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MEMORANDUM FOR: K. V. Seyfrit, A/D, TP, ROI, [illegible]

FROM: R. W. Woodruff, TP, ROI

SUBJECT: TRIP REPORT/OCONEE POWER OSCILLATIONS

Background

Operator Licensing, while conducting an oral examination at Oconee-3, discovered that reactor power was oscillating. The Licensee stated that the oscillations originated in the secondary cooling system.

References 1 and 2 state that oscillation of secondary flow and pressure can occur in B&W steam generators and can cause variations in reactor power. Reference 1 also states that power oscillations can be eliminated by adjusting an orifice assembly installed on the secondary side near the inlet to the tube bundle.

The steam generators are vertical tube and shell components with a water box at each end. Primary coolant is on the tube side and secondary coolant is on the shell side. Feedwater is sprayed downward into the annulus formed by the shell and the baffle surrounding the tube bundle. The feedwater spray aspirates steam into the annulus from ports for that purpose in the baffle. The lower part of the annulus contains preheated feedwater and condensed steam which flows thru feedwater ports at the bottom of the baffle. The orifice plate assembly is located in the annulus immediately above the feedwater ports. The water level in the annulus is determined by the orifice setting, feedwater flow, and reactor power.

Oscillations

For Oconee Units 1, 2, and 3, the Licensee considers 0.25 hertz power oscillations to be normal in the power range from 40 to 70% when the peak-to-peak amplitude is 1.5% of full power. Following the first refueling outage for Unit-3 which occurred last fall, the power oscillations became progressively larger as shown in Figure 1.

For Unit-3, the following parameters also oscillate at 0.25 Hz:

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a. Steam generator levels
b. Feedwater flows
c. Feedwater pump suction and discharge pressures
d. Reheater drain flow to the condenser
e. Reactor inlet temperature
f. Reactor average temperature

The control rods do not oscillate.

Selected recorder charts from June, 1977, for water levels in the annuli of the steam generators were reviewed. The level in steam generator A oscillated 10 inches peak-to-peak, and in steam generator B, 4 inches peak-to-peak. At the same time, feedwater flow to steam generator A oscillated 0.2 million poinds/hour over the flow range from 1.0 to 5.5 million pounds/hour. For steam generator B, the oscillation varied between 0.2 and 0.3 million pounds/hour in the same flow range. The feedwater flows for the two steam generators were 180° out of phase. Indicated reactor inlet and reactor average temperatures oscillated 3°F and 1°F, respectively. Actual oscillations would be larger because of the response time of the temperature sensors. In addition, one set of drain valves in the reheater drain system were opening and closing at 0.25Hz.

Steam Generator Performance

Steam generator A is not performing as well as B, as indicated by steam temperatures. For A, the outlet steam temperature is 578° as compared to 598°F for B. The saturation temperature is approximately 540°F. The difference in performance may be related to orifice settings which in turn may affect the amplitude of the oscillation.

Testing

The Licensee, with the assistance of B&W, has performed a number of tests to determine the cause of the increasing amplitude of the reactor power oscillation. In these tests, various sections of the control system were placed on manual control. Although the reactor power oscillations were significantly reduced under certain conditions, the Licensee considers the results to be ambiguous and additional work is planned.

The Licensee expects to shut Oconee-3 down next month for refueling. During the power reduction and the power ascension following refueling, the Licensee plans to perform additional tests to determine the cause of the increase in amplitude of the power oscillations. During the refueling outage, the Licensee plans to inspect the adjustable orifices in both steam generators.

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Safety Review

The Licensee's off-site committee has not reviewed the power oscillations. Further, the Licensee does not believe that the oscillations constitute an unreviewed safety question. This belief is based on the fact that there is a limiting safety system setting on flux flow ratio. This setting limits reactor power to 1.07 times percent flow. When power and flow are matched, the peak-to-peak amplitude of the power oscillation would be limited to less than 14%. However, if power were reduced larger oscillation would be tolerated by the control system without tripping the reactor.

The limiting safety system setting for flux flow ratio is based on consideration of DNBR resulting from a loss of flow accident and on thermal limits (linear power density and DNBR). To the best of our knowledge, oscillatory effects have not been considered.

Followup after the Visit

Following the trip to Oconee, the oscillations were discussed with one of B&W's control engineers who has been involved in the Oconee-3 tests. In his opinion, the cause of the oscillations may be the control system for the secondary cooling system. He states that there is not a significant difference between the Oconee-3 steam generators and the steam generators for Oconee-1 and 2. He also states that all other operating B&W plants are operating in a stable manner.

Information obtained during and following the visit was described to the Licensing Project Manager.

Recommendations

1. IE should monitor the efforts of the Licensee in resolving this problem, specifically, the tests prior to shutdown of Unit-3 for refueling, inspection of the orifice assemblies, and tests performed during the power ascension after refueling.

2. If significant progress in identifying the cause of oscillation does not result from these tests and the Licensee's inspection, IE should send a controls engineer to Oconee to inspect the Licensee's effort.

3. If the amplitude of oscillation increases significantly, a transfer of lead responsibility should be prepared.

References

1. BAW-10002, "Once-through Steam Generator Research and Development Report." August, 1969.

2. BAW-10002, Supplement 1, June, 1970.

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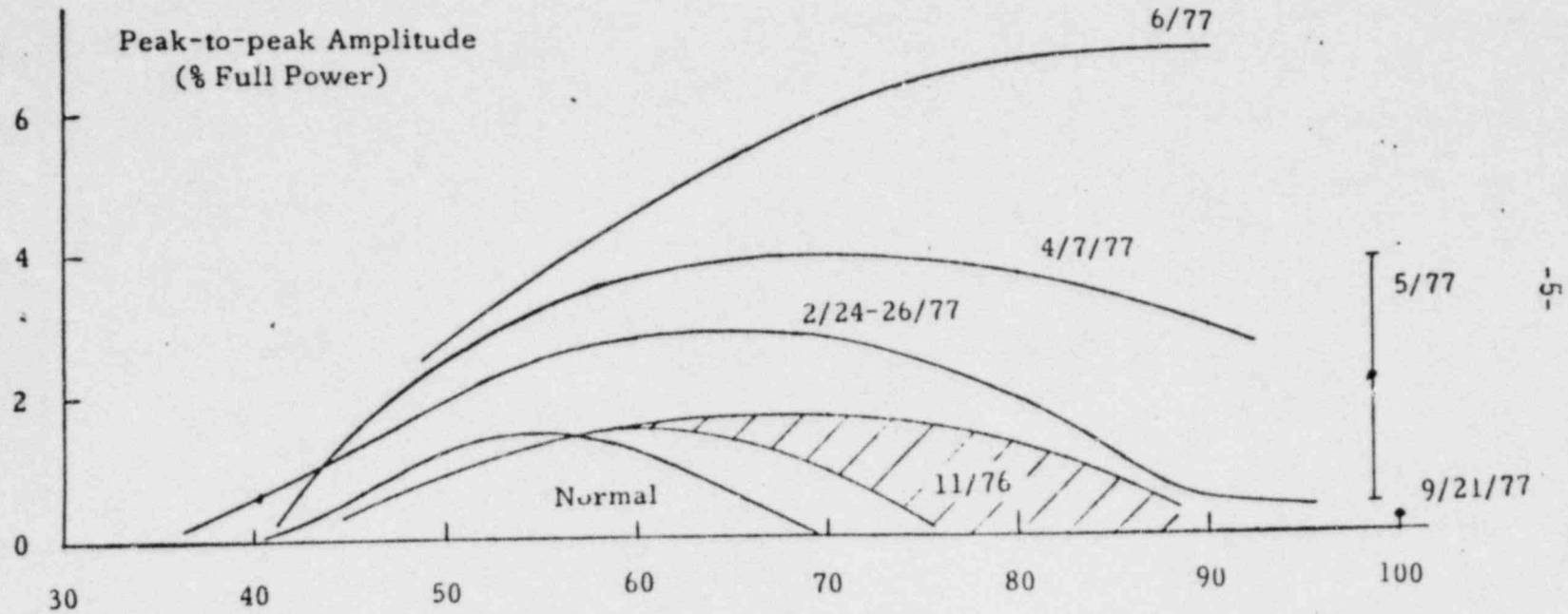

Fig. 1; Oconee-3 Power Oscillations