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SUBJECT: Reactivity Effects Associated with Two-Phase Separation

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Based on experimental work at LASL,* the HRT would be very much below critical if two-phase separation occurred and the heavy phase were not dispersed. Also, if the heavy-phase were dispersed under steady-state conditions, no reactivity problem appears to exist.

Under some non-steady-state conditions, however, some reactivity problems are encountered. The most serious one is associated with the following situation: Consider that two-phase separation has occurred, that the 400A pump is off, and that all the fuel has accumulated at the bottom of the core vessel (as a result of natural convective fluid flow). Although the reactor would be very much sub-critical under these conditions, start-up of the 400A pump at this time could possibly disperse the heavy phase throughout the core volume, with an accompanying rate of reactivity addition of ~ 10 percent/second. The accompanying reactivity addition would result in pressure vessel rupture. If the dispersion did not occur until after full pump speed were attained, the rate of reactivity addition could be ~ 3 times greater than the above figure.

To eliminate the above situation, the 400A pump should not be started unless the reactor is critical (this supposes previous operation, and the possibility of two-phase separation). Following previous power operation, the reactor would attain a power level of ~ 500 kw by natural convective flow several minutes after pump failure if two-phase separation has not occurred. If criticality is not attained, the safest procedure would be to dump the reactor. The fission chamber should be used to determine reactor power (and criticality) following pump failure (the ion

*Richard N. Alcott, "Homogeneous Heavy Water Moderated Critical Assemblies Part I, Experimental. March 14, 1956. Submitted to Nuclear Science and Engineering."

Chamber could be used if sufficient time elapsed so that γ - β afterheat decayed sufficiently; however, use of a fission chamber would be preferable).

It is suggested that the above be written into the reactor operating instructions.

A much less serious reactivity problem would be associated with two-phase separation under conditions of normal pump operation (this assumes that the presence of corrosion or fission products lowers the temperature at which two-phase separation occurs). If two-phase separation occurred at 280°C , and all the fuel accumulated within the core in accordance with the fluid flow rate, the associated rate of reactivity addition would not cause rupture of the pressure vessel, or of the core tank if the initial reactor power were ~ 5 Mw. The two-phase separation temperature would have to be less than $\sim 200^{\circ}\text{C}$ before danger of rupturing the pressure vessel would exist for this case.