NEER FY 2001 PROJECT ABSTRACT	
Grant Number:	01ID14111
Project Title:	Experimental Investigation on the Effects of Coolant Concentration on Subcooled Boiling and Crud Deposition on Reactor Cladding at Prototypical PWR Operating Conditions
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Abstract:	Core designs now require much higher peaking factors than only a few years ago in order to provide better economy and improve safety in operating units. These increases are due to the need to compete in a deregulated electricity market. Several utilities are uprating their nuclear units, which often requires an increase in their licensed peak power limits. Low leakage loading patterns, which reduce the fluence to the reactor vessel wall, and high burnup fuel designs also require increases in hot assembly peak power. A major impediment to increases in reactor fuel performance is known as the "Axial Offset Anomaly," which is an unexpected deviation in the core axial power distribution during operation from the predicted distribution. The Axial Offset Anomaly (AOA) is though to occur when sufficient crud deposits build up on the cladding and subcooled nucleate boiling occurs. This leads to the concentration and precipitation of lithiated compounds such as lithium metaborate (LiB02) on the rod. Because of the very high neutron capture cross section for boron, only a small amount of precipitated boron is believed necessary to cause the AOA. Prediction of the AOA is difficult, because there is little information on the interaction between heat and mass transfer during subcooled nucleate boiling. The deposition rate of corrosion products and boron compounds that build up on the rod surface is temperature dependent. The clad temperature depends on the subcooled boiling heat transfer heat transfer coefficient, which in turn depends on nucleation site density, frequency, and in the case of small subcooling the bubble departure size. Existing data however are scarce, and are not prototypical of nuclear fuel rods. The basic mechanisms of subcooled boiling heat transfer in the presence of a concentration gradient must be better understood in order to mitigate the AOA problem. The proposed investigation will improve the understanding of this phenomenon by: (1) Generating an experimental data base for subcooled pool boiling heat transfer coefficients on Zircaloy clad rods for coolants that contain varying concentrations of boron and lithium. The data will include sensitivities to bulk subcooling, heat flux, system pressure, and coolant concentration. These data will be unique, in that none such data currently exists. (2) Obtain a visual record of nucleation site density, bubble size, and nucleation frequency for subcooled boiling in dilute mixtures on Zr?4 clad rods. (3) Develop experimental techniques using neutron depth profiling to measure the deposition rate of boron and lithium on Zr?4 rods.