THE PENNSYLVANIA STATE UNIVERSITY
207 OLD MAIN BUILDING
UNIVERSITY PARK, PENNSYLVANIA 16802

Vice President for
Research and Graduate Studies

Area Code 814
865-6332

1 August 1980

Mr. James R. Miller
Standardization and Special
Projects Branch
Division of Licensing
Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Reportable Event

Docket No.: 50-5
NRC License: R-2

Dear Mr. Miller:

On the afternoon of July 17, 1980, it was determined that the Penn State Breazeale Nuclear Reactor (PSBR) had been loaded with fuel to give it an excess reactivity of approximately $7.66. This exceeds the limits established by Technical Specifications; the maximum excess reactivity allowed by Technical Specifications for the core is $7.00. No other limits of Technical Specifications were exceeded, i.e., all control rod shutdown margins were maintained and the core remains in excellent condition. That same afternoon, Dr. Samuel H. Levine conveyed this information by telephone to Mr. Gino Simonetti, NRC Project Inspector of Region I and Mr. George Gower of the NRC Operation Center.

Excess reactivity, ρ, of the PSBR can only be determined accurately after the control rods have been calibrated which takes approximately one full day of reactor operation. Once the calibration data is plotted on graph paper, ρ is determined by subtracting from the total integrated worth of the control rods, the integrated worth of the control rods inserted into the core to maintain the reactor critical. The calibration involves adding the reactivity contribution of all four control rods. Calibration of control rods are first performed when the core reactivity is between $4 and $5 using calibration curves of the previous core. They are recalibrated again once the final core configuration is attained having a ρ close to $6.00. The increase in reactivity between calibration is made by adding a few fuel elements in steps and estimating the increase in reactivity of each such step using the latest control rod calibration curves. However, the reactivity of each new core, attained by adding a few fuel elements, is determined in a different manner. Once the reactivity of the first core is accurately determined, the reactivity of each new configuration is determined using the measured change in the critical control rod heights.

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This measurement gives the increase in ρ corresponding to the addition of the few fuel elements. During one of the step increases in reactivity, the reactivity change produced by movement of the regulating rod was inadvertently left out of the calculation and ultimately resulted in this event.

The actions leading up to this event were as follows:

The reactor had been unloaded of all its fuel for the annual fuel element inspection as required by the Technical Specifications. By July 8 all of the fuel elements had been checked and reloading of the fuel into the core commenced. On July 11, the core had been loaded with 81 fuel elements and both pneumatic rabbit systems were installed. The first control rod calibrations were made with this core and its excess reactivity was found to be $4.66. Four more fuel elements were then added to the core and the resulting excess reactivity was calculated, using the change in critical control rod height, to be $5.31. The next step was made by adding six more fuel elements. The step increase in reactivity was calculated to be another 57 cents resulting in an excess reactivity of $5.81. It was at this point that an error in the reactivity calculation was made by neglecting to include the contribution of the regulating rod to the reactivity. The calculated excess reactivity was $5.81 whereas it should have been $6.38. The next step was to add two more fuel elements increasing the excess reactivity by 23 cents to approximately $6.04. Following this, two additional fuel elements were added and the new measurements indicated a step increase in reactivity of 24 cents, bringing the estimated excess reactivity to $6.28. At this point, a check was made to measure the worth of moving the core against the D_2O tank. The heavy water tank added an additional 39 cents which would bring the core excess reactivity up to $6.60. The core was then moved away from the D_2O tank and two more fuel elements were added which were believed to be worth less than 40 cents. The control rods were then calibrated. After graphing the calibration data and performing accurate calculations, the excess reactivity of the core was determined to be $7.66. Six fuel elements were then removed from the core to reduce the excess reactivity below $7 to be in compliance with Technical Specifications.

A special form exists to provide a guide for making excess reactivity calculations; however, they are not used when making the small step changes in reactivity. As stated above, it was observed that a major error occurred after the second step when six fuel elements were added. At this point, $1.20 was added whereas it was estimated to be less than 60 cents. The remaining error can be attributed to changes in control rod worth that occurred during the addition of the other fuel elements. The error would

not have occurred if the referenced form was completed after making each step change in reactivity instead of waiting for the rod calibration data.

In the future, these forms will be used to determine the excess reactivity of the core after each step change in reactivity to prevent this type of event from recurring.

Sincerely yours,

R. G. Cunningham
Vice President for Research
and Graduate Studies

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