FLUCTUATION EVENTS OF

NOVEMBER 4 AND DECEMBER 12, 1978

EVALUATION AND RESULTANT REVISIONS

TO NORMAL AND TEST OPERATING PROCEDURES

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1.0 INTRODUCTION

The fluctuation event of November 4, 1978, which occurred during testing under the approved RT-500 test, exhibited larger amplitudes in temperature fluctuations than had been exhibited in any previous fluctuation event. The localized, small amplitude fluctuation event of December 12, 1978, occurred at a value of ΔP less than the established threshold value. The purpose of RT-500 testing, which had been suspended due to exceeding a test limit on November 4, is to systematically establish the threshold line.

This report, in Sections 3.1 and 3.2, provides a description of the sequence of events, a data package and an evaluation including any consequences to plant safety for the November 4 and December 12, 1978 fluctuation events, respectively. Section 3.3 provides a comparison of all the fluctuation events regarding operating conditions at the start and stop of the fluctuation and amplitudes of nuclear channel and thermocouple signal changes which took place during the fluctuation. Each event is individually identified permitting an assessment of significant changes which may have taken place with time. Section 3.4 discusses the fluctuation threshold line and other operating constraints which can limit plant operation. Section 3.5 is an evaluation of the test limits and monitoring capability previously contained in RT-500 and provides a revised RT-500 as a result of the evaluation.

2.0 SUMMARY AND CONCLUSIONS

Since the first occurrence of fluctuations at Fort St. Vrain on October 31, 1977, there have been a total of 30 fluctuation events identified through the last event which occurred on December 12, 1978. A listing of the 30 fluctuation events is provided in Section 3.3.

The latter events, which occurred on November 4, 1978, and December 12, 1978, exhibited unique characteristics different than those observed in prior events. The second event on November 4, resulted in the largest temperature swings for region outlets, steam generator module helium inlet, and main steam outlet observed for any fluctuation event. Analysis of the event has resulted in the conclusion that the measured temperature swings were real as opposed to changes in region outlet temperatures caused by colder bypass flow leaking into the graphite tube containing the measuring thermocouple. To account for the magnitude of the region outlet temperature swings observed, some flow redistribution into and out of regions must occur. One mechanism, which is consistent with the observed data, is flow inleakage into the plenum element or near the top of the region. This possibility for flow redistribution has been recognized for some time. In prior fluctuation events, however, the observed changes in steam generator module helium inlet temperatures were generally consistent with displacements of relative cold bypass flows as a result of internal core component movements. In all probability, some amount of flow redistribution was also occurring although to a lesser degree than for the November 4 event. Evaluations of the flow redistribution theory indicate there are no detrimental safety consequences nor do they compromise or invalidate the operating limits specified in the Technical Specifications.

The December 12 event is unique in that the fluctuation was localized to the northwest quadrant of the core and that it occurred at a lower core ΔP and core resistance than previously experienced at the 67% thermal power level. Prior to the December 12 event, localized fluctuations had only been observed

at thermal power levels less than 40% of rated. This fluctuation event most probably represents the fluctuation threshold limit in that it was localized and was terminated with only a 2% reduction in power. The fluctuation threshold limit line for normal power production was reduced as a result of the December 12 event. There are no safety consequences as a result of the event.

An evaluation of fluctuation amplitudes in neutron flux and helium and steam temperatures for the 30 fluctuation events did not reveal any apparent chronological trend. The evaluation did indicate the need to revise a limit constituting a reportable incident to the NRC (with further testing suspended until again authorized by the Commission). Specifically, the module outlet main steam temperature limit is revised from 60°F peak to peak to 150°F (Section 3.5). The 60°F constraint is retained as an operational limit for fluctuation testing. Additionally, the instrumentation has been upgraded to provide improved on-line monitoring for both operating and test personnel during fluctuation testing.

3.0 DISCUSSION

3.1 November 4, 1978 Fluctuation

3.1.1 Sequence of Events

Testing on November 1-3, 1978, succeeded in reproducing the mini-fluctuation observed on October 6 at low power and high core resistance.

Near midnight on November 3, the core resistance parameter was reduced from a value of 105 to a value of 64 and the fluctuation threshold mapping portion of the test program was initiated. Power was raised from 38% to 42% with an overshoot to roughly 49% at approximately 0100 on November 4. No fluctuations were observed on region outlet temperatures. Subsequent review of FM system data revealed that some slight offsets in nuclear flux channels and fluctuation in gap thermocouple temperatures occurred, but immediately damped out. A second power increase was made from 42% to 47% power with an overshoot to 54% at 0340. During the power rise, offsets were observed on nuclear flux channels at 0344 and at 0345 the helium inlet temperature to steam generator module B-1-6 departed from the expected value indicating the start of temperature fluctuations.

Power reached the 47% level at about 0400 and fluctuations were of the character previously observed.

At 0413, gap temperature thermocouples and nuclear channel III start new trends, and module B-2-2 starts a 60°F increase in steam temperature. At 0415 nuclear channel III drops about 3%, module B-1-4 starts a 50°F increase in steam temperature, and module B-1-1 starts a 120°F decrease in steam temperature.

At 0426, a 2% drop in channel IV is followed by the start of a 70°F drop in module B-1-6 steam temperature. Power reduction was initiated at 0428 and reached 42% at 0432. Fluctuations continued at a lower amplitude. Power was then reduced to 33% from 0445 to 0450.

By 0525, the fluctuations had apparently stopped. Power remained at the 33% level until 0620, when a return to 40% power was attempted. Fluctuations were again observed at about 0635. They were observed to be of a very regular and medium amplitude, i.e., roughly 20°F amplitude character as has been previously observed at the 40+% power level. The regulating rod was put into manual control (not moved) from 0715 to 0745, and the fluctuations continued.

At 0750, power was reduced to 35% and the fluctuations stopped at 0755. Subsequent review of the FM system data indicated roughly 5-10^{o} changes in gap thermocouple temperature prior to the fluctuation at 0630, suggesting that the affects of the previous fluctuation may not have completely damped out. The fluctuation at 0630 occurred at a core ΔP and resistance value which was lower than the previously established threshold line and it was therefore presumed that it was a continuation of the previous event.

3.1.2 Data Package

This section contains a summary of significant data from the November 4 fluctuation events. Data presented include locations of initiation points of the threshold curves and indications of what portions of the core were involved. PCRV displacement probe data, nuclear channel data, steam generator helium and steam temperature data, core region outlet temperature data, gap thermocouple temperature data, and average plant parameter data are also presented.

Gap thermocouples 3-6, 7-10, and 15-18 are not located in gaps, but rather are under the core support blocks for regions 37, 36 and 34, respectively, for this series of tests.

This data package was previously presented and discussed with the NRC in meetings in Bethesda on November 16 and December 14, 1978. Significant portions of the data package pertinent to the evaluation of the event are discussed in other sections of this report.