV of the treaty goes on to provide that all treaty parties shall "facilitate, and have the right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy."[11]

Past initiatives in this field have been designed at least in part to assuage concerns about the reliability of supply under virtually all conceivable circumstances. Some have relied on fuel leasing arrangements supported by comprehensive back-up fuel supply arrangements and an "international nuclear fuel bank," along with provisions for the return of "rented" spent fuel for storage by the original owner. These initiatives have all been influenced by a finding encapsulated in a 1987 study by the Organisation for Economic Co-operation and Development and the Nuclear Energy Agency, namely, that "serious consideration of the multinational storage concept posed 'no insurmountable safety, technical, economic or institutional obstacles.'"[12] Recent initiatives in this field have included:

- The report of an ad hoc "International Working Group" that carried forward the pioneering work of the first International Atomic Energy Agency (IAEA) expert group grappling with multinational spent fuel storage questions in the early to mid-1990s.[13] While this early effort to create a full-fledged framework for the multinational storage of spent nuclear fuel was unsuccessful, the final document highlights the key elements any potential, viable host state should be able to convincingly demonstrate:
    - an established nuclear and radioactive waste management infrastructure;
    - technical and regulatory infrastructures designed to handle radioactive waste management or that could readily be adapted to do so; and
    - a geologically stable and otherwise suitable land mass.

11. The principal international framework designed to ensure the peaceful use of the nuclear fuel cycle consists of the provisions of the NPT, which entered into force in 1970 (and currently numbers 190 parties), and the application of IAEA safeguards—mainly to "non-nuclear weapons states"—for the purpose of ensuring that these national nuclear programs are being undertaken solely for peaceful purposes. For further background, see the 1995 Review and Extension Conference of the Parties to the Treaty on the Non-Proliferation of Nuclear Weapons, NPT/CONF.1995/7/Part II, 18 April 1995.

12. Charles McCombie and Neil Chapman, "Nuclear Fuel Cycle Center: An Old and New Idea" (paper presented at the 2004 Annual Symposium of the World Nuclear Association, September 8–10, 2004, Arius, Switzerland), 5. See as well the 1987 study of the Radioactive Waste Management Committee of the Nuclear Energy Agency on possible international approaches to radioactive waste disposal, which concluded that no significant safety, technical, economic, or institutional obstacles existed. According to this report, two basic international approaches were open in the spent fuel storage arena: (1) an international project or an extension of a national project on a commercial basis to accept additional spent fuel from other nations; and (2) creation of an international repository through the commercial extension of national programs judged more credible than formation of an international project from scratch. OECD Nuclear Energy Agency, Radioactive Waste Management Committee, *International Approaches on the Use of Radioactive Waste Disposal Facilities: A Preliminary Study* (Paris: NEA Radioactive Waste Committee, 1987).

13. IAEA, *Developing Multinational Radioactive Waste Repositories: Infrastructural Framework and Scenarios of Cooperation* (Vienna: IAEA, 2004).

- The Pangea Project (1997–2002) produced a reasonably detailed framework for the creation of a commercial international storage facility, most likely in Western Australia.
- The Association for Regional and International Underground Storage (Arius) involved the cooperation of several smaller nuclear programs (founding members included Belgium, Bulgaria, Hungary, Italy, Japan, and Switzerland) and focused on establishing a safe and secure multinational storage facility. One of the key Arius initiatives was the SAPIERR project ("Support Action: Pilot Initiative on European Regional Repositories") undertaken within the framework of the then European Community (EC) and the Community's "EC Framework Program." The SAPIERR project was designed to serve the "special" needs of nations with small nuclear power programs that did not have the resources to build and operate their own national repositories.[14]
- The "International Monitored Retrievable Storage System" (MRSS), which was developed in the mid-1990s for interim storage of spent nuclear fuel from power and research reactors and possibly excess separated plutonium. As originally envisioned by Wolf Hafele (former leader of Germany's nuclear power program) and Chauncey Starr (former president of the Electric Power and Research Institute in the United States), the MRSS site or sites would be operated on a commercial basis with overall management in the hands of an international consortium of nations. As has been the case with many other efforts in this field, this approach presented many advantages in terms of structure as well as in its political and financial appeal, but it failed to attract sufficient interest to generate actual negotiations.

Some progress has been made in recent years, however, regarding long-term spent fuel repository approaches, most notably in Finland and Sweden and, on a different scale, with the Russian and American research reactor spent fuel return programs.[15] Nonetheless, because of economic and financial questions,[16] geological concerns, the growing volume of material that requires secure storage, legal constraints, and, above all, the need to find an appropriate nation (or nations) to host a multinational facility, the topic has remained controversial and satisfactory medium- and long-term solutions elusive. The net result is

14. V. Stefula and Charles McCombie, "SAPIERR Paves the Way towards European Regional Repository" (paper presented at the Fifth International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids, Dubrovnik, Croatia, May 16–20, 2004).

15. This is unrelated to ongoing highly enriched uranium management programs, although they share some safety and nonproliferation goals.

16. The IAEA's *Final Report of the Expert Group on International Spent Fuel Management* stresses at several points that medium- and large-scale spent fuel storage facilities "have significant lower fees" associated with them than do small facilities quite aside from the issue of storage duration. See pages 4, 29, and 34 of the Subgroup A Report. Other, more recent studies have confirmed this basic economic judgment.

that no full-fledged, viable, large-scale multinational spent fuel storage options have emerged.[17]

In this paper, we build on past efforts to set forth a concrete set of proposals that have the potential to change the global conversation on multinational spent nuclear fuel storage. Our goal is to develop a focused legal and political pathway for the creation of one or more viable regional interim spent nuclear fuel storage facilities for spent fuel from civilian nuclear power stations generated in nations without sound local storage options from economic, geological, or nonproliferation perspectives.

This is extremely important for nations hosting a nuclear power industry, but it is especially so in parts of the developing world where nuclear power is either well established (e.g., Taiwan and South Korea) or is on the drawing board and may be headed in the direction of significant growth (e.g., Vietnam and the Philippines). Long-standing impediments to the establishment of a functioning multilateral spent fuel storage facility could possibly be overcome by opening a path for the commercial development and operation of such a facility under strict Host State and appropriate international supervision in adherence to widely accepted international physical security and safeguards standards. Alternatively, an international consortium of interested governments—or commercial enterprises designated by them—could be structured to operate the sort of multinational spent fuel storage facility that is needed.

In either scenario, the core interests of both Host State authorities and potential customers (and Customer States) would need to be addressed in a forthright fashion. Host States will require assurances that capital and operating expenses for any multinational facility would be recovered through service charges, that the spent nuclear fuel or high-level radioactive waste in question would not be left as a long-term responsibility of the Host State unless this were agreed to explicitly by contract, and that all parties would be required to adhere to all agreement terms and conditions. Customers of a new multinational facility would, on the other hand, require assurances that safe, sound interim storage, along with any associated fuel cycle services, would be performed with great care and in a timely manner as per contract terms and conditions.[18] Because significant cost overruns have been a major problem in nuclear facility construction, measures will be required to ensure effective management of capital and operating costs and overall risk sharing among public and private project investors, facility operators, and spent fuel storage customer entities.

17. The notion of a "shared" storage and ultimate disposal site or sites has been discussed for decades in academic, scientific, private enterprise, and government circles. During the 1990s, abortive efforts were launched on the Marshall Islands, Palmyra Island, and in Western Australia.

18. Many of the potential participants in the sort of multinational arrangement proposed and analyzed in this paper are deeply concerned that an "interim storage facility" could—either through inertia or due to bad faith—easily become a de facto permanent or semi-permanent repository. Managing this concern in a convincing fashion and providing binding assurances that contractual obligations will be fully adhered to in this respect will be a major challenge in the structuring of a viable, acceptable spent fuel storage arrangement.

To fully address this challenge, a consensus will be required on several key issues, some of which have been addressed conceptually in earlier reports and studies produced by the Global Nuclear Future Initiative of the American Academy of Arts and Sciences.[19]

1. Although approved by national regulators in all concerned nations, the current situation of simply authorizing or at least permitting the "short-term" storage of spent nuclear fuel in pools next to operating reactors and then in nearby dry cask storage tanks is not likely to be tenable in the long term. Among other factors, it has long been assumed to be more prudent, from a nonproliferation perspective, to house spent nuclear fuel—for interim storage purposes as well as for final disposal—at a limited number of highly secure locations where it can be certain that international safety, physical security, and nonproliferation standards are rigorously applied.

2. A "credible" state will need to be recruited to host the envisioned interim spent nuclear fuel storage facility. This Host State will need to be one with (a) a basic level of political and legal system stability; (b) a focus on transparency and honesty in all commercial transactions and regulatory relations; (c) a regulatory regime that could effectively and credibly undertake the supervision of key aspects of spent fuel storage operations; and (d) a capacity to supply at least some of the highly qualified personnel needed to undertake the engineering, construction, regulatory, and legal functions required for an multinational spent fuel storage operation to be a long-term success.

3. While fashioning an effective spent nuclear fuel storage facility and associated regulatory regime, steps should be taken to ensure that the sovereign and contractual interests of the Host State are fully protected in firm legal terms so that they are always politically defensible.

19. See, for example, the following American Academy of Arts and Sciences Global Nuclear Future Initiative reports: Charles McCombie, Thomas Isaacs, Noramly Bin Muslim, Tariq Rauf, Atsuyuki Suzuki, Frank von Hippel, and Ellen Tauscher, *Multinational Approaches to the Nuclear Fuel Cycle* (Cambridge, Mass.: American Academy of Arts and Sciences, 2010); Stephen M. Goldberg, Robert Rosner, and James P. Malone, *The Back-End of the Nuclear Fuel Cycle: An Innovative Storage Concept* (Cambridge, Mass: American Academy of Arts and Sciences, 2012); and Robert Rosner, Lenka Kollar, and James P. Malone, *The Back-End of the Nuclear Fuel Cycle: Establishing a Viable Roadmap for a Multinational Interim Storage Facility* (Cambridge, Mass.: American Academy of Arts and Sciences, 2015). As part of its Global Nuclear Future Initiative, launched in 2008, the American Academy of Arts and Sciences has engaged a range of experts to grapple with all manner of challenges related to safely and securely managing, on a global scale, the entire nuclear fuel cycle from uranium enrichment and fuel fabrication to the security of the nuclear fuel supply to improved reactor design to the many complex issues arising at the back-end of the nuclear fuel cycle. The present report is the latest of these Global Nuclear Future Initiative documents.

4. The storage regime put in place must be both commercially attractive to customers and sufficiently well and reliably funded that all parties—including, in certain scenarios, private investors—will be able to use it with complete confidence.[20] For many nations, these matters touch on core issues of national security that go well beyond financial considerations.
5. The handling of the "retrievability" of spent or "used" nuclear fuel being provisionally stored in a new multinational facility in the event safer, more proliferation-resistant reprocessing and recycling technologies are developed and become commercially viable.
6. Explicit contractual terms and conditions—and remedies in the event of nonperformance—designed to govern any transition from an interim storage facility to long-term disposal arrangements.
7. Responsibility for decommissioning spent fuel storage facilities.

20. The private or semiprivate entity approach to the operation of a multinational interim spent nuclear fuel storage facility or facilities would necessarily entail management on a highly regulated but ultimately commercial basis. Investors of a private or a public character would surely expect no less.

Section 2

Background: "Nuclear Waste"

The complete nuclear fuel cycle—from the mining and milling of uranium to possible reprocessing and recycling of "used" fuel to the final disposal of a range of waste products—basically involves the production of four major types of waste. These categories of waste, which are defined somewhat differently from nation to nation and by the International Atomic Energy Agency,[21] are (1) low-level waste, (2) mill tailings, (3) gaseous effluents, and (4) high-level waste.

For purposes of this paper, the principal areas of concern require a focus on the following:

Low-Level Waste covers materials that have been contaminated at various points in the nuclear fuel cycle and thus includes items that have become radioactive due to exposure to neutron radiation. These sorts of waste materials encompass contaminated clothing, rags, cleaning equipment, reactor water treatment residues, tools, medical waste, and other waste originating in research reactor laboratories. The amount of radioactivity in low-level waste can vary widely from background levels found in nature to levels as high as those found in the interior of parts of a reactor vessel in an operating nuclear power plant. Typically, low-level waste is stored at a reactor site until it has either decayed and can be disposed of as ordinary garbage or until it can be safely shipped to a low-level waste disposal site. Ordinarily, low-level waste management and ultimate disposal would be subject to a detailed national licensing process that would include the development of a detailed plan covering key issues such as disposal siting, material retransfer conditions and rights, material security, and safeguards standards and enforcement.

Low-level nuclear waste has no intrinsic value now or (most likely) in the future, so the goal in managing it is one of permanent disposal in as safe and economical a manner as possible.

21. According to the IAEA, radioactive waste is "any material that contains or is contaminated by radionuclides at concentrations or radioactivity levels greater than the exempted quantities establish by the competent authorities and for which no use is foreseen." Classification systems vary to some degree by country, but general classification schedules are set forth internationally, and they all take into account the intensity of the residual radiation, the time required for radioactivity decay to "insignificant levels," and suitable storage and disposal options. Organisation of Economic Co-operation and Development (OECD) and the Nuclear Energy Agency (NEA), *The Economics of the Back End of the Nuclear Fuel Cycle*, NEA No. 7061 (Vienna: NEA, 2013), 23.

Uranium Mill Tailings are the residues of uranium mining and milling operations.

High-Level Waste principally comprises either spent nuclear fuel or radioactive waste materials remaining after the completion of spent fuel reprocessing.[22] The classification is largely based on heat and radiation emission rates derived from spent nuclear fuel rods generated in the processing of the fuel. Unless reprocessed for further nuclear power plant use, spent fuel at this stage is no longer useful in creating electricity and is highly radioactive. While the full effects of low-level radiation on human beings are not known, exposure to high-level radiation is known with certainty to be lethal if not managed with great attention and care. High-level radiation may also be the origin for certain categories of genetic mutation. A portion of high-level waste materials is not only highly radioactive but highly toxic. They remain so for millennia, during which time they must be isolated from contact with living things.

Absent the construction and operation of proper long-term spent nuclear fuel repository facilities, spent fuel and other civilian high-level waste in most affected nations has been stored in two stages at most reactors around the world. Used fuel rods are stored in special pools next to a reactor—often for about five years—so that the fuel rods can cool to ease handling. Then, the spent fuel rods are moved to aboveground dry cask storage near the reactor site, where they can cool further in what has to date been a largely safe and secure storage environment. Dry cask storage entails the encasement of spent fuel in inert gas inside heavily reinforced concrete and steel cylinders.[23]

22. High-level waste can also include reactor core components such as control blades or control rods, as well as a range of nuclear instrumentation.

23. See, for example, U.S. Nuclear Regulatory Commission (NRC), *Radioactive Waste: Production, Storage, Disposal*, NUREG/BR-0216, Rev. 2 (Rockville, Md.: NRC, 2002).

Section 3

Multinational Spent Nuclear Fuel and High-Level Waste Storage Concepts

Despite a long history of government-run efforts to develop viable spent fuel storage options, after more than sixty years since the first commercial nuclear reactor began operations in the United States we still lack a centralized high-level nuclear waste facility (or set of facilities) designed to provide interim storage, let alone a final repository as required under the Waste Policy Act of 1982, as amended. The same result largely obtains (albeit for different reasons) for the long-term disposal arrangements of a large percentage of the roughly 450 civilian nuclear reactors currently operating around the world.

To spur development at the international level of such a much-needed facility (or facilities), we propose consideration of several new paths forward. A privately run enterprise with limited national government participation and with a focused safeguards verification (and perhaps a supplementary "advisory") role for the IAEA has the potential to bring a spent fuel and high-level waste storage facility into effective operation. An IAEA role of this sort—given the agency's deep expertise and longtime central role in the application of physical security regulations and binding safeguards regimes—would be essential to constructing a spent fuel storage framework in which all parties would have the required confidence.

Under the right legal and political conditions, in a highly stable political environment, and with world-class national regulatory supervision in place, such a storage facility, if properly funded, well-structured from a legal perspective, and successfully managed, could at a subsequent stage also spur the development of a commercially operated, final, *long-term*, high-level nuclear waste disposal facility.[24] Given the nature of the nuclear fuel cycle, such a

24. Despite concerns in some quarters about the risk of private enterprise management focusing excessively on profit motives as opposed to safety and security above all other goals, examples of this sort of commercial enterprise exist in the field of interim storage of spent nuclear fuel and other high-level waste of "domestic origin." For example, great progress has been made in this respect in recent years in Finland, Sweden, as well as in Switzerland through Zwilag Zwischenlager Würenlingen AG, an enterprise that has been in successful operation since 1996.

facility or facilities designed to permanently house an irreducible amount of spent nuclear fuel and residual high-level waste will be required regardless of progress toward the development of safer, more proliferation-resistant spent fuel reprocessing technology.[25]

Another option would be to create an international consortium of key nation-states with the political and financial capacity and will to direct the construction of the required spent fuel storage facility and to play a major role in ensuring its safe, proliferation-free operation. Successful models for this mode of managing the current situation also exist.

Establishment of a truly viable multinational spent nuclear fuel storage facility—one that has credibility both with a Host State subject to its own legal regime and financial, safety, and safeguards requirements, and with a range of "nuclear power operator-customers"—would likely require a highly apolitical, business-like framework defined by preexisting rules and carefully negotiated contractual arrangements. Models closely tied to local political regimes or that could conceivably be seen as part of a controversial regional political settlement of some sort could be tainted by extraneous, unrelated issues and thereby be doomed to premature failure.

What we propose is the development of a neutral legal framework that could be available to spent nuclear fuel customers in need of efficient, secure, verifiable, and politically neutral interim spent nuclear fuel storage services. At the same time, such a neutral legal framework would need to be sufficiently sound that a credible Host State could be recruited with confidence that its legitimate, clearly identified interests would always and without question be protected.[26]

We provide some background and framework language for two possible models.

25. "Pyro-processing," for example, may increasingly open the way to much more proliferation-resistant spent nuclear fuel recycling and reuse for power generation purposes.

26. Recruiting a credible Host State has proved to be highly challenging and is perhaps the greatest hurdle to fashioning a sound legal framework and melding it into a successful operating spent fuel storage business. Recruitment will require the negotiation of detailed, enforceable contractual provisions covering financial arrangements, employment obligations and practices, and likely arrangements for infrastructure enhancements and a range of medium- and long-term in-country research and development activities. In addition, to meet head on the pervasive local concerns likely to be raised anywhere in the world that an interim storage facility—particularly if it is highly successful—is likely to become a permanent repository, one of the key contract terms may have to contain absolutely clear, binding language concerning the length of any "interim" storage arrangements, the timing of the return of stored spent fuel to its owner absent specific contract language providing otherwise, and the financial penalty that would be imposed should these terms not be adhered to. As noted in Goldberg, Rosner, and Malone, *The Back-End of the Nuclear Fuel Cycle*, state participation will likely be necessary in one way or another to ensure that, while such provisions are faithfully carried out, the spent fuel would under no circumstances be returned to a nation that appears to have no intention of honoring its previous nonproliferation commitments. Ibid., 17.

THE CORPORATE ENTITY APPROACH

To ensure that a corporate enterprise can successfully operate and manage a spent fuel storage facility and provide the security that would be required by Host State leadership, customers, and the international community, the formation of a corporate spent fuel storage enterprise would need to account for certain core parameters, including the following:

Enterprise Purpose and Goals—subject to (1) the strict supervision of the Host State regulatory authority described below and (2) the application of the IAEA legal and regulatory framework focused on the storage and transportation of all covered nuclear material:

- To achieve the highest possible level of safety in the management of spent nuclear fuel and other high-level radioactive waste housed at the proposed spent fuel storage facility;
- To ensure that even in the distant future, effective measures are taken to protect against the harmful effects of ionizing radiation;
- To prevent accidents with radiological consequences and to mitigate their consequences should they occur;
- To ensure that all stored spent nuclear fuel and high-level radioactive waste is handled in a way that is:
    - financially sound;
    - protective of the spent fuel owners' contractual property rights;
    - protective of the Host State's contractual rights, in particular with respect to financial arrangements with customers and any changes in interim storage facility use; and
    - consistent with Host State nonproliferation regulations and the binding comprehensive safeguards arrangements to be established by the IAEA and the Host State.

Directors: Although a private corporation, the proposed new enterprise could strive to include at least one director from the IAEA's senior leadership[27] as well as directors from nations with extensive experience in the nuclear power and radiological safety and safeguards fields. Strict criteria for the selection of company directors and senior company leadership would need to be established by Host State regulatory authorities, and these criteria would need to be rigorously

27. Under current IAEA practice this is highly unlikely; however, such an approach, if pursued with the IAEA leadership, could strengthen the actual operations of any multinational spent fuel storage facility and enhance public confidence in its safe and secure operation.

adhered to so as to ensure the safe and secure operation of the enterprise and to protect the international credibility of the entire program.

Situs of Incorporation: The new entity should be incorporated under the laws of a nation that is a party in good standing of the NPT and is a signatory of a comprehensive IAEA Safeguards Agreement.

Equity Limitations: Limitations should be placed on equity investment in the proposed new private entity to a maximum of 10 percent per party/investor to ensure that no one shareholder (be this a private or public party) could exert an inordinate amount of control.

Liability Backstop: Commercial interest in the new business enterprise will likely be impossible to attract without having detailed liability limitation backstop arrangements firmly in place. Moreover, even a true limited liability corporation would not provide the level of comfort and security that would be necessary given the storage and overall management of sensitive resources of this nature. Serious consideration should be given to adopting liability limitations and protections drawing on the laws and regulations of the most advanced nuclear power nations, along with requiring eventual Host State adherence to the Vienna Convention on Civil Liability for Nuclear Damage.[28]

- Consistent with Vienna Convention obligations, legal jurisdiction over most covered “nuclear damage” arising out of the operation of a multinational spent fuel storage facility would lie with the courts of the Host State absent any contractual agreement to the contrary.[29] In addition, the operator of the proposed spent fuel storage entity would be required to obtain the maximum amount of coverage concerning spent nuclear fuel storage–related incidents that is available in the private insurance market.
- Customers that use the spent fuel storage facility or facilities would be required to contribute a certain amount per year—based on facility use—to a coinsurance fund to cover the excess of any claims. This contribution could consist of a fee based on storage space used per year. A portion of this fee could then be used to support an insurance pool, the size of which should be based on the likelihood and the range of consequences of an accident in the spent nuclear fuel storage space. The fund could then be capped in proportion to the amount of spent fuel at a given site.
- An international indemnity program would be needed to cover claims in excess of the mandatory insurance coverage. A secondary fund would have to be established and funded. Language covering much of this

28. See the Vienna Convention on Civil Liability for Nuclear Damage, IAEA INFCIRC/500. See as well the discussion of this topic in Bunn et al., *Interim Storage of Spent Nuclear Fuel.*

29. See Article 11 of the Vienna Convention on Civil Liability for Nuclear Damage, IAEA INFCIRC/500.

would need to be included in contracts negotiated with "customers" following core Vienna Convention principles. Ideally the new facility operator would over time provide customers with standard contract language covering this topic. The proposed language for such contracts with the Host State and/or customers would need to be approved by the Host State regulatory authority described below.

See Annex A for a description of the sort of liability backstop regime that will be necessary.

Host State License and Permit Procedures: The proposed new corporate entity would be responsible for obtaining required Host State licenses and permits for the storage and movement of spent nuclear fuel. Detailed criteria for all such activities, including spent fuel retrieval, would need to be developed and put into place in a way that would ensure adherence with the NPT and all relevant IAEA regulations and at the same time facilitate all required international supervision and inspections.

Staffing Limitations: Selection of "senior" spent fuel storage facility personnel should be subject to approval by the Host State regulatory authority based on strict criteria covering, among other qualifications, a high-level competence in the fields of physical security, public health and safety, safeguards, overall managerial experience, and a record of strict adherence to all relevant national and international compliance and ethical standards. In this crucial area, IAEA personnel might be able to play a very useful support role.

Potential Services to Be Provided by the Spent Fuel Storage Entity

- Interim spent-fuel long-term storage for up to 75 years . . . at least as a first step.
- Initial storage capacity in the range of 10,000–15,000 metric tons.
- Transport of spent nuclear fuel and other high-level waste per detailed plans jointly approved by (and ultimately supervised by) the Host State regulatory authority with the participation of appropriate IAEA personnel for verification purposes.
- Implementation of strict, enforceable rules covering spent fuel "retrievability" in the event reprocessing technology advances sufficiently to assuage current nonproliferation concerns. The rules to be applied in this respect would need to be carefully drafted and assiduously negoti-

ated and implemented with the approval of the Host State regulatory authority and the IAEA.[30]

Regulatory Oversight for a Corporate Spent Fuel Storage Facility Operator

- **Legal Framework:** In crafting detailed regulations governing the activities of the spent nuclear fuel storage facility operator, it may well be appropriate—in light of the interests of all contracting parties and those of the Host State itself—to follow standard administrative practice used in many nations concerning "notice and comment" rule making. When well managed, this would allow for an open airing of all substantive issues and provide assurance that procedural equity was in place. Host State adherence to widely recognized and followed judicial review procedures to correct any "abuse of administrative agency discretion" would likewise be appropriate.
- **Regulators:** A seven- or nine-member commission would be made up of commissioners serving five-year overlapping terms and selected through the normal Host State regulatory process. Two-thirds approval would be required for a defined set of core decisions.
- **Host State Regulatory Authority Role:** Through a well-defined and open legal process, the Host State would formulate and publish binding, enforceable regulations covering the following activities:
  - Implementing national safety requirements that would at a minimum include IAEA standards and other mandatory requirements of the Convention on Nuclear Safety, the Joint Convention on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and the Convention on the Physical Protection of Nuclear Materials (along with its 2005 amendment);[31]
  - Licensing coverage and procedures (storage and transportation requirements, including export and re-export controls);
  - Implementing a proper records system encompassing the location and volume or mass of the radioactive waste at the spent fuel storage facility;

30. IAEA inspections have been part of the highly successful multinational URENCO uranium enrichment program, and they also played a significant role in the development of the new "nuclear fuel bank" in Kazakhstan. If properly structured and implemented, there would appear to be no reason why IAEA safeguards inspection could not play an active and very positive role in ensuring that a multinational spent fuel storage facility was being operated as required.

31. Convention on Nuclear Safety, adopted June 17, 1994 (INFCIRC/449); Joint Convention on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, adopted September 5, 1997 (INFCIRC/546); and Convention on the Physical Protection of Nuclear Materials, adopted October 26, 1979 (INFCIRC/274), amended July 8, 2005 (INFCIRC/274/Rev.1/Mod.1).

- Promulgating the IAEA "Safety Standard Series," including the requirement of routine inspections;
- Developing criteria governing Host State regulatory approvals of all plans to move, transport off-site, retrieve for reprocessing purposes, or otherwise alter the handling or disposition of stored spent fuel or high-level waste over which the spent fuel storage entity has control. This would include approvals for the retransfer of spent fuel or other high-level radioactive waste for any reason and regardless of national origin or proposed destination. Host State regulations would include, as appropriate, the application of all IAEA standards and would be designed above all to achieve the following results:
    - To the satisfaction of the Host State regulatory authority, ensure that any potential licensee agrees to adhere to all applicable requirements and that the licensee is able to meet those requirements;
    - Guarantee the safe operation of the spent fuel storage facility through the application and enforcement of safety and security requirements;
    - Demonstrate at the storage facility "design and construction" licensing stage that the following standards have been adhered to:
        - Adequate safety measures have been taken with respect to radiological and other construction and operational risks to human beings and the environment;
        - A systematic overall safety assessment of the planned storage facility has been undertaken, and its results have been incorporated in all concrete plans;
        - A thorough environmental assessment has been undertaken to the satisfaction of the regulatory body.
    - Demonstrate to the satisfaction of the regulatory body that appropriate site decommissioning and emergency preparedness plans have been developed, are in place, and will be properly funded on an ongoing basis;
    - Establish an internal body to review hiring decisions at the spent nuclear fuel storage site or sites to focus attention on strict adherence to the objective qualification criteria referenced above, including standards designed to ensure avoidance of "specially designated nationals" or any appearance of favoritism;
    - Pursuant to Host State laws, applicable international agreements, and binding contractual language, formulate procedures for the regulation of storage facility (or facilities) operations in a secure proliferation-resistant manner;

- Conduct quarterly face-to-face regulatory authority meetings—including senior staff—to review comprehensively all aspects of spent fuel storage operations, the degree of adherence to all mandatory rules and standards, and any needed improvements along with concrete plans for the implementation of such improvements;
- Establish procedures for mediation and binding arbitration with respect to commercial disputes related to the application of well-defined regulatory standards. The anticipated arbitration regime would ideally follow (but at the very least be consistent with) the arbitration rules set out by the United Nations Commission on International Trade Law (UNCITRAL). The UNCITRAL rules provide a comprehensive set of clear, widely accepted procedures governing arbitrations of a commercial nature. Acceptance of these dispute settlement procedures would need to be included in all contracts between the anticipated spent fuel storage entity, spent fuel storage customers, and, as appropriate, the Host State itself.[32]

- **International Advisory Council:** The regulatory authority commissioners would work closely with an independent "international advisory council" established to ensure adequate attention is paid to key regulatory "best practices." The international advisory council would ideally include members from major regulatory agencies across the globe and the IAEA administration itself.[33]

Funding Options

(a) Governments that wish to see the creation of a Host State spent fuel storage regulatory authority should contribute a share of its "start-up costs," including those related to its initial staffing. Once the new regulatory authority was successfully up and running, it would be funded on an ongoing basis largely by a tariff on storage services tied to facility usage; or

(b) The development and implementation of the regulatory authority's charter would be financed through customer tariff payments based on the real and anticipated customer needs as determined by the amount of storage space required and the timing of national or industrial requirements. Provision for a modest annual fee paid by the spent fuel storage enterprise could also be appropriate and assessed in an equitable fashion.

32. See UNCITRAL, *UNCITRAL Arbitration Rules (as Revised in 2010)* (Vienna: UNCITRAL, 2010), https://www.uncitral.org/pdf/english/texts/arbitration/arb-rules-revised/arb-rules-revised-2010-e.pdf.

33. For example, the United Kingdom Office for Nuclear Regulation; the French Nuclear Safety Authority; the China Atomic Energy Authority; Finland's Radiation and Nuclear Safety Authority; the Swedish Nuclear Power Inspectorate; Japan's Nuclear Regulation Authority; Russia's Federal Service for Environmental, Technological, and Nuclear Supervision; and the U.S. Nuclear Regulatory Commission.

The Host State regulatory authority should be self-funded on an ongoing basis; that is, it should be financially independent. The regulatory authority's independence from any national government or private party, both in reality and in appearance, is of paramount importance.

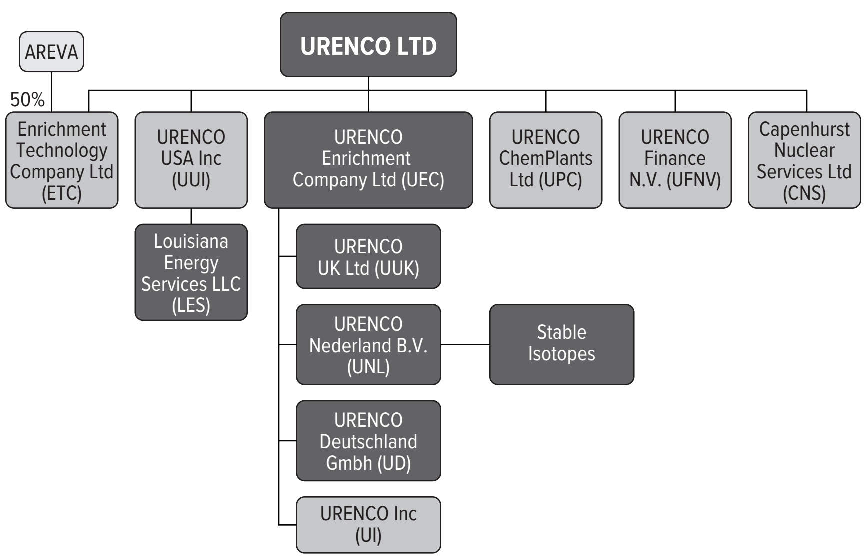
See Annex B for a short summary of the key terms and conditions for the establishment of the sort of corporate entity referred to above. See Annex C for a summary of the key terms and conditions applicable to the establishment of an effective spent fuel regulatory agency required for the successful supervision of the spent fuel storage operations.

AN INTERNATIONAL CONSORTIUM APPROACH

An alternative approach would involve the establishment of a consortium of nations that, in conjunction with the Host State authorities, would take responsibility—either directly or indirectly through local power companies in need of spent fuel and other high-level radioactive waste storage services—for the construction and operation of the proposed multinational storage facility. While there are some important differences, the URENCO model in the field of gas centrifuge uranium enrichment collaboration provides an excellent example of how this might work in practice with respect to the aspects of the back-end of the nuclear fuel cycle being examined in this essay.[34]

One of the significant challenges with promoting and implementing this approach would be managing perceptions of political domination by certain of

34. Uranium Enrichment Company (URENCO) corporate structure:



the major nuclear power nations, either nuclear weapons states or key nuclear supplier states or both.

See Annex D for a summary of key organizational factors that will need to be carefully addressed should this approach be appealing to the key players (e.g., Host State, potential spent fuel storage customers, most affected governments, and the international nonproliferation community as a whole).

Section 4
Host State Role

Threshold Requirement

Should be a signatory in good standing of the NPT and agree to abide by all of its required terms and conditions.

Additional Binding and Mandatory International Agreements

(a) Should be a signatory to a comprehensive IAEA Safeguards Agreement and must be an IAEA member state in good standing; and

(b) Should have signed, implemented, and in all respects be in adherence to an IAEA Additional Protocol Agreement.

Commercial Operation Agreement with the Selected Host State and the Spent Nuclear Fuel Entity

- Depending on the scope of the role of the Host State or States, develop commercial contract documents ensuring the necessary (direct and/or indirect) compensation to the chosen Host State or States. This compensation could take many forms depending on the location and infrastructure issues and other Host State requirements. Contractual arrangements could include—but should not be limited to—the development of required transportation infrastructure, education and advanced training funding, electrical transmission system development, financing of local housing programs to help ensure the availability of highly qualified local personnel, employment guarantees, and the establishment of a local research, development, and testing center tied to spent fuel storage and safeguards issues.
- Establish payment schedules for spent fuel storage facility customers based on, among other factors:

  (a) the amounts and condition of the spent nuclear fuel when received for storage;

  (b) contract length, with detailed specification of spent fuel ownership and ownership rights and limitations;

  (c) transportation arrangements;

(d) security protection arrangements;

(e) spent fuel retrieval criteria and related arrangements; and

(f) any storage company obligations to provide financial support for the ongoing operation of the new regulatory authority.[35]

- Set forth in detail the responsibilities and obligations of the spent fuel storage enterprise in the operational and financial realms.
- Set forth in detail the responsibilities and obligations to be undertaken by spent fuel storage enterprise customers, including their ultimate responsibility for long-term spent fuel disposal.
- Include explicit language ensuring adherence to decisions rendered by a Host State court of appropriate jurisdiction as well as the "binding" judgments of properly constituted arbitration panels within the "dispute settlement framework" set forth in commercial operation agreements and other related contracts. This language would explicitly address dispute settlement procedures to be followed in the event of a disagreement concerning, among other matters: (a) interpretation of the commercial contract or contracts to be negotiated between the spent fuel storage entity and its customers and (b) actions of the newly established regulatory authority.

See Annex E for the basic terms and conditions underlying the foundational agreement or agreements between the new spent fuel storage entity and the Host State government.

35. Extreme care would need to be exercised in formulating any regulatory authority funding arrangements involving customers, Customer States, and/or the proposed spent fuel storage enterprise itself to ensure that they would in no way impede the complete independence of the regulatory authority in carrying out its complicated duties.

Annex A
Limitation on Liability

To be implemented successfully, centralized siting and management of used nuclear fuel, whether involving interim storage for up to seventy-five years or final disposal, will require the skillful application of risk management techniques, risk sharing, and shared responsibility in the event of a serious accident. The most powerful way to reduce risks is to take all reasonable measures to ensure the spent fuel storage facility is managed and operated in the safest possible fashion.

Nonetheless, it is crucial to prepare for accidents that could occur despite the development and implementation of the best of safety programs. Not only would this be essential to protect employees and the surrounding population, any financial partner in the spent fuel storage enterprise that is to be established would surely require that such steps be taken. This would include enterprise shareholders (of either a private or public nature) in a new spent fuel storage enterprise, the Host State government, and likely any customer contemplating use of the new facility on a long-term basis.

The magnitude of potential damage from a nuclear incident at a storage facility could be significant in terms of possible damage payments, potential criminal and civil liability, loss of reputation, and legal fees required in any adjudication that might follow. Not managing these sorts of risks in a clear and competent fashion would ensure that qualified contractors and other business partners would decline commercial relations with the new storage enterprise.

The Structure of a Liability Regime

The nuclear industry has adapted to the reality of potentially ruinous damages in the context of reactor facilities by adopting national and international laws that set forth limited liability regimes. National laws such as the Price-Anderson Nuclear Industries Indemnity Act in the United States and international conventions such as the Vienna Convention on Civil Liability for Nuclear Damage have made nuclear power economically feasible despite the potential for large-scale liability, while also ensuring prompt compensation to those affected by an accident. These legal arrangements provide a roadmap for the establishment of a liability management framework founded on similar basic principles, including the following:[36]

- The operator (as opposed to suppliers) of a nuclear installation is strictly and exclusively liable for "nuclear damage" with only very limited exceptions.
- The courts of one state are granted exclusive jurisdiction.
- Liability is limited in amount and in time (i.e., the period for making damage claims).
- The nuclear installation operator is required to have adequate insurance to cover the extent of its limited liability.

A similar model could be effectively applied to a multinational spent nuclear fuel storage facility. Liability would be exclusively placed on the entity operating the storage facility. Channeling liability to the operating entity would incentivize the party overseeing facility construction, storage operations, and transportation to take the maximum level of care at every step. It also avoids lengthy ex post determinations of fault, providing potential claimants with a quicker system of recovery. The operating entity could separately contract around this arrangement with customers if, for example, it believes that the spent fuel assemblies provided by the customer do not provide the highest level of safety.

Without limited liability, finding the necessary insurance to offset the perceived risks may be prohibitively difficult for the storage facility operating entity. Therefore, to promote the development, construction, and successful operation of a storage facility, a damage limitation (or "indemnification") regime should similarly limit the liability of a licensee, perhaps capping it at different levels depending on certain clearly defined facts and circumstances. Depending on the facts, Host State and Customer State governments would need to be prepared to make funds available for damages above the agreed-upon cap.

To be eligible for a liability limit, a licensed facility should be required to adhere to all applicable international safety convention requirements. The licensed facility would also need to hold the maximum amount of privately purchasable liability insurance coverage, with policy limitations being subject to review by the Host State regulatory authority.

Should damage in a particular incident exceed the maximum insurance policy coverage amount, the storage facility operating company would then be liable for all additional claims up to an aggregate limit of $300 million having been paid out (including insurance payouts).[37] Required payments above this amount

36. See Mohit Abraham, *Nuclear Liability: A Key Component of the Public Policy Decision to Deploy Nuclear Energy in Southeast Asia* (Cambridge, Mass.: American Academy of Arts and Sciences, 2014); *The 1997 Vienna Convention on Civil Liability for Nuclear Damage and the 1997 Convention on Supplementary Compensation for Nuclear Damage—Explanatory Texts* (Vienna: IAEA, 2007); and the Price-Anderson Nuclear Industries Indemnity Act of 1957, 42 U.S.C. § 2210.

37. This figure ($300 million) is the minimum liability amount set forth in the Vienna Convention and in the Convention on Supplementary Compensation for Nuclear Damage (not yet in force).

would be the responsibility of "customer company" governments. The "excess funds" paid by customer company governments would come from a supplementary risk management fund that these governments would be required to establish. Financial support for this fund would be based on the amount of spent fuel and other high-level waste each country has stored at the facility.

Such an indemnification regime would not necessarily protect the operator/licensee or its contractors from criminal or civil liability, especially in the case of gross negligence, but it would be designed to ensure that injured parties would be compensated in appropriate cases and that legal recourse was available. It would also provide a powerful financial incentive to ensure that all aspects of spent fuel storage operations were at all times conducted with the greatest degree of care.

Payments could be made in the style of no-fault insurance. Under this sort of an arrangement, a claimant would, for example, need to show only personal injury or damage to property, a monetary value for the loss, and, in certain cases, that the injury or damage in question resulted from exposure to radioactive materials stored at, leaked from, or in transit to or from the licensed facility and for what period.

If the indemnified operator/licensee and customer governments can demonstrate in an appropriate arbitral proceeding that damage from a covered incident will exceed the $300 million limit, then it or they would be entitled to the following legal protections regarding the payment of liability claims:

- An order limiting the liability of the persons indemnified (assuming an indemnity regime had been put in place);
- Orders staying the payment of claims and the execution of legal judgments;
- Orders apportioning the payments to be made to claimants;
- Orders permitting partial payments to be made prior to final decisions concerning the totality of related claims; and
- An order setting aside a part of the funds available for possible latent injuries not discovered until a later time.

Implementation of an Indemnification Regime

The implementation of an indemnification regime would depend largely upon the existing laws of the Host State. If the Host State has no existing laws that address liability for a nuclear waste storage facility, the agreements between the storage entity customers, Host State government, and customer company governments could be developed anew. Supervision of these arrangements would be under the authority of the Host State regulatory agency.

Alternatively, effective licensing and regulation of a nuclear waste storage facility as described in this paper could possibly be included within the ambit of preexisting Host State laws that address, among other matters, liability for nuclear installations more broadly. That is, liability for the storage facility could be addressed through the same national laws governing liability for installations such as reactors and fuel processing plants. As an example, the Vienna Convention[38] focuses on liability for "nuclear damage" caused by a "nuclear incident" occurring in a "nuclear installation" or in the course of a transport of "nuclear material to or from such an installation."[39] The definition of "nuclear installation" does not explicitly include a waste storage facility, but it includes "such other installations in which there are nuclear fuel or radioactive products or waste as the Board of Governors of the International Atomic Energy Agency shall from time to time determine."[40] Therefore, even if the waste storage facility were to be included under preexisting Host State laws governing nuclear installation liability, amending these provisions may be easier than creating an entirely new liability regime.

Lastly, to minimize spent fuel storage liability risks and, therefore, the likely financial burden imposed in handling a damage incident, the regulatory authority would establish a "Committee on Best Practices." This committee would be responsible for periodically auditing the physical safeguards and security of the spent fuel storage facility, providing a detailed report of its findings and recommendations to the board of directors of the spent fuel storage entity and to the IAEA director general. The committee would be composed of international experts in the field of radioactive waste storage, experts on the local geology and geography, and at least one member from the Host State and each Customer State.

38. Contracting states to the Vienna Convention may either enact national laws that adhere to the principles of the convention or simply implement the convention itself.

39. Article II, Consolidated Text of the Vienna Convention on Civil Liability for Nuclear Damage of 21 May 1963, as amended by the Protocol of September 1997.

40. Article I.I(j)(iv), Consolidated Text of the Vienna Convention on Civil Liability for Nuclear Damage of 21 May 1963, as amended by the Protocol of September 1997.

Annex B

Spent Nuclear Fuel Storage Company Corporate Structure

The Company	The Spent Nuclear Fuel Management Corporation (the *Company*).
State of Incorporation	The *Company* will be incorporated under the laws of ___________.
The Investors	Investment in the *Company* is open to all public and private investment vehicles. Any investor may purchase up to 10% of the outstanding stock, but no investor may hold interest, in any form, of any stock in excess of this 10% cap.
Purpose of Corporation	The *Company* will be formed with the purpose of constructing and operating a spent nuclear fuel storage facility or facilities and to do so under the supervision of the Host State's regulatory authority (and, where relevant, the rules and regulations of the International Atomic Energy Agency [IAEA]) in a safe, secure, and proliferation-resistant fashion. The *Company* agrees to be subject to all relevant laws, regulations, and other international commitments of the Host State. This would specifically include the requirements imposed by the Host State's governing regulatory authority as well as the IAEA physical security, safety, and safeguards regulations currently in force. Subject to review and approval by the governing regulatory authority, the *Company* will offer interim storage of spent nuclear fuel for a period of no longer than seventy-five (75) years. The *Company* acknowledges its prime responsibility for ensuring the safety and security of spent nuclear fuel and high-level radioactive

waste placed under its control during the pendency of the relevant license of authorization. This responsibility would include seeking and securing all required operating licenses and other necessary permits for the safe and secure operation of the spent fuel storage facility, the establishment of the initial insurance pool referred to in the liability limitation section of this paper, and undertaking all necessary infrastructure upgrades (e.g., dock facilities, road and rail enhancements, communication operations) necessary for the *Company's* success.

The *Company* will solicit fees for the storage service from any entity, public or private, interested in storing its spent nuclear fuel at the *Company's* storage site. The terms and conditions of the storage arrangement, as well as the return of any spent fuel to its owner, will be subject to detailed contractual arrangements followed by review and obligatory approval by the governing regulatory body.

To carry out its purposes and functions, the *Company* shall possess full legal capacity under Host State law—in particular, the capacity to (1) contract; (2) lease or rent real property; (3) acquire and dispose of personal property; and (4) institute legal proceedings.

Board of Directors

The Board will consist of five to seven independent Directors. A majority of Directors must have a substantive background and direct experience in managing an entity engaged in nuclear power generation and supply with a special emphasis on the back-end of the nuclear fuel cycle. In addition, Directors should possess deep financial and overall corporate management skills.

Serious consideration should be given to providing for at least two senior IAEA officials serving on a special International Advisory Council along with other internationally recognized experts in the high-level radioactive nuclear waste management field. The key function of this International Advisory Council would be to ensure that adequate attention is at all times paid to key global regulatory "best practices." The International Advisory Council would be specifically charged with providing advice to the *Company's* chief executive officer and other senior management, with the goal of ensuring that all *Company* operations are carried out as efficiently and safely as possible and in full compliance with global best practices.

Information Rights

At a minimum, the *Company* will provide to the governing regulatory authorities and each Director:

a) Monthly and year-to-date consolidated financial statements prepared in accordance with generally accepted international financial reporting standards consistently applied. These financial reports would include, at a minimum, profit and loss statements and appropriately detailed balance sheets, and they would be made available as soon as reasonably practicable after being provided in final form to the *Company's* management, and in any event within 20 days of the end of a month;

b) Annual independent certified audit report within 90 days after the year's end from the *Company's* independent accounting firm;

c) Within 20 days after filing or receipt thereof, as applicable, (i) pleadings of any material lawsuits filed by or against the *Company* or any subsidiary; and (ii) written notice of all commenced legal or arbitration proceedings, and all proceedings by or before any governmental or regulatory authority or agency, in which the *Company* or any subsidiary is a party, provided that, in both cases, the *Company* will not be required to provide information or documents that would cause the *Company* or any subsidiary to lose the benefit of attorney/client privilege or violate a confidentiality obligation;

d) Documentation related to (i) material lawsuits threatened against the *Company* or any subsidiary and (ii) material developments in any commenced legal proceeding to which the *Company* or any subsidiary is a party, provided that the *Company* would not be required to provide information or documents that would cause the *Company* or any subsidiary to lose the benefit of attorney/client privilege or violate a confidentiality obligation;

e) Within 20 days after filings, copies of all material documents provided to the IAEA and any government agencies outside of the ordinary course of business;

f) Within 10 days after receipt, copies of any notifications received by the *Company* or any subsidiary regarding material defaults on any loans, leases, or material contracts to which the *Company* or any subsidiary is a party or pursuant to which any of its properties or assets are bound;

g) Such other information concerning the business, financial condition, corporate affairs, or operational activities of the *Company* or any subsidiary as may be reasonably requested and which does not substantially interfere with the management of the *Company* or any of its subsidiaries.

In addition to normal safeguards verification inspections conducted by IAEA inspectors following standard IAEA procedures, the *Company* will permit any other designee of the IAEA, the United Nations, the Host State regulatory body, or any NPT member states to visit and inspect the properties of the *Company* and its subsidiaries, including their respective corporate and financial records, and to discuss its business and finances with officers of the *Company* and its subsidiaries, as applicable, during normal business hours, following reasonable notice and as often as may be reasonably requested, so long as any such visit or

	inspection does not interrupt in a substantial way the business of the *Company* or any such subsidiary. Notwithstanding the foregoing, the *Company* will not be required to provide access to information or documents that would cause the *Company* to lose the benefit of attorney/client privilege or violate a confidentiality obligation.
Right of First Offer	If any Investor wishes to sell, transfer, or convey any securities of the *Company* owned by such person or entity, then the selling stockholder will be required to offer the shares first to the *Company* at the price and on the terms proposed by the Selling Stockholder (the "Proposed Terms"). The *Company* would have the right (the "Surviving Corporation Right") to purchase all, but not less than all, of the offered shares in accordance with the Proposed Terms. If the Surviving Corporation does not exercise the right to purchase all offered shares, then the selling stockholder may sell the offered shares to a third party upon terms and conditions no more favorable than the Proposed Terms.
Indemnity	Application of the civil liability regime provided for under Host State law and the Vienna Convention on Civil Liability for Nuclear Damage and the Convention on Supplementary Compensation for Nuclear Damage must be extended to the *Company*. (Other aspects of the civil liability regime governing the *Company's* operations are summarized in Annex A of this paper.)
Insurance	The *Company* must obtain the maximum amount of insurance that is required to cover the consequences of design accidents at spent fuel storage facilities and that is available in the insurance market. Any such insurance contract must be consistent with the liability limitation provisions in Annex A of this paper and the requirements of the Vienna Convention on Civil Liability for Nuclear Damage and the

	Convention on Supplementary Compensation for Nuclear Damage.
Employment Agreements	The executive officers of the *Company* must in all cases be approved by the Host State regulatory authority. Further, the *Company* must agree to abide by regulations to be promulgated by the Host State regulatory authority concerning employee standards and safeguards covering, among other matters, physical security, public health and safety, safeguards, and overall competence and ethical standards.
Governing Law	This Term Sheet and the related transaction documents and all matters arising directly or indirectly therefrom will be governed by the laws of the Host State on all matters, in each case, without reference to the choice or conflicts of law provisions thereof.
Dispute Settlement	All disputes arising out of the interpretation or implementation of the *Company's* purposes will be resolved either through a decision or decisions of the Host State court of appropriate jurisdiction or, if of a purely commercial nature, through binding United Nations Commission on International Trade Law–based arbitration with the rules of The Hague Convention on Recognition and Enforcement of Foreign Judgments in Civil and Commercial Matters and/or The Convention on the Recognition and Enforcement of Foreign Arbitral Awards being applicable. The dispute settlement provision would be designed to provide reasonable assurance that decisions of national courts and/or arbitration panels with the required jurisdiction will be enforced in a timely manner.

Annex C

A Governing Regulatory Agency

The Regulatory Agency

A seven- or nine-member independent Regulatory Agency should be created under the authority of Host State law and in all respects operate consistent with the goals, mandates, and requirements set forth in the charter of the International Atomic Energy Agency (IAEA) and in those of other relevant United Nations institutions. The Regulatory Agency will be appropriately funded and staffed by highly competent personnel.

Governing Law

In preparing and implementing guidelines as well as binding rules and regulations related to the operation of the spent fuel storage facility, the Regulatory Agency will follow standard administrative practice of "notice and comment" rulemaking as provided for under local law and in a manner followed by United Nations agencies.

The Regulators

The Regulatory Agency's members will serve overlapping five-year terms. They will be selected in strict adherence to the Host State's regulatory process. A two-thirds positive vote will be required for a defined set of decisions governing spent fuel storage facility licensing and a range of central operational questions.

International Advisory Council

The Host State Regulatory Agency will establish an International Advisory Council with the mandate of focusing attention on existing and emerging "best practices" in the field of interim spent fuel storage and long-term disposal as well as with respect to other issues linked to the safe and secure management of the back-end of the nuclear fuel cycle. Members of this Council will be drawn from Host State experts but, whenever possible, from the IAEA leadership and the ranks of the following national agencies:

The United Kingdom Office for Nuclear Regulation; the French Nuclear Safety Authority; Atomic Energy of Canada Limited; Germany's Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety; Finland's Radiation and Nuclear Safety Authority; the South Korean Nuclear Energy Agency; Japan's Nuclear Regulation Authority; the Ministry for Atomic Energy of the Russian Federation; the Swedish Radiation Safety Authority; and the U.S. Nuclear Regulatory Commission.

Regulatory Agency Purpose

The Regulatory Agency will promulgate regulations to govern the operation of the spent fuel storage operator, including but not limited to:

- Granting licenses for the storage of spent nuclear fuel and other high-level waste as well as the transportation of these materials;
- Safety requirements, including standard IAEA inspections, and the application of all applicable IAEA requirements, including those that may exceed the mandatory requirements of the Convention on Nuclear Safety, the Joint Convention on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, and the Convention on the Physical Protection of Nuclear Materials (along with its 2005 amendment);
- Requirements designed to ensure adherence to all safety, nuclear materials accountancy and control, physical protection, and any other relevant Host State legal provisions;

- Detailed criteria and a regulatory framework for the approval of all plans to move, transport off site, sell, retrieve for any purpose, or purchase spent fuel or high-level waste. Aside from licensing criteria, this would include Host State requirements for nuclear safety, radiation protection, transportation of spent fuel and other high-level radioactive waste, and liability issues;
- A clear, transparent regulatory framework for the management of the legal liability limitation regime to be put in place;
- Review/approval of employee hiring decisions at the spent nuclear fuel site or sites to ensure strict adherence to objective qualification criteria, including standards designed to ensure avoidance of "specially designated nationals" or any appearance of favoritism;
- A system of enforcement to ensure compliance with applicable regulations and the terms and conditions of authorizations (licenses) for spent nuclear fuel and high-level radioactive waste management activities;
- In appropriate, carefully defined cases, binding arbitration consistent with the arbitration rules of the United Nations Commission on International Trade Law.

Annex D

The International Consortium Approach

Effective implementation of an international consortium arrangement would require extremely close cooperation—on legal, operational, and scientific fronts—among nations with the capacity and the will to make multinational spent fuel and high-level radioactive waste storage a reality. Many nations have a great interest in the safe and secure management of the back-end of the nuclear fuel cycle across the globe, but making this a reality would undoubtedly require considerable effort, political ingenuity, and financial support.[41]

One possible approach would include the following:

- Key nations would agree to establish one or perhaps several regional multinational storage facilities that would be designed to be in operation for a specific period.
- The nations participating in this approach would need to be members in good standing of the Nuclear Non-Proliferation Treaty, have in place, as appropriate, a comprehensive safeguards agreement and an IAEA Additional Protocol Agreement. These agreement parties would also need to undertake a firm commitment that no information gained or equipment or material used in or in any way related to the spent fuel storage operation would be used by or to assist, encourage, or induce any nonnuclear weapon state to manufacture or otherwise acquire nuclear weapons or nuclear explosive devices.

41. In this context, a note of caution touching on recent experience in a related field is worthwhile. For a variety of diplomatic and liability management reasons, senior officials in the U.S. Department of State strongly resisted attempting to establish a new international organization for the purpose of implementing key provisions of the Agreed Framework Between the United States of America and the Democratic People's Republic of Korea (Geneva, October 21, 1994). These concerns were overruled and the Korea Peninsula Energy Development Organization (KEDO) was established on April 1, 1996, as an international organization under U.S. law. Aside from the United States, initial member state participants included the Republic of Korea and Japan with others, such as the European Union, joining later. KEDO struggled to carry out its assigned tasks tied to the construction of two new light water reactors and the Democratic People's Republic of Korea's (DPRK) adherence to a series of basic nonproliferation terms and conditions. Having for a variety of complex reasons failed to achieve its extremely ambitious, highly complex goals, KEDO was closed in 2006 amid political acrimony on all sides and DPRK's apparently increasing intent to develop a truly menacing nuclear weapons capability.

- To achieve this goal, the agreement should provide that the parties would establish a joint industrial enterprise or enterprises to carry out this purpose. Such enterprises could be created under the laws of one or more of the agreement signatories or alternatively under the laws of the Host State once that nation is agreed upon.
- Nation-state parties to the agreement would authorize national commercial entities (of a private, public, or semi-public nature) with special expertise in the field to participate in operations as approved by the spent fuel storage Host State or States.
- Once a Host State has been identified and has agreed to accept this role, the purpose of the business entity to be established and managed pursuant to the consortium agreement among the member nations would be to ensure the safe and secure construction and operation of a world-class spent fuel storage facility with the duties and obligations of facility operators and customers clearly delineated.
- In conjunction with regulatory requirements that would undoubtedly be put in place by the Host State and its regulatory regime, a "Joint Committee" would be created with the purpose of supervising the contracting parties to ensure that all agreement provisions were being adhered to, especially with respect to safety, physical security, nonproliferation safeguards, and all related financial management matters. This supervisory responsibility would need to be carefully outlined and undertaken in light of the sovereign responsibility of Host State authorities with respect to activities taking place on their nation's territory.
- In this context, the Joint Committee would take on the following responsibilities, among others:
    - Leadership of independent reviews (other than those conducted under the auspices of the IAEA) to ensure all Host State and Customer State safeguards agreements and/or understandings are being in all respects followed;
    - Approval of any retransfer, within the Host State or internationally, of special nuclear material stored in the Host State;
    - In conjunction with Host State regulatory authorities, approval of any required licenses, including those related to facility construction and expansion and related transportation networks;
    - Approval of any royalty arrangements;
    - Ensuring that the spent fuel storage facility or facilities are operated in a commercially sound fashion, without certain commercial parties or nation-states being favored or illegally assisted to the detriment of other parties;

    - Within current commercial arrangements, ensure that the spent fuel storage operating company has a free nonexclusive license to use and exercise any preexisting industrial rights relevant to the operation of a spent fuel storage facility and that any payments owed to intellectual property owners are handled in an equitable fashion.

    - By means of consultation and mediation, take all reasonable steps to ensure settlement of all disputes among the parties coming within the ambit of a consortium arrangement. Should such settlement not be possible in specific circumstances, a special ad hoc international arbitration procedure would be established with the purpose of ensuring that all disputes requiring international arbitration would be handled in a fair, equitable, and timely fashion.

- The Joint Committee would in some respects act as a supervising regulatory authority and it would thus be extremely important for the Joint Committee to be led by individuals of the highest integrity, expertise, and overall competence. The following approach is one example of how this goal might be achieved:

    - The Joint Committee would be composed of a representative from each agreement nation-state party. The Joint Committee would always include at least one member appointed by the Host State government and, if within the legal and political authority of the IAEA, a senior IAEA officer chosen by the IAEA director general.

    - The chairmanship of the Joint Committee would rotate on a two-year basis.

    - All decisions would be taken by unanimous vote.

    - Binding international arbitration would be the remedy for irremediable disagreement on an important point of agreement text or related regulatory or commercial matter.

Annex E

Role of the Host State

The Host State

_______ agrees to serve as the Host State for the spent nuclear fuel storage company's storage facility.

Governing Law

The agreement establishing the spent fuel storage facility will be governed by domestic law, taking into account relevant requirements of international law and specifically the application of all international physical security, safety, and safeguards provisions adopted and applied by relevant United Nations agencies.

Prerequisites

The Host State certifies that:

- It is a signatory in good standing to the Treaty on the Non-Proliferation of Nuclear Weapons;
- It is a member in good standing of the International Atomic Energy Agency (IAEA);
- It is a signatory to a comprehensive IAEA Safeguards Agreement;
- It has signed, implemented, and will adhere in all respects to an IAEA Additional Protocol Agreement;
- It is a party in good standing of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;[42]
- As a member of the United Nations, it will abide by all guidance and decisions issued by the IAEA;

42. IAEA INFCIRC/546, December 24, 1997, https://www.iaea.org/sites/default/files/infcirc546.pdf.

- It commits to adhere in all respects to the judicial review and international arbitration regime to be established and to confirm these commitments through binding contracts with Customer State parties; and
- Depending on the circumstances and the negotiation of other agreement provisions, it is a member party in good standing of The Hague Convention on the Recognition and Enforcement of Foreign Judgments in Civil and Commercial Matters or the New York Convention on the Recognition and Enforcement of Foreign Arbitral Awards.

Consideration

The Host State will negotiate directly with the spent fuel storage company for appropriate consideration in the form of direct payments, establishment of research and development and testing facilities, and the like. The Host State and the *Company* will enter into separate agreements detailing the type and range of consideration to be paid to the Host State by the *Company*, taking into account additional payments and "contributions" from individual customer utilities seeking spent nuclear fuel storage arrangements and governments of key legacy spent nuclear fuel customers. Any such agreement or agreements would be reviewed by the IAEA to ensure consistency with all outstanding national and international obligations.

[Separate draft agreements on these issues would follow.]

Section 5
Conclusion

The task of creating a sound, credible legal framework for the interim storage of spent nuclear fuel has for many decades been extremely daunting for nuclear power plant owners and operators across the globe. It has also been at the top of the agenda of nuclear safety experts, nuclear nonproliferation policy-makers concerned about rigorous IAEA safeguards implementation, and those interested in preserving the option of retrieving spent nuclear fuel once it can be reprocessed in a more proliferation resistant manner and then safely recycled and reused in a range of closed nuclear fuel cycle systems. No full-scale, politically and financially acceptable solutions have been found to date with respect to certain nuclear power programs despite growing alarm, particularly in those civilian nuclear power states where the size of the national program in no way justifies the construction and operation of a separate spent fuel storage facility meeting international standards. The risks inherent in this situation are clearly understood in many Nuclear Non-Proliferation Treaty (NPT) member states and in policy-making and academic circles as well.

First-rate articles have been published, government and international organization reports have been forthcoming, narrow national programs tied to notions of “taking back” categories of spent fuel of national origin have been initiated on small scales, and excellent international fuel leasing arrangements have been broached. But globally we have not been able to make serious progress in this field despite these efforts because of a series of perceived political, financial, physical security, and safeguard risks.

This paper is an effort to advance the cause and to generate serious, concrete discussion at senior levels among government leaders, commercial operators, and international technical experts as well as safety and safeguard officials. In short, it seeks to put forward a concrete set of proposals for the multinational storage of spent nuclear fuel and other high-level radioactive waste. Certain aspects of what is being proposed here are likely to be controversial and may not comport with notions held by some of how highly sensitive cross-border issues such as spent nuclear fuel storage should be handled.

Depending on one’s perspective, the idea of a *private company*—albeit one with potentially significant government ownership and participation—managing multinational spent fuel operations could raise serious concerns. Alternatively, pursuing a *system dominated by several nations* could engender significant opposition on the grounds of it being (or appearing to be) controlled by other national governments—in particular, by governments in certain nuclear weapons states with their own political agendas.

While acknowledging these varying points of view but bearing in mind the importance and complexity of achieving the overall goal, now is the time to review these proposals and to react so that we can move forward with the safe and secure management of the large amount of high-level nuclear waste that currently exists and is being built up year after year. At the same time, concrete success in this effort would enable a healthy nuclear power industry to continue to produce huge amounts of badly needed base load electric power around the world and to do so without contributing to the growth in greenhouse gases and the resulting global warming threat.

Contributor

Robert D. Sloan is a nationally regarded lawyer whose practice focuses on energy and corporate law. In the energy field, his practice concentrates on transactions in the United States, Western Europe, and Asia, as well as on finance and state and federal regulatory matters. In the corporate area, he works on corporate governance issues for public and private companies. He served as Executive Vice President, General Counsel, and Secretary of Entergy Corporation, a major multi-state electric utility based in New Orleans, and earlier was Vice President and General Counsel for a division of GE Industrial Systems. In these positions, he was involved in developing corporate governance constructs for which he received recognition in the industry. He has also worked extensively on a broad range of nuclear industry issues, both at Entergy and as a senior attorney at the U.S. Department of State. He is currently a professor at Tulane Law School in New Orleans, a senior fellow at the University of Chicago's Energy Policy Institute at Chicago (EPIC), and Senior Counsel at Sidley Austin LLP.

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