Reprocessing and Spent Nuclear Fuel Management at the Savannah River Site

Some of the terms used in this factsheet are defined in IEER's on-line glossary.

Tens of thousands of tons of radioactive material were reprocessed at the Savannah River Site (SRS) near Aiken, SC, from the mid-1950?s through the beginning of this decade. Since the end of the Cold War, though, operations at SRS have been predominately aimed at trying to stabilize the waste and contamination created by past reprocessing and at stabilizing a few hundred tons of radioactive material, most of which has been stored on-site since the 1980?s.

The Draft Environmental Impact Statement (EIS) is a document to help the Department of Energy (DOE), which owns SRS and the rest of the nuclear weapons complex, decide how to manage 68 tons of radioactive material, almost all of which is a type called spent fuel. Most of this material is already at SRS, and the remainder is scheduled to arrive there during the next 35 years. The Draft EIS describes this spent nuclear fuel (SNF) and other radioactive material, proposes alternative ways to manage it, and describes some of the impacts of these alternatives.

The information below puts the Draft EIS in a historical context and explains the decisions facing DOE.

Background

Reactors are fueled by a mixture of uranium. The most important type of uranium in this mixture is the isotope uranium-235 (U-235). When uranium is mined from the earth it contains only about 0.7% U-235. Industrial processes enrich uranium by concentrating the amount of U-235 to 3% or more for use as reactor fuel. Uranium with more than 20% U-235 is called highly-enriched uranium (HEU). Fuel is comprised of enriched uranium surrounded by, or clad with, a metal. The cladding used at SRS was aluminum. Stainless steel and other metals are often used elsewhere.

U-235 decays inside a reactor. Since there's so much other U-235 nearby, the neutron given off by one atom decaying often bumps into another U-235 atom causing it to split apart, or fission, quicker than it would have naturally. This sets off a chain reaction during which a very large number of U-235 atoms split apart in a very short time. After a while, operators of the reactor stop the chain reaction by inserting control rods which absorb the neutrons coming off the decaying and splitting U-235, and then they remove the fuel from the reactor. At that point the fuel is considered to be spent. Spent fuel is sometimes also called irradiated fuel, meaning it has been exposed to radiation.

The primary mission of SRS throughout the Cold War was to produce tritium, a radioactive element used in nuclear weapons. This was done by placing fuel into one or more of the site's five production reactors. Targets made of lithium were also placed inside the reactors. During the chain reaction, some of the neutrons coming off the U-235 were absorbed in the target rather than bumping into another atom of U-235. This created tritium inside the lithium target rod.

When the SRS reactors were not being used to make tritium, they were often used to make plutonium for nuclear weapons (Pu-239). This was done in a very similar way using depleted uranium targets instead of

lithium ones. Depleted uranium is what's left when most U-235 has been removed from natural uranium during the enrichment process. Sometimes other target materials were used to produce different radioisotopes. For example, neptunium-237 was used to produce Pu-238 for heat sources and special batteries for space exploration, as well as military and intelligence missions. The last SRS reactor operated in 1988.

Nuclear weapons are not made of irradiated targets. The tritium or plutonium first has to be separated from everything else in the target — the metal cladding and the other radioactive elements. The separation process for plutonium is called reprocessing. Reprocessing was also used at SRS to recover HEU from spent fuel to be made into new fuel. Some of this fuel came from SRS reactors, and spent fuel containing HEU was also sent to SRS from research and test reactors in the U.S. and other countries. Continued reprocessing is one of the options in the Draft EIS for managing SNF in the future.

Reprocessing is probably the dirtiest operation in the nuclear fuel cycle. (If there's a dirtier step, it's the initial mining and milling of uranium which has scarred the landscape of affected areas with millions of tons of dangerous dirt called tailings and large amounts of low-grade ore.) In South Carolina alone, reprocessing is responsible for creating the most radioactive waste in the country — over 30 million gallons of high-level liquid waste containing chemicals used in the separation process combined with a long list of radioactive elements created inside the reactors. Reprocessing has also generated tens of thousands of containers of solid radioactive waste which is buried just a few miles from the Savannah River. Already some of that waste has moved into soils and groundwater at SRS, while some liquid low-level radioactive waste from reprocessing began seeping into creeks at SRS years ago.

It will cost U.S. taxpayers tens of billions of dollars to contain the waste from past reprocessing. There are no plans to ever completely clean it up. No one yet knows how to do so safely, even if there was money to try.

Ending Reprocessing

In 1992, the Bush Administration decided it was time to phase out reprocessing. The reprocessing plants, usually called canyons because of their size, are old and expensive to operate. With the Cold War over, the facilities have served their purpose.

DOE has been struggling with how to bring reprocessing to an end for the last seven years. It found a way to do so quickly at the other sites with reprocessing plants — Hanford in eastern Washington and the Idaho National Engineering and Environmental Laboratory. But it's a different story at SRS.

Partly the difference is because the two reprocessing plants at SRS — the F- and H-Canyons — are the last ones in the country. Some people resist shutting down the last plants out of fear that there's some nuclear material out there that will one day urgently need reprocessing. This is the argument that has kept the plants operating for the last few years and seems likely to keep them going another 4-5 years.

The reprocessing canyons are being used to stabilize several kinds nuclear materials left over from SRS' production days. Some of this material had been allowed to corrode for over a decade. Other material was in liquid form. In a few years, all the material currently at SRS with a chance of presenting a safety problem will have been reprocessed. But some say there may be nuclear material elsewhere that should be

sent to SRS for reprocessing.

Some people want to see reprocessing continue in the hope that it will somehow become part of commercial nuclear operations in the U.S. A patch of land just beyond the border of SRS in Barnwell County is home to a partially completed commercial reprocessing plant. It's construction was halted in the late 1970?s and early 1980?s for a variety of reasons, most notably concern about treating plutonium which can be made into nuclear weapons as a commercial product and the simple economics that reprocessing is not cost effective.

A third reason people argue for continued reprocessing is to maintain jobs. In the waning years of the Cold War, SRS was fiercely competing for new federal projects that would have continued the site's bomb-making role for another half century. There is a common fear that without a mission to produce something, the site will cease to exist. Reprocessing is one of the last of the old production operations still operating.

SRS employs about 15,000 people in the Aiken-Augusta area. That's twice the number of people employed by SRS in the region during the 1960?s and 1970?s. Only about 1,500 of the jobs are directly related to reprocessing. When reprocessing ends, there won't suddenly be 1,500 people out of work. Most of the jobs will continue for several years as the reprocessing buildings are cleaned out and put into a safe condition. There is lots of other work to be done at SRS, too, such as trying to safely manage the vast quantities of waste and contamination created there during the Cold War.

Future SNF Management

Compared to the amount of radioactive material handled at SRS throughout the Cold War, the amount DOE is currently proposing to manage there is small. Whereas for nearly 40 years decisions were regularly made about how to manage hundreds or thousands of tons of spent fuel and irradiated targets annually, in the Draft EIS DOE is deciding how to safely manage less than 70 tons over the next 40 years. But since DOE has not made any new nuclear weapon materials in over a decade, this represents a significant portion of the nuclear material in DOE's inventory.

During the Cold War, the decision was a choice between continued storage and reprocessing. Today, the decision involves a few more options. DOE prefers to manage spent fuel in the future using a combination of three techniques: reprocessing, melt and dilute, and repackaging for shipment off-site.

Since the Bush Administration's decision to phase out reprocessing, the SRS canyons have only been used to stabilize nuclear material for which there was a claimed health and safety concern. That is, someone made a case that the spent fuel or other nuclear material posed a risk of unnecessarily exposing workers or in some other way becoming unsafe. Many of these claims were controversial, but DOE has so far used this rationale to justify all its recent decisions to reprocess. As a result, the most dangerous materials left over from SRS production have already been reprocessed.

Of the material evaluated in the Draft EIS, DOE wants to reprocess a little over 19 tons of spent fuel and less than a ton of other material, including 16 bundles of targets. The targets were originally intended for the production of a kind of plutonium used in nuclear weapons testing and development (Pu-242). This is about 28% of the total mass of material evaluated in the Draft EIS. Nearly all this nuclear material is

already at SRS.

DOE applies the health and safety rationale to almost all the material proposed for reprocessing, but then adds two additional rationales for about 1 ton of it. Some material is to be reprocessed because it may not be acceptable in a geologic repository and one kind of material is to be reprocessed because it contains stainless steel which is not suitable for the melt and dilute option. The rationale for this latter material — a filter used in a test reactor in Idaho — is that it is not cost effective to develop a technique other than reprocessing to handle a single, unique item.

This reprocessing is scheduled to occur over the next three years and so be complete by the end of 2001. During this time, both reprocessing canyons at SRS are planned to be operating anyway to stabilize the last of the nuclear materials at SRS for which safety concerns have been raised and some plutonium wastes from DOE's Rocky Flats plant in Colorado.

The second technique DOE proposes to use is called melt and dilute. This is DOE's preferred alternative for about 28 tons of material — or about 41% of the total mass evaluated in the Draft EIS. Very little of this spent fuel is at SRS now. Most of it is at the research or test reactor where it was, or still is being, used. When, and in some cases if, it will arrive at SRS is uncertain.

If all 28 tons of spent fuel were at SRS now, it could be reprocessed in about 3 years. But the spent fuel will arrive through 2035. Shipments of spent fuel from outside the U.S. should be complete by 2010. Then over the next 5 years, aluminum-clad spent fuel will arrive from DOE's Idaho National Engineering and Environmental Laboratory. All the while, a few hundred elements of spent fuel per year will arrive from domestic research reactors, mostly small reactors located at universities. These shipments from U.S. research reactors will continue through at least 2035.

It costs approximately $400 million per year to maintain and operate the reprocessing canyons at SRS. The facilities were not designed to accept spent fuel trickling in small amounts. They are designed to operate at much higher levels. It is a waste of money to operate them for reasearch reactor fuel.

Reprocessing is also the option that generates the largest amount of radioactive waste. The most dangerous of this waste is called high-level waste — a liquid waste stream carrying chemicals used in reprocessing along with many radioactive isotopes from the spent fuel or other material. This high-level waste would be added to over 30 million gallons of liquid waste from past reprocessing already stored in underground tanks at SRS. Some of these tanks have leaked, and storage of the waste in this form poses risks of fire or explosion resulting from chemical reactions inside the tanks. Moreover, in January 1998, SRS officials acknowledged — after over a decade of warnings and a half billion dollars in expenses — that one of the techniques intended to help remove waste from the tanks is unsafe. A replacement technology may not be ready until 2005.

Furthermore, continued reprocessing would mean relying on a Cold War technology well into the 21st Century — hardly the example the U.S. should set for the world if it is serious about stopping the spread of weapons of mass destruction. And, so long as the canyons operate for a small amount of spent fuel, DOE will consider proposals to bring more waste into South Carolina for reprocessing. If DOE is spending the money anyway, SRS will always appear as an attractive option for accepting additional waste. Still, some people will tell DOE in their comments on this Draft EIS that it should reprocess research reactor fuel, at

least until 2010, if not 2015 or even 2035.

DOE wants to end reprocessing and begin using a simpler technology — melt and dilute. With this technique, the spent fuel or other nuclear material will be heated, diluted with depleted uranium if the fuel contains HEU, and sealed inside a stainless steel container. The result would be a stable waste form.

There are two drawbacks to the melt and dilute approach. First, SRS has repeatedly refused to request full funding to develop this technology, leaving DOE officials in Washington, DC, to add it to the SRS budget. This reflects internal DOE politics and the preference of many people at SRS to continue reprocessing as long as possible.

Second, when the fuel is heated to be melted, some of the radioactive material may be volatilized. That would make it airborne and carried along with the air leaving the melt and dilute facility. DOE is confident a system can be designed and implemented to capture most of the radionuclides before they go out the building's exhaust stack, but until they prove it, the technology cannot be safely implemented.

The third approach DOE proposes is to repackage some of the spent fuel for transportation. This is how DOE would manage approximately 20 tons of spent fuel and irradiated targets that either contain radionuclides that DOE thinks may be used in the future or that are clad in stainless steel or zirconium. The stainless steel and zirconium clad fuels would be sent to Idaho to be stored along with similar spent fuel already there.

IEER Recommendations

- DOE should accelerate funding of the melt and dilute technology and make it a high priority to determine whether volatilized radionuclides can be captured in the facility's off-gas system. In making this determination, DOE should make all information publicly available so as to allow full and open review. DOE should also initiate an independent technical review panel to evaluate engineering designs.
- DOE should underscore the importance of its previous decisions to phase out reprocessing and during the phase out period DOE should only reprocess as needed to resolve clearly demonstrated, imminent hazards. DOE should take a lead in demonstrating to the world that nuclear materials can be safely managed without separating weapons usable materials. This is an important policy to maintain if the spread of nuclear weapons is to be curtailed.
- In the Final EIS, DOE should clearly compare potential future reprocessing rates, costs, and waste generation with historic levels. This comparison should be sufficient to allow independent confirmation of DOE's estimates and whether the SRS reprocessing canyons are appropriate for the proposed activities.
- DOE should describe the EIS in the context of all other pending decisions which could result in decisions to reprocess additional materials. It is important for the public to understand the full scope of future reprocessing activities, the point at which reprocessing facilities will be safely decommissioned, and the ways nuclear materials will be managed in the future.

Related documents:

1. IEER's Comments on the Savannah River Site Spent Nuclear Fuel Management Draft

Environmental Impact Statement February 8, 1999
2. SRS Spent Nuclear Fuel Management Draft EIS, December 1998, DOE/EIS-0279D (can be found on the Department of Energy website)

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