NUCLEAR WASTE IN SOUTH CAROLINA

An Issue Brief for Citizens

The League of Women Voters of South Carolina

December 13, 2013

ABOUT THE LEAGUE OF WOMEN VOTERS

Established in 1920, the League of Women Voters is a nonpartisan political organization that encourages the active and informed participation of citizens in government. At the local, state, and national levels, the League works to increase understanding of major public policy issues through education, and influences public policy through advocacy. Membership in the League is open to any citizen of voting age, male or female.

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This report, including the links to footnotes, is on the LWVSC web site,
and will be updated as important events develop.

FOREWARD

In 1997, Dr. Mary T. Kelly, a chemist and Natural Resources Director for the League of Women Voters of South Carolina (LWVSC or "League"), authored a ground-breaking document, *The Aging of the Nuclear State: A Survey of South Carolina's Nuclear Utilities"* that described the nuclear industry in South Carolina. At that time, both the commercial nuclear industry and the weapons activities at the U.S. Department of Energy (DOE) site on the Savannah River were mysteries to most South Carolina citizens. Dr. Kelly wanted to uncover the facts, and particularly to focus public attention on the leaking tanks of neglected high-level waste at what is now called the Savannah River Site (SRS). The purpose of this updated Issue Brief, *South Carolina's Nuclear Options*, is to carry forward Mary's legacy to both inform the public about current nuclear affairs in South Carolina and to promote the League's goals of environmental protection.

In November 20, 2010, the State Board authorized a policy and plan for opposing SRS as a storage site for commercial spent fuel, stating in part:

> "Thirty years ago South Carolina stood almost alone in urging federal funding for the permanent management of defense wastes collected at the Savannah River Site (SRS). The League of Women Voters of South Carolina was then part of the concerned community, and now will do all we can to keep this state from becoming a storage site for commercial nuclear wastes."

By publishing *Nuclear Waste in South Carolina*, the LWVSC hopes that the citizens of South Carolina will increase their understanding of this critical public health and safety, environmental, and economic issue for our state.

This document is dedicated to
the memory of
Mary T. Kelly, Ph.D.

a tireless advocate for the environment!

January 18, 1923 – November 9, 2013

ACKNOWLEDGMENTS

We are grateful for the contributions of Suzanne Rhodes to this brief on nuclear waste issues in South Carolina. Dr. Mary Kelly deserves special thanks, as her long commitment to the well-being of people of South Carolina inspired this report. Today's leaders of the LWVSC try to follow the path of scientific rigor and political courage that Mary Kelly set.

We would like to acknowledge and thank the following for their assistance over the course of the project: Tom Clements—Southeastern Nuclear Campaign Coordinator at Friends of the Earth, Columbia, SC; Mary Olson—Nuclear Information and Resource Service Southeast Office, Asheville, NC; and Becky Carr— LWV Florence Area, who helped with initial editing and framing the issues. Importantly, without Barbara Zia's leadership, encouragement, optimism, and grace, the effort may have faltered. We appreciate the work of Dianne Haselton for her design and formatting work on this report, and Betsy Oakman for final editing.

Finally, we are grateful to the members and friends of the LWVSC Mary Kelly Environmental Fund for their contributions that make publication of *South Carolina's Nuclear Options* possible, especially Kathleen Kempe and Ron Sobczak for sponsoring an event in 2009 to honor Mary Kelly and her work on behalf of the environment.

JoAnne Day, Susan Richards, Co-Presidents
League of Women Voters of South Carolina - December 13, 2013.

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Introduction

At the time of publication of the first brief on nuclear issues by the LWVSC, a few citizens in other states had similar concerns about their federal defense neighbors. The governors and delegations of South Carolina, Washington State and Tennessee had been leaders in the cleanup of defense facilities and passage of the Nuclear Waste Policy Act (NWPA) of 1982.[1]

Although some of the most difficult wastes remain untreated at SRS, much has been accomplished over the past three decades. Cleanup is now the primary mission of site management—to stabilize old wastes in preparation for safe storage onsite and ultimate shipment of most high-level wastes to a permanent repository. If SRS receives adequate congressional appropriations, legacy management goals should be accomplished in approximately 20 years. However, schedules have slipped recently as a result of federal budget cutbacks, unforeseen technical challenges, and competition with SRS digressions such as nuclear energy parks and pursuit of a small modular reactor design.

SRS has provided the Aiken, South Carolina, and Augusta, Georgia, areas with important, interesting jobs and has attracted a unique workforce. Many citizens in the SRS area desire to maintain the workforce and have been searching for new opportunities. A recurring proposal from SRS boosters[2] has been to bring commercial spent fuel to SRS for storage and reprocessing. Southern Carolina Alliance, the regional economic development organization representing six South Carolina counties [Allendale, Bamberg, Barnwell, Colleton, Hampton and Jasper], has also promoted various nuclear ventures, particularly the development of one of the small modular reactor designs at SRS.

The apparent closing of Yucca Mountain as a geologic repository for commercial spent fuel has provided an opportunity for SRS boosters to reissue the "invitation" to bring commercial wastes to Aiken.

France's AREVA, a very active leader of the international nuclear industry, has been heavily lobbying the United States to adopt the French model of designing and building more nuclear plants for electricity, and subsequently reprocessing spent fuel to separate plutonium. AREVA is currently building the controversial Mixed Oxide plant at SRS.

"Don't Waste Aiken," a citizens group in the Aiken area, has been formed to oppose the "invitation" of spent fuel to SRS. The group's interest is to educate citizens regarding the community's

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[1] http://www2.epa.gov/laws-regulations/summary-nuclear-waste-policy-act.

[2] SRS Community Reuse Organization (CRO) and Citizens for Nuclear Technology Awareness (CNTA).

long-range responsibilities if commercial spent fuel were brought to the SRS area. These concerns include: transportation impacts on the community, the decades anticipated for storage, and dispelling the misunderstanding that reprocessing wastes would lessen the need for geologic storage.

Thirty years ago, South Carolina stood almost alone in urging safe management through federal funding of defense waste management at the Savannah River Site (SRS). The LWVSC was part of the community raising concerns. LWVSC currently has serious concerns about South Carolina becoming a storage site for commercial nuclear wastes, as some are now advocating, because "temporary" storage is likely to last at least several decades. Both citizens and Congress must become actively involved in identifying and establishing a geologic repository if one is to be developed. In addition, commercial waste management at SRS would detract from defense waste management responsibilities, which are substantial. Unfortunately, important tasks at SRS remain very challenging and schedules have been slipping. The 2014 DOE Budget Request for cleanup at SRS was about 20 percent lower than previously agreed upon to meet cleanup schedules, which now will be extended.

LWVSC believes that, until a permanent solution is found, all current and future nuclear wastes should be managed safely and monitored regularly at the locations where wastes are generated - at both SC commercial and defense sites. Public attention and monies should be focused on a permanent repository, rather than on a "temporary" plan that could become permanent and risky.

Nuclear Waste Overview

Nuclear Fuel Cycle

The manufacturing of nuclear fuel is very complicated. The process is depicted in Figure 1. This paper focuses on the management of waste fuel after it has been "spent." For more details, one good source of information is the Blue Ribbon Commission Report[3] (more on Page 11).

Waste Storage

Spent commercial nuclear fuel is stored, generally, at the reactor site where it produced electricity. Savannah River Site (SRS) is a weapons facility that contains defense wastes accumulated since the 1950s. Wastes are principally from operation of five reactors to produce plutonium and other weapons materials. SRS management has been tasked with securing nuclear and other wastes at 310-square-miles along the Savannah River, across from Augusta, Georgia. Cleanup is now the primary mission —stabilizing old wastes in preparation for ultimate shipment of some wastes to a permanent repository, and permanent onsite storage of other wastes.

[3] http://cybercemetery.unt.edu/archive/brc/20120620211605/http:/brc.gov//

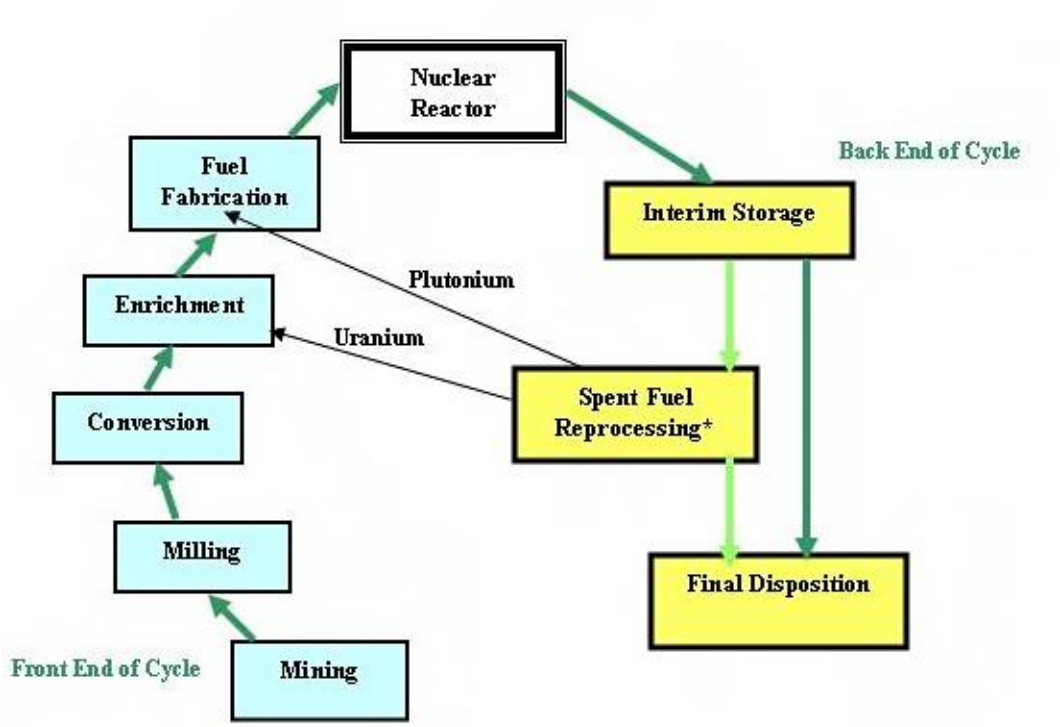

Figure 1. The Nuclear Fuel Cycle

* Spent Fuel Reprocessing is omitted from the cycle in most countries, including the United States; enrichment of reprocessed uranium has been troubled. Adapted from the Blue Ribbon Commission report, Page 9.

Yucca Mountain in Nevada has long been anticipated as a permanent geologic storage site for U.S. spent fuel and other high-level nuclear wastes generated in the United States, but progress was slow and congressional appropriations were both slow and inadequate. Initially, the Nevada site selection was based on politics; the decision in 2011 to halt the program was also based on politics. The League and other supporters of nuclear safety are hopeful that selection of the next repository site will be based on science. The future of Yucca Mountain is very uncertain.

The primary feature on the Yucca Mountain site consists of two large tunnels that DOE bored into and underneath Yucca Mountain. The main tunnel is U-shaped with two entrances—the north portal and the south portal—and is about 5 miles long and 25 feet in diameter. Another 2-mile tunnel branches off of the main tunnel. Each tunnel contains minor spurs and alcoves used to house equipment and conduct experiments. DOE officials said that most of the aboveground facilities and infrastructure at the Yucca Mountain site were constructed more than 20 years ago and were intended to be temporary and have not been maintained[4]. Today,

[4] GAO-11-847, Pages 10 & 11.

- the site today has been abandoned,
- nothing exists but a boarded up tunnel to nowhere,
- there are no miles and miles of waste disposal tunnels,
- there are no receiving and handling facilities,
- there are no containers or casks for transporting and disposing of the waste,
- there is no railroad to the site.[5]

SRS employees and community leaders have been advocating for assured nuclear activity at SRS after current waste management responsibilities are completed, perhaps in 20 years. A "Nuclear Energy Park" concept at SRS was first publicly proposed at community meetings in 2008 and 2009, although the general concept is much older. SRS nuclear park proposals have varied widely but have usually been elaborate and included at least one reactor, a reprocessing experiment or demonstration, and they always anticipate federal funding.

Many in the SRS community are convinced that reprocessing commercial spent fuel (separating plutonium from other spent materials) would present a desirable economic opportunity for the region. Local, state and federal governments are being actively lobbied for concept support and for public funding. SRS boosters commissioned a $200,000 study which was published in February 2013 to promote "invitation" and storage of commercial spent fuel and reprocessing at SRS (more on Page 13).

Most proponents of reprocessing anticipate that reprocessing waste volumes would be less than the original spent fuel storage volumes when placed in the geologic repository. However, because reprocessing does not reduce decay heat, which is a key factor in determining geologic placement, disposal volumes would not change significantly after reprocessing.[6] Independent studies of the economics of reprocessing report it costs more than the recovered products are worth in the foreseeable future.

The U.S. nuclear power industry is eager to remove spent nuclear fuel (SNF) from overfilled fuel pool storage at most reactor sites, where the utilities are responsible for safekeeping. According to the Government Accountability Office, this SNF was accumulating at 75 sites in 33 states in 2011.[7] With 100 nuclear units still active and supplying 20 percent of the nation's electricity, 2,000 metric tons of spent nuclear fuel continues to be added each year to the almost 70,000 metric tons of spent fuel already stored at reactor sites. About one-third of the industry's spent fuel

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[5] http://www.state.nv.us/nucwaste/news2011/pdf/nv110427ym.pdf.

[6] http://www.scribd.com/doc/127913259/Nuclear-Fuel-and-HLW, December 2012.

[7] GAO-11-229.

has been removed to "dry cask storage"—usually at the reactor site. More will have to be moved from fuel pools in the next two years.

A draft U.S. Senate bill, S-1240, Nuclear Waste Administration Act of 2013[8] under discussion in Summer 2013 favors co-locating "interim" or temporary commercial spent fuel storage at an undetermined geologic repository site, and seems to also favor federal sites for "interim" or "consolidated" waste storage until a repository is available. The bill only vaguely addresses repository issues. SRS is, of course, a federal site.[9] All recently proposed programs for waste storage and geologic storage are linked to some kind of "consent" from the community. However, consent is not defined. SRS boosters have already "invited" commercial spent fuel storage from time to time.

Thus a confluence of events—the likely closing of Yucca Mountain, the desire for new nuclear jobs at SRS, spent fuel storage pressures on the nuclear utility industry, and heavy French influences—have invited many nuclear interests to look longingly at South Carolina as the nation's "temporary" commercial spent nuclear fuel dump.

Concerns about Spent Commercial Nuclear Fuel Storage at SRS

If South Carolina were to become a spent fuel storage site, as many as 70 congressional districts in 39 states and many related and powerful industries would no longer have concerns about spent fuel accumulating in their communities. Ratepayers and taxpayers would be responsible for the expenses of storing spent fuel, its management and ultimate disposal. It would be up to the delegations from South Carolina and Georgia to ensure that the money and policy were forthcoming to move the spent fuel to a final repository. Storage at SRS would neither encourage the broad federal discussion of, nor investments in, the country's much-needed permanent geologic repository.

The nation has a historic pattern of delay in making decisions about nuclear waste management. South Carolina was one of a few states finding itself in exactly this position into the 1960s and 70s, when defense waste was stored and largely ignored at SRS and other federal facilities. Similarly, Nevada's concerns about faulty geology and hydrology at Yucca Mountain were ignored.

Furthermore, the transportation of spent fuel twice—once to a "temporary" site for interim consolidated storage, and again to the repository—would increase transportation costs, worker exposures, and public outrage. Community concern regarding nuclear waste transportation should not be minimized.

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[8] Permalink: http://www.energy.senate.gov/public/index.cfm/2013/7/full-committee-hearing-to-consider-the-nuclear-waste-administration-act-of-2013.

[9] http://www.energy.senate.gov/public/index.cfm/nuclear-waste-bill-feedback.

Congressional Role in Yucca Mountain and the Future Waste Program

For decades, science and technology have taken a back seat to politics in the design, planning and funding of our nation's nuclear waste management program. Programmatic challenges thus far include the:

- optimistic schedule that required the U.S. Department of Energy (DOE) to begin to "take title" of spent fuel by January 31, 1998;
- initial selection of Yucca Mountain for political reasons;
- cancellation of the search for a second site, which would have been in the West;
- decision to halt the search for a second repository in the East;
- suggestion to double the capacity of Yucca Mountain;
- diversion of funds to develop a future repository.[10]

The Waste Fund was absorbed into the U.S. Treasury in the 1980s during minor budget challenges (Figure 2, Page 7). Slow and inadequate congressional appropriations for the Yucca Mountain project have been an ongoing problem (Figure 3, Page 8). The Blue Ribbon Commission on America's Nuclear Future (BRC) and the Government Accountability Office (GAO) have recommended that Congress re-establish a stand-alone revolving fund for fees collected from consumers of nuclear-generated electricity to enable future program management. The DOE concurs.[11]

Despite the BRC and DOE recommendations to reinstitute the system of collections for a repository program, Congress may not promptly reopen the site selection process for a repository, and perhaps not even for a temporary storage facility. Preferable geological sites tend to be located in areas where citizens can be anticipated to be hostile rather than to "volunteer" or "invite" as hosts. Even if Congress follows the recommendations of the BRC in a timely manner, South Carolina will continue to accumulate additional waste at SRS, at least until 2048, probably decades longer.[12]

[10] BRC, Page viii.

[11] DOE 2013, Page 14.

[12] DOE 2013, Page 2.

Nuclear Waste Fund

The *Nuclear Waste Policy Act of 1982 (NWPA)* provided a mechanism to pay for the management of nuclear wastes at a permanent repository. The Nuclear Waste Fund (Fund) has been theoretically financed from a fee of one-tenth of a cent per kilowatt-hour generated from nuclear electricity, a fee which could have been renegotiated, but has not. The nuclear power utilities and their ratepayers have invested about $750 million in annual revenues in recent years into this "Fund." There have been discussions among concerned nuclear safety interests that, when Congress next amends the NWPA, it commits the Waste Fund or other monies for a thoughtful, coordinated program of on-site dry storage casks at reactor sites suitable for both long-term storage and also for rail transportation to the repository. This might become difficult with the closing and depowering of older plants. The Waste Fund will be shrinking annually in the near term. Very recent proposals would enable utilities to use their contributions to the Fund for onsite dry cask storage.

On November 19th 2013 three judges on the U.S. Court of Appeals for the District of Columbia Circuit said DOE fell far short of justifying why it continues to collect $750 million per year from utilities. "We are not unaware of the political dilemma in which the Department is placed," wrote Senior Judge Laurence Silberman. "But until the Department comes to some conclusion as to how nuclear wastes are to be deposited permanently, it seems quite unfair to force petitioners to pay fees for a hypothetical option, the costs of which might well—the government apparently has no idea—be already covered."[13]

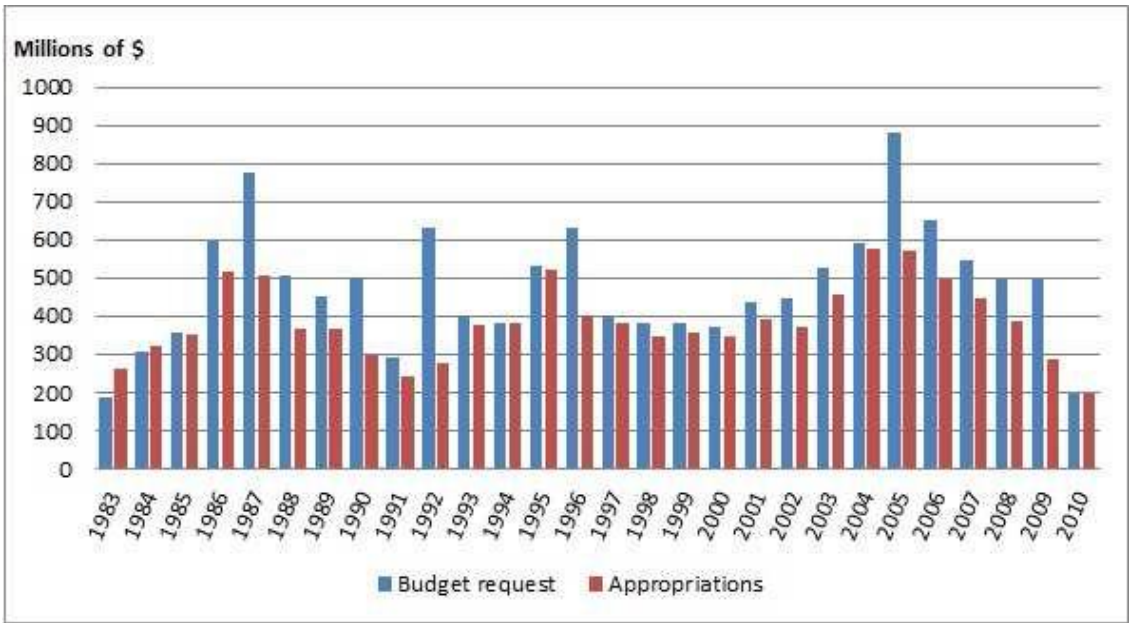

Figure 2. Nuclear Waste Program: Budget Requests versus Appropriations (BRC, Page 86)

[13] http://www.cadc.uscourts.gov/internet/opinions.nsf/2708C01ECFE3109F85257C280053406E/$file/11-1066-1466796.pdf.

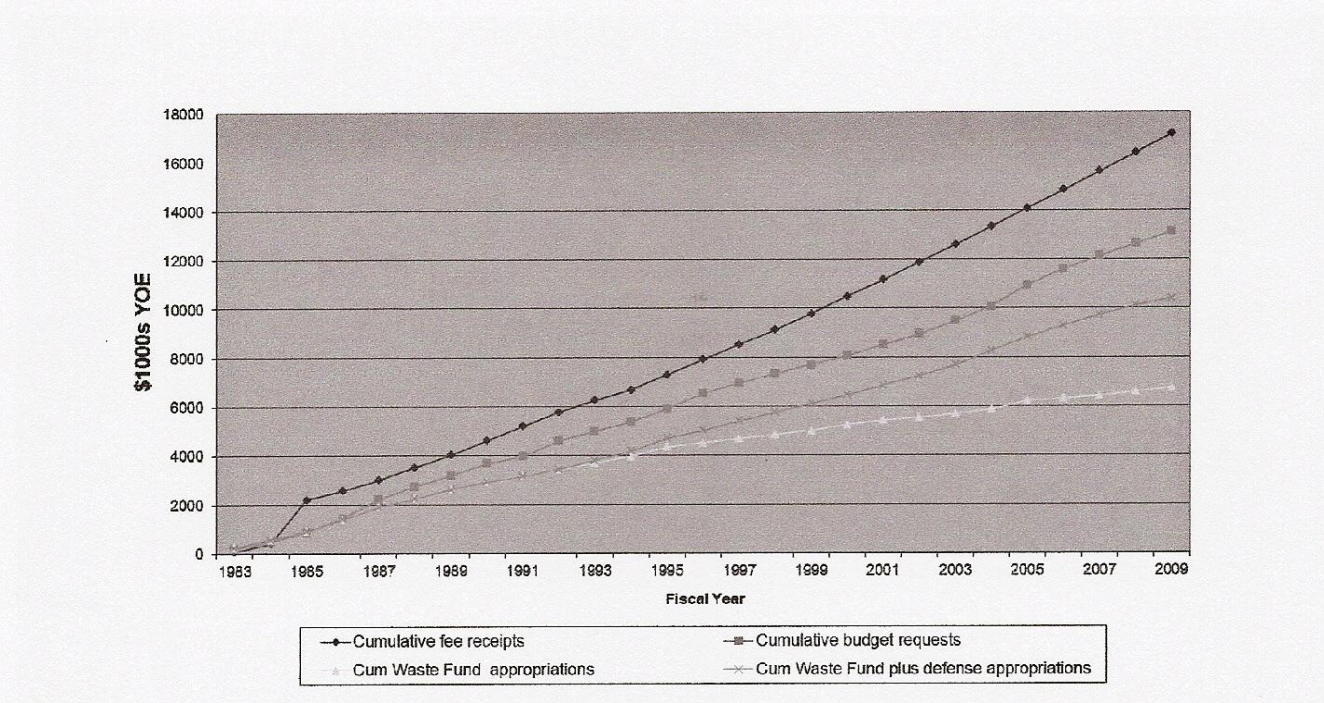

Figure 3. Cumulative Nuclear Waste Fees, Budget Requests, and Appropriations (BRC, Page 90)

Less than half of the Waste Fund input has been invested in the repository program (Figure 3). Congress has diverted the other fees to other purposes.

The GAO has made many interesting and important revelations and recommendations about past and possible future management of the Waste Fund.[14] GAO recommended a new organizational structure, new funding, oversight independence, and new transparency within the Fund in the future. Since problems with the geology and hydrology of Yucca Mountain have become apparent, the GAO has been suggesting interim storage. The Blue Ribbon Commission (BRC) makes very similar recommendations. DOE sponsored a Rand study published in 2012 which discussed options to replace DOE oversight of the nuclear waste program.[15] It is one of the few studies that fully describe the role of Congress in the tortured U.S. nuclear waste program.

[14] GAO 11-229.

[15] http://www.rand.org/pubs/monographs/MG1230.html.

SC Nuclear Facilities and SRS Facilities

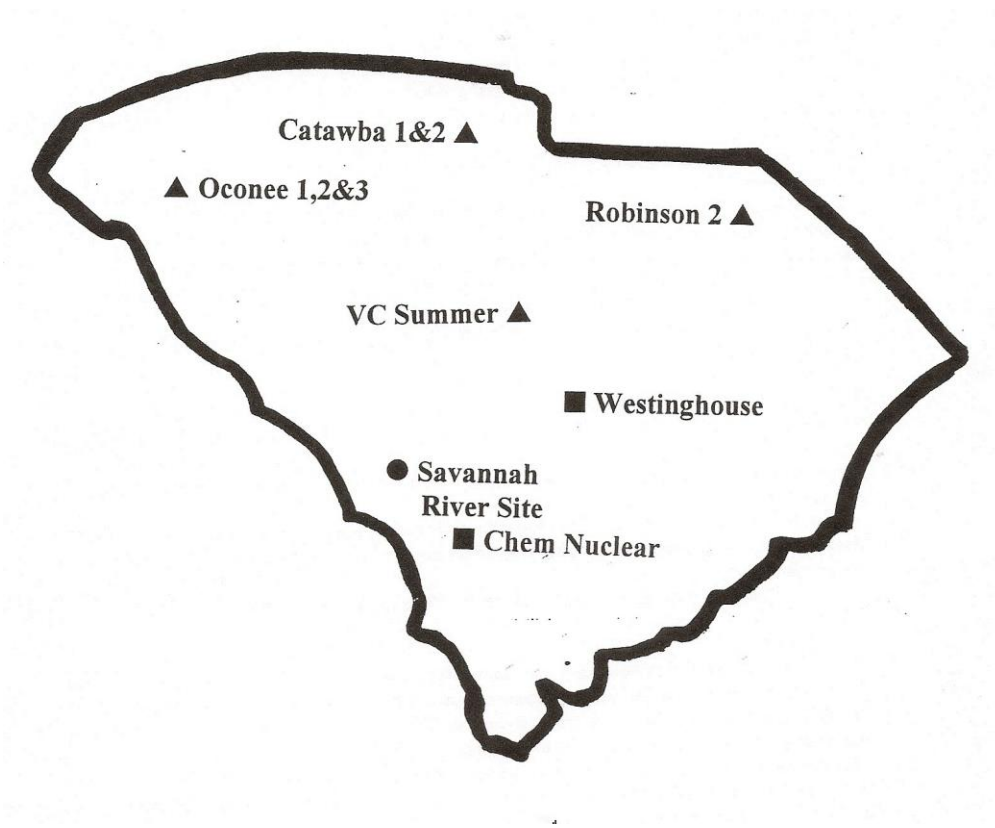

Figure 4. Major Nuclear Facilities in South Carolina

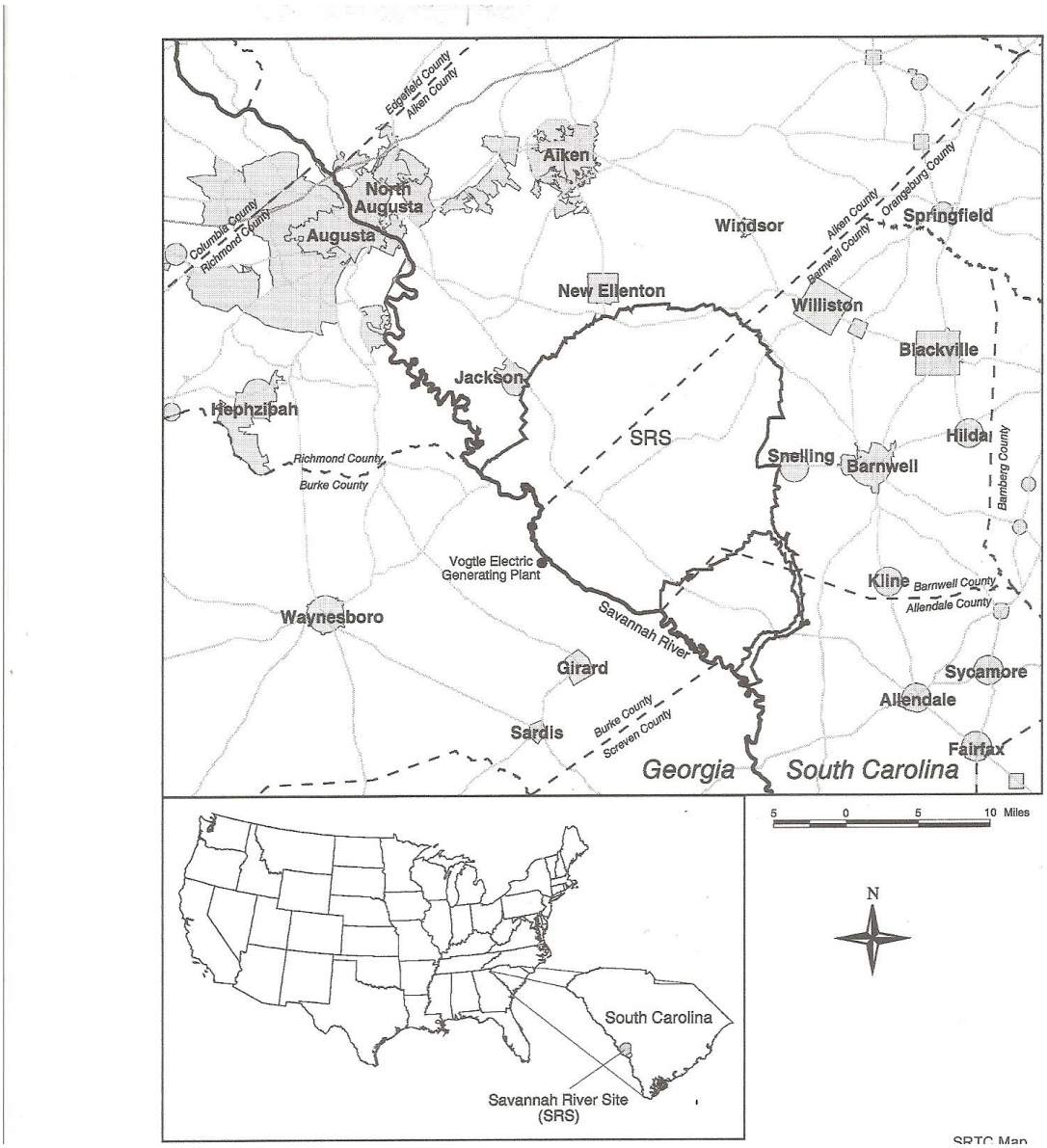

Figure 5. The Savannah River Site

SRS is located in South Carolina, about 12 miles south of Aiken, South Carolina, and about 15 miles southeast of Augusta, Georgia. The Savannah River flows along a portion of its southwestern border.

Recent Reports and Decisions on Nuclear Activities

Blue Ribbon Commission on America's Nuclear Future

The Blue Ribbon Commission (BRC) was formed in January 2010 by the U.S. Secretary of Energy at the request of the President "to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle and recommend a new strategy." The final report of the BRC in January 2011 is impressively comprehensive, includes important recommendations, and may have profound effects on South Carolina as well as the industry. It recommends one or more temporary or "interim" "consolidated storage facilities" for commercial spent fuel, and perhaps for other high-level nuclear wastes at a "willing" site. The BRC does not describe the "consent" that would be required for a storage facility or a geologic repository (Figure 6).

The BRC report also points out that DOE has entered into agreements with Colorado and Idaho that high-level radioactive waste will be removed from those DOE sites by 2035. Unless a geologic repository is available at that time, which is highly unlikely, it is possible that some of those wastes could be coming to the DOE sites at SRS and Hanford Washington (which lack similar removal agreements), for still more "temporary" storage responsibilities.

The final BRC report recommendations include:[16]

1. a new, consent-based approach to siting future high-level nuclear waste facilities;

2. a new organization dedicated solely to implementing the waste management program and empowered with the authority and resources to succeed;

3. access to the funds nuclear utility ratepayers are providing for the purpose of nuclear waste management;

4. prompt efforts to develop one or more geologic disposal facilities;

5. prompt efforts to develop one or more consolidated storage facilities; and

6. prompt efforts to prepare for the eventual large-scale transport of spent nuclear fuel and high-level waste to consolidated storage and disposal facilities when such facilities become available.[17]

[16] http://cybercemetery.unt.edu/archive/brc/20120620211605/http:/brc.gov//.

[17] Blue Ribbon Committee Report to the President, January 2012, Page vii.

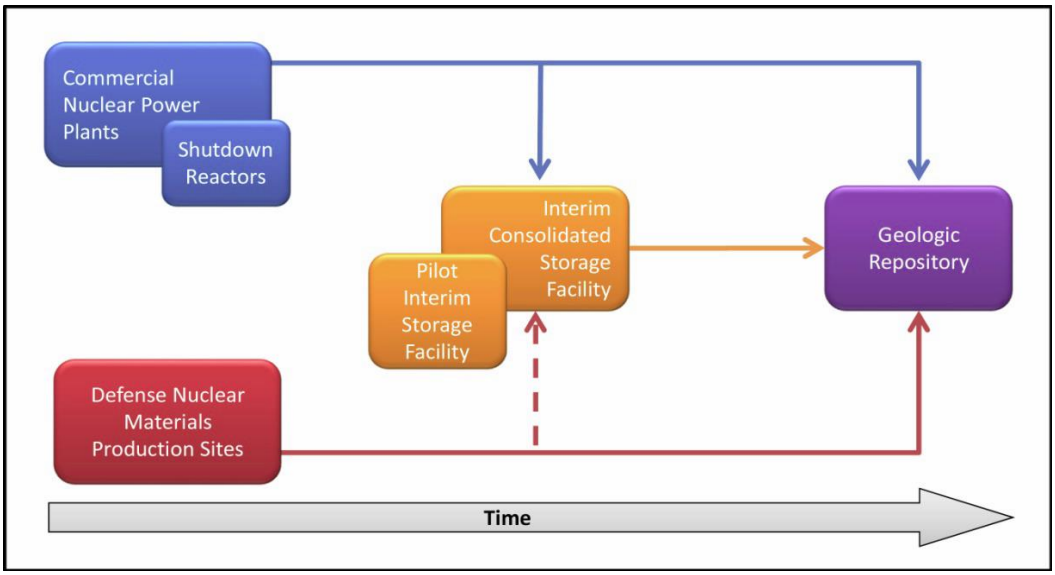

Figure 6. Possible System Pathways (DOE, Page 5)

The BRC report did not recommend reprocessing except to keep the option open as a future possibility. The report, including draft committee reports, contracted studies and meeting records, are all available online.[18]

The LWVSC testified before the BRC that the League was: "delighted that you on the Blue Ribbon Commission are assessing long-term nuclear waste challenges, and we are hopeful that this is the beginning of a focused national program. Our nation's priority today should be to select a suitable permanent solution, rather than to rush to find a "volunteer" for an imprudent temporary solution. Although not part of the original plan, the current nuclear waste storage at defense and commercial sites has been workable. An appropriate final solution requires that each affected state and commercial interest maintain the financial support and technical vigilance that is required to solve our collective challenge."[19]

DOE Response to BRC Report

In its January 2013 response, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, DOE agreed that before any decision to pursue reprocessing, several concerns such as cost, nonproliferation, national security, environmental concerns and technology limitations would need to be addressed.[20]

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[18] http://cybercemetery.unt.edu/archive/brc/20120620211605/http:/brc.gov//.

[19] http://www.lwvsc.org/files/brcfinalcomments201110.pdf.

[20] http://energy.gov/downloads/strategy-management-and-disposal-used-nuclear-fuel-and-high-level-radioactive-waste, DOE 2013, Page 8.

A report commissioned by DOE found that, in the near term, about 98 percent of the total current inventory of commercial spent nuclear fuel, by mass, can proceed to permanent disposal without the need to reprocess. This assessment would not preclude a future decision about future fuel cycle options (such as reprocessing).[21]

BRC recommends and DOE anticipates a program planning system which integrates consent-based siting principles within the next 10 years. A pilot interim storage facility would have limited capacity for accepting spent nuclear fuel and high-level radioactive waste. Both BRC and DOE would initially focus on storing spent fuel from closed reactor sites, sometimes called "orphan waste" at the initial interim storage facility.

BRC and DOE recommend that a larger, consolidated interim storage facility would potentially be co-located with the pilot facility and/or with a geologic repository. Finally there would be a permanent geologic repository for the disposal of spent nuclear fuel and high-level radioactive waste, perhaps in 2048.[22] The number of consolidated interim storage and geologic repository sites is not specified in either program.

The Cycle Research Study

Commissioned by the Savannah River Site Community Reuse Organization (CRO), the *Cycle Research Study* assumes that an interim consolidated storage site in the region is an initial step to developing fuel cycle reprocessing facilities and Research Development & Demonstrations in the Valley. It emphasizes the economics associated with commercial spent fuel storage in or near the SRS—economic benefits, jobs, tax revenues and additional compensation. This report remodeled Blue Ribbon Committee conclusions that had not encouraged near term reprocessing. It also promoted "regional" waste storage of spent fuel rather than "orphaned" waste storage. Most importantly, barriers to reprocessing (costs, waste management and proliferation) were completely ignored except for a mention that Purex separation would not be acceptable (the Purex process produces the most proliferation-vulnerable plutonium). Further, the CRO report presents no plan for using the tons of plutonium that could be removed via reprocessing.[23]

Proliferation

Robert Alvarez stated at the Aiken Municipal Center on February 28, 2013, "The unsuccessful history of fast reactors has created a plutonium legacy of major proportions. Of the 370 metric tons of plutonium extracted from power reactor spent fuel over the past several decades, about

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[21] http://www.scribd.com/doc/127913259/Nuclear-Fuel-and-HLW, December 2012.

[22] DOE 2013, Page 4.

[23] http://www.srscro.org/wp-content/uploads/2013/03/FINAL-Comprehensive-Fuel-Cycle-Research-Study-02-19-2013.pdf.

one-third has been used. Currently, about 200 tons of plutonium sit at reprocessing plants around the world—equivalent to the amount in some 30,000 nuclear weapons in global arsenals."[24]

Government Accountability Office

The GAO reported on options for commercial high-level waste disposal, post-Yucca Mountain closing, at the request of the House Energy and Commerce Committee.[25] GAO interviewed DOE and Nuclear Regulatory Commission (NRC) officials and others knowledgeable of the industry and government agencies. It repeated its past reviews which had determined that commercial reprocessing is expensive, doesn't resolve the waste problem, and is a proliferation risk. GAO recommended both a more stable funding option for the repository program and that the program have independence (as the BRC later recommended, and DOE concurred in 2013). It offers a rare enumeration of the costs and other challenges associated with temporary storage. This report partners with a follow-up report on DOE weapons waste management, such as those wastes at SRS.[26]

Those interested in more detailed information may wish to review GAO reports on *Information on Alternative Uses of the (Yucca) Site and Related Challenges*,[27] and another on *Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives*.[28]

The GAO considers continued on-site storage as the option that requires the least effort to implement since it is the current method of waste storage. However, GAO also notes that this option could trigger significant financial liabilities as a result of industry lawsuits stemming from the federal government's inability to accept the waste in 1998, as specified by law in the original *Nuclear Waste Policy Act*. The federal government had already paid $956 million in penalties, and future liabilities are estimated to be at least $15.4 billion through 2020.[29] More recently, the taxpayers have paid out nearly $2 billion for losing lawsuits, and taxpayers are estimated to be liable for about $20 billion for more lawsuit losses.

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[24] https://docs.google.com/file/d/0B34tchlsLOXfY3RHaHRMUU9IRE0/edit?pli=1, Page 14 (more on pg 38).

[25] *Lessons Learned*, GAO 11-229, April 8, 2011.

[26] http://www.gao.gov/new.items/ 11-229.pdf, http://www.gao.gov/new.items/ 11-230.pdf.

[27] GAO 11-847, September 2011.

[28] GAO 10-48, November 2009.

[27] GAO 11-731T, Disposal Challenges and Lessons Learned from Yucca Mountain 6/1/2011.

Waste Confidence Rule

A relatively obscure but very important federal court ruling in June 2012 requires long-range planning for nuclear waste storage. This ruling has halted the licensing and relicensing of reactors until a new "waste confidence rule" is in place. The related suit was brought by a variety of state and non-governmental groups concerned that nothing more promising than continued storage in spent fuel pools and a variety of on-site dry cask storage concepts had been regarded as "final." The NRC had previously claimed "confidence" that a permanent repository would be available "when necessary."

The U.S. District Court of Appeals determined that "The Commission apparently has no long-term plan other than hoping for a geologic repository. If the government continues to fail in its quest to establish one, then [spent nuclear fuel] will seemingly be stored on site at nuclear plants on a permanent basis. The Commission can and must assess the potential environmental effects of such a failure." NRC "must examine both the probability of a given harm occurring and the consequences of that harm if it does occur." The Court also said NRC failed to analyze the consequences of not building a repository, and did an insufficient examination of the risk of leaks and fires in spent fuel pools.[30]

Significant Nuclear Developments in South Carolina

Barnwell Low-Level Waste Disposal Site

This State of South Carolina-owned burial site at Barnwell, adjacent to SRS, has been closed to the nation since mid-2008. It continues to be operated by Chem-Nuclear Systems, LLC. Only South Carolina, New Jersey and Connecticut can use the site, according to the Atlantic Interstate Low-Level Radioactive Waste Management Compact signed in 2000 by South Carolina Governor Jim Hodges. Successful citizen legal challenges have resulted in packaging of the wastes prior to shipment to the site and improved barriers; at the site, the containers are now buried in trenches with a new drainage collection system.

Low-Level Waste Laundry

A commercial nuclear laundry, once located in the Rosewood neighborhood of Columbia, was moved in 2003 to a site near SRS and Chem-Nuclear, and is now owned by UniTech.

[30] http://www.cadc.uscourts.gov/internet/opinions.nsf/57ACA94A8FFAD8AF85257A1700502AA4/$file/11-1045-1377720.pdf.

Charleston Navy Shipyards

As a result of the Base Realignment and Closure Study, U.S. Navy and Air Force facilities were merged in 2010 into Joint Base Charleston. The land has been cleaned to Brownfields standards. New services include training and medical facilities and a shared runway with Charleston International Airport. Part of the old shipyards is now the site of the Clemson/DOE Wind Turbine Drive Train Test Facility. Spent research reactor fuel from reactors around the world is handled in the port and then shipped to SRS.

Allied-General Nuclear Services Plant (AGNS)

Adjacent to SRS, AGNS is a failed commercial experiment to reprocess commercial spent fuel. It was not supported by successive presidential administrations because of plutonium proliferation risks, as well as a lack of any management strategy for liquid high-level reprocessing wastes. Briefly used for a federal experiment in 1982, it was subsequently closed. The March 2013 CRO Report (Page 13) considers the AGNS plant a regional asset. It is now linked to the "Aiken-Edgefield Economic Development Partnership," part of a local Economic Development Partnership.

Westinghouse Nuclear Fuel Company

Located in eastern Richland County, this plant has been manufacturing fuel rods, fuel assemblies, plant designs, and other services to utility and industrial customers worldwide for nuclear power reactors. Westinghouse has been located south of Columbia, South Carolina, since 1969 and contributed to the world's first pressurized water reactor in Shippingport, Pennsylvania, in 1957. Now a group company of Toshiba Corporation. A subsidiary of Westinghouse, WesDyne International, assembles special rods which are subsequently irradiated in a commercial reactor in Tennessee for the production of tritium, which is then used both to trigger the thermonuclear (hydrogen) bomb and to boost the explosive power of other nuclear weapons. Westinghouse will produce fuel assemblies for the new AP1000 reactors and has also produced a prototype fuel assembly for the Westinghouse "small modular reactor."

Agreement in Principle (AIP)

Initiated in 1989, this federal program now enables states that host DOE facilities such as the SRS to participate in oversight monitoring and emergency preparedness capabilities. The South Carolina Department of Health and Environmental Control (DHEC) began participating in this program in 1992 and created the Environmental Surveillance and Oversight Program in 1995. Through regulatory programs and independent agreements such as the AIP, DHEC and the Atlanta regional office of the Environmental Protection Agency (EPA) now work more closely with DOE at the SRS to provide the public with independent sources of environmental information.

MOX Program at SRS

Plans began in 1999 for a 600,000 square foot facility, including support facilities. This construction program at SRS is designed to ultimately manufacture MOX fuel from surplus weapons plutonium, mixed with uranium, for use in commercial fuel rods at one or more electricity-generating reactors. This program has suffered from major redesigns, delays, huge cost overruns, staffing problems, quality control problems, and other shortcomings including lack of contingency plans for plutonium storage. Problems at the facility were first aired in *The State* newspaper in January 2013.[31] After an initial GAO study, funding was cut from the 2014 budget and DOE announced that the MOX program at SRS was under review (more on Page 28).

Carolinas-Virginia Tube Reactor

The experimental Parr reactor north of Columbia, South Carolina, in Fairfield County and 28 other reactors have been licensed to operate but subsequently shut down.[32] Parr was a demonstration heavy water reactor named after its location in Parr, South Carolina. It was built in the 1960s and operated by the Carolinas Virginia Nuclear Power Associates and shut down after tests in the late 1960s. It was returned to Brownfield condition in 2009. Sixty-three other commercial reactors have been proposed and then canceled over the years. Some proposals involved more than one reactor, such as Votgle #2 & 3, which was subsequently revisited.[33]

Four New Nuclear Power Reactors

The first reactors to receive licenses since the 1979 Three Mile Island nuclear accident are now being constructed in South Carolina and Georgia by SCANA Corporation and Southern Company. SCANA is a South Carolina energy-based holding company that serves electric and natural gas customers in parts of South Carolina, Georgia and North Carolina. Southern Company, headquartered in Atlanta, is an electric utilities holding company serving parts of Georgia, Alabama, Florida and Mississippi.

A new "standardized design" was conditionally granted a license in February 2012 to Southern Company for two reactors at the Vogtle site in Burke County, Georgia, across the Savannah River from SRS. The SCANA/Santee Cooper license has also been conditionally granted for two plants adjacent to the existing V.C. Summer site in Fairfield County, South Carolina. There are a variety of site-specific changes to this design at both locations. These first combined "construction and operation" licenses will not be the subject of further public hearings except for the periodic rate hikes that enable them. Construction and operation are currently anticipated to take another four years.

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[31] http://www.thestate.com/2013/01/27/2606562/critics-fear-7-billion-srs-boondoggle.html.

[32] NRC Information Digest (NUREG-1350, Volume 24), Appendix B.

[33] NRC Information Digest (NUREG-1350, Volume 24), Appendix C.

SCANA anticipates its two reactors will cost slightly more than $10 billion; the estimate for the two Vogtle reactors is currently $14 billion, although cost estimates and scheduled delays for both sites has increased with every review. According to communication from the South Carolina Office of Regulatory Staff, the current charge on the South Carolina Electric & Gas (SCE&G) bill, to pay for the VC Summer AP1000 is 10.78 percent as of October 2013 for financing charges. As the first reactor won't come on line until 2017 or 2018, there will be more financing charges. Just before the first reactor comes on line, the capital costs will also be reflected in local bills.

Existing Nuclear Plants in South Carolina

Existing plants have been of relatively little concern, particularly in comparison with coal plant emissions. Nuclear plants have been economical to operate, although maintenance costs and risks rise with any aging facility. Existing plants include:

- Catawba Nuclear Station (2 units), Duke, located on Lake Wylie, York County
- Oconee Nuclear Station (3 units), Duke, located on Lake Keowee, Pickens County
- V. C. Summer Plant, (1 unit) SCE&G/Santee Cooper, located in Fairfield County
- H. B. Robinson, 2 plants (1 unit; [Robinson 1 is a coal plant] Robinson 2 is nuclear), now owned by Progress/Duke, located in Hartsville

Each of these reactors' owners has adequate wet and dry cask storage facilities for at least 40 years; both Duke and Duke/Progress have shipped spent fuel within their service area.

Regional Nuclear Power Companies

A once-abandoned TVA plant, "Watts Bar Nuclear Generating Station" between Knoxville and Chattanooga, resumed construction October 15, 2007 and operations are expected to begin in 2015.

Proposed Nuclear Plants

In addition to the plants approved this year for Southern Company and the SCANA Corporation and Santee Cooper, other plants have been considered. Until the "Waste Confidence" issue has been resolved, NRC will not be considering new licenses or renewals (more on Page 15).

Proposed nuclear power plants have been the subject of citizen challenges, particularly on the issues of costs and water consumption. Many of the existing and proposed coal and nuclear plants in the Carolinas are planned along the Broad River, which has been nicknamed the "Skinny River" by some environmentalists due to the large amounts of water required to cool the plants.

In 2006, Duke Energy proposed the construction of two or three AP1000 nuclear power plants in conjunction with Southern Company adjacent to the once-abandoned Catawba site near Gaffney on the Broad River. Sometimes called the Cherokee plant or William States Lee III Nuclear Stations 1 & 2, these would be located in Cherokee County, South Carolina, if Duke pursues licensing.

Other reactors have been considered at the Shearon Harris site in Wake County, North Carolina, and a second nuclear facility at the Robinson site near Hartsville, South Carolina, but neither is being pursued at this time and cancellation is anticipated.

For an interactive map of applications that have been received by the NRC, search planned new plants: http://www.nrc.gov/reactors/new-reactors/col/new-reactor-map.html; select a site name to view the NRC's website for the specific application.

Ownership

There have been changes in the ownership of regional power companies and more changes can be anticipated:

- **CP&L—**Formerly Carolina Power and Light, merged with Florida Progress Energy in 2000 to become Progress Energy, Inc. Duke Energy, (formerly Duke Power) has merged with Progress Energy Inc. to create the largest U.S. electric utility.

- **Duke Energy—**About half of Duke's Carolina generation is nuclear. Duke Energy now operates 12 nuclear units at seven sites in the Carolinas and Florida. Its reactors in South Carolina are at Catawba Nuclear Station, Oconee Nuclear Stations on Lake Keowee near Seneca on the Savannah River, and the Robinson plant in Florence; in North Carolina the Harris Nuclear Plant, Brunswick Nuclear Plant, and McGuire Nuclear Station. Duke announced this year that it will close the Crystal River Plant in Florida, recently purchased from Progress Energy.[34] A plant proposed near Gaffney South Carolina on the Broad River, is under consideration and reportedly will not be pursued.

- **Southern Company—**In addition to Plant Votgle, Southern Company operates two nuclear plants in Georgia and one in Alabama.[35]

[34] http://www.duke-energy.com/power-plants/nuclear.asp.

[35] http://www.southerncompany.com/about-us/our-business/southern-nuclear/home.cshtml.

Important Industry Changes

Projected Nuclear Renaissance

The commercial nuclear industry had been projecting a massive 21st Century renaissance since the passage of the Energy Policy Act of 2005, with its potential $18.5 billion subsidy for new nuclear plants. As many as 100 new nuclear power plants had once been envisioned over the coming decades, requiring both federal and ratepayer subsidies, at least initially. In February 2012, a Standard & Poor analyst stated, "In our opinion, the current market conditions combined with nuclear projects' long planning and construction timelines will prevent the construction of additional new units until at least the end of this decade for the above reasons, as well as the newer option of gas-fired generators; the likelihood of a U.S. 'nuclear renaissance' would be faint in this decade."[36] Subsequent economic analyses concur.

Location of Projected New Nuclear Power Reactors

For applications that have been received by the NRC, you may select a site name to view the NRC's website for the specific application. Websites for the remainder of the applications will be created when they are received.

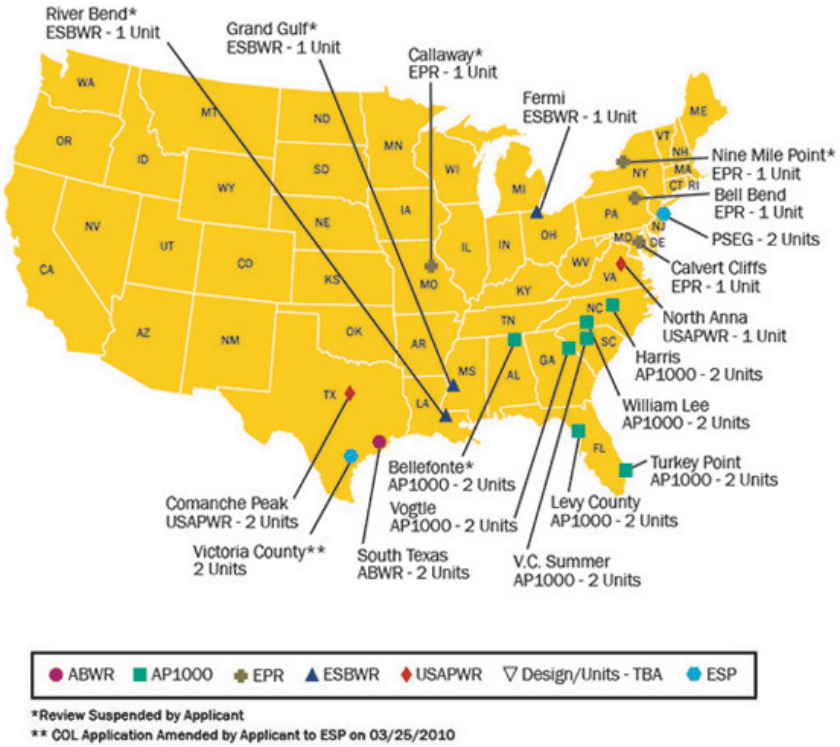

Figure 7. Projected New Nuclear Power Reactor Sites (BRC, Page 16)

[36] Washington (Platts)--15Feb2012/405 pm EST/2105 GMT.

Once the "Waste Confidence Rule" is negotiated to address the interim between operations and repository storage, the construction of future reactors seems to hinge on terms for ratepayer financing during construction as well as continued federal loan guarantees and insurance subsidies. Placement of all risk on ratepayers via a "prudency" decision by the Georgia and South Carolina public service commissions (rather than placing risk on the company or its shareholders) is a key reason that new reactor projects have been initiated in South Carolina and Georgia.

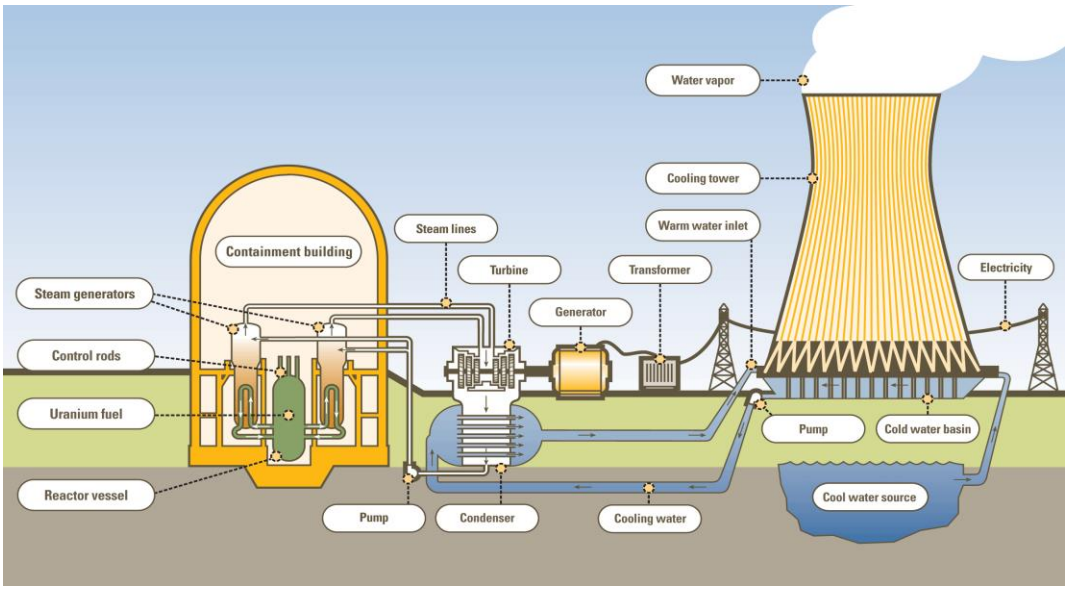

Figure 8. Stylized "Current" Reactor Design (Source Bing)

New Generation Nuclear Power Plants

The NRC has been reviewing the pressurized water design by the Westinghouse/Toshiba Corp AP1000 (Advanced Passive) since 2002 (Figure 9). This reactor design is proposed for construction in the southeastern region by SCANA/Santee Cooper, Georgia Power/Southern Company, and perhaps Duke Energy. This design takes advantage of longer fuel operational life; it also anticipates fewer core damage events, longer periods of time between fuel rod replacements, and other efficiencies and cost savings, including a "passive" emergency cooling tank that will deliver water to the outside of the containment if a meltdown is in progress inside. This NRC review was slowed to reconsider issues associated with the Fukushima disaster, particularly earthquake and storm events.

For interactive graphics and more detailed information on the AP1000 go to http://www.ap1000.westinghousenuclear.com/exploreap1000.html or to http://www.ap1000.westinghousenuclear.com/

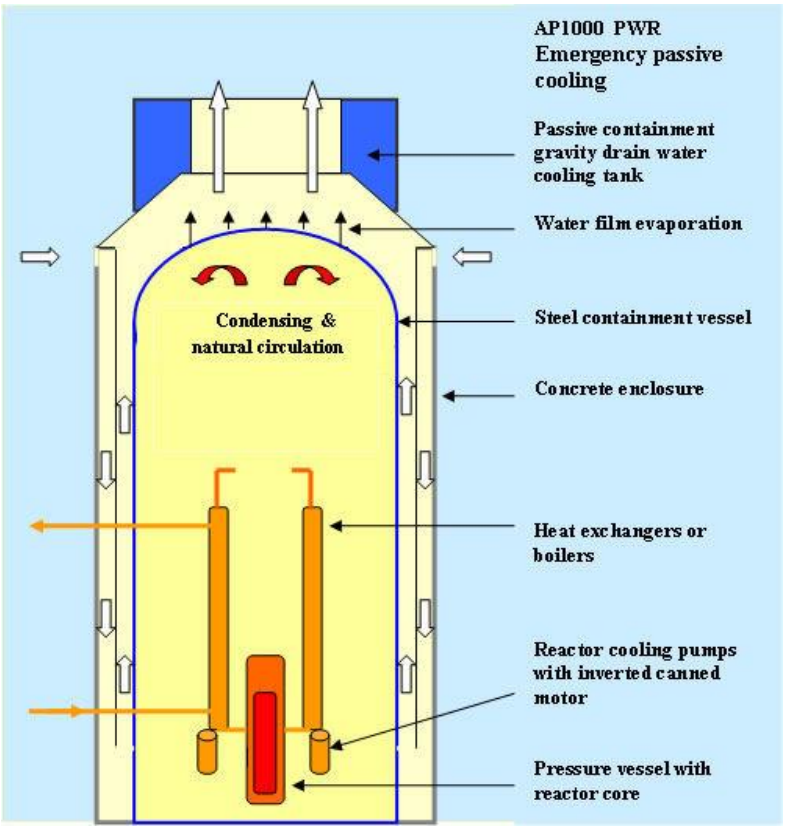

Figure 9. AP1000 or 600 Passive Emergency Cooling Reactor Design

Southern Company has been the considered the tentative recipient of an $8.33 billion conditional federal loan guarantee. Under the loan-guarantee program, the government promises to assume a share of the company's obligations if Southern Company defaults on debt incurred for the projects, and allows borrowing from the Federal Financing Bank. Because new nuclear reactors cost billions of dollars to develop, the loan guarantees are a key step for nuclear energy companies that plan to undertake such projects. Contingency negotiations in case of cost overrun have slowed the Southern Company loan agreement. Challenges include increasing costs for definitive construction and reactor materials, increasing costs associated with delays in Federal Financing Bank loan guarantee, decreased energy demand as a result of the recession, and cheaper gas and oil from fracking.[37]

[37] More on CWIP at: http://www.nei.org/filefolder/CWIP.pdf; http://www.ncwarn.org/2007/07/qa-on-cwip-transferring-risks-to-the-customer/; http://www.prnewswire.com/news-releases/public-service-commission-of-south-carolina-approves-sceg-rate-adjustment-under-base-load-review-act-171826811.html.

Figure 10. SCE&G/Santee Cooper Site*
Photo credit to "High Flyer" December 2012.

*The rectangular holes on either side of the crane are where the reactors would be located, on the so-called "nuclear island." The reactor containment vessel being welded for unit 2 can be seen in the lower right.

In addition to the AP1000, other reactor designs have been proposed for NRC design certification, particularly the "Small Modular Reactor."[38] Generic new concepts are casually proposed, always with claims of increased safety and/or decreased costs, and each would require decades for development.[39]

[38] http://www.nrc.gov/reactors/new-reactors/design-cert.html.

[39] http://www.nrc.gov/reactors/new-reactors/design-cert/ap1000.html;
http://www.nrc.gov/reactors/advanced.html.

Yucca Mountain Geologic Repository

Vision and History

As originally legislated, a national site selection process narrowed down to three candidate sites including Yucca Mountain in Nevada that would have buried most of the commercial spent fuel as well as some weapons waste, such as that at SRS.

The original *Nuclear Waste Policy Act (NWPA)* in 1982[40] would have sited a second repository, probably in Texas or Washington State, to store additional wastes. In 1987 Congress amended the NWPA to focus on Yucca Mountain and to defer the second repository, designating it instead as an "eastern site"—somewhere east of the Mississippi River. Congress later suggested doubling the capacity of the Nevada site, even as geological and hydrological complications were uncovered. The eastern site was never legislated.

In 1998 more than 200 citizen and environmental organizations across the United States petitioned the Department of Energy to disqualify the Yucca Mountain site since it could not meet either the site guidelines in the Nuclear Waste Policy Act or the generic EPA radiation standard for geologic disposal.[41] Groundwater travel times, which had been falsified by contractors working for USGS, were made public later.

In 2002 the President approved Yucca Mountain for geologic storage of the nation's spent fuel and other high-level nuclear wastes. In 2004, a Nevada legal challenge was upheld—that the EPA's 10,000-year compliance period for isolation of radioactive waste was too short—leading to a series of legal battles.

Both the hydrology and the geology of the Yucca Mountain site had been of concern to observers, particularly those living in and around Nevada. Technical "fixes" to overcome the challenges had dominated the project since the early 1990s. Yucca Mountain had become an expensive venture with a planned retrofit of titanium drip shields to be placed over waste canisters after about 100 years, in an effort to overcome the corrosive site conditions. The program was also plagued with DOE staff turnover, funding and budgeting challenges, and other administrative shortcomings, including systematic delay in congressional appropriations to Yucca Mountain.

Finally, the relationship between DOE and the State of Nevada was highly contentious. Nevada had rejected the site because of serious concerns about many issues, especially newly understood water transport and earthquake activity. After Congress overturned the Nevada governor's veto, Nevada engaged in every possible legal action, including withholding water permits, which remain in litigation. (See latest legal challenge at http://www.lasvegassun.com/news/2013/aug/26/attorney-generals-office-yucca-mountain-hearings-s/) See history of Nevada

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[40] BRC, Page 20.

[41] http://www.nirs.org/press/11-18-1998/1.

earthquakes at http://www.seismo.unr.edu/Earthquake. Little Skull Mountain is close to Yucca Mountain. Or go to http://www.state.nv.us/nucwaste/yucca/seismo01.htm.

Cancellation

President Barack Obama promised Nevada Senator Harry Reid that the Yucca Mountain repository would be terminated. The President first directed the DOE to withdraw the Yucca license application from consideration. When that was challenged, NRC was directed to stop the review, and money for the review process was cut from the budget in 2010.

Yucca Mountain Court Challenges

The State of South Carolina, Aiken County, and several others have brought challenges in federal courts regarding the decision to halt review of the DOE license application for Yucca Mountain as a repository. The initial South Carolina challenge was deemed premature. In August 2013, by a 2-1 vote, the U.S. Court of Appeals for the District of Columbia ordered NRC to complete the licensing process and approve or reject the DOE application for a waste site. According to the BRC, the DOE has spent an estimated $7 billion[42] on the site but has never completed it. No waste is stored there. The financing issue was not addressed in the court decision, but is pivotal. After the courts resolve challenges, technical scrutiny of Yucca Mountain geology and hydrology conditions may be reopened, but most consider it unlikely that this Congress will provide funds for any review of the Yucca Mountain license application.

Followup to Fukushima Daiichi

On March 11, 2011, a huge earthquake and subsequent tsunami off the coast of Japan killed approximately 19,000 people and disabled three reactors (#1, 2, and 3) and their spent fuel pools, including emergency cooling systems. Fukushima is in central northeast Japan, about 160 miles north of Tokyo. The reactor and spent fuel pool of Reactor #4 were also seriously damaged.

The DOE and the NRC have avoided raising alarm, but they offered services to Japan immediately after the tragic event. The affected Japanese plants employ a General Electric design that is not used in South Carolina. The certain effect of radiation releases in Japan is unclear, and keeping the plant from overheating has been an unending challenge. Of particular concern is the spent fuel pool which remains over Reactor #4; the fuel pool remains full and fragile. Containment of contaminated cooling water is another continuing challenge.

The focus of international post-Fukushima reviews includes hazard considerations of earthquakes, venting of emergency emissions, flooding, regulations and their enforcement, emergency preparedness, and worldwide communication at times of risk. An NRC task force recommended

[42] BRC, Page 75.

new safety measures in U.S. spent fuel pools that contain more spent fuel than initially designed to store; the industry has resisted change. NRC has directed that owners/operators of the Japanese design make certain improvements. The GAO has recommended reactor risk assessments for natural hazards,[43] and NRC has agreed to follow up. Cleanup of Fukushima is anticipated to take decades.

Highlights of Activities at SRS since 1997[44]

SRS Cleanup Operations

The U.S. DOE currently has contracted responsibilities to Savannah River Nuclear Solutions, LLC, and several other corporations. For several decades the site, under a variety of contractors, has been managing the results of 1950s Cold War-era activities. Defense, research and research reactor waste continue to be received and generated at SRS. The waste management stabilization and cleanup process has, of course, presented several hurdles. Nevertheless, important progress has been made. The SRS manages weapons-related wastes - mainly from the United States, but also the products of "Atoms for Peace" and other research reactors. Plutonium and other research reactor fuel from around the world are sent to the SRS for safe keeping in an ongoing program. Once locally called "the bomb plant," SRS continues to produce nuclear weapons materials, but its primary responsibility is cleanup.

Although DHEC staff has repeatedly asked DOE representatives at public meetings to ask Congress for continued funding to meet agreed-upon cleanup schedules, the September 2014 DOE Budget Request cut the SRS cleanup budget by about 20 percent. Some other DOE facilities which have missed their performance schedules were awarded with increased budget requests. This will significantly delay SRS cleanup performance and could affect environmental risks.

Waste Solidification

The two primary waste facilities operated within the Waste Solidification program at SRS are the Defense Waste Processing Facility (DWPF) that produces glass waste intended to be shipped offsite, and the Saltstone Disposal Facility for onsite storage of treated high-level tank wastes.

The DWPF has been operating since 1996 and is anticipated to fill thousands of canisters with solidified glass wastes in the next 20 to 25 years. It is behind schedule but thus far has managed about 25 percent of the legacy waste once stored in aging tanks. Various salts make up much of the 33 million gallons of material in the storage tanks. Treatment will separate and evaporate tank materials. A salt solution will be mixed to make a cement-like grout. The grout will then

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[43] GAO-12-465, April 26, 2012.

[44] Find a brief history at http://www.srs.gov/general/about/history1.htm or http://www.srs.gov/general/news/factsheets/srs.pdf

be pumped into large concrete vaults divided into sections where it cures into "saltstone." Other tank wastes are mixed with glass at the DWPF.[45] As of December 13, 2013, the salt treatment process—and budget cutbacks—are delaying SRS management closure schedules, and it is experiencing other problems.

SRS Tanks

Decades of weapons production begun in the early 1950s has generated what is currently 37 million gallons of liquid high-level waste stored in 47 underground carbon-steel waste tanks grouped into two "tank farms" at SRS. Four tanks at SRS have been "closed" with most of the waste removed and solidified, and residual wastes grouted in place. Eight tanks are below the water table in wet months. Two were closed (with residual waste) in 2012; four more are near closure. Forty-three are scheduled to be closed over the next two decades, if DOE requests adequate funds and if Congress appropriates them.

SRS Transuranic Wastes (TRU)

"Transuranic" refers to certain U.S. defense wastes that have half-lives greater than 20 years with isotopes heavier than uranium, including plutonium. SRS held large quantities of TRU waste due to production and processing of plutonium-239 and, to a much lesser extent, plutonium-238 (for space probes).

An ingenious waste management program at SRS took advantage of the American Recovery and Reinvestment Act of 2009. Federal "stimulus monies" have been used to train workers, many previously unemployed, in the management and repackaging of TRU wastes. Approximately 11,000 cubic meters of legacy TRU wastes have been sorted, contained and shipped, or are prepared for shipment in the current effort. SRS is optimistic that all legacy TRU wastes eligible for burial at the Waste Isolation Pilot Plant (WIPP) are likely to be re-packaged and shipped to the WIPP site in New Mexico in 2014. TRU waste is also generated routinely at SRS.

WIPP is a DOE site in the desert outside Carlsbad, New Mexico, in a salt formation about a half mile below the surface. The WIPP site began disposal operations in March 1999 and is the world's only operating permanent geologic nuclear waste repository. It accepts wastes only in certified containers in truck/trailer shipments. SRS, which began shipments to WIPP in 2001, is hopeful that other DOE defense sites can take advantage of SRS container certification successes. Both transportation to the site (by truck only, not by rail) and operation at the site have been uneventful.[46] For more information, see http://www.srs.gov/general/news/factsheets/tru_waste_esrs.pdf

[45] http://www.srs.gov/general/news/factsheets/interim_saltwaste.pdf.

[46] http://www.wipp.energy.gov/.

Incineration at SRS

Incineration of mixed wastes (both radioactive and chemical) at SRS has been halted. Similar incineration projects at other sites in the U.S. have been problematic.

Mixed Oxide Fuel

SRS is the site of a huge and troubled "nonproliferation" project to convert surplus weapons plutonium into commercial fuel. Russia initially agreed to manage its weapons materials in a similar manner but no longer has a parallel program. The Russians are now pursuing construction of a "breeder" reactor that can make more plutonium, assuming its operation will be successful.

This construction program at SRS is designed to manufacture Mixed Oxide Fuel (MOX—Mixed Oxide—Uranium and Plutonium reactor fuel) from 34 or more metric tons of plutonium, to be mixed with uranium, for use in commercial fuel rods at one or more electricity-generating reactors. This project includes a partially-built Mixed Oxide Fuel Fabrication Facility, support facilities, and a Waste Solidification Building. It is more than 10 years behind schedule and significantly over budget. This program has suffered from major redesigns, delays, large cost overruns, staffing problems, quality control problems, and other shortcomings, including lack of contingency plans for plutonium storage. The MOX program is operated by the National Nuclear Security Administration (NNSA), a semi-autonomous division of the DOE, created by Congress in1999, and AREVA is a partner in building the plant.

The purpose of NNSA was to provide additional security to defense stockpiles. An ongoing intervention by public interest groups against issuance of an operating license for the MOX facility will soon be before the Atomic Safety and Licensing Board Panel, which oversees safety/technical and environmental questions before the NRC.

As part of an ongoing GAO review, a witness testified in March 2013 that the MOX plant contractor's new costs estimate for the MOX plant construction had increased from the original $1.8 billion in 2004, to $4.9 billion in 2008, and now to $7.7 billion.[47] Estimates for the total program costs are in the neighborhood of $22 billion according to critics, if it is carried out; there are no official program costs available. In April 2013, the White House and DOE announced that the MOX plutonium disposition program at SRS was under review, and funding was cut for 2014. DOE stated that "considering preliminary cost increases and the current budget environment, the Administration is conducting an assessment of alternative plutonium disposition strategies in FY 2013." Most observers believe the budget cuts are a prelude to cancellation of the MOX program.

The MOX program at SRS depends upon cooperation from at least one nuclear power plant operator (to accept and use the fuel), and thus far reactor owners have been reluctant to participate in the program. Duke Energy expressed interest initially, participated in an uncompleted test at

[47] GAO on MOX, March 20, 2013.

its Catawba site in 2008, but has withdrawn interest. Friends of the Earth, as a result of a Freedom of Information request, uncovered that Energy Northwest in Washington State was once considering participation, apparently under pressure from DOE. Tennessee Valley Authority (TVA) is now reportedly involved in MOX-use deliberations relative to its Browns Ferry plants near Athens, Alabama, and its Sequoyah Nuclear Plants located 18 miles north of Chattanooga, Tennessee. Issues of concern to utilities include hotter fuel effects impacting reactor operation and spent fuel storage, reactor control issues, the likely continued availability of fuel from experienced vendors, and DOE's inability to guarantee delivery schedules. DOE is currently working with AREVA to develop a contract to promote the MOX fuel through fuel vendors.

The cheaper alternative to producing MOX fuel, as recommended by the LWVSC and others in the 1990s, is to mix the weapons materials with SRS high-level wastes and immobilize them in glass.

Hydrogen Research

South Carolina's political leaders have been enthusiastic about the future of hydrogen fuel, and SRS has participated in studies of the production of hydrogen from water using nuclear power. The University of South Carolina is involved in the program, much of which is being carried out at the Center for Hydrogen Research, which is located adjacent to SRS.

Small Reactor Program

Cleanup tasks at SRS are currently scheduled to be concluded around 2035. SRS management has been exploring new missions for the site. As part of a program called "Enterprise SRS," it has teamed up with private companies engaged in the cleanup. The cornerstone of Enterprise SRS is pursuit of a new generation of smaller nuclear reactors. These small modular reactors (SMRs) produce less than 300 megawatts (compared to around 1000 megawatts for today's reactors). SMRs exist today only as concepts and lack demonstrated economic viability except for the jobs created to research the concept.

Several SMR companies have formally joined with SRS in a "memoranda of understanding" to cooperate in pursuit of the reactors at SRS. A competing design won a DOE subsidy of up to $225 million in November 2012. That subsidy has to be matched by the company winning the award: Babcock & Wilcox, for its mPower model, being pursued with the Tennessee Valley Authority. DOE has offered a second subsidy of up to $225 million, and two companies are competing for their SMR models: Holtec International and NuScale. Another award was expected to be announced in late 2013. Funds would contribute to design and licensing work at the technical headquarters of the SMR companies involved. Currently, there is no indication that private money would be forthcoming for construction of any SMRs, making the projects dependent on the federal government at a time of declining budgets.

Federal Search for One or More Sites to Manage "Greater Than Class C" Wastes

SRS is one of a few sites under consideration to manage and indefinitely store these difficult wastes. As originally proposed by DOE, the Greater Than Class C (GTCC) wastes would include federal, medical and even commercial power plant waste streams. The LWVSC spoke against this activity at SRS, which has a high water table and already contains more curies than any other federal facility. GTCC wastes already generated at SRS are awaiting packaging and transportation options. Although technically still under consideration, the GTCC wastes are likely to be stored at a drier climate with an appropriate water table. In responding to the GTCC proposal, LWVSC questioned the appropriateness of commercial GTCC wastes being sent to any DOE defense facility, especially SRS.

Future Program Proposals at SRS

Nuclear Park

Proposed projects for the SRS site include wide-ranging concepts generically described as nuclear parks. These proposals have included at least one nuclear power plant, possibly the Small Modular Reactor, and spent commercial fuel storage, usually with research into fuel reprocessing. Older, recurring proposals have included more reactors, tritium manufacture, and other specialty manufacturing, all requiring government financing.

Storage of Commercial Spent Nuclear Fuel

SRS boosters, particularly Citizens for Nuclear Technology Awareness in the Central Savannah River Area and the SRS Community Reuse Organization, have advocated two goals: (1) shipment of treated SRS high-level wastes to a reopened Yucca Mountain repository; and (2) the rather contradictory goal of relieving the commercial nuclear industry of spent fuel storage responsibilities by "volunteering" SRS or a nearby area as an "interim" storage site.

The February 2013 SRS Community Reuse Organization (CRO) report suggests the possibility of moving SRS defense waste from the DWPF to a nearby Consolidated Interim Storage Facility. Shipment of "orphan" spent fuel to SRS for temporary storage, as prioritized by the BRC, could approximately triple the radioactivity contained at the site.[48] The CRO report proposed, instead, shipment of spent fuel from regional reactors rather than from "orphan" sites.[49]

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[48] Robert Alvarez, https://docs.google.com/file/d/0B34tchlsLOXfY3RHaHRMUU9IRE0/edit?pli=1, Page 4.

[49] http://www.srscro.org/energy-park/, http://www.srscro.org/wp-content/uploads/2013/03/FINAL-Comprehensive-Fuel-Cycle-Research-Study-02-19-2013.pdf.

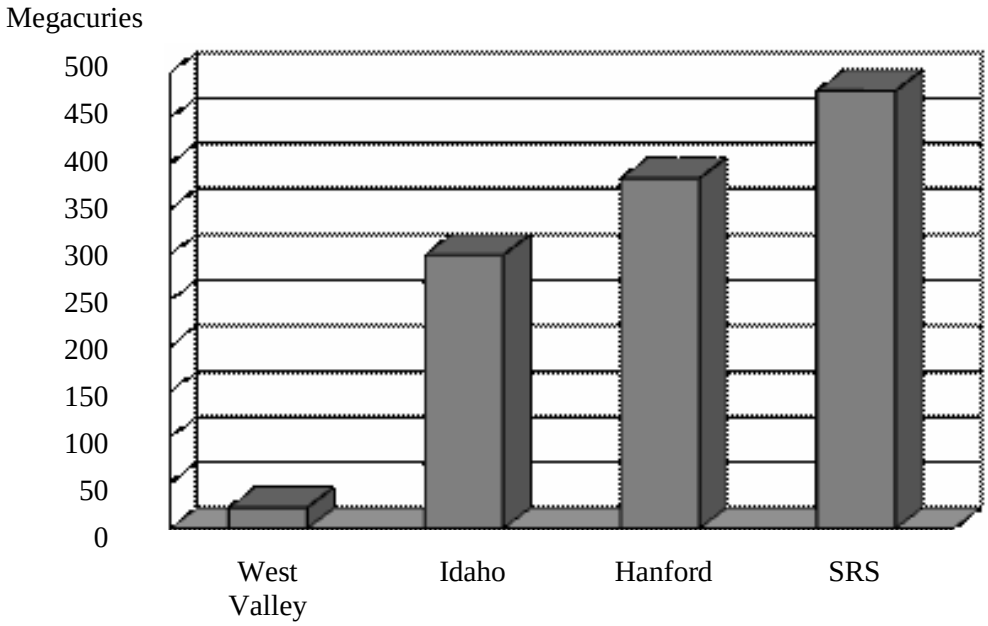

Figure 11. Radioactivity in DOE High-Level Wastes

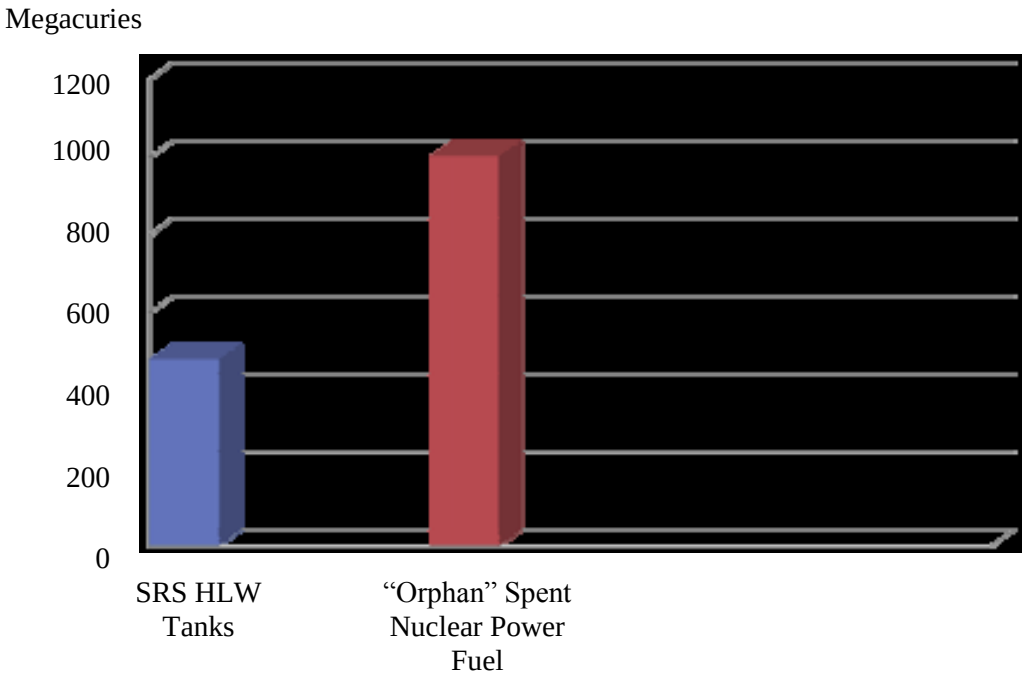

Figure 12. Comparison of Radioactivity between SRS HLW Tanks and Interim Storage of ~5000 Metric Tons of Spent Fuel from "Orphan" Reactor Fuel
Sources: NEI SNF Data (12-31-2011); DOE/EIS-2-25, Appendix A.

Nuclear waste management is ultimately a federal taxpayer/ratepayer responsibility. The research and various other responsibilities for reprocessing would provide very interesting jobs for those in the nuclear industry. They are likely to be jobs funded by taxpayers, not financed by the industry, unless the Waste Fund is considerably expanded.

Spent Fuel Issues

Storage of Nuclear Wastes Once Headed for Yucca Mountain

The nation's inventory of almost 70,000 metric tons of commercial waste consists mostly of spent nuclear fuel removed from commercial power reactors (Figure 13). Approximately 74 percent of this waste is stored in pools of water and 26 percent has been transferred to dry storage casks.[50] Volumes of spent nuclear fuel (SNF) are expected to more than double by 2055, assuming the 100 currently operating reactors receive license extensions and no new reactors are built. This SNF is currently accumulating at 75 sites in 33 states.[51] In addition, DOE manages about four percent of non-commercial SNF in the United States[52] as well as other high-level wastes. These wastes are primarily generated by the nation's weapons programs, but also by the nuclear Navy and worldwide research projects.[53] Navy submarine spent fuel is managed at the Idaho National Laboratory in casks designed for the Yucca Mountain geologic repository.

On-Site Dry Cask Storage

The rule of thumb for commercial spent nuclear fuel management has been to remove it from the fuel pool to dry casks after about five years. However, the NRC has allowed reactor operators to store more fuel in pools than initially designed because dry casks are expensive and would be a utility operating expense. Utilities have been hopeful that a near-term federal responsibility for spent fuel (which includes financial responsibility) would relieve them of the responsibility of investing in dry casks.

Some critics of current fuel pool practices are proposing "hardened on-site dry cask storage" (HOSS)[54] at reactor sites, in casks suitable for shipment. If standardized and financed by a newly conceived and legislated Nuclear Waste Fund, perhaps with berms to reduce visibility and vulnerability, storage could await the final repository. For 25 years Germany has been storing

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[50] GAO-12-797, August 15, 2012.

[51] GAO-11-229.

[52] Congressional Research Service U.S. Spent Nuclear Fuel Storage, May 24, 2012, Page 2.

[53] GAO-11-230.

[54] BRC, Page 46.

spent nuclear fuel older than five years in dry casks (Figure 14). The NRC is investigating considerations that fuel storage in casks might be possible for 100 years, or even 300 years, which should allow plenty of time for a thoughtful repository program.[55]

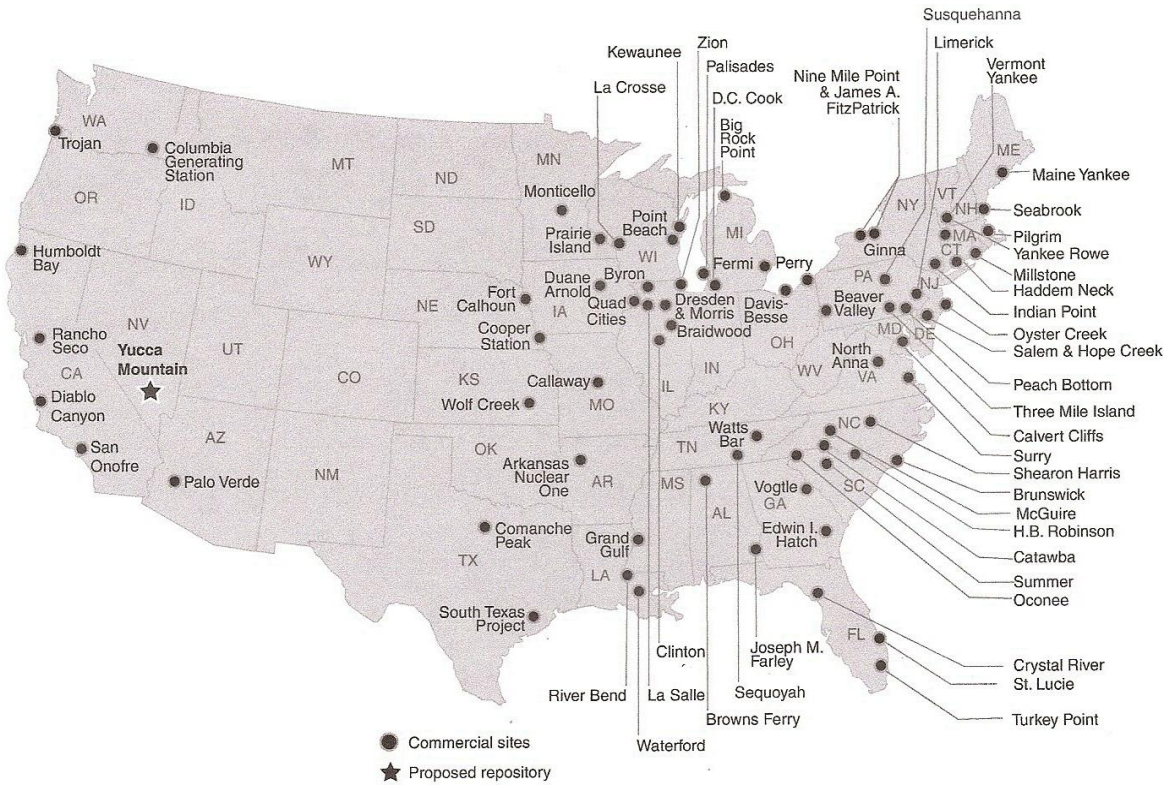

Figure 13. Current Storage Sites for Commercial Spent Nuclear Fuel and Proposed Yucca Mountain Repository Site[56]

The above are South Carolina's future partners in the pursuit of a permanent geologic repository

The BRC report recommends negotiations to limit costly legal challenges, primarily by waste generators (funded by taxpayers). These contracts guaranteed federal responsibility for waste on the schedule stipulated in the *Nuclear Waste Policy Act of 1982*. Financing of spent fuel storage at commercial reactor sites will hopefully be addressed either by Congress, as recommended by the BRC, or as a result of one of the many federal court challenges to the closing of Yucca

[55] BRC, Page 140, footnote 85; GAO 11-229, Page 26.

[56] Source: DOE 11-220. Figure 1. Locations are approximate. DOE has reported that it is responsible for managing nuclear waste at 121 sites in 39 states, but this includes high-level waste and spent nuclear fuel at 5 sites managed by DOE—2 of which are licensed by NRC and contain commercial spent nuclear fuel, at Fort St. Vrain in Colorado and the Idaho National Laboratory—and several sites that have only research reactors that generate small amounts of waste that will be consolidated at the Idaho National Laboratory for packaging prior to disposal.

Mountain. Most of these suits are yet to be tried. Thus far, taxpayers have paid reactor operators damages of $2 billion based on breach of contract. In addition, the Department of Justice has expenses of about $188 million to defend DOE in litigation.[57] In the interim, the courts appear to be looking for language from Congress regarding the status of the review.

The safe and secure storage of spent fuel at reactor sites is of utmost importance. While the BRC mentioned the problem of high-density spent fuel pool storage, it failed to recommend a path forward. Fuel pools are often full, and some dry storage casks may need repackaging, especially for transportation. In addition, extended on-site fuel pool storage could introduce possible risks to the safety and security of the waste as storage systems degrade. As the nuclear waste program proceeds, Congress must study and implement the BRC recommendations, redirect and fund spent fuel dry cask research, and restructure the Waste Fund so that it is adequate for future nuclear waste storage and repository needs. Congress must also secure the Fund for waste purposes

Figure 14. German Dry Casks are Used for Spent Fuel after Five Years in a Pool
Germans have been using Dry Casks for 15 years. File from Wikimedia Commons.

[57] BRC, Page 79, 8.5.

The GAO estimated in 2009 that casks would cost from about $30 million to $60 million per reactor, with costs increasing as more spent fuel is added to dry storage.[58] The GAO also reported that spent fuel would likely have to be repackaged about every 100 years, with repackaging costs ranging from about $180 million to nearly $500 million, although industry reviewers of the report questioned the need for repackaging.

Duke Energy has significant experience with spent fuel storage—including in dry casks. SCE&G/Santee Cooper plan for dry cask storage at their new facility. As of 2010, 54 different licensed spent fuel storage sites were located in the United States, some site-specific and some general, in 33 states. There are about 34 dry cask storage designs, some very similar.[59]

The Simpler, Safer Choice—Why Nuclear Waste Should be Moved to Dry Casks

After five years in a cooling pool, spent fuel assemblies are cool enough to be moved into dry casks: concrete and metal containers that are filled with inert gas, then placed on concrete pads or in large concrete silos at the reactor site. Unlike cooling pools that require mechanically driven water circulation, dry casks employ "passive" cooling: air enters an opening at the bottom of the cask, absorbs heat from the spent fuel, then rises and exits through an opening at the top, creating a "chimney effect" that pulls more air into the bottom of the cask.

Passive cooling makes dry casks less likely to lose their cooling capacity than "active" systems like cooling pools, which are vulnerable to mechanical failure, technical or human error, terrorist attack, and natural disaster. In addition, maintaining safety is simpler with dry casks, involving such mundane tasks as ensuring that birds have not built nests that block the chimney's air flow.

It is worth noting that some of the spent fuel from Japan's Fukushima Daiichi plant had already been stored in dry casks prior to the 2011 earthquake and tsunami. The safety of this radioactive waste was never a concern during the subsequent crisis.

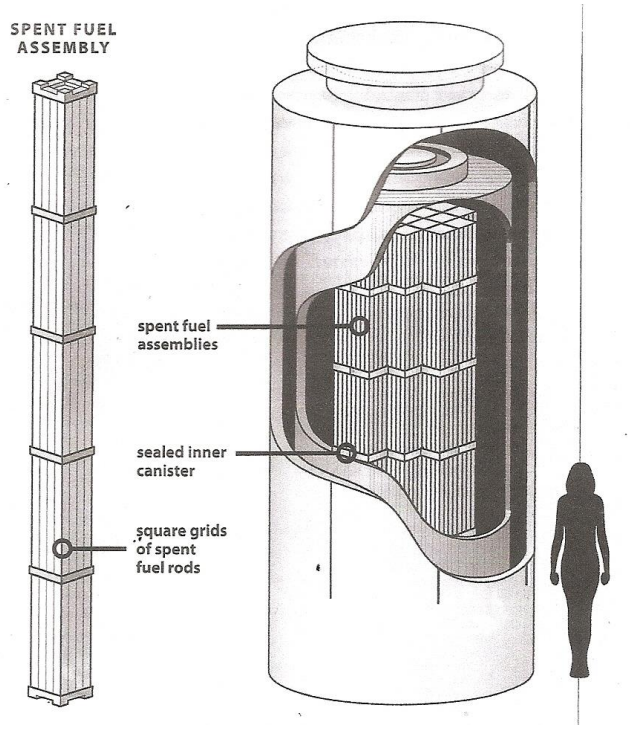

Figure 15. Dry Cask Storage
Source: Union of Concerned Scientists "Catalyst," Spring 2013

[58] GAO 10-48, Page 34.

[59] http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/.

Consolidated Storage

The costs of consolidated (sometimes referred to as interim or independent) storage are significant. They are generally proposed as off-site, independent of electricity generating reactors, containing older fuel in concrete casks. The GAO noted on-site storage of spent fuel would provide an alternative requiring little change from the status quo but might face increasing challenges over time. It would also allow time for consideration of final disposal options. (Yucca Mountain problems were not explicitly mentioned but were well known at the time.) The GAO noted that the additional time in storage would make the waste safer to handle ("cooler"), reducing risks when waste is transported for final disposal.[60]

DOE statutory authority to provide consolidated or interim storage at sites away from the generating reactor has been debated and will likely require congressional action. Finding a state willing to host a facility could be extremely challenging. Unless consolidated storage is located adjacent to a site suitable for final waste disposal, waste would be transported twice to reach its final destination, GAO also noted. Despite the reactor and fuel pool destruction caused by the earthquake and tsunamis, the dry casks at the Fukushima site were unscathed. BRC estimated that consolidated storage would cost about $100 million.[61]

Spent Fuel Efficiencies and Spent Fuel Pools

Because the nuclear industry has been developing design and management strategies to enable more efficient use of fuel, less spent fuel has accumulated than once anticipated. The more recent spent fuel, sometimes called increased burnup or "high burnup," requires more attention during pool storage and prior to dry cask storage. Spent fuel storage volumes in pools have increased markedly, and there was criticism even prior to the accident at Fukushima Daiichi of safety issues associated with the increased fuel pool storage. The industry and the public have seemed satisfied with on-site dry cask storage of older spent fuel, especially when bunkered, but no major program has been initiated to move toward thoughtful long-term, transportable dry cask development. Recently NRC/EPRI began looking into the long-term implications of this 15-year-old practice of the management of "high burnup" spent fuel.

International Reprocessing Experience

Although France has been vigorously promoting the reprocessing of spent fuel from nuclear power generation, international interest has been fading because of costs, accidents, waste management, proliferation risks, and the failure of once-envisioned new nuclear reactors to use plutonium, which is the major product of reprocessing.

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[60] From Nuclear Waste Management: Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives, GAO-10-48, November 4, 2009, summary.

[61] BRC, Page 40.

Reprocessing has presented the United States, France, England and Japan with problems—both during reprocessing and waste management. Most proponents of reprocessing anticipate that resulting wastes would require less geologic storage space than the original spent fuel storage volumes. However, because reprocessing does not reduce decay heat, which is the key factor in determining geologic placement, the disposal requirements would not change significantly if the U.S. were to reprocess.[62] Further, if the plutonium recovered through reprocessing were used to make mixed oxide fuel (MOX), as currently proposed at SRS, the resulting irradiated fuel rods would not be reprocessed, so the issue of final disposition of spent nuclear fuel would be deferred, not resolved. Although AREVA claims that MOX fuel can be reprocessed, the French have not yet done so. About one-third of France's 58 reactors are partially fueled with MOX fuel made from reactor-grade plutonium.

A major problem has been the significant volumes of very hot wastes generated from reprocessing. AREVA claimed to have overcome the waste heat/volume challenge in an undocumented presentation to the S.C. Governor's Nuclear Advisory Council in December 2012. Wastes will continue to be a problem, since plutonium is a hazard for 240,000 years. Because of the socialist nature of the nationalized French nuclear industry, some facts have been elusive and the economics of French reprocessing is completely different from that in a capitalist economy. AREVA is already involved in the plutonium fuel factory for MOX fuel at SRS from dismantled nuclear weapons and seemingly has goals to manage reprocessing and other nuclear ventures at SRS and elsewhere in the United States.

Japan has been struggling to start a commercial reprocessing plant that is over budget and behind schedule. Japan has separated plutonium, is concerned about associated proliferation issues, and was reviewing its options before the Fukushima Daiichi accident. It resumed construction of a reprocessing facility in March 2012, primarily because local community control of reactors can limit the quantities of spent fuel stored in the neighborhood, thus forcing reprocessing.

Independent studies by two federal agencies (GAO and National Academy of Sciences) have determined that reprocessing is more expensive than the reclaimed materials are anticipated to be worth in the next few decades. In addition, both agencies noted that reprocessing contributes to plutonium proliferation risk and does not resolve the challenge of permanent disposal. The BRC report draws the same conclusions[63] and the DOE response to BRC recommendations concurs.[64]

England has attempted Light Water Reactor fuel reprocessing and experienced troublesome releases of radiation. In August 2011 it announced the phasing out of its reprocessing program after fulfilling reprocessing contracts (perhaps 2016), as have some other members of the European Union. Denmark, Norway and Ireland have sought the closure of various nuclear and reprocessing plants in France and England because of radioactive waste washing up on their

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[62] Alvarez, https://docs.google.com/file/d/0B34tchlsLOXfY3RHaHRMUU9IRE0/edit?pli=1, Page 8 – NAS 1996.

[63] BRC, Page 35.

[64] DOE 2013, Page 7.

shores. However, the European nuclear industry continues to anticipate changing policies. In February 2012, England's Prime Minister David Cameron agreed to a deal to strengthen nuclear power links between his nation and France, stating his commitment to developing nuclear "as part of a diversified energy mix." In January 2013 Hitachi-GE applied for its Advanced Boiling Water Reactor and the government approved the processing, likely to take about four to five years.

France has not found a permanent storage site or strategy but the BRC reports that it is making progress.[65] The nuclear industry in socialist France is largely owned, subsidized and vigorously promoted by the French government. High-level waste is now stored in above-ground refrigerated facilities at AREVA's fuel reprocessing plant in La Hague on the northwestern coast of Normandy. Under French law, AREVA will have to bury the waste in a permanent repository by 2025; the planned repository site media is clay.

[65] BRC, Page 49.

LIST OF ACRONYMS

BRC – Blue Ribbon Commission on America's Nuclear Future

CRO – SRS Community Reuse Organization

DOE – U.S. Department of Energy

DWPF – Defense Waste Processing Facility

EPA – Environmental Protection Agency

FY – fiscal year

GAO – Government Accountability Office

GTCC – Greater than Class C

HLW – high-level waste

HOSS – hardened on-site (spent fuel) storage

MOX – mixed oxide (plutonium and uranium) fuel for nuclear reactor power

NAS – National Academy of Sciences

NGO – non-governmental organizations

NNSA – National Nuclear Security Administration

NRC – Nuclear Regulatory Commission

NWPA – Nuclear Waste Policy Act of 1982, amended in 1987

RD&D – research, development, and demonstration

SNF – spent nuclear fuel

TRU – transuranic wastes

TVA – Tennessee Valley Authority

WIPP – Waste Isolation Pilot Plant in New Mexico

DEFINITIONS

In addition to traditional definitions linked below, the terms "host," "consent," "willing," "temporary," and "volunteering" are used alternatively in various reports and legislative proposals. Each refers to a vague process by which communities or states might "welcome" or "consent" to spent fuel or geologic storage. The terms are never defined.

NRC, Glossary of nuclear waste terms, http://www.nrc.gov/reading-rm/basic-ref/glossary.html.

NRC, Fact Sheets, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/.

NRC, http://www.nrc.gov/reading-rm/doc-collections/cfr/part034/part034-0003.html.

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BRC, Report to the Secretary of Energy January 2012 htttp://cybercemetery.unt.edu/archive/brc/20120620211605/http:/brc.gov//.

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GAO, Nuclear Regulatory Commission - Natural Hazard Assessments Could Be More Risk-Informed, GAO-12-465, April 26, 2012.