Solidification and Disposal of SPRU Radioactive Sludge Waste

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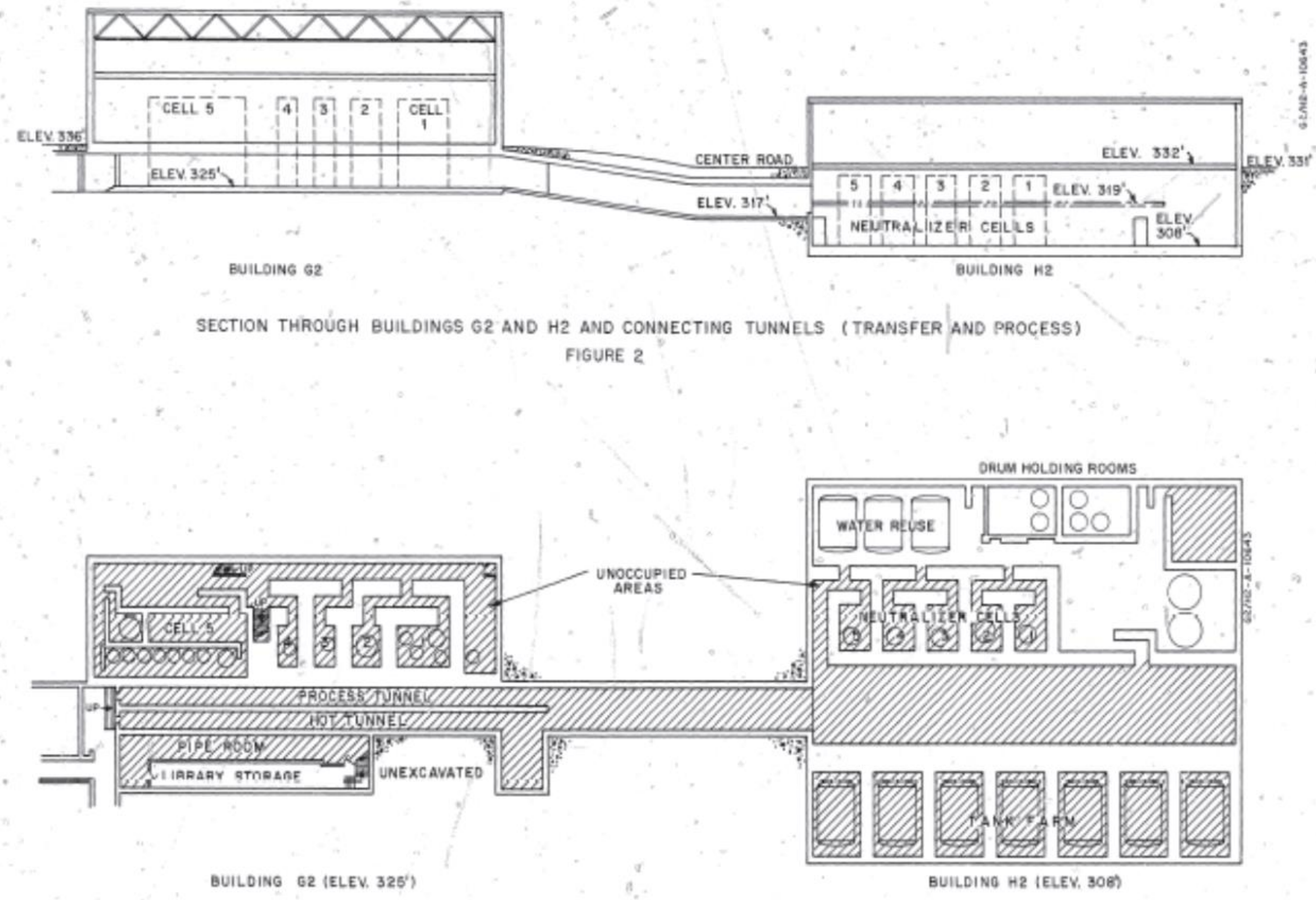
Historical Perspective

- The Separations Process Research Unit (SPRU) is located near Schenectady, New York, adjacent to the Mohawk River and occupies approximately 5 acres of land.
- SPRU was operated from 1950 to 1953 as a pilot plant to research the REDOX and PUREX chemical processes to extract Uranium and Plutonium.
- Research supported operations at the Hanford Site (Washington State) and the Savannah River Site (South Carolina).
- The research was performed on a laboratory scale; SPRU was not a production plant.
- Construction began in 1948 and was completed in 1949

The SPRU Facility is Primarily Two Connected Buildings

- Building G2 housed the laboratories, hot cells, and separations process testing equipment

- Building H2 was used for liquid and solid waste processing



Sludge Waste Remained in the Tank Farm in SPRU Building H2

- At the end of operations, residual waste (sludge) was contained in 7 underground concrete-enclosed stainless steel tanks in the SPRU H2 building, where liquid radioactive waste was stored for processing during operations.
- In 2010 the sludge was consolidated into a single tank (509E) in preparation for sludge waste processing and disposition.
- The processing technology chosen was to stabilize the waste in a liner using a cement/fly ash/slag mixture.

Waste Regulation

- DOE Order 435.1, Radioactive Waste Management, defines DOE policy and regulation and applies to SPRU site activities.
  - DOE Manual 435.1-1 includes requirements and definitions.
- DOE Manual 435.1-1 allows for disposition in Federal and commercial facilities.
  - Use of commercial facilities requires an “exemption approved by DOE, demonstrating, e.g., compliance, cost effective, and in best interest of US Government.
- DOE disposal facilities have a formal Disposal Authorization, subject to annual review by the LLW Federal Review Group.
- When DOE waste is transferred to a commercial facility, treatment or disposal is regulated by an NRC and/or Agreement State license.
- DOE waste is not formally classified until all processing is complete and a stabilized waste form is produced for final disposition.

SPRU Sludge Waste Characteristics

- 9,700 gallons of sludge processed
- The sludge contained approximately 1480 gallons (200 cubic feet) solids in the tank
- Waste included fission products and transuranic (TRU) radionuclides
- Initial characterization of the solids estimated:
  - Between 30 and 50 Curies (Ci) of total radionuclides
  - Including 2.5 and 6.5 Ci of long-lived transuranic radionuclides
- Actual content based on in-process sampling was 36 Ci total:
  - 31.3 Ci (87%) Cs-137 and Sr-90
  - 4.5 Ci (12.5%) TRU radionuclides (primarily Pu-239)
- Long-lived transuranic radionuclides in final waste liners ranged from 11.5 to 65.5 nCi/g.

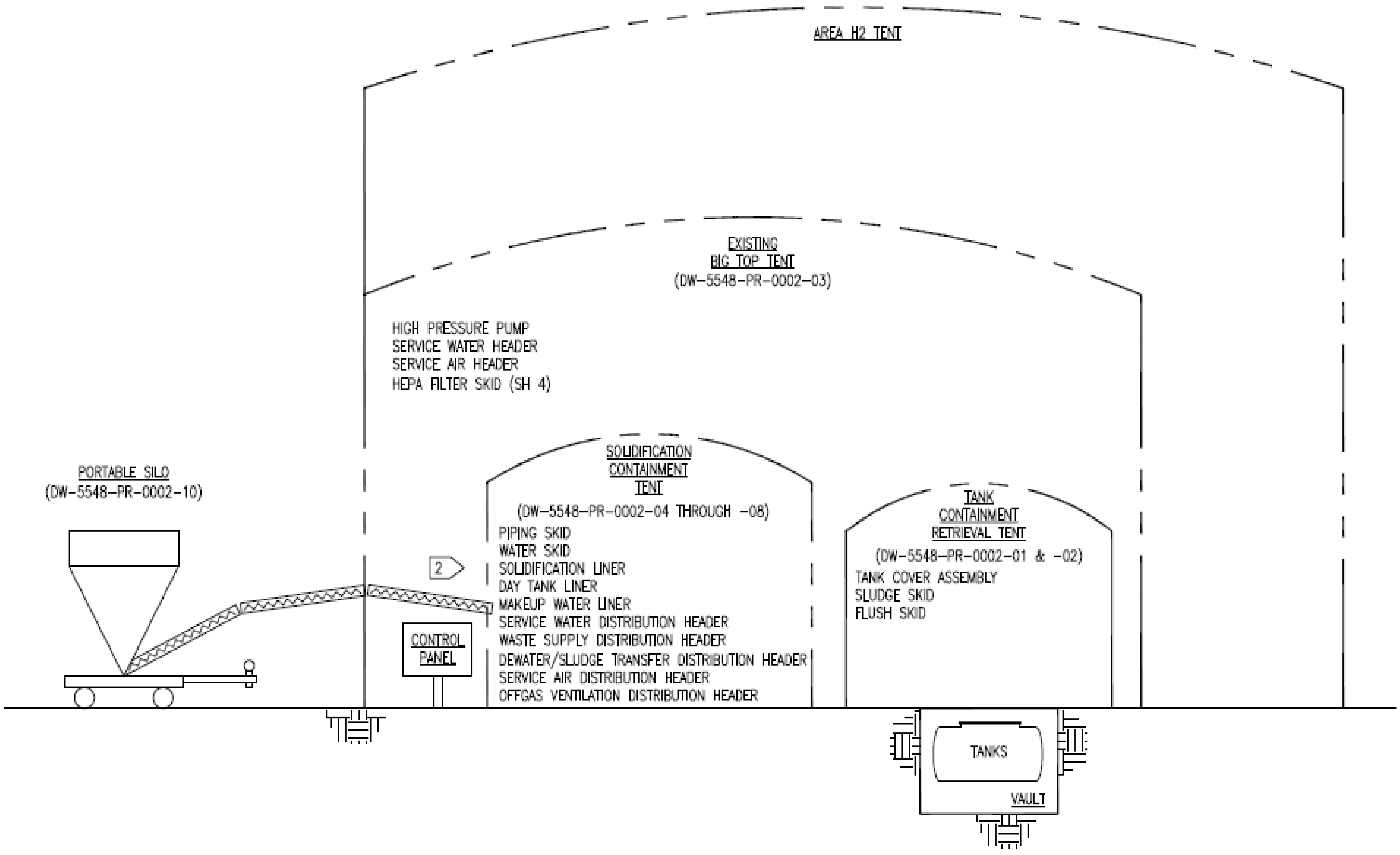
SPRU Sludge Waste Characteristics

- Early project characterization data indicated sludge would likely be a RCRA characteristic hazardous waste for metals
  - Classification as RCRA waste would have complicated management and processing
  - Total mercury was over 1% and sludge contained high levels of lead, chromium and cadmium
- Two Toxicity Characteristic Leaching Procedure tests concluded levels were at 0-3% of regulatory levels, due to low solubility of metals

Disposal Planning

- Federal or commercial disposal?
  - Options for disposal were limited to DOE's Nevada Nuclear Security Site Area 5 (Federal) and Waste Control Specialists (WCS) Federal Waste Facility (commercial).
  - DOE explored both options, but selected WCS for disposal.
  - The WCS option supported the project's constrained schedule – profile review time is typically shorter and DOE had an existing "National" Indefinite Quantity/Indefinite Delivery Contract with WCS.
- WCS worked the waste profile through their standard process with their Texas regulators. Texas regulators accepted DOE's policy that waste is classified when in the final disposal container.
- The solidification system was designed, tested offsite by the vendor, and installed in the H2 tank vault area.
  - Testing occurred on site prior to hot operations.

Contamination Enclosures



Primary Process Steps - 1

- A tank mixing pump was used for recirculation mixing of the contents of Tank 509E (solids were mobilized).
- After a minimum recirculation time of two hours, a batch of sludge was transferred to a "day tank."
- The day tank was mixed with the internal paddle mixer and recirculation mixing occurred through the sample loop with the peristaltic pump.
- Radiation dose readings were taken at several locations from the top to the bottom of the day tank. When the dose reading profile was stable, mixing was considered complete and a sample was taken.

Primary Process Steps - 2

- The sample was analyzed on-site to verify that the radionuclide concentrations, when stabilized, would meet the disposal criteria (also the predicted dose rate from the solidified liner would meet shipping limits).
- The batch was transferred to the solidification liner and the cement/fly ash/slag mixture was added.
- The mixture was periodically checked by a penetration test to determine when it was solidified. If there was any remaining free water, additional cement mix was added.
- The liner was moved into a shielded temporary storage area and then shipped off-site for disposal.

Solidified Sludge in Liner

General Subject	Assoc Doc	Pic ID	Date	Specific Location	Pic Description	Photographer	Comment
Sludge Liner 22 SPRU/120041 01 13 14	SPRU-OPS-210	SL22S-01 13 14-001	01/13/14	SPT Tent	Liner 22 solidified	D. Lodman	N/A

Sludge Processing Overview

- **Began Sludge Processing September 9, 2013**
- **Completed Shipments on February 27, 2014**
  - 28 liners solidified, shipped and disposed at WCS in Texas.
  - The campaign removed majority of radionuclides from SPRU site, and allowed deactivation to resume in the H2 basement.
  - Upon completing the sludge solidification project, the SPRU Disposition Project had achieved more than 2¾ years and more than 1.1 million safe work hours without a lost-time accident or injury.

First Liner Shipment

Disposal of First Liner

What Were the Obstacles?

- A facility and waste stream that were decades old and difficult to access.
  - The top of the facility had been demolished, and work was performed in tent-type containment structures
- A sludge waste form – solids mobilized in liquids required continual mixing to keep homogenous.
- Limited physical area to work and waste management in proximity to operating laboratory facilities and the site boundary.
  - Limited onsite storage (constrained to curing liners, plus one shipment)
- Initial uncertainty over final waste classification.
  - Questions arose regarding the conclusion that the waste was not HLW. This was resolved with historical research, additional evaluation, and management attention.
- Resources to ensure samples were representative and attention to ensure as solids were removed the remaining inventory waste concentration limit
  - Mixing in the tank bottom, became more difficult as the process proceeded.
  - As the contents lowered, unexpected solids on the tank bottom were exposed. Adjustments to nozzles and sluicing were required to suspend and remove all solids.

What Significantly Contributed to Success

- Workforce dedicated to safety and mission completion.
- DOE Federal Project Director and staff technical competence.
- Frequent communication among DOE participants and support from a “Senior Integrated Project Team.”
- Cold testing of treatment system at the vendor site and onsite prior to hot operations.
- Waste disposal experts from the disposal site engaged early in the project with the D&D contractor.
- Close communication and cooperation with disposal site operator – in turn WCS did the same with Texas regulators.
- Coordination with DOE packaging and transport expertise.