STUDENT RESEARCH IN CRITICALITY SAFETY AT THE UNIVERSITY OF ARIZONA

D. L. Hetrick
University of Arizona

This is a brief progress report on four student projects at the University of Arizona:

1. simulations of power pulses in aqueous solutions,
2. the effect of assembly shape on the expansion coefficient of reactivity for solutions,
3. some reactivity computations for SHEBA, and
4. computations in support of the French experiment to measure temperature coefficients of dilute plutonium solutions.

The contributing students are Robert Kimpland (now a post-doctoral fellow at Los Alamos National Laboratory), Drew Kornreich (a doctoral student and DOE fellow at the university), and Sung Lee (candidate for a master's degree at the university).

1. Kimpland's dissertation was completed in the summer of 1993. His two-dimensional model for solution excursions shows improvements over previous one-region models. Expansion reactivity coefficients from TWODANT computations may now be used in computations without empirical adjustments. A second improvement is that the computed results for the delayed-neutron tail are closer to experimental data. Thirdly, the pressure-time curves are broader than before (closer to experimental data).

2. Simulation of criticality accidents requires knowledge of shutdown coefficients. The volume expansion contribution to shutdown is a function of assembly shape as well as composition (more important for tall, thin cylinders and less important for squat cylindrical shapes). TWODANT computations have been performed for uranium solutions (various enrichments) and for plutonium solutions, all for various fuel concentrations and aspect ratios. The results may be correlated by simple one-speed diffusion models. The goal is to present these correlations in a form suitable for use in accident predictions that do not require transport theory calculations.

3. We computed critical heights for the Los Alamos Critical Experiments Facility SHEBA assembly, both as it was suspended above its concrete-lined well and when lowered into the well. We used an extremely simple model (a bare cylinder of solution without any structure). We computed a decrease in critical height of 0.74 cm, or alternatively a reactivity increase of 65 cents (a sensitivity of 88 cents/cm). These results are within a factor of two of the preliminary measurements. More refined calculations are needed.

4. Experimental measurements of temperature coefficients in a dilute plutonium solution are planned at Valduc, France. The assembly is a water-reflected cylinder of radius 34 cm and reflector thickness 31 cm. Our computations employed a 69-group model for the spectral part of the temperature coefficient. A typical result (15 g/liter of Pu, 80 percent Pu-239, critical height 76.5 cm) shows expansion feedback of -0.0156 $/°C, spectral feedback +0.0670 $/°C, and net feedback +0.0514 $/°C. The proposed experiment therefore appears to be feasible, but its performance will require care.