

June 30, 2004

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MEMORANDUM TO: Cynthia D. Pederson, Director  
Division of Reactor Safety  
Region III

FROM: Edwin M. Hackett, Acting Deputy Director /RA/  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

SUBJECT: REQUEST FOR TECHNICAL ASSISTANCE (TIA 2003-002) - REVIEW  
OF LICENSEE'S RESPONSE TO CONCERN REGARDING  
POTENTIAL FOR BYRON NUCLEAR POWER STATION TO EXCEED  
ITS LICENSED THERMAL POWER LIMITS (TAC NO. MB7378).

In a memorandum dated January 28, 2003 (ML030280539), you requested assistance from the Office of Nuclear Reactor Regulation (NRR) in addressing an issue regarding the potential for the Byron Station to exceed its licensed thermal power limits.

#### Background

Ultrasonic flow measurement instruments (UFMs) were installed at Braidwood in April 1999 and at Byron in May 1999 to recover lost power due to feedwater venturi fouling. Pre-implementation data review by the licensee indicated that unexplained differences in electric megawatt output would result between the two sites, particularly between Byron, Unit 1 and Braidwood, Unit 1, if the UFMs were used as the basis for determining feedwater flow rates. In particular, Byron, Unit 1 would be producing more electrical power than Braidwood, Unit 1 and a number of secondary side instruments would indicate non-conservatively biased results at Byron. UFM use was implemented at Braidwood in June 1999, but implementation was delayed at Byron.

Following further evaluation that provided no satisfactory understanding of the observed and predicted behavior, use of UFMs was implemented at Byron in May 2000 on the basis that the UFMs were accurate and all other instrument behavior was within estimated uncertainty bounds. The estimated Byron/Braidwood differences were immediately observed. Later, Byron, Unit 1 was not able to fully implement the 5 percent power uprate approved in May 2001. The issue was submitted to the licensee's corrective action program and a condition report (CR 91771) was written. Although differences between the two units continued to be acknowledged, the licensee was not able to identify the cause for the differences between the two units.

TIA 2003-002 requested that NRR determine if Byron was operating within its licensed thermal power. As the basis for the request, the TIA noted that in comparing Byron, Unit 1 and Braidwood, Unit 1, Byron, Unit 1 was producing more electrical power at an apparent lower

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thermal power; yet Byron, Unit 1 appeared to have a higher fuel burn-rate, and certain secondary instruments were reading higher at Byron, Unit 1 than they were at Braidwood, Unit 1.

### Evaluation

In an effort to determine the basis for the differences between the two units, the NRR staff reviewed documentation provided by Region III as it related to the technical issues, met with the licensee on January 24, 2003, and reviewed information submitted by the licensee by letters dated February 5 and August 15, 2003.

In its August 15, 2003, submittal, the licensee informed the staff that it had implemented a test program to determine the root cause of shifts in the UFM-to-venturi correction factors which had been observed prior to implementation of the five percent power uprates approved in May 2001. One of the actions taken by the licensee was to install an UFM on the common header to measure total feedwater flow and compare the reading with the sum of the UFM reported flows for each of the four loops. This test was performed in May 2003; the result was within the acceptance criteria. This test was again performed in August 2003, and this time the result was outside of the acceptance criteria. Contamination of the signal from the UFM's installed on the four loops was identified as the cause of the problem. The UFM on the common header had no noise contamination and was considered to be providing accurate flow measurement. On August 29, 2003, the licensee informed the NRC (Event Number 40117), that there were discrepancies in the UFM measurements at Byron 1. The loop UFM's were removed from service with an ensuing reduction in reactor power. Licensee Event Report 454-2003-003-00 (September 29, 2003) reported that Byron 1 exceeded its maximum licensed power level by 1.64 percent. The licensee and the UFM vendor concluded that the cause of the erroneous readings was likely due to noise contamination of the signal from the UFM's installed in the loops, most likely resulting from feedwater flow pressure pulses occurring at frequencies which affected the UFM signal. The UFM installed on the common header did not display noise signal contamination, and therefore, was concluded to give an accurate measure of total feedwater flow as reported by the LER 2003-003-00 (September 29, 2003). The overpower was determined from a comparison of the sum of the UFM readings on each loop with the reading from the common header.

In February 2004, the licensee conducted a feedwater flow measurement utilizing a radioactive tracer. In a letter dated May 13, 2004, the licensee provided information on the tracer tests. The results supported the reading of the venturi meters. The licensee determined that the UFM on the common header, which was indicating lower flow rates than the venturis, was showing a non-conservative bias. In LER 2003-003-01 (March 31, 2004), based on the results of the tracer test validating the accuracy of the venturi flow measurement, the licensee concluded that Byron, Unit 1 had exceeded its licensed power by 2.62 percent.

### Conclusions

Based on the results of the testing that was done by the licensee and the UFM vendor, the NRR staff concludes that an overpower condition existed for Byron, Unit 1, since initial implementation of the UFM's in May 2000. The maximum power level at Byron, Unit 1 was

determined to be 102.62 percent. Comparable conditions existed at Byron, Unit 2, and Braidwood, Units 1 and 2, with maximum calculated power levels of 101.88 percent, 101.07 percent, and 101.21 percent, respectively.

Although the Byron, Unit 1 maximum overpower level is above the 102 percent used in the emergency core cooling system evaluation models (Appendix K of Title 10 of the *Code of Federal Regulations*) to account for instrument uncertainties, the licensee has concluded that evaluation of the response of Byron, Unit 1, to accidents and transients met all of the acceptance criteria. The NRR staff has not reviewed the licensee's evaluation to confirm this conclusion. However, there are conservatisms inherent in the assumptions for the calculational models that lead the NRR staff to the conclusion that the overpower condition at Byron, Unit 1, was not safety significant. The accident analyses include the most damaging scenarios rather than the most probable ones with regard to accident progression and mitigation. Analyses also include programmed failures that inhibit recovery. In the Byron accident analysis, the thermal power was assumed to be 1.02 times the licensed thermal power; the actual overpower appears to have been a fraction of a percent above this allowance which is not enough to significantly affect the predicted accident analyses results. Consequently, the NRR staff does not believe that a complete re-analysis of the Byron analysis to account for an overpower condition would identify any significant changes in predicted plant response to accidents.

#### Other Related UFM Activities

Since the UFM use was first questioned at Byron, the application of UFM industry wide has come into sharper focus for the staff and there has been an increased sensitivity on the part of the vendor to the NRC concerns regarding its application. In particular, Westinghouse has issued three communications to the Advanced Measurement and Analyses Group (AMAG) users listing recent problems with AMAG UFM applications and provided specific recommendations to the users to help assure that the devices are performing as intended. The vendor also implemented an action plan which addresses: (1) evaluation of operating experience; (2) recent operational problems (i.e., flow profile and signal contamination); and (3) instrument installation criteria. Further, in view of questions raised regarding how well operational parameters are translated from laboratory to plant, some plant-specific hydraulic model testing was undertaken. And finally, the Westinghouse owners group (WOG) has undertaken the AMAG implementation question as an initiative. The WOG Crossflow Task Force, which is comprised of members with both Westinghouse and non-Westinghouse plants, has informed the NRC that it will closely monitor the activities and work with Westinghouse and AMAG to implement any generic lessons learned from the plant specific occurrences.

The NRR staff formed a task group that assessed application of UFM in nuclear power plants. Much of the task group's evaluation focused on the Byron and Braidwood history and included

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recent actions taken by the UFM vendors to address both plant-specific and generic issues. The final version of the task group's reports was issued on June 7, 2004 (ML041410202).

The NRR staff will follow the activities as included in the action plan and will continue to interact with the AMAG vendor regarding resolution of the implementation concerns.

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