Risky Relapse into Reprocessing

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Summary, Findings and Recommendations

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In the late 1980s and early 1990s, the Department of Energy halted reprocessing [1] at its three military reprocessing locations: Hanford, Washington; the Savannah River Site, South Carolina, and the Idaho National Engineering Laboratory. The end of the Cold War, a large plutonium stockpile, and safety issues related to the reprocessing plants all contributed to this decision. The cessation of reprocessing left many nuclear materials in limbo — spent fuel originally slated for reprocessing remained in storage pools, and fissile material-containing solutions were left inside reprocessing plants at the Savannah River Site.

The solutions and some DOE spent fuel now pose environmental and safety problems because of accident risks and the possibility of increased radiation exposure to workers. Much of DOE's inventory of approximately 2,700 metric tons of spent fuel was not intended to be stored for long periods, and some spent fuel is corroding and releasing radioactive material into cooling pool water.

Over the past two years, the Department of Energy has issued four major Environmental Impact Statements (EIS's) and a number of other documents relating to spent fuel and nuclear material management. This report is a close evaluation of the following documents:

- *Final F-Canyon Plutonium Solutions EIS, December 1994*
  Outlines options for stabilizing plutonium-containing solutions stored in the F-Canyon reprocessing plant at the Savannah River Site.
- *Final Interim Management of Nuclear Materials EIS, October 1995*
  Discusses options for stabilizing seven types of nuclear materials at the Savannah River Site and for obtaining three types of "programmatic" materials deemed necessary for scientific research and DOE programs.
- *Draft Foreign Research Reactor Spent Fuel EIS, March 1995*
  Outlines alternatives for managing spent fuel from foreign research reactors. DOE is considering storage in the United States, reprocessing in the United States, reprocessing abroad, or some hybrid as the primary management alternatives.
- *Final Spent Nuclear Fuel/Idaho National Engineering Laboratory EIS, April 1995*
  DOE's overall spent fuel management plan, the SNF/INEL EIS focuses mainly on where spent fuel should be shipped to for interim storage. It also discusses possible stabilization techniques for DOE spent fuel, including reprocessing.
- *Proposal for the Demonstration of Electrometallurgical Processing*
  Several documents issued by DOE and Argonne National Laboratory in 1994 and 1995 describe this new kind of reprocessing technology whose testing is now delayed pending completion of an

Environmental Assessment.

Although in 1992 DOE halted reprocessing and decided to permanently phase it out, these documents and others indicate that DOE is looking to reprocessing as a method of spent fuel and nuclear material management, possibly over the long-term. DOE believes that extracting fissile material from spent fuel and converting it to a solid form can reduce safety risks from interim storage. It also believes that the products of reprocessing may be easier and cheaper to dispose of in a geologic repository than some un-reprocessed spent fuel. DOE's current reprocessing proposals center around the Savannah River Site in South Carolina, but it is also investigating new reprocessing technologies, such as electrometallurgical processing, and it has considered constructing a new reprocessing plant in the United States. In addition, DOE is considering the use of one or more foreign reprocessing facilities to ease the waste management burden in the United States.

The reprocessing proposals at present apply to under 10% (by mass) of DOE's total spent fuel inventory, but DOE has not put any form of upper bound on the amount of spent fuel that may be reprocessed in the future. [2] Reprocessing could occur for as long as twelve years pursuant to the EIS's and even longer if additional spent fuel is found in the future to be corroding or if DOE implements several possible "future missions" for the reprocessing plants at the Savannah River Site. Over 4,000 kilograms of weapons-usable uranium and over 400 kilograms of weapons-usable plutonium could be extracted under current reprocessing proposals.

Principal Findings

1. There is no option for managing DOE spent fuel that is without risks, but reprocessing would be especially detrimental to U.S. non-proliferation interests and to sound environmental management of the nuclear weapons complex.
2. DOE has failed to adequately assess the non-proliferation and environmental issues surrounding reprocessing, and DOE appears to be drifting back toward reprocessing without a clear-sighted analysis of its drawbacks and risks.
3. DOE reprocessing policy is being made in piece-meal fashion in separate documents prepared by separate offices, and the overall impression is of policy incoherence.
4. Although DOE decided in 1992 to phase out reprocessing, reprocessing remains an open-ended project because DOE has not put any end-point on the amount of spent fuel that may be reprocessed or on the time-period in which reprocessing would take place. DOE has clearly stepped back from that 1992 decision.
5. Re-starting reprocessing, even if for environmental management purposes, would undermine current and future U.S. non-proliferation efforts, including efforts to convince Russia and other countries to halt reprocessing. It may also be the first step toward a return of civilian reprocessing in the United States.
6. There are positive signs in the DOE documents that some DOE officials are questioning the assumptions behind reprocessing and are working toward a spent fuel management program based on alternative technologies.
7. DOE has not adequately examined its experience with N-reactor spent fuel at Hanford for the environmental and cost lessons it holds for current spent fuel management policy.
8. Interim dry storage of spent fuel, possibly preceded by short-term improvements in wet storage, is the best alternative to reprocessing from the points of view of safety, environmental protection,

and non-proliferation.

Discussion of Principal Findings

While the challenge of spent fuel management is formidable and complex, the Department of Energy appears to be drifting back toward reprocessing as a solution without an adequate analysis of its consequences or alternatives. Because reprocessing was what was done with most DOE spent fuel during the Cold War, parts of the DOE bureaucracy are resistant to considering other options, especially since many DOE and contractor personnel built their careers on the operation of reprocessing facilities. Maintaining a steady flow of money for some of the sites where reprocessing occurred in the past is an important political factor behind reprocessing, as is the strong belief in many quarters that plutonium is an energy asset rather than an economic liability, despite many independent studies to the contrary.

Reprocessing involves serious environmental and safety liabilities that have not been given due consideration by DOE. U.S. military reprocessing plants were never intended for environmental management, and in fact reprocessing was the leading cause of environmental contamination among all stages in the nuclear weapons production process. The reprocessing plants at the Savannah River Site that DOE is considering operating for up to twelve years or longer are already over forty years old.

One of the most significant flaws in DOE's analysis is that the EIS's do not discuss the increased risks of fires or explosions in high-level waste tanks that could result from generation of liquid high-level waste in reprocessing options. At the same time, DOE exaggerates the amount of high-level waste that would be generated in non-reprocessing options such as dry storage. DOE's haphazard approach to waste management issues is exemplified by the fact that some of its waste generation figures in the SNF/INEL EIS came from a report that stated that "…there is little documented basis or calculations to support the data presented." [3]

DOE data show that reprocessing solid spent fuel at the Savannah River Site pursuant to the Interim Management EIS will increase high-level waste at the Site by about three million gallons (about 9% of the high-level wastes currently stored at the SRS). [4] The plutonium extracted through reprocessing will become an additional waste burden for DOE, but again there is very little discussion of its disposition. Stored plutonium already poses serious environmental problems at many sites within the nuclear weapons complex. The last thing the United States should want to do as it struggles with the question of disposing of plutonium from dismantled nuclear warheads and other sources is to extract more plutonium through further reprocessing.

Further, while DOE's own data show significant negative health effects from reprocessing, DOE does not give sufficient weight to this factor in its decision-making. The estimated incremental radiation dose to the population within fifty miles of the Savannah River Site is four to five million times greater from reprocessing than from interim storage, and DOE has estimated that one worker will die from cancer if it implements reprocessing at the Savannah River Site. [5]

DOE has also provided a misleading discussion of the possible advantages of reprocessing for final waste disposal. DOE believes that the vitrified high-level waste that will result from reprocessing will be easier and cheaper to dispose of in a geologic repository than some un-reprocessed DOE spent fuel. DOE's repository program has had a troubled history, however, and DOE spent fuel will not be put into a

repository for two decades at the very earliest. DOE is investigating the suitability of Yucca Mountain in Nevada for a repository, but there is a chance that it will not be suitable, and the waste acceptance criteria, the rules that will govern what types of materials can go into a repository and in what form, have not been issued. A three-volume preliminary investigation by Sandia National Laboratories concluded that "*…most decisions on* [spent fuel] *treatment or conditioning should wait until a repository type and site are known.*" [6] [italics in original] It may very well turn out that reprocessing in the near-future for the purpose of long-term cost savings or to avoid technical uncertainties will be a waste of money and counter-productive on environmental grounds. DOE cost estimates for ten year periods, let alone the forty year period within which DOE believes repository emplacement could be completed, are highly speculative.

The best alternative to reprocessing is to store spent fuel for an interim period in dry storage facilities. DOE's own data show that interim storage poses far fewer safety, environmental, and health risks than reprocessing, and interim storage would allow DOE to conduct research on engineered barriers and non-separative processing options. In addition, interim storage would allow DOE to gain more information about a repository before making spent fuel stabilization decisions. Keeping corroding spent fuel in current storage facilities while new ones are built does carry risks, but reprocessing involves much greater risks. Further, current wet storage could be improved in some cases by putting the spent fuel in sealed containers, as was done at Hanford for some spent fuel well over a decade ago.

Perhaps the greatest flaw in DOE's current reprocessing policy is its open-ended nature, especially given the fact that DOE decided in 1992 to phase-out reprocessing operations. As long as DOE views reprocessing as a sound method for managing spent fuel, reprocessing will continue to be justified as the solution when additional types of spent fuel are found to be corroding or unstable in the future, and funds will not be devoted in a serious way to developing alternatives. In a November 15, 1995 letter, the Defense Nuclear Facilities Safety Board recommended that both reprocessing plants at the Savannah River Site be kept open indefinitely, stating that "the Department of Energy will always need to have available a capability for chemical processing of spent nuclear fuel…" [7] This is just one example of the commitment to reprocessing in some quarters.

A recent DOE study recommended against re-starting one of the reprocessing plants at the Savannah River Site and proposed consolidating operations in the other. While this is a positive development, DOE is also considering several possible "future missions" for reprocessing at the Savannah River Site that could involve reprocessing through 2012 in the single reprocessing plant. Because spent fuel management is such a long-term project, the current signs of a favorable attitude toward reprocessing provide a very real possibility that the United States will still be reprocessing in a decade or more from now. This is a remarkable retreat from DOE's 1992 position of phasing reprocessing out.

One positive development is DOE's decision not to reprocess N-reactor spent fuel at Hanford, which forms the bulk of the spent fuel inventory. There is no indication, however, that DOE has taken the lessons from Hanford and applied them to its larger reprocessing policy. Over five years ago, DOE proposed reprocessing the over 2000 metric tons of N-reactor spent fuel in Hanford's PUREX plant, using many of the same justifications it uses today. A 1990 study by IEER concluded that reprocessing was probably among the most expensive spent fuel management options and that it would increase the risk of a fire or explosion in the Hanford waste tanks. A U.S. General Accounting Office report also

concluded that DOE had not shown that reprocessing was necessary. Despite DOE's sound eventual decision to store the fuel instead, DOE's current arguments for reprocessing other types of spent fuel exhibit many of the same analytical mistakes as the PUREX proposal and similarly underestimate the advantages of dry storage.

Some officials within DOE have been questioning the rationale for reprocessing and are beginning to raise non-proliferation concerns, and some of the inconsistencies among the EIS's may be related to the relative influence of those who support reprocessing compared to those who place a fundamental value on implementing U.S. non-proliferation policy. The Foreign Research Reactor EIS is the best of the recent documents in its more careful consideration of non-proliferation issues, and it discusses some of the environmental liabilities of reprocessing as well.

The non-proliferation drawbacks of reprocessing are numerous. The U.S. is the only declared nuclear weapon state not currently reprocessing for military or civilian purposes. As such it is in an extraordinary position to work to stem the proliferation dangers from reprocessing in other countries. Long-term reprocessing in the United States, even if for environmental management purposes, would undermine U.S. credibility in this area by creating the perception of a double-standard.

Shutting down all reprocessing in North Korea and curtailing military reprocessing in India and Russia have been key U.S. non-proliferation goals over the past several years. The connection between U.S. reprocessing and stopping reprocessing abroad was made by President Bush in 1992 when he officially halted U.S. military reprocessing. He said his decision was part of a "set of principles to guide our non-proliferation efforts in the years ahead," and the White House added that his decision was "intended to encourage countries in regions of tension such as the Middle East and South Asia to take similar actions." [8]

U.S. plans for several years of reprocessing in former military plants could have negative consequences for negotiations on the international treaty for a cut-off of military fissile material production and for negotiations on the 1994 U.S.-Russian agreement ending military fissile material production. Moreover, reprocessing would undermine U.S. credibility to halt civilian reprocessing in countries such as Britain, France, India, Russia, and Japan. President Clinton stated in 1993 that the U.S. abstention from reprocessing is important for not encouraging civilian plutonium programs abroad. Finally, reprocessing would undermine the U.S. position to halt nascent reprocessing programs in countries such as China, Ukraine, and Pakistan.

Most of the DOE documents evaluated in this report do not assess the impact of reprocessing on U.S. non-proliferation efforts. Moreover, DOE has not made a comprehensive commitment to blend-down any extracted highly enriched uranium (HEU) into non-weapons-usable low enriched uranium and to put any extracted plutonium under International Atomic Energy Agency safeguards. Despite a Clinton administration policy to "submit excess fissile material not needed for our deterrent to the IAEA," only one EIS mentions the policy and commits to doing so. The other EIS's are much more vague about the fate of extracted fissile material, and one document indicates that extracted HEU would be stored as HEU for an interim period rather than blended-down.

The negative non-proliferation consequences of reprocessing, combined with its environmental drawbacks, lend support to the argument for taking a more prudent, cautious approach to spent fuel

management based on interim dry storage of spent fuel. Unfortunately, DOE has failed to properly consider the benefits and feasibility of this option.

Other Findings

1. *DOE terminology is obfuscating and obscures the sheer number of reprocessing proposals it is considering.* DOE terms such as “processing”, “conditioning”, and “treatment” may all refer to reprocessing, that is, the separation of plutonium and/or uranium from spent fuel, but the actual proposal being described is not immediately apparent from these terms. The option in the SNF/INEL EIS of constructing a new reprocessing plant at Hanford (a major development in U.S. non-proliferation policy) is referred to as Process Q, an opaque term to say the least. Misleading terminology is a poor foundation for coherent policy, and it may be a purposeful effort to hide reprocessing programs behind unfamiliar names.
2. *The materials that can most justifiably be reprocessed are the fissile material-containing solutions in the reprocessing plants at the Savannah River Site.* These solutions do pose serious accident risks, and if the reprocessing plants are ever to be shut down and dismantled the solutions must be removed. For solid spent fuel at the Savannah River Site, DOE should reconsider the option of monitoring and improving current storage conditions while at the same time constructing a dry storage facility.
3. *Despite the National Academy of Sciences’ conclusion that plutonium is an economic liability, some parts of DOE continue to view plutonium and possibly spent fuel as resources.* The SNF/INEL EIS refers to reprocessing as a method of “resource recovery,” and the Record of Decision for the F-Canyon EIS states that “[i]t would not be appropriate…to characterize the stabilized plutonium as waste,” with no further explanation. [9] DOE has not yet declared that its spent nuclear fuel is a waste product. It is apparent that the view of plutonium as a valuable asset still lingers within DOE and that DOE has not adjusted its plutonium policy to reflect post-Cold War circumstances.
4. *The National Academy of Sciences has also found problems with DOE’s spent nuclear fuel management policy.* In a recent study on electrometallurgical processing, the NAS asserted that it had difficulty assessing the technology in comparison to other options, including direct disposal of spent fuel, because it “was unable to determine that DOE has developed a broad comprehensive strategy covering interim management and ultimate disposition” of DOE spent fuel and nuclear materials. The NAS also asserted that the absence of criteria for repository emplacement “precludes a full comparative analysis of the alternatives” of interim storage and reprocessing. [10]
5. *Electrometallurgical processing is not an appropriate waste management technology, and its continued development keeps the door open to a return of civilian reprocessing in the United States.* Argonne National Laboratory has touted the potential applications of the technology to commercial nuclear power plant spent fuel, and the technology has been tested with a small amount of commercial spent fuel. In addition, DOE plans to apply it to commercial spent fuel under future research and development efforts. Reprocessing commercial spent fuel would reverse long-standing U.S. practice and undermine U.S. authority to discourage commercial reprocessing in other countries.
6. *Reprocessing small amounts of spent fuel or nuclear material pursuant to one EIS with a short time-frame raises the incentives to use the reprocessing plants for larger amounts of spent fuel or nuclear material over the long-term.* It is a ripple effect that could result in eventually

reprocessing all of the aluminum-clad spent fuel in the United States, once it is consolidated at the Savannah River Site under DOE's preferred alternative in the SNF/INEL EIS.

7. *The potential implementation of reprocessing may be driven by political and pork-barrel considerations.* Senators Strom Thurmond and Frank Murkowski, key committee chairmen with oversight responsibility for DOE and energy policy, continue to look favorably on reprocessing for spent fuel management. Senator Thurmond has advocated reprocessing research reactor and commercial spent fuel at the Savannah River Site in his state, as well as "legislative mandates that reprocessing, once begun, not be interrupted." [11] An internal DOE memo proposed constructing a new reprocessing plant at the SRS in an effort to create "economic benefits" and convince South Carolina to drop a lawsuit against DOE. Given the politics of reprocessing and the pork-barrel nature of some of the projects, it may be very difficult to end reprocessing operations once they are initiated.

Recommendations

1. The Department of Energy should undertake a comprehensive review of current reprocessing proposals and re-evaluate dry storage options for solid spent fuel based on more realistic data for cost and waste generation. In proceeding to address the environmental legacy of fifty years of nuclear weapons production, the Department of Energy needs to clarify its intentions, goals, and methods regarding reprocessing and make these transparent to the public.
2. Given the vast uncertainty regarding a repository, it would be prudent to store spent fuel for an interim period until there is more information about the form and type of fuel that can be put in a repository. A period of interim storage would also allow DOE to develop canisters and engineered barriers that could safely contain diverse types of spent fuel, as well as new technologies that could prepare spent fuel for disposal without separating the fissile material. As long as DOE views reprocessing as a sound method of spent fuel management, there will be little incentive to fully fund these essential R&D activities.
3. DOE should announce firm dates for decommissioning and dismantling its reprocessing plants. This announcement would strengthen U.S. non-proliferation efforts and would eliminate the current open-ended nature of reprocessing operations. The date for decommissioning should allow enough time to remove fissile-material containing solutions from the reprocessing plants at the Savannah River Site but should not be more than one or two years away.
4. A thorough non-proliferation analysis that recognizes international proliferation risks from U.S. reprocessing should be included in any future EIS's containing reprocessing proposals. Such an analysis should also be integrated into DOE's internal discussions and decision-making regarding spent fuel management.
5. Weapons-usable material extracted through reprocessing operations should be placed under IAEA safeguards, and DOE should make a policy declaration to that effect. DOE should also consider inviting international monitors to observe the reprocessing procedures. The plutonium that will be extracted, along with plutonium in DOE's current stockpile deemed surplus to military requirements, should be declared a liability.
6. DOE should abandon development of electrometallurgical processing and other new reprocessing technologies. Instead, DOE should focus its spent fuel R&D efforts on developing new types of canisters and engineered barriers that might make diverse forms of spent fuel compatible with repository disposal. Such an investigation should not assume that Yucca Mountain will necessarily be the repository location. On the contrary, it should investigate compatibility with

various rock types.

7. DOE should use the term “reprocessing” for all technologies and proposals involving separation of uranium or plutonium from spent fuel. This would eliminate ambiguities surrounding use of the term “processing” or other terms, allowing the public to better evaluate the proposals DOE is considering.

Introduction to the Full Report

For over forty years, the Department of Energy and its predecessor agencies operated reprocessing plants [12] to extract fissile material for nuclear weapons and other military purposes. These plants extracted approximately 96 metric tons of plutonium from spent nuclear fuel and irradiated target rods and at the same time generated enormous amounts of highly radioactive waste. [13] Military reprocessing occurred at three sites: Hanford, Washington; the Savannah River Site, South Carolina; and the Idaho National Engineering Laboratory. The Department of Energy began to curtail military reprocessing in the late 1980s as the Cold War drew to a close, and some time before or during 1992 DOE ceased reprocessing spent fuel for nuclear weapons purposes.

The cessation of operation of DOE reprocessing plants in the late 1980s and early 1990s left spent fuel that had been slated for reprocessing, as well as other nuclear materials, in limbo. Over 2,100 metric tons [14] of spent fuel was left underwater in cooling pools, and some solutions containing fissile material were left inside the reprocessing plants at the Savannah River Site. Most DOE spent fuel and the fissile material-containing solutions were not intended to be left in storage for extended periods, and they now pose some environmental problems and safety risks. For example, some DOE spent fuel is corroding and releasing radioactive material into cooling pool water, and some of the facilities now storing spent fuel are not believed to be stable in the event of seismic activity. The main safety risks from the spent fuel and solutions is increased radiation doses to workers and the potential that an accident involving the solutions or corroding spent fuel would have larger consequences than if they were put into a more stable form.

The Department of Energy is engaged in developing plans to manage its inventory of approximately 2,700 metric tons of spent fuel for an interim period and to dispose of it in a geologic repository along with a much larger amount of spent fuel from commercial nuclear power reactors. DOE’s Office of Spent Fuel Management, which is under the Office of Environmental Management (EM), is largely responsible for this program. EM is also developing plans to address environmental and safety issues stemming from the solutions in the reprocessing plants and various fissile-material containing scraps and residues. The problem of managing these materials is just one component of the overall environmental management task that DOE faces, which also includes decontaminating weapon production facilities, disposing of wastes, improving storage of plutonium, converting high-level liquid waste into solid forms, and many other tasks.

DOE has categorized its spent fuel into 53 different types depending on uranium enrichment level, [15] cladding material, [16] and fuel type. [17] Some spent fuel, such as naval spent fuel, is considered “high integrity” and can be stored for decades. Other spent fuel is less stable and is chemically reactive and/or corroding. Early in her tenure, Secretary of Energy Hazel O’Leary made spent fuel management a high priority, and in November 1993 DOE released its *Spent Fuel Working Group Report* which identified

spent fuel “vulnerabilities,” or conditions that may lead to radiation exposure or environmental contamination, within the nuclear weapons complex. Subsequently, DOE released three *Plan of Action* reports on resolving spent fuel vulnerabilities. [18]

As Brian Costner of the Energy Research Foundation and Beatrice Brailsford of the Snake River Alliance pointed out at a 1995 conference, “DOE is moving toward being able to clearly and fairly describe what comprises its SNF program. This is a vital first step, and despite other criticisms of DOE’s actions regarding SNF…the value of this effort should be recognized.” [19]

Over 98 percent of DOE spent fuel is at three sites, and over 75 percent of it is from a single source, Hanford’s N-reactor.

1995 DOE Spent Fuel Inventory(in Metric Tons)

Location
Hanford
INEL
Savannah River Site
Oak Ridge Reservation
Other DOE facilities
Universities
Other
TOTAL

SOURCE: SNF/INEL EIS, Summary, p. 8

NOTE: According to DOE, approximately 95 metric tons of spent fuel will be added to the inventory by 2035 from foreign research reactors, naval reactors, domestic research reactors, and other sources.

Over the past year, the Department of Energy has released several documents and environmental impact statements (EIS's) that indicate that it is considering re-starting reprocessing — this time not for military purposes, but for the purpose of addressing environmental and safety problems stemming from some DOE spent fuel. DOE's aim in reprocessing is to remove the fissile material from spent fuel and convert it to a solid form to reduce safety risks from continued storage of spent fuel. DOE also believes that the products of reprocessing may be easier and less costly to dispose of in a permanent geologic repository than some types of un-reprocessed spent fuel. In addition to re-starting existing reprocessing plants, DOE is investigating several new types of reprocessing technologies, and it has considered constructing a new reprocessing plant in the United States and utilizing reprocessing facilities in foreign countries.

Four recent EIS's relating to spent fuel and nuclear materials management contain proposals involving reprocessing:

- Final F-Canyon Plutonium Solutions EIS, December 1994
- Final Interim Management of Nuclear Materials EIS, October 1995
- Draft Foreign Research Reactor Spent Fuel EIS, March 1995
- Final Spent Nuclear Fuel/Idaho National Engineering Laboratory EIS, April 1995

Additionally, DOE and Argonne National Laboratory have issued several documents that outline a proposal to demonstrate electrometallurgical processing, a new kind of reprocessing technology.

The various reprocessing proposals at present apply to under 10% of the spent fuel in the DOE inventory, but much larger quantities of spent fuel, as well as other nuclear materials, could be reprocessed in the future. DOE has not put any kind of upper bound on the amount of spent fuel that may be reprocessed over the next few decades before repository emplacement. The reprocessing proposals center around the two reprocessing plants, F-Canyon and H-Canyon, [20] at DOE's Savannah River Site in South Carolina, though a recent DOE study concluded that DOE reprocessing missions could be accomplished using F-Canyon only. [21] Reprocessing of DOE spent fuel may also occur at the INEL in Idaho and at foreign reprocessing facilities. Reprocessing could occur for twelve years or longer pursuant to the various EIS's and documents, and over 4,000 kilograms of weapons-usable uranium [22] and over 400 kilograms of weapons-usable plutonium [23] could be extracted from spent fuel under the most likely reprocessing scenarios. DOE has pledged not to use fissile materials that may be extracted through reprocessing in nuclear weapons, but it has provided few details about the destination and possible uses of these materials.

While recognizing the complexity of DOE's spent fuel management task and the associated environmental and safety issues, this report argues that re-starting reprocessing would be detrimental both to sound environmental practice at DOE facilities and to U.S. non-proliferation interests. Although it is now being proposed as a tool for environmental management, reprocessing has been one of the leading causes of environmental contamination from nuclear weapons production in the United States and in other countries. The reprocessing plants that DOE may re-start at the Savannah River Site are aging structures that are over forty years old. Reprocessing will involve substantial waste generation, an increase in the risk of an accident in reprocessing waste tanks, and the extraction of materials whose ultimate disposition is a formidable task in itself. DOE data show that reprocessing creates more radioactive waste and more risks to workers and nearby communities than storing spent fuel for an interim period until its ultimate disposition can be decided. The spent fuel management program is a complex one involving dozens of variables, and there are large uncertainties regarding the proposed repository for spent fuel at Yucca Mountain, Nevada. Given these uncertainties, it makes sense to take an approach based on interim storage of spent fuel designed to allow development of options for final disposal.

This report draws a distinction between solid spent fuel and the fissile material-containing solutions that were left in the reprocessing plants when the plants were shut down. If the reprocessing plants are to be permanently decomissioned and closed, the solutions need to be taken out. Pumps, separations modules, and conversion lines may all have to be operated in order to pass the solutions through the system. This may involve separating fissile material from fission products and converting the fissile material to a metal or oxide form, but there are no other good options for the safe closure of the plants. Solid spent fuel stored in pools, on the other hand, does not pose the same magnitude of safety risks and can be monitored for a longer period until it can be moved to dry storage.

The present international arena is vastly different from the political circumstances under which reprocessing occurred in the past. The United States is the only declared nuclear weapon state that is not currently reprocessing for either military or civilian purposes. [24] As such it has the credibility to work to halt reprocessing in other countries and especially in Russia, where reprocessing and fissile material accumulation pose increasing proliferation risks. The Bush administration halted reprocessing in part to improve the international non-proliferation regime. The Clinton administration has stated that it does not want to encourage the commercial plutonium programs of other countries (which pose proliferation risks) and that the United States' abstention from reprocessing is important to achieve this goal. Reversing current practice, even if for environmental management purposes, would legitimize reprocessing and undermine U.S. non-proliferation efforts.

What is especially disturbing about DOE reprocessing policy is that it is a retreat from its own 1992 policy to phase out reprocessing at the Savannah River Site and INEL. While the 1992 policy envisioned some limited reprocessing in order to shut down reprocessing facilities in a safe manner and stabilize materials at the two sites, current plans appear to involve much longer-term reprocessing. DOE is considering several new "future missions" for one or both of the Savannah River Site reprocessing facilities, missions that may involve nuclear materials that are not currently at the SRS. DOE's interest in reprocessing means that funds will not be devoted in a serious way to investigating alternatives to reprocessing, since spent fuel projects tend to compete with each other for funds.

Given the drawbacks of reprocessing, why is DOE considering it so strongly as a waste management

tool? DOE appears to be drifting back toward reprocessing without sufficient analysis of its consequences, alternatives to reprocessing, and the current non-proliferation climate. Because reprocessing was what was done with most DOE spent fuel throughout the Cold War, parts of the DOE bureaucracy seem resistant to seriously considering other options for spent fuel management. There are also obvious institutional interests in continuing to operate and/or keep operational reprocessing plants upon which thousands of jobs depend.

Various branches of DOE have issued dozens of documents relating to spent fuel management, and there has been poor coordination among them. This has not only lent to the prevailing confusion of DOE spent fuel management policy, but it has also served as a vehicle for advancing reprocessing proposals. Some DOE documents are better than others in terms of pointing out some of the liabilities of reprocessing, and the differences appear to result from internal DOE debates over the environmental and non-proliferation consequences of reprocessing.

This review of reprocessing and alternatives to it is divided into three main sections. The first section provides background information on the history of reprocessing in the United States, both military and civilian, and the Clinton administration's policy on reprocessing and fissile materials. The second section examines the non-proliferation and environmental consequences of reprocessing. It assesses the validity of DOE's main arguments in favor of reprocessing and discusses some alternatives. The third section is the bulk of the report and examines each of the EIS's and the electrometallurgical processing proposal in detail, pointing out areas of flawed analysis and the inconsistencies among the documents.

Notes:

1. Reprocessing is the separation of spent nuclear fuel into its constituent parts, mainly plutonium and/or uranium and lighter elements that are the product of nuclear fission in reactors. ? Return
2. Until recently, Hanford N-reactor spent nuclear fuel, which accounts for over 75% of the DOE spent fuel inventory, was being considered for electrometallurgical processing. ? Return
3. Westinghouse Savannah River Company, *Technical Data Summary Supporting the Spent Nuclear Fuel Environmental Impact Statement*. Revision 2, Westinghouse Savahnnah River Company. March 1994, p. 8. ? Return
4. Department of Energy, *Final Environmental Impact Statement — Interim Management of Nuclear Materials*. DOE Savannah River Site, October 1995, pp. 2-55 to 2-58. ? Return
5. Department of Energy, *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*. DOE Office of Environmental Management and DOE Idaho Operations Office, April 1995, Volume 1, Appendix C, pp. 5-41 to 5-43. ? Return
6. Sandia National Laboratories, *Performance Assessment of the Direct Disposal in Unsaturated Tuff of Spent Nuclear Fuel and High-Level Waste Owned by the U.S. Department of Energy*. Volume 1: Executive Summary. SAND94-2563/1. Sandia National Laboratories, 1995, p. ES-37. ? Return
7. Conway, John T. (Chairman, Defense Nuclear Facilities Safety Board) Letter to Secretary of Energy Hazel R. O'Leary. Defense Nuclear Facilties Safety Board. November 15, 1995. ? Return
8. Statement by the President and Fact Sheet on Nonproliferation Initiative. White House Office of the Press Secretary, July 13, 1992. ? Return
9. Department of Energy, *DOE-Owned Spent Nuclear Fuel Strategic Plan*. DOE December, 1994, p. 14. ? Return

10. National Academy of Sciences, *An Assessment of Continued R&D into an Electrometallurgical Approach for Treating DOE Spent Nuclear Fuel.* NAS 1995, pp. 27-28. ? Return
11. Letter to Senator Frank Murkowski, June 29, 1995. ? Return
12. Reprocessing is the separation of spent nuclear fuel into its constituent parts, mainly plutonium and/or uranium and lighter elements that are the product of nuclear fission in reactors. ? Return
13. Over 103 metric tons of plutonium was produced in reactors. However, 7.4 metric tons remains in irradiated spent fuel and has not been extracted. ? Return
14. A metric ton is 1,000 kilograms. Throughout this report, the term “metric ton” of spent fuel is used as a short-hand for a more technical measurement called metric ton of heavy metal (MTHM), which is DOE’s traditional measurement of spent fuel mass. MTHM refers only to the mass of plutonium, uranium, and thorium in the spent fuel. The actual mass of spent fuel is always larger than the mass of its heavy metals. ? Return
15. Uranium enrichment refers to the percentage of the fissile uranium isotope U-235 in the fuel. Natural uranium contains roughly 0.7% U-235 and 99.3% U-238. The ratio of U-235 to U-238 can be increased in a uranium enrichment plant. Most commercial nuclear power reactors use uranium enriched to 3%-4% uranium-235. The fuel for most naval and some research reactors contains weapons-usable highly enriched uranium (HEU) enriched to 90% or more in U-235. ? Return
16. Cladding material refers to the type of material out of which the tube that contains the fuel pellets is made. Cladding materials include aluminum, zirconium, stainless steel, and others. ? Return
17. DOE 1994d, p. 31. Fuel type refers to the chemical form of the fuel pellets. Types include uranium oxide, uranium carbide, mixed uranium plutonium oxide (MOX), uranium zirconium hydride, and uranium metal. ? Return
18. The reports were released in February, April, and October 1994. ? Return
19. Costner, Brain and Brailsford, Beatrice, “Managing Spent Fuel Without Building Bombs.” Proceedings of the Waste Management 1995 Conference, Tucson Arizona, February 26 – March 2, 1995. ? Return
20. Reprocessing plants are sometimes called canyons because they are long, narrow structures. ? Return
21. Department of Energy, *Facility Utilization Strategy for the Savannah River Site Chemical Separation Facilities*. DOE, December, 1995. ? Return
22. The Foreign Research Reactor EIS considers reprocessing 18.2 out of a total of 19.2 metric tons of foreign research reactor fuel and states that the total contains 4,600 kilograms of HEU. Mark-16 and -22 fuels, which are highly enriched, contain several hundred kilograms of uranium. ? Return
23. 400 kilograms is a rough estimate. It is based on DOE figures that show 300 kilograms of plutonium in irradiated materials at the Savannah River Site (Grumbly 1994). Most of these materials are planned to be reprocessed. In addition, Argonne National Laboratory has said that 200 kilograms of plutonium are contained in the EBR-II spent fuel planned to be electrometallurgically processed (McFarlane and Lineberry, p. 3). About 4,000 kilograms of plutonium would be extracted if Hanford N-reactor fuel were reprocessed (Grumbly 1994). ? Return
24. Civilian reprocessing refers to reprocessing spent fuel from commercial nuclear power reactors. The plutonium and uranium extracted through civilian reprocessing is normally fabricated into new fuel for nuclear reactors. ? Return