From: Diane Jackson NRR
To: Charles Tinkler, Glenn Kelly, GTH, Jared Wermie... NRR
Date: Sun, Jul 23, 2000 10:27 AM
Subject: partial draindown - GSI 82

Recently and in the meeting on Wednesday partial drain down was discussed, it was mentioned that GSI 82 dismissed partial drain downs. I looked into the reason...

NUREG/CR-0649 by SNL did some analysis on partial drain down. They concluded that :
1) "it is clear that an incomplete drainage can potentially cause a more severe heatup problem than a complete drainage" (if water level is between less than 10% of the fuel to the lower baseplate)

AND

2) "the clad oxidation effect has not been calculated for this case of incomplete drainage because it is believe to be substantially reduced by the unavailability of oxygen within the assembly"

9/217

Partial Drain down

The possibility of a partial (or incomplete) drain down versus a complete drain down of the spent fuel coolant has been raised. Many spent fuel rack designs provide a hole (or orifice) at the bottom of the rack for convective flow but little or no holes along the vertical sides of the racks. An incomplete drain down could block convective flow of the bottom orifice that would occur if in a complete drain down. It is possible that this scenarios would have worse consequences than a complete drain down.

Although a detailed analysis of the spent fuel heatup was not undertaken, SNL (NUREG/CR-0649) in support of GI 82 performed an approximate analysis to estimate the amount of aggravation that might occur if the water did not completely drain. The amount of heat produced above the water level was determined against the amount that could be removed by various mechanisms, including water boiling (latent heat), convection tot he steam produced by boiling (sensible heat). Radiation to the building, and convection to the air. If the heat removal rate is larger than the rate of production, then a configuration is coolable. If the heat removal rate is smaller than the rate of production, then overheating and melting would occur. SNL found that if 80 percent of the fuel was uncovered, the geometry was temporarily coolable.

The exact percentage of uncovery of the fuel that would cause overheating varies due to several factors, particularly burnup. If the burnup increases, a smaller percentage of fuel uncovery would be needed to be uncoolable to a certain level. Current operating practice burns fuel at a higher rate than when SNL performed its study. The percentage of uncovery that would be worse for today's fuel is not known. However, the heat from a rod is not uniformly distributed over the entire length of the fuel rod. The heat generated in a spent fuel rod is concentrated in the middle of the fuel rod. Regardless of the burnup, uncovery of the upper portion of the fuel (at least the top quarter) would not produce sufficient heat to be produce overheating. Again, the exact uncovery percentage that would be uncooled is not known.

The structure of the pool should be examined for likelihood of an incomplete drain down. The spent fuel pool structure is generally 40 feet deep. The spent fuel is approximate 12 feet tall. The spent fuel rack is six to 12 inches above the bottom of the pool. In order for a partial drain down to occur, the bottom of the pool and the sides up the bottom of the fuel would have to remain intact. The seismic event to cause a incomplete drain down would have to cause cracks from the top of the pool to at least 29 feet (perhaps even to 36 feet) down to reach the point where the geometry would cause overheating but cannot crack past 39 feet. The crack must stop mid-pool in a range of 4 feet or at most 9 feet to be worse than a complete drain down. The probability, although not calculated, is most likely less than the probability of seismic events that would cause a complete drain down and any drain down between 0 to 29 feet. Using this reasoning, the staff did not analyze the incomplete drain down.