AEOD TECHNICAL REVIEW REPORT

PLANT:	Oconee Station, Units 1, 2, 3	TR REPORT NO.:	AEOD/T703
DOCKET NO.:	50-269, 270, and 287	DATE:	March 16, 1987
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NSSS/AE:	Babcock and Wilcox/Duke		

SUBJECT: POTENTIAL FOR LOSS OF EMERGENCY FEEDWATER DUE TO PUMP RUNOUT DURING CERTAIN TRANSIENTS

SUMMARY

A lack of runout protection for the emergency (also known as auxiliary) feedwater (EFW/AFW) pumps which could result in the loss of EFW function during certain design basis transients was identified by Duke Power Company (Duke) in a licensee event report (LER 86-010) submitted for the Oconee Station. Duke attributed this to a weakness in their design engineering program which failed to require a formal list of design inputs. To specifically address the lack of pump runout protection problem, Duke has instituted procedures and training for operator actions to prevent/mitigate the problems associated with EFW pump runout in the short term, and is evaluating long term system modifications which would eliminate the need to rely on operator action. To solve the design program deficiency, Duke is evaluating upgrading the design engineering program to meet ANSI N45.2.11 standards.

The lack of EFW pump runout protection, if uncorrected, could lead to a degradation or loss of EFW function during a steam line break accident. The licensee's implemented and planned corrective actions were determined to be adequate. The issue of loss of EFW/AFW function due to pump runout for other plants has been adequately addressed in IE Bulletin 80-04 and industry action. Hence AEOD plans no further action on this subject other than a followup review of the licensee's updated report scheduled for May 1987.

DISCUSSION

1. Description of Deficiency

In LER 86-010 (Ref. 1), Duke stated that no automatic runout protection for the EFW pumps was provided for high flow rates and in certain transients with steam generator pressure significantly lower than normal operating pressure, the possibility of runout flow with subsequent damage to the pumps existed. The lack of runout protection for the EFW pumps was attributed to insufficient analysis of the EFW system performance for all design basis transients. This was caused by the urgency of the TMI-related changes and a weakness in the licensee's design engineering program which failed to require a formal list of design inputs to ensure all inputs were incorporated into the design as required by ANSI N45.2.11 (Ref. 2). While reviewing calculations which were made earlier in the year quantifying concerns over low steam generator pressure with resulting EFW pump runout

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flow, an NRC safety system functional inspection team concluded that potential EFW pump runout at Oconee was a significant finding in their August 1, 1986 report (Ref. 3).

2. Licensee Corrective Actions

Duke proposed operator action to control EFW pump speed as the immediate corrective action. Revisions to operating procedures instructing operators to monitor and limit EFW flow to less than runout flow have been completed along with corresponding training to alert operators to the potential for runout during certain transients.

As a long term corrective action, Duke is currently evaluating system modifications which will prevent EFW runout without requiring operator action. A report describing the selected option along with alternates and a schedule for implementation is planned by May 1, 1987. To address the weakness in the design engineering program, Duke is evaluating the upgrading of the program for implementation of ANSI N45.2.11 by March 31, 1987.

3. Safety Significance

In the event of a main steam line break, timely operator action to prevent EFW pump runout is unlikely. The motor-driven pumps would reach runout speed after steam generator pressure drops below 400 psia, which would occur in a matter of seconds. For the loss of main feedwater with the loss of all ac power and the small break loss of coolant accident, several minutes would occur between the accident initiation and the onset of pump runout. For these scenarios, operator action to prevent EFW pump runout becomes more likely. In all cases, operator action to mitigate EFW pump damage due to runout is likely, because the pump is estimated to be able to operate with some degradation of flow about 10 minutes before the onset of damage due to runout.

If damage to the turbine driven pump and the motor driven pump due to extended operation at runout flow conditions occurs, the remaining motor driven pump or the main feedwater pump could be utilized for feedwater supply. Additionally, the decay heat removal system could be placed in operation after depressurization and cooldown of the primary system. These observations were summarized by the licensee in their response to an Inspection and Enforcement Bulletin (IEB) 80-04, "Analysis of a PWR Main Steam Line Break With Continued Feedwater Addition" (Refs. 4, 5), which required licensees, in the context of containment pressure response, to consider the "ability to detect and isolate the damaged steam generator from these (EFW runout flow, feedwater, condensate) sources and the ability of the pumps to remain operable after extended operation at runout flow."

4. Generic Implications

An evaluation of selected licensee responses to IEB 80-04 indicated that the issue of loss of EFW/AFW function due to pump runout had been adequately addressed. Eight sites besides Oconee were found to have Bingham-Willamette pumps installed in their EFW/AFW systems. These sites are McGuire, Catawba, Palisades, Palo Verde, Waterford, Millstone 3, Trojan, and Summer. Three of them, Trojan, McGuire, and Palisades, were required to respond to IEB 80-04.

Their responses indicated that the EFW/AFW pumps would not be expected to reach runout speed during a steam line break accident (Palisades), or have pump overspeed protection (Trojan and McGuire).

Three other licensees' responses to IEB 80-04 (Turkey Point, Surry, and Maine Yankee) indicated similar conclusions. The EFW/AFW pumps at Turkey Point would not be expected to reach runout speed in a steam line break accident. Surry has pump overspeed protection in the form of discharge line venturis. The EFW/AFW pumps at Maine Yankee would not be expected to be damaged during pump runout operation. In their response to IEB 80-04, the licensee stated "in the event of a main steam line rupture upstream of the excess flow check valve (EFCV), it is assumed that the operator isolates the flow to the rupture stream (sic) generator within 10 minutes. As a result, the auxiliary feed pumps (AFW) may experience cavitation due to pump runout for a period of 5 minutes." This timing includes a five minute delay to initiate AFW. The licensee stated that no pump damage would be expected for the following reason:

"At Maine Yankee, if the auxiliary feed pump is operating at runout conditions while discharging to a depressurized steam generator, moderate cavitation is expected to occur at the eye of the impeller vane. Without pre-heat, there is no possibility of forming and sustaining large voids in the suction pipe and losing pump suction as a result. Since the pump is cooled by the water pumped, there is no threat of overheating. As the cavitational voids increase in size, the problem becomes self-correcting, because there is a rapid drop in pump efficiency, or flow, which in itself eliminates the voids. The result can be a surging flow condition but not a loss of flow so long as the water pumped is cold. The effects of surging and collapsing voids are not expected to cause damage since these forces are significantly less than the design capabilities of a boiler feed pump which, according to the manufacturer, are experienced at shutoff conditions." (Ref. 6)

FINDINGS

1. The lack of runout protection for the EFW pumps was attributed to insufficient analysis of the EFW system performance for all design basis transients. This was caused by the urgency of the TMI-related changes and a weakness in the licensee's design engineering program which failed to require a formal list of design inputs to ensure all inputs were incorporated into the design as required by ANSI N45.2.11.

2. Procedures and training for operator action to prevent/mitigate pump runout has been established by the licensee as a short term corrective action.

3. Duke is evaluating the options for system modifications to eliminate the need for operator action and a program to upgrade their design change control to meet the ANSI N45.2.11 standards.

4. In the event of a main steam line break, timely operator action to prevent runout is unlikely. The motor-driven pumps would reach runout after steam generator pressure drops below 400 psia, which would occur in a matter of seconds. For the loss of main feedwater with the loss of all ac power and the small break loss of coolant accident, several minutes would occur between the accident initiation and the onset of pump runout; hence, successful operator intervention is more likely.

5. In all cases, operator action to mitigate EFW pump damage due to runout is likely, because the pump is estimated to be able to operate with some degradation of flow about 10 minutes before the onset of damage due to runout.

CONCLUSIONS

The results of the study indicated that the lack of runout protection for the EFW pumps at Oconee was attributable to a deficiency in Duke's design engineering program which failed to require a formal list of design inputs. This deficiency, if uncorrected, could lead to a degradation or loss of EFW function during a steam line break accident. The licensee's implemented and planned corrective actions were determined to be adequate. The issue of loss of EFW/AFW function due to pump runout for other plants has been adequately addressed in IEB 80-04 and industry action. Hence AEOD plans no further action on this subject other than a followup review of the licensee's updated report scheduled for May 1987.

REFERENCES

1. Duke Power Company, Licensee Event Report 50-269/86-010, Oconee Nuclear Station, Units 1, 2, and 3, dated August 28, 1986.

2. ANSI N45.2.11 - 1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants," American Society of Mechanical Engineers, 345 E. 47th Street, New York, NY 10017.

3. U. S. Nuclear Regulatory Commission, James M. Taylor, Director, Office of Inspection and Enforcement, letter to Mr. H. B. Tucker, V. P. Nuclear Production, Duke Power Company, transmitting Safety System Function Inspection Report Numbers 50-269/86-16, 50-270/86-16, and 50-287/86-16, August 1, 1986.

4. U. S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, Bulletin No. 80-04: "Analysis of a PWR Main Steam Line Break With Continued Feedwater Addition," February 8, 1980.

5. Duke Power Company, William O. Parker, Jr., letter to Mr. James P. O'Reilly, Director, Region II, USNRC, transmitting response to IEB 80-04, May 7, 1980.

6. Maine Yankee Atomic Power Company, D. E. Vandenburgh, V. P., letter to USNRC, responding to IEB 80-04, May 7, 1980.