January 31, 2007

MEMORANDUM TO: Farouk Eltawila, Director
Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research

FROM: E. William Brach, Director
Division of Spent Fuel Storage and Transportation /RA/
Office of Nuclear Material Safety
and Safeguards

SUBJECT: USER NEED MEMORANDUM – REQUEST TO RESEARCH TO PERFORM A HYDRAULIC CHARACTERIZATION OF A PROTOTYPIC 17X17 PWR FUEL ASSEMBLY FOR LAMINAR FLOW AT LOW REYNOLDS NUMBERS

Background

The Division of Spent Fuel Storage and Transportation (SFST) has previously used results from the Hydraulic Analysis of the Spent Fuel Pool Experiment to validate the analytic prediction of flow friction factors for spent fuel dry storage casks. These results were obtained by the Office of Nuclear Regulatory Research (RES) through a contract with Sandia National Laboratory (SNL). SFST used these results to validate some of the predicted flow resistance parameters used to perform the thermal analysis of spent fuel dry storage casks. However, the measured hydraulic parameters obtained from RES were based on testing a 9x9 BWR fuel assembly including the channel box and are either not directly applicable to or have limited use for PWR assembly designs. Lacking measured data for a PWR fuel assembly type, the staff rely on computational fluid dynamics (CFD) techniques and predictions to approve spent fuel storage casks loaded with PWR spent fuel.

Area of Needed Assistance

SFST is requesting RES to continue additional experimental work to hydraulically characterize a prototypic full length PWR 17x17 fuel assembly in low Reynolds number laminar flow expected for normal storage conditions in spent fuel dry storage casks. Accurate flow friction factors are needed to reduce uncertainties in predicting the flow inside the fuel assemblies in a dry storage configuration. The scope of the measurements should be similar to the measurements documented on white paper entitled “Hydraulic Analysis of the Spent Fuel Pool Experiment” that RES provided to SFST to report BWR fuel assembly measurements. Usually, calculated friction factors do not include uncertainties which could result in underpredicted temperatures in dry cask performance analyses. This is important for cases where there is small or no margin left in the calculated thermal results and design limits.

The flow resistance issue may be more critical in a PWR assembly. A PWR assembly is fully populated with rods along the entire length (no partial length rods) and there are no water rods. The guide tubes in the PWR assembly may provide an air flow path similar to the water rods in the BWR fuel assembly types, but the guide tubes are often plugged when the assembly is

placed in the spent fuel pool. Furthermore, the PWR assembly has more spacers and the spacers are longer than in a BWR assembly. All of these factors may lead to a significant reduction in the natural circulation flow under dry cask storage. A highly prototypic PWR assembly characterized under realistic laminar flow conditions would be very beneficial in eliminating uncertainties and providing the required hydraulic parameters for use in analysis of dry cask performance.

This request is of high priority to effectively review new or current designs that are expected to increase both in technical complexity and heat load. As we have discussed with your staff, this activity will continue to enhance our technical understanding and analysis capabilities of current and future designs involving innovative heat removal systems, high decay heat loads from high burnup fuel, and anticipated new designs and contents that push the envelope in both technical complexity and reduced design margins. It is our projection that the completion of these tasks will take approximately 12 months.

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