ARKANSAS POWER & LIGHT COMPANY
POST OFFICE BOX 551 LITTLE ROCK, ARKANSAS 72203 (501) 371-4000

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1-050-14

Director of Nuclear Reactor Regulation
ATTN: Mr. R. W. Reid, Chief
Operating Reactor Branch #4
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Subject: Arkansas Nuclear One - Unit 1
Docket No. 50-313
License No. DPR-51
Small Break LOCA Information
(File: 1510)

Gentlemen:

By your letter dated November 21, 1979, the NRC staff requested additional information concerning small break loss of coolant accidents. Arkansas Power & Light Company provided our schedule for submittal of the requested information in our December 4, 1979 letter. Pursuant to the above, we hereby provide the requested information.

Item 1 - Transitions from solid natural circulation to reflux boiling and back to solid natural circulation may cause slug flow in the hot leg piping. By use of analysis and/or experiment address the mechanical effects of the induced slug flow on steam generator tubes.

RESPONSE

The loads imposed on the tubes of the OTSG during the postulated "slug flow" have been conservatively evaluated and found to be acceptable. Based on very conservative assumptions, the end loading on each tube will be 21.5 lb_f compared to a theoretical buckling load of about 700 lb_f.

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It was assumed for this analysis that a water level has been established in the hot leg piping and inside the tubes of OTSG. The transient consists of a "front" of solid water impinging on the primary face of the upper tubesheet. The flow was assumed to be equal to a full 100% power flow (about 70,000,000 lb/hr). The load is assumed to be a suddenly-applied load. The upper tubesheet is conservatively assumed to offer no resistance to the load and the lower tubesheet is assumed to be fixed so that the entire load is absorbed by tubes directly under the primary inlet nozzle. The flow is assumed not to follow the diffuser so that the velocity impinging on the tubesheet is the same as the velocity in the 36-inch nozzle. Hot leg temperature is assumed to be 605^{o}F.

The velocity in the 36-inch pipe would be 64.4 ft/sec. By use of the momentum equation, the steady-state force on the upper tubesheet due to the velocity would be 16,080 lb_f. There are about 1500 tubes in a 36-inch diameter circle. Thus the 32,160 lb_f will result in 21.5 lb_f per tube. Since the cross-sectional area of each tube is 0.070 in., the momentary axial compressive stress in these tubes would be 307 psi.

Item 2 - This item is not applicable to Arkansas Nuclear One - Unit 1 (ANO-1).

Item 3 - Evaluate the impact of RCP seal damage and leakage due to the loss of seal cooling on loss of offsite power. How long can the RCP seals sustain loss of cooling without damage?

RESPONSE

During normal pump operation, both seal injection water and intermediate cooling water are supplied to each pump. Seal injection water is provided by a makeup or high pressure injection pump which is powered from a safety grade bus which receives its power from either offsite or an associated diesel generator. The intermediate cooling water pump power supply is offsite power.

The reactor coolant pump seal system consists of 3 seals. For discussion purposes, the space between the upper and middle seals is known as the upper seal chamber. The space between the lower and middle seals is known as the intermediate seal chamber and the space below the lower seal is known as the injection cavity.

During normal operation seal injection flow provides about 8 gpm of water to each pump seal. About 7 gpm is injected into the external portion of the recirculation system which taps off of the injection cavity. When the reactor coolant pump is running there is a recirculation flow of approximately 70 gpm generated by the recirculation impeller. The recirculation flow passes through heat exchangers which are cooled by intermediate cooling water. This recirculation system provides cooling for the RCP seals in case of loss of seal injection flow.

About 7 gpm of the seal injection water flows down into the reactor coolant system (RCP bowl). The remainder of the 8 gpm injection flow (about 1 gpm) flows into the intermediate seal chamber, out through a pressure breakdown orifice and then into the upper seal chamber. From the upper seal chamber it passes through another pressure breakdown orifice and into the seal return line.

If offsite power is lost, intermediate cooling water would be lost. Of course, reactor coolant pumps would be de-energized. Though it is very unlikely, seal injection flow might also be lost. Babcock & Wilcox recently performed an evaluation of this situation. The evaluation shows that leakage would not increase appreciably for approximately ten minutes and would not be severe for up to sixty minutes. In this evaluation it was assumed that at time zero the RCP's were stopped when both seal injection and cooling were lost, that the seal return valves would remain open and that the initial leakage was at a high level of two gallons per minute for mechanical face type seals. In the situation described above, the capability exists to manually reinitiate seal injection flow. ANO-1 procedures exist to cover such reinitiation. In addition, the seal return valve will automatically isolate under such a condition. This minimizes seal heatup rate and makes the analysis done to cover this situation very conservative. The details of this analysis continue.

Seal cavity temperatures and seal leak rates for the first four to five minutes after time zero will remain essentially stable due to the mass of the heat sink at the shaft seal cartridge and pump heat exchanger. This time period could be extended by about two to three minutes if the seal return valve is closed within ninety seconds. The ANO-1 seal return valve would close at time zero.

With the seal return open, when the seal cavity temperature starts to rise it will increase at a rapid rate. The seals will begin to pass steam within four or five minutes. The temperature ramp will be turned around if seal injection can be gradually reinitiated or if the intermediate cooling water flow is started within about ten minutes. Although some internal damage may occur, the seal system will gradually stabilize and return to approximately the initial leakage rate. Closure of the seal return valve within this time frame is most effective in slowing down the rate of temperature rise on those pumps that had low seal leakage at time zero. Closure of the seal return valve shortly after time zero reduces the heatup rate by as much as 75 percent for seals which normally operated at low seal leak rates and by as much as 50 percent for pumps operating with high seal leak rates. If cooling continues to be unavailable, the seal cavity temperature will continue to increase. It is predicted to reach at least 350°F within twenty minutes. At this time, the shaft directly above the seals will be at about 300°F and the recirculation heat exchanger will be at full system temperature (about 540°F).

After steaming conditions are reached, significant seal degradation would not be expected for up to one hour after time zero. The elastomers which make up a part of the seal assembly will start to soften at approximately 300°F and can start to extrude before 500°F. The amount of extrusion is based upon time, temperature and annular clearances. Experience shows that leakage from seals because of elastomer extrusion does not increase appreciably within the first thirty minutes. It is estimated that under the worst condition, leakage from a static pump may reach five gpm in thirty minutes and ten gpm in sixty minutes.

Also, the RCP's, by design and field experience, are not susceptible to a loss of coolant accident due to seal failure resulting from loss of seal cooling water.

Very truly yours,

David C. Trimble

David C. Trimble
Manager, Licensing

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