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## SHORT PERIOD DURING REACTOR STARTUP

### DESCRIPTION OF CIRCUMSTANCES:

Recent events of concern to the NRC occurred at the Monticello and Dresden BWRs involving inadvertent high reactivity insertions causing short periods during reactor startup.

At Dresden Unit No. 2 on December 28, 1976 during a reactor startup following a scram from unrelated causes about 9 hours earlier, a rod withdrawal of one notch resulted in a rapid power rise associated with a reactor period of about one second and caused an Intermediate Range Monitor (IRM) Hi-Hi flux scram. The IRM was on its most sensitive scale. The moderator was essentially without voids and the reactor water temperature was 338F. A similar event occurred at this facility on August 17, 1972.

At Monticello on February 23, 1977, following a reactor scram about 10 hours earlier from unrelated causes, a reactor period of about one second was experienced during startup before the reactor tripped on IRM Hi-Hi flux. The IRM was on its most sensitive scale and the short period resulted from the withdrawal of a control rod one notch. The reactor moderator had few voids and the water temperature was 480F.

The two most recent events were similar in the following respects:

1. Prior to the earlier, unrelated scram, both plants had been operating at or near full power with axial flux peaking in the bottom portion of the core.
2. The time from the earlier scrams to the subsequent startups maximized the xenon concentrations in the core.
3. High worth rod locations were similar and both plants were using the same generic control rod pattern (identified as B1).
4. Prior to the IRM scram at both facilities, dramatic indications of high notch worth had been seen with rod withdrawals resulting in periods ranging from 10 to 30 seconds, which were terminated by reinsertion of the rod.

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Review of the events showed that all of the systems including the reactor protection system functioned as required. Analyses indicate that the combination of essentially no voids in the moderator and high xenon concentration accounted for the conditions that resulted in the control rod notch acquiring an unusually high differential reactivity worth which approximated one-half percent delta K/K at Monticello. This excessive worth of rod notch was the result of essentially no voids in the moderator and peak xenon conditions which necessitated the withdrawal of significantly more control rods than is normally required to reach criticality. The resultant flux distribution at criticality magnified the normal axial peaking at the top of the core due to the heavy xenon concentrations at the bottom. Additionally, the radial contribution to flux peaking was enhanced due to the withdrawal of peripheral rods.

A review of NRC records showed that after the earlier event at Dresden Unit No. 2 on August 17, 1972, corrective measures were taken for the subsequent startup consisting of notchwise withdrawal of the group of rods. This corrective action was taken only for that operating cycle.

Evaluation of these events indicates that essentially trouble-free startups can be accomplished by avoiding the peak xenon with no moderator voids condition or possibly by the use of a rod pattern developed for these particular conditions.

These events indicate a need for all licensees of operating BWRs to review their startup procedures and practices to assure that their operating staff has adequate information to perform reactor startups avoiding such short periods in the event that the above-described conditions of peak xenon with no moderator voids exist at the time of startup. Operators should be made aware that extremely high rod notch worths can be encountered under these conditions. The procedures should include requirements for a thorough assessment following the occurrence of a short period before any further rod withdrawals are made. These considerations should be included in the operator training and requalification training programs.

No written response to this Circular is required. If you need additional information regarding this matter contact the Director of the cognizant NRC Regional Office.

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