Waste Encapsulation Storage Facility

Potential Catastrophe, Emergency Response and Prevention

The following is provided as supplemental information Hanford Challenge created in consultation with Dirk Dunning, retired chemical engineer and nuclear specialist, for the Sept 2020 Washington State Department of Ecology Public Comment Period to add WESF to Section III of the Resource, Conservation, and Recovery Act (RCRA) Permit as Operating Unit Group 14 to transfer the capsules into dry cask storage.

The potential for a Chernobyl-like catastrophic spread of contamination from WESF should be eliminated by moving the strontium and cesium capsules to dry storage as soon as possible. The following is a description of what could happen if a major earthquake or other event caused water to drain from the pools.

The nearly 2,000 stainless steel capsules of cesium and strontium stored in underwater steel lined concrete pools at WESF are highly radioactive. Concrete is known to degrade when exposed to radiation for prolonged periods of time. DOE's own analysis in 2011 showed severe damage to the walls and floor from radiation. The walls between cells then were calculated to have less than 85% of their original strength at their centers, and essentially no strength at the wall surface behind the stainless-steel liner.

The safety basis DOE used for that analysis was based on accepted standards for radiation damage. All of the data to develop those standards came from studies of concrete with high moisture contents. The limited available data for dry concrete lacking this moisture points to it being equally damaged at total doses 500 to 2,000 times lower doses. As a result, it is likely that the concrete at WESF is far more badly damaged than DOE's own analysis suggests.

Imagine a major earthquake causing a rupture to the liner, or failure of the concrete, or an inaccessible pipe at the bottom of the pools failing, causing water to drain from the pools.

Once the water level falls to within 6 feet of above the capsules the radiation dose from gamma rays from the decay of radioactive cesium becomes so enormous that human entry to the building is simply not possible. Once the capsules are fully exposed, the temperature in the building rises to several hundred degrees Centigrade. No human can then enter the building. Facility control is lost.

When the water level falls well below the capsules, the radiation field created makes approach to the building within 50 yards lethal. Access even to the outside of the building is lost, as is access over the top of the building.

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Once facility control is lost, the capsules overheat from lack of cooling. The salts in the cesium capsules attack and damage the capsules and they progressively fail, slowly releasing their contents. Radioactivity then spreads, gradually making the building and the areas around the building ever more unsafe to enter. The spread of radioactivity continues for months and years if nothing is done to stop it. However, the radiation levels and contamination make doing anything extremely dangerous, and potentially impossible. The contamination then spreads until the entire Hanford site is contaminated and potentially rendered inaccessible for hundreds of years.

So how would DOE respond to scenarios like this? One way (not in DOE's current plans) might be to pile tens of feet of dirt over the collapsing building to create a radiation shield covering the capsules, and doing so as fast as possible to slow the spread of radioactivity. Once complete, a barrier would then be needed to stop water moving into the wastes.

To do something like this would require using heavy earth moving equipment to bulldoze and dump the dirt closer to the building and ultimately over it. The radiation levels before that happens are enormous near the building. The equipment would have to be heavily shielded with lead to protect the workers. Even then the radiation doses may be high. The Russians did something similar at Chernobyl. They used ten thousand workers to shovel radioactive debris back into the reactor hall. Huge numbers of those workers reportedly ultimately died from their exposures.

If the capsules have failed before they begin, that might not even be possible. That would be far more like Chernobyl, where radioactive material was on the loose everywhere.

The Russians tried to use a remotely operated bulldozer at Chernobyl. It died before ever moving any waste. The Japanese repeatedly tried to use robotic equipment. Every attempt ended in failure as the electronic circuits were fried by the radiation fields.

Other methods could be tried. Each has equally large drawbacks.

The best answer is to ensure that no such catastrophe is even remotely possible. And the way to do that is to get the capsules into safe dry storage.

That should include using another capsule (DOE calls them sleeves) made of super alloys that will not crack, corrode or fail if or when the cesium capsules themselves fail. In truth, the cesium capsules should have been made of such an alloy from the start. But that cannot be changed now.

The dry cask storage is also planned to include air cooling of the capsules and concrete as a radiation shield. DOE must remember the lesson from WESF – that radiation destroys concrete. The concrete used must play no structural role - or – it must itself be shielded from radiation exposure. A better answer would be to use a material that is not destroyed by the radiation exposure, such as lead. If concrete is used it must be structurally contained itself so that when the radiation destroys it that it does not further complicate the problem, or result in high radiation areas around the casks.

The same holds true for the pad the casks sit on. Radiation dose and damage to the pad must be planned, and damage prevented that might further complicate the problem by allowing the casks to sink or tip over, or that makes their retrieval for disposal more difficult.

Once the capsules are removed from the basin, it is essential to immediately begin a detailed forensic analysis of the concrete walls and floor to determine the degree of damage to the concrete. This must then be assessed against the estimated radiation dose to the concrete from the known history of the capsules stored in the basin. This real-world data is essential for evaluating every other nuclear facility in the DOE complex, all of the other DOE pools and basins, operating nuclear reactors, and all of their spent fuel pools. This analysis must be a very high priority. And on completion the data needs to be widely and publicly shared, so that nuclear facilities all over the world can use this information to assess their own risks and hazards.