# U.S. NUCLEAR WASTE TECHNICAL REVIEW BOARD

# DEPARTMENT OF ENERGY-MANAGED SPENT NUCLEAR FUEL AT THE SAVANNAH RIVER SITE

## OVERVIEW

The U.S. Department of Energy (DOE) manages approximately 2,500 metric tons of heavy metal (MTHM)[1] of spent nuclear fuel (SNF) that resulted mostly (85% by mass) from defense-related nuclear activities (primarily weapons plutonium production reactors and naval propulsion reactors). Nearly all the SNF is stored at four locations: the Hanford Site in Washington State, the Idaho National Laboratory in Idaho, the Savanah River Site (SRS) in South Carolina, and the Fort St. Vrain Independent Spent Fuel Storage Installation in Colorado (see the Board's fact sheet on DOE-Managed Spent Nuclear Fuel).[2] Approximately 30 MTHM of SNF are stored at SRS, a 310-square mile site about 20 miles southeast of Augusta, Georgia (Figure 1). Beginning in the early 1950s, five nuclear reactors on the site produced nuclear materials (mainly tritium and plutonium) for nuclear weapons (Savannah River Nuclear Solutions 2017). The reactors ended operations in the late 1980s; however, SRS continues to receive, inspect, and store SNF from domestic and foreign research reactors. All SNF at SRS is stored at the L area in the L Basin building (Figures 1 and 2).

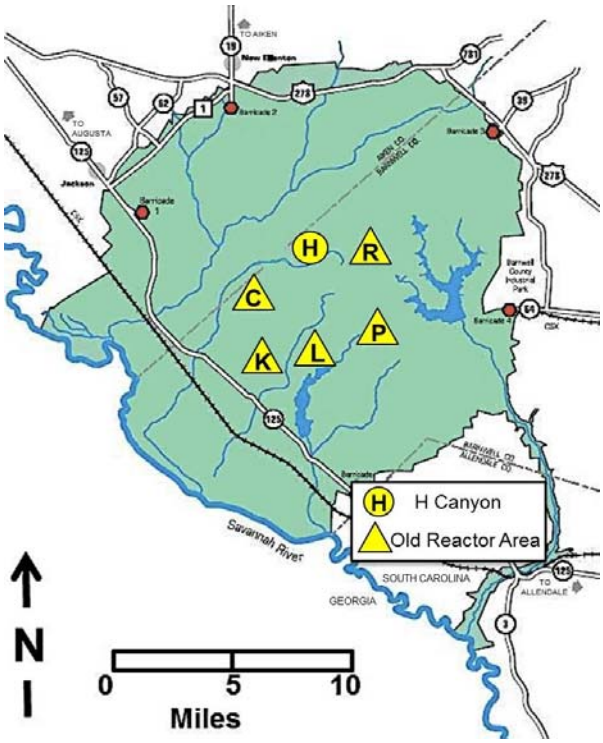


**Figure 1. Savannah River Site Map (Savannah River Nuclear Solutions 2011).**

## SPENT NUCLEAR FUEL AND STORAGE FACILITIES AT THE SRS

**Spent Nuclear Fuel**. Information on the predominant types of stored SNF, such as the source, fuel type, cladding type, and amount, is presented in Table 1. DOE groups the SNF into "aluminum-based SNF" and "non-aluminum-based SNF."

Approximately 13,000 aluminum-based SNF assemblies and 2,000 non-aluminum-based SNF assemblies are stored at SRS. The

[1] Metric ton of heavy metal is a commonly used measure of the mass of nuclear fuel. Heavy metal refers to elements with an atomic number greater than 89 (*e.g.*, thorium, uranium, and plutonium) in the fuel. The masses of other constituents of the fuel, such as cladding, alloy materials, and structural materials (and fission products in spent nuclear fuel), are not included in this measure. A metric ton is 1,000 kilograms, which is equal to about 2,200 pounds.

[2] Fact sheets providing summary information on DOE-managed SNF stored at the Hanford Site, Idaho National Laboratory, and Fort St. Vrain can be found at the Board website: http://www.nwtrb.gov/our-work/fact-sheets. A more detailed description of DOE-managed SNF and SNF storage facilities is provided in the Board report, *Management and Disposal of U.S. Department of Energy Spent Nuclear Fuel* (NWTRB 2017).

**Table 1. Characteristics of SNF stored at SRS***

| SNF Source | Description# | Amount (MTHM) | Storage System |
|---|---|---|---|
| Foreign and domestic research reactors, test reactors, and other reactors | Aluminum-based: aluminum-clad uranium oxide, aluminum-clad uranium-aluminum alloy | ~10† | 4 or 5 SNF assemblies per aluminum tube in vertical tube storage; ~13,000 assemblies total |
| Research and test reactors | Non-aluminum-based: zirconium-alloy clad, stainless-steel clad, and declad‡ thorium and uranium oxide or uranium-zirconium alloy | ~20 | Various, including oversized isolation cans; ~2,000 assemblies total |

*Because of the wide variety of SNF types within the aluminum-based and the non-aluminum-based SNF groups (>30 types in each group), only the predominant types are included in the table.
#From Rose (2013) and DOE (2000).
†Does not include aluminum-clad SNF being processed in H Canyon (see below).
‡Declad SNF is SNF from which the metal cladding has been removed.

aluminum-based SNF is primarily research reactor fuel assemblies (DOE 2000) that were transported to SRS from other countries under the "Foreign Research Reactor Program" and from U.S. research reactors under the "Domestic Research Reactor Program" (DOE 1996). The aluminum-based SNF includes aluminum-clad uranium oxide SNF and aluminum-clad uranium-aluminum alloy SNF. The non-aluminum-based SNF includes zirconium-alloy-clad and stainless-steel-clad thorium and uranium oxide or uranium-zirconium alloy SNF. The cladding from some of the non-aluminum-based SNF has been removed.

**L Basin Storage Facility**. At the L Basin building (Figure 2), the majority of SNF is stored underwater in the L Basin[3] (Figure 3). The remaining SNF, which is not described in Table 1, is stored in two small, dry storage areas in the L Basin building (Gillas 2011).


**Figure 2. L Basin Building (from Hixson 2015).**

L Basin is divided into an upper (North) and a lower (South) basin. The upper basin is mostly 30-ft (9.1-m) deep and includes the vertical tube storage area that contains bundles of SNF (Figure 3). It also includes the dry cave basin, machine basin, and emergency basin areas. The lower basin is mostly 17-ft (5.2-m) deep and includes the horizontal tube storage area, the bucket storage area, the monitor basin, and the transfer bay. Sindelar and Deible (2011) provide details of the storage systems in the L Basin.

[3] L Basin is a reinforced concrete structure with walls 2.5- to 7-ft (0.76- to 2.1-m) thick and holds ~$3.4 \times 10^6$ gal (~$12.9 \times 10^6$ L) of water (Maxted 2014). The basin is approximately 160 by 230 ft (48.8 by 70 m) in plan dimensions and has seven interconnected sections that are 17- to 50-ft (5.2- to 15.2-m) deep and configured for SNF storage (Sindelar and Deible 2011).

## PATH FORWARD FOR MANAGING AND DISPOSING OF SRS SNF

Historically, SNF from the five nuclear material production reactors at SRS was processed in the F Canyon and H Canyon chemical separations plants to recover plutonium and other materials. In September 2014, DOE began a new processing effort at H Canyon to dissolve 3.3 MTHM of aluminum-based SNF from the L Basin and recover highly enriched uranium to be isotopically diluted and used to fabricate fresh fuel for commercial nuclear reactors. DOE plans to continue processing this SNF for up to eight years (Gunter 2014). This will reduce the SNF inventory in the L Basin, which will allow SRS to continue to accept and store foreign and domestic research reactor SNF and other SNF that is of concern for proliferation reasons. The program for accepting foreign research reactor SNF will expire in 2019 (DOE 2008, 2009b), whereas the program for accepting domestic research reactor SNF extends through 2035 (DOE 1996).

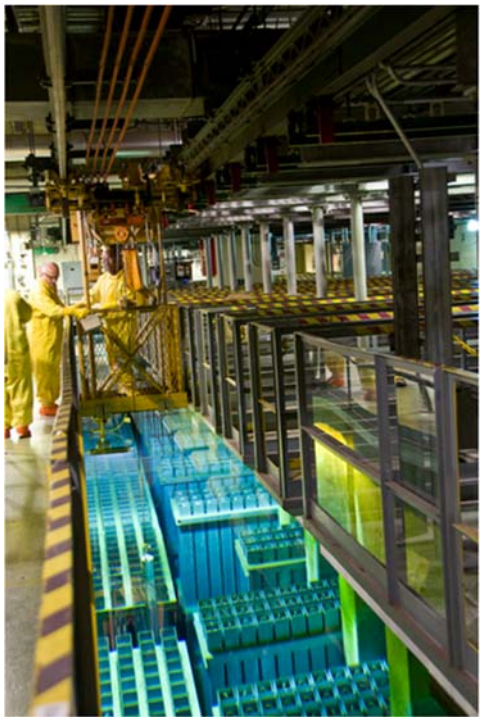

**Figure 3. Spent Nuclear Fuel Storage in the Vertical Tube Storage area at the L Basin (from Hixson 2015).**

DOE recognizes that a departmental decision is needed on the future direction of SRS SNF management and is considering different disposition options (Maxted 2014, 2017). These options include (i) continued SNF storage in the L Basin, (ii) loading the SNF into dry-storage systems, and (iii) processing the aluminum-based SNF in the H Canyon chemical separations plant. Pending a decision, all SNF will be stored in the L Basin indefinitely, except for the 3.3 MTHM being processed in H Canyon (DOE 2013).

NWTRB (2017) provides a more detailed discussion of the path forward for managing and disposing of SRS SNF.

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**The U.S. Nuclear Waste Technical Review Board** is an independent federal agency established in the 1987 amendments to the Nuclear Waste Policy Act (NWPA).

The Board evaluates the technical and scientific validity of U.S. Department of Energy activities related to implementing the NWPA and provides objective expert advice on nuclear waste issues to Congress and the Secretary of Energy.

The eleven Board members are nominated by the National Academy of Sciences and are appointed by the President.