Assumption of 3.5 Cores in Thermal Hydraulic Analysis

Why was 3.5 cores originally chosen?

1) GSI-82 used 3.5 cores as the source term, which was the whole inventory in the pool, for consequence calculations. GSI-82 estimated, using the SFUEL computer code, that **after 1-3 years of decay**, a fire would not propagate to the older fuel. The draft SNL study on self-sustaining zirconium oxidation propagation estimated that areas of the SFP **with greater than 3 years of decay time (with ventilation)** would not propagate self-sustaining zirconium oxidation using high density PWR racks. However, we knew that the higher burnups for today's operation would extend the critical decay time. **Using a 18-month cycle and 3 years since final shutdown, this would be less than 2 cores; therefore using 3.5 cores was conservative.**

2) Using the existing source term would make RES consequence calculations faster. During the initial 3-month study, time was a critical factor.

How many cores could be involved in a fire?

- Extensive research has not been performed to know exactly how and if a fire propagates.

- Draft SNL study on self-sustaining zirconium oxidation propagation estimated that if a assembly could reach within 100 °C of self-sustaining zirconium oxidation, then if an adjacent assembly ignited, the heat could cause it to ignite. However, after review of the study, we cannot ensure that the results are supportable for an actual SFP environment.

- It takes over 4 times longer to heat up (30 - 800 °C) at 5 years (23 hrs) than at 1 year. (5 hrs) based on adiabatic heat up calculations for PWR burnups of 60 GWD/MTU. However, **decay heat is a small fraction of heat input during a zirconium fire (>2000 °C).**

How important/sensitive is the number of cores to the consequences?

- 3.5 cores includes assemblies that are up to 10.5 years old, based on an 18-month fuel cycle.

- Radioisotopes with short half-lives that contribute to consequences for reactor accident contributors are gone, such as Ru-103 (39 d), I-131 (8 d)

- Only the last core has significant Ru-106 (1 y) and Ce-144 (285 d) at one year after final shutdown. The last core is the dominant contributor, hence 3.5 cores includes the significant radioactive inventory (except for long lived radioisotopes). Ruthenium dominated health effects at one year. (RES 8/25/00 memo)

- There is a linear relationship (generally) of Cs-137 (30 y) and Sr-90 (29 y) inventories with number of cores. (The very old fuel may have gone through one half-life.) Cesium, at one year, had a notable effect on latent fatalities (+2,000) and negligible effect on

early fatalities (+1). For long time periods (five years and longer), Cesium would dominate the health effects (RES 11/12/99 memo). Although not calculated, the consequences are not linear. Consequences would be affected by relocation criteria and population. Strontium was not a major contributor to health effects.

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