CALCINE

Produced for the Leadership in Nuclear Energy (LINE) Commission and residents of the State of Idaho by the Energy Policy Institute with contributions and review by Idaho National Laboratory, Fluor Idaho, and Boise State University.

Summary

This report on calcine is part of a series of technical reports that was completed on nuclear waste and spent fuel. Special emphasis is on the relevance of the topics for Idaho.

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1. Definition: What is calcine?

Calcine is a dry, solid, granular material, similar to coarse sand. It is highly radioactive and classified as hazardous waste that is required by law to be permanently disposed of in deep geologic isolation from humans and the environment.

Calcine is inherently safer in intermediate storage compared to a liquid waste form in tanks. Its primary chemical components are zirconium, aluminum, fluoride, and calcium. While its radionuclide inventory includes plutonium, it is primarily made up of short-lived cesium and strontium atoms. The overall radioactivity of calcine is expected to decrease by 50% by 2048, meaning that it actually becomes easier to handle over time. Figures 1 and 2 depict photos of calcine samples.

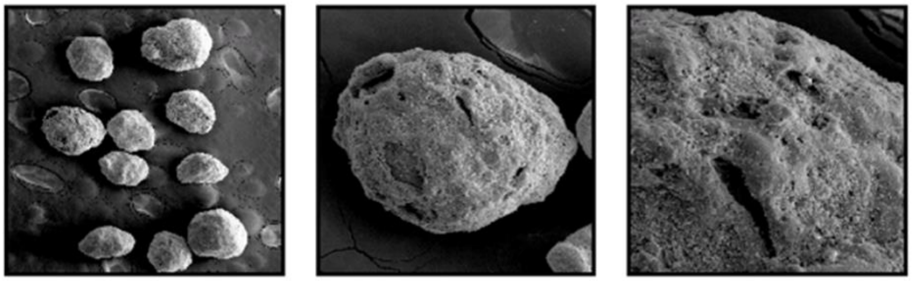

Fig 1. Magnified Photos of Calcine Granules. *Source: [12].*

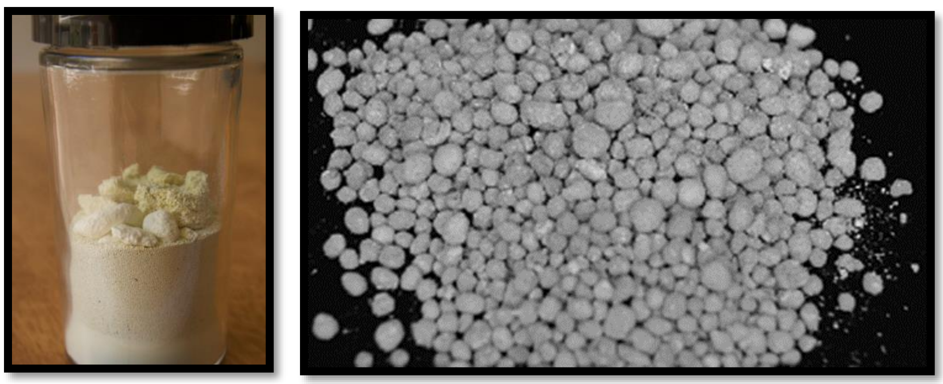

Fig 2. Photos of Simulated Calcine Waste
Sources: (Left) [2], (Right) [8].

2. Source: Where did calcine that is in Idaho come from?

The Department of Energy's (DOE) Cleanup Site, based in Idaho Falls, and Idaho National Laboratory (INL) house intermediate storage facilities for many types of nuclear waste from the US Navy Fleet, nuclear test reactors worldwide, and spent nuclear fuel (SNF) from a variety of US sites. In the past, the former Idaho Chemical Processing Plant, now the Idaho Nuclear Technology and Engineering Center, reprocessed SNF to recover high value uranium. The resulting liquid, high-level waste was converted into solid granular material -- calcine. Figure 3, below, depicts the process as it occurred at the DOE's Cleanup Site.

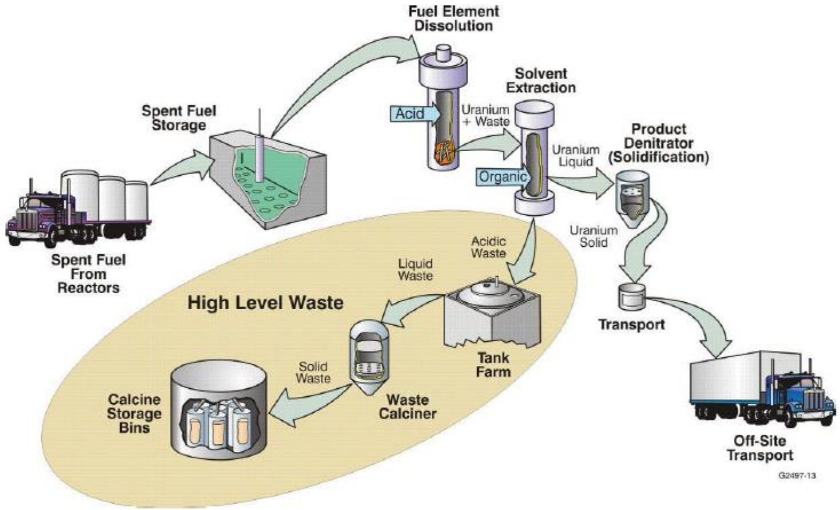

Fig 3. Spent Nuclear Fuel to Calcine Process
Source: [18].

3. Quantity: How much calcine is there in Idaho?

The Idaho Nuclear Technology and Engineering Center (INTEC) reprocessed approximately 7.5 million gallons of liquid high-level waste between the 1960s and 2000. This resulted in the creation of 4,400 m^3 (approximately 1 million liquid gallons) of calcine, stored in a series of stainless steel vessels contained within reinforced concrete silos at INTEC [3].

4. Storage: How is calcine stored?

Calcine is stored in bin sets -- stainless steel storage vessels that are contained within reinforced concrete silos, [1] referred to as the Calcine Solid Storage Facilities (CSSF). Calcine was transferred to bin sets for intermediate storage, with each bin set containing a cooling system and accessible ports. The bins have a 500-year corrosion allowance with the bounding service life of the bins projected to be 1,300 years [3]. Inspections of the bin sets are completed daily with more comprehensive inspections done monthly and annually. The bin vaults are inspected via video every five years. To date, no degradation of the bin sets has been observed. Figure 4 illustrates bins and Figure 5 depicts the location at INTEC where the calcine is stored.

The Idaho Cleanup Project is developing and testing a full-scale retrieval system to demonstrate DOE’s ability to safely retrieve calcine from CSSF 1 and transfer it to CSSF 6. The objectives of this effort are to eliminate risks, optimize final design configurations, and determine the efficacy of calcine removal for environmental closure.

[1] The silos are all or partially underground, designed to withstand natural disasters (i.e., fire, flood, earthquakes, etc.).

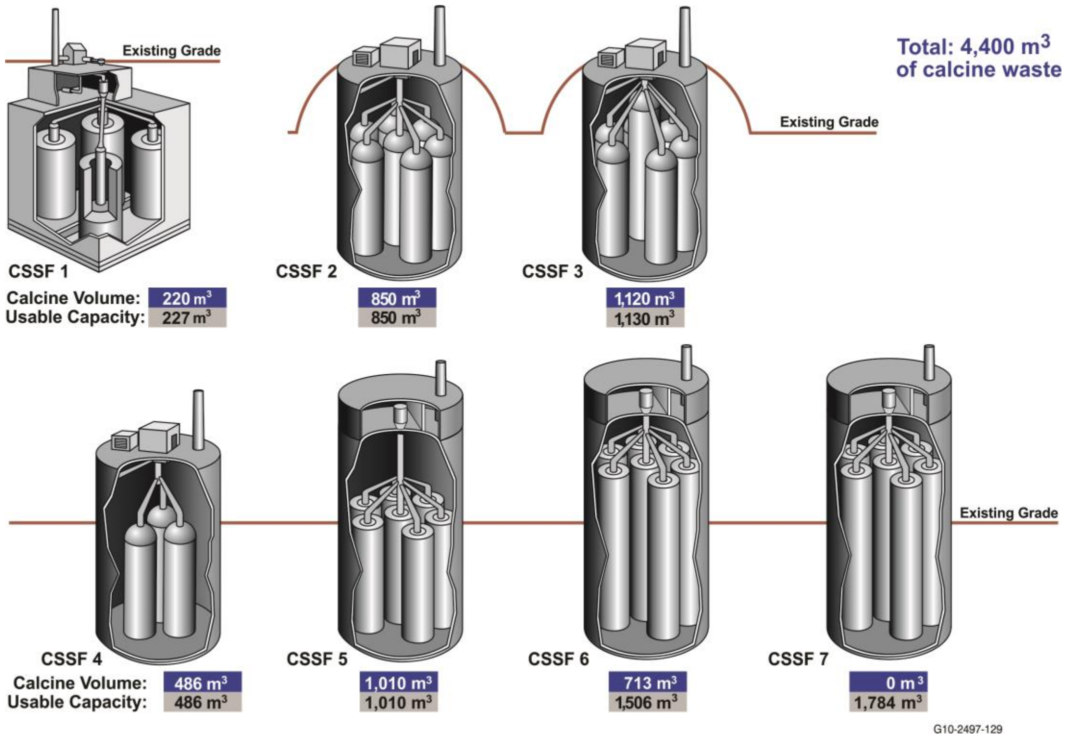

Fig 4. Calcine Bins
Source: [9].

Fig 5. Calcine Silos at INL
Source: [10].

5. Risks: What environmental and safety risks are associated with calcine?

There is minimal environmental and safety risk, including risk to the Snake River Plain Aquifer, associated with calcine storage. This is because of the structural design of the bin sets and the fact that the material is a granular solid, not a liquid. The minimal risk that exists must be managed, however, because calcine is highly water-soluble, and any water intrusion into the bin sets could cause corrosion and complicate future calcine retrieval. Any release of calcine out of the bin set could potentially release radionuclides into the environment. Risk of a release to the environment is mitigated by the purposeful design of the bin sets, which have two levels of containment, continuous monitoring systems, and routine surveillance and maintenance of the bin sets and equipment.

6. Settlement Agreement: How does the 1995 Settlement Agreement apply to calcine?

In October of 1995, the State of Idaho, U.S. Navy, and U.S. Department of Energy (DOE) reached a settlement agreement, which requires the DOE to treat calcine waste, putting it into a form that is suitable for transport to a permanent repository or interim storage outside of Idaho by December 31, 2035.

7. **Settlement Agreement: What is the status of calcine in relation to the 1995 Settlement Agreement?**

DOE has selected hot isostatic pressing (HIP) as a treatment option. HIP generates a robust, glass-ceramic waste form that is essentially water insoluble. However, continued delays in opening the high-level waste repository at Yucca Mountain or in developing an interim storage facility outside of Idaho may affect the DOE's ability to meet the December 31, 2035 deadline. Therefore, no acceptance criteria can be determined for selection of a final waste form. Calcine is specifically prohibited by law from being stored at the Waste Isolation Pilot Plant (WIPP) in New Mexico without changes to current state and federal law or regulations. As an interim step, the DOE is exploring ways to transfer calcine from Bin Set One to newer bin sets as a way to inform future processes for transferring calcine once a treatment facility is constructed and operational.

8. REFERENCES

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