TRANSIENT EFFECTS ON CRITICAL HEAT FLUX AND QUENCHING IN DIRECTLY HEATED TUBES

by

S.C. Sutradhar, D.C. Groeneveld and L.K.H. Leung
Chalk River Nuclear Laboratories
Atomic Energy of Canada Limited
Chalk River, Ontario, K0J 1J0

SUMMARY

The effect of flow and power transients on critical heat flux (CHF) and rewetting were investigated experimentally in a high-pressure steam-water loop at CRNL. Experiments were performed in a 5 mm ID tubular test section equipped with 6 pressure taps and 15 surface-mounted thermocouples along its 3 m heated length. The test conditions included Loss-of-Regulation-Accident (LORA) conditions of interest:

Pressure:	7-10 MPa
Mass flux:	2-7.5 Mg.m-2.s-1
Dryout Quality:	0.0 - 0.3.

The following transient CHF occurrences were simulated: (1) CHF during a power ramp, (2) rewetting during a power ramp, (3) CHF and rewetting during an oscillation in flow, (4) CHF during a reduction in flow, and (5) rewetting during an increase in flow.

Initially, reference CHF measurements were obtained at steady-state conditions. Subsequently, power transients were generated by programming a linearly increasing power ramp followed by a linearly decreasing power ramp (the only variables were the minimum and maximum power, and the speed of the transient). Next, flow transients were generated by manually controlling the flow in such a way that oscillations of a prescribed period (10-60s) were created. For these runs the power was fixed at levels corresponding to (i) dryout at the low-flow boundary encountered during the oscillation, and (ii) dryout at the mean flow during the oscillation.

The results showed that the CHF is primarily a function of the local instantaneous flow conditions. No significant effects of the flow oscillation on the CHF were observed. During the fast power-ramping tests, occasionally a slight reduction in heat flux was observed at the return to nucleate boiling compared to the CHF.