



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
FOR THE BABCOCK & WILCOX OWNERS' GROUP SUBMITTALS
RELATING TO THE POTENTIAL FOR COMMON-MODE
FAILURE OF THE HIGH PRESSURE SAFETY INJECTION
SYSTEM FOR B&W PLANTS

1. INTRODUCTION

During a shutdown of Oconee Unit 3 in May of 1997, two of the three high pressure injection (HPI) pumps were damaged when the letdown storage tank (or make-up tank) was emptied and gas was introduced into the system causing the pumps to bind. The operators were not aware of the reduction in level because the common reference leg for the two make-up tank (MUT) level indicators was not filled and both channels were reading low. Had the HPI system been called upon to respond to an ECCS signal, all three pumps would have been damaged, causing a complete loss of high pressure make-up capability. As a result, the NRC was concerned that there was a common-mode failure potential at other B&W plants. The staff requested that the Babcock and Wilcox Owners' Group (B&WOG) address the potential for common-mode failure of the HPI system and recommend proposed solutions to any problems that may be identified. The staff sent questions and follow-up questions (References 3 and 4) to the B&WOG and the B&WOG responded to both (References 1 and 2).

The licensee for Oconee has addressed the issue by making plant modifications, reducing the potential for common-mode failure, and committing to perform a system reliability study. Review of that study is being performed under a separate, Oconee specific, action (TAC M98454). The responses provided by Crystal River indicate that there are two open items related to the questions the staff sent. The necessity of a HPI alternate mini-flow flow path to the containment sump is restart issue D-01 and the adequacy of the RG 1.97 instrumentation is the subject of restart issue D-64. These items are currently under review under different actions and no additional work will be performed under this TAC. This evaluation addresses Arkansas Nuclear One Unit 1 (ANO-1), Crystal River Unit 3 (CR3), Davis-Besse Units 1 and 2 and Three Mile Island Unit 1 (TMI). This safety evaluation does not address the Oconee Units.

2. DISCUSSION

While Oconee Unit 3 was shutting down, the level in the make-up tank dropped to the point where gas was drawn into the suction of the operating HPI pump. The reactor operators were unaware of the loss of MUT level because both level

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channels had failed. The operating pump experienced damage because of inadequate suction head and pumped flow dropped. Because flow had dropped, a second HPI pump received an automatic start signal and it also experienced damage because of inadequate suction head. The third and last pump does not receive the same automatic start signal on low flow and was subsequently started after the suction header was filled and vented with water. Oconee runs with all three of the HPI pumps on a common suction header that is cross-connected so the gas from the MUT can affect all three pumps. The MUT is not isolated from the MUT on an engineered safeguards (ES) signal and all three pumps receive a start signal on an ES actuation. As a result, all three pumps would have been damaged had an ES signal been present.

Because the MUT is not isolated from the HPI pumps, there is an operational window on a pressure vs level curve for the MUT that protects the HPI pumps. When an ES signal occurs, following a loss-of-coolant accident, the HPI pumps take suction from both the borated water storage tank (BWST) and the MUT. The pressure and level in the MUT are controlled to prevent the MUT from draining and drawing gas into the suction of the HPI pumps. As a result, at Oconee, when the level in MUT was lower than it should have been, all three pumps were vulnerable to gas binding had an event occurred that required an ES signal.

The loss of level indication was attributed to the partial draining of a common reference leg in the two level channels. The partial draining of the common level reference leg was attributed to a test fitting leak. There is only one pressure channel maintaining pressure within the acceptable window of the pressure vs level curve and all the instrumentation is not safety-related.

The B&WOG response to the staff questions indicates that this is not a generic concern. The two Davis Besse HPI pumps do not take suction from the MUT. As a result, the HPI system does not draw water or gas from the MUT during an accident and this issue is not a concern. For ANO-1, CR3, and TMI the systems are not operated in the same configuration as Oconee. Only two of three HPI pumps are ES selected and receive a start signal. Additionally, they maintain train separation by not cross connecting the suction header of the HPI pumps. The two ES selected pumps do not draw from the same header. At ANO the technical specifications prohibit both ES selected pumps being attached to the same header, at CR3 the operating procedures and Appendix R considerations prohibit this configuration, and at TMI the procedures prevent this configuration.

With regard to instrumentation and operating in an acceptable window of the MUT pressure vs level curve ANO-1, CR3 and TMI are similar to the Oconee units. However, if the administrative controls fail and operation goes outside the acceptable window, the error could only affect one train of HPI and not cause a common-mode failure. Additionally, there are control room annunciators that would alert the operators to the pressure or level failing high or low. The two level channels share the connection to the tank, however, there are separate reference legs. This prevents the type of failure that occurred at Oconee because draining a reference leg would only affect one of the two level channels and the comparison check of the two level channels, performed each shift, would have identified the problem.

Although the ANO-1, CR3 and TMI HPI systems rely on administrative controls and non-safety related instrumentation to protect one of the HPI pumps, they do not rely on these controls to protect all of the HPI pumps. As a result, the staff has determined that the common-mode failure vulnerability identified during the May 1997 Oconee event is not generic to the other B&W plants.

3. CONCLUSION

Based on the information provided by the B&WOG, the staff does not find that the problems that led to the May 1997 Oconee event represent common-mode failure vulnerabilities at the other B&W units. The staff bases this conclusion primarily on the maintenance of train separation in the suction of the HPI system. The draining of the MUT will not cause the gas binding of both trains of HPI at any of the other B&W plants. As a result, the staff plans no further generic activity on this TAC (M99019).

4. REFERENCES

1. Letter, W. W. Foster, B&WOG, to Document Control Desk, B&WOG Report in Response of May 27, 1997 Request of Information, June 5, 1997.
2. Letter, W. W. Foster, B&WOG, to Document Control Desk, B&WOG Report in Response to July 21, 1997 Request for Additional Information, August 8, 1997.
3. Letter, J. L. Birmingham, USNRC, to B&WOG, Request for Information on Inaccurate Make/up Tank Level Indication Leading to High Pressure Injection Pump Cavitation at Oconee Unit-3, May 27, 1997.
4. Letter, J. L. Birmingham, USNRC, to B&WOG, Request for Additional Information Relative to the High-Pressure Injection Pump Cavitation at Oconee Unit-3 (M99019), July 21, 1997.

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