SENSITIVITY OF SRP LOCA POWER LIMIT TO BREAK SIZE AND LOCATION

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INTRODUCTION

SRP reactors are low pressure, heavy water reactors with six external process water loops that drive the coolant into an upper plenum and then downward through the assemblies. Assembly LOCA power limits are currently set in these reactors to prevent Ledinegg flow instability (FI) in any assembly flow channel. These limits are based on a postulated break area and location. This study determined the sensitivity of the power limit to the break area and location¹.

SUMMARY

The TRAC² code was used to compute system flows and pressures³ and the FLOWTRAN⁴ code was used to compute assembly thermal-hydraulic conditions⁵. The TRAC code also determined the assembly transient pressure boundary conditions. The FLOWTRAN code used these pressures to determine the minimum assembly power for which the onset of nucleate boiling (ONB) is predicted. This power was then adjusted to account for the difference between ONB and FI.

Assembly power limits were calculated for five different break areas at six different locations in the primary loops. The limit for a 360° tank crack with maximum displacement [leak area = 348 cm² (54 in.²)] was also determined. Figure 1 shows the locations of the postulated breaks in the external loops. The five break sizes consisted of one double-ended guillotine break (DEGB) and four partial breaks, with sizes of 15%, 30%, 45%, and 60% of the flow area at the point of the break.
The DEGBs in TRAC were modeled by replacing a component with two atmospheric boundary conditions (break components). For the partial breaks, a "tee" component was inserted at the point of the break. The branch portion of the "tee", which was assumed to be perpendicular to the rest of the component, was connected to an atmospheric boundary condition and its flow area was set to the break area. No discharge coefficient was used at the end of the branch and the "tee" itself was assumed to be frictionless. For all cases, it was assumed that the leaks occurred instantaneously.

RESULTS

The results of the study are shown in Figure 2. These results indicate that for the partial breaks:

1) The lower pressures in the pump suction line cause the leak rates for the two locations in that line to be much lower (and the corresponding power limits higher) than for the other locations;

2) The lowest assembly power limits for partial breaks occur at the heat exchanger inlet due to the larger flow area at that location. When breaks with equal flow areas were assumed, all four locations on the downstream side of the pump had about the same power limit; and

3) Assembly power limits decrease almost linearly as the break size is increased (due to a linear decrease in assembly flow with increasing break size).

The DEGB calculations at the six locations indicate that the plenum inlet is the most severe location for a DEGB. This is because it provides the least resistance to backflow leakage from the plenum.

The power limit obtained for the case of a 360° tank crack was the same as that for a 15% break in the high pressure line. The relatively high limit obtained was due to the small flow area and low pressures in the tank.
REFERENCES


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FIGURE 2

FLOW ZONE 1 ASSEMBLY POWER LIMIT vs. RELATIVE LEAK SIZE

Note: DEGB results plotted as 200% breaks