April 2, 2003

EA-02-031
EA-03-057
EA-03-059

Mr. Alfred J. Cayia
Site Vice President
Point Beach Nuclear Power Plant
Nuclear Management Company, LLC
6610 Nuclear Road
Two Rivers, WI 54241-9516

SUBJECT: POINT BEACH NUCLEAR PLANT SPECIAL INSPECTIONS: RESOLUTION OF AUXILIARY FEEDWATER OLD DESIGN ISSUE AND PRELIMINARY RED FINDING - AUXILIARY FEEDWATER ORIFICE PLUGGING ISSUE; NRC INSPECTION REPORT 50-266/02-15(DRP); 50-301/02-15(DRP)

Dear Mr. Cayia:

On March 24, 2003, the results of two special inspections at your Point Beach Nuclear Plant were discussed with you and members of your staff. The enclosed report presents the results of those inspections. The inspections were examinations of activities conducted under your license as they relate to safety and to compliance with the Commission's rules and regulations and with the conditions of your license. Within these areas, the inspections consisted of a selective review of procedures and representative records, observations of activities, and interviews with personnel.

Initially, a special inspection was conducted September 23-26, 2002, to determine whether a Red inspection finding associated with the auxiliary feedwater (AFW) system should be treated as an old design issue as described in NRC Inspection Manual Chapter 0305, "Operating Reactor Assessment Program." This finding was discussed in NRC special Inspection Report 50-266/01-17(DRS); 50-301/01-17(DRS), dated April 3, 2002, and in the NRC's Final Significance Determination letter, dated July 12, 2002. On October 29, 2002, while the results of the September inspection were being reviewed by the NRC, you notified the NRC of a potential for a common mode failure of the AFW pumps from the plugging by debris of the pressure reduction orifices in the AFW recirculation lines. A second special inspection was subsequently conducted, beginning on October 31, 2002, to review the orifice plugging issue and its relation to the earlier Red inspection finding.

Based upon the results of these inspections, we have concluded that the Red inspection finding, which involved the potential common mode failure of the AFW pumps due to inadequate operator response to a loss of instrument air (IA), will not be treated as an old design issue. As detailed in Section 6.06.a of Manual Chapter 0305, there are four criteria that must be met for the NRC to classify a problem as an old design issue and thus allow the NRC to not consider the finding in its assessment of Point Beach's overall performance.

The inspections identified that the criterion pertaining to corrective action was not met in that the implementation of corrective action associated with your evaluation of the AFW/IA issue did not prevent recurrence of another, separate potential common mode failure of the AFW pumps. The failure to implement thorough and complete corrective actions became apparent during our review of the October 2002 AFW recirculation line orifice plugging issue and the identification of other problems related to AFW design. These problems included the use of a nonsafety-related power supply for relays associated with the proper operation of the AFW recirculation line air-operated flow control valves and the single electrical bus dependencies of three of the four recirculation line air-operated flow control valves and three of the four service water supply motor-operated valves. The failure to implement adequate corrective actions for the AFW/IA issue is a violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action." The other old design criterion that may not have been met pertained to the AFW/IA Red finding not being reflective of a current performance deficiency. From our inspections, we concluded that deficiencies in your engineering program that resulted in the AFW/IA issue were likely responsible for the recent problem with the AFW recirculation line orifices and other problems related to AFW design.

Because the AFW/IA Red finding did not meet the criteria for consideration as an old design issue, Point Beach is in the Multiple/Repetitive Degraded Cornerstone Column of the Action Matrix of Manual Chapter 0305. Consequently, your plant will be discussed at the upcoming Agency Action Review Meeting. We will notify you via separate correspondence of any agency actions that result from that discussion and as specified in the Action Matrix.

This report also discusses the potential plugging of the AFW pump recirculation line orifices during operation of AFW with service water. This issue appears to have high safety significance. During development of modification packages in 1999, your staff recognized the potential for these orifices to plug. However, because of the lack of understanding of AFW design basis, the orifices were installed. In late 2001 and early 2002, the AFW/IA issue presented an opportunity to correct this lack of understanding, but no action was taken until the orifice for the "A" motor-driven AFW pump was found partially plugged on October 24, 2002, after post-maintenance testing of the pump. In February 2003, testing conducted for you by an independent laboratory demonstrated that the orifices would quickly plug when subjected to water-borne debris similar to that found in your service water system. The installation of the orifices is an apparent violation of 10 CFR Part 50, Appendix B, Criterion III, "Design Control." This issue was assessed using the NRC's Significance Determination Process (SDP) and was preliminarily determined to be Red, an issue with high safety significance that may result in additional inspection. This issue is of high safety significance because a common mode failure

of the AFW pumps would result in substantially reduced mitigation capability for safely shutting down the plant in response to certain accidents. The assumptions and results of our preliminary SDP analysis are in Section 3.4.B of the attached inspection report.

Your immediate compensatory and corrective actions for the apparent violation were adequate. These actions included a revalidation of the design basis of the AFW system, and the revision of procedures and training of operators so that the AFW system could be operated during accidents without dependence on pump recirculation flow. The apparent violation is being considered for escalated enforcement action in accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions" (Enforcement Policy), NUREG-1600. The current Enforcement Policy is included on the NRC's website at www.nrc.gov.

Before the NRC makes a final decision on this matter, we are providing you an opportunity to request a Regulatory Conference where you would be able to provide your perspectives on the significance of the findings, the bases for your position, including any revised or new information associated with your risk analysis, and whether you agree with the apparent violation. If you choose to request a conference, it should be held within 30 days of the receipt of this letter and we encourage you to submit your evaluation and any differences with the NRC evaluations at least one week prior to the conference in an effort to make the conference more efficient and effective. If a conference is held, it will be open for public observation. The NRC will also issue a press release to announce the conference. If you decide to submit only a written response, such submittal should be sent to the NRC within 30 days of the receipt of this letter.

Please contact Mr. Kenneth Riemer at (630) 829-9757 within seven days of the date of this letter to notify the NRC of your intentions. If we have not heard from you within 10 days, we will continue with our significance determination and enforcement decision and you will be advised by separate correspondence of the results of our deliberations on these matters.

Since the NRC has not made a final determination in this matter, no Notice of Violation is being issued for the inspection finding related to design control at this time. In addition, please be advised that the number and characterization of apparent violations described in the enclosed inspection report may change as a result of further NRC review.

The NRC has determined that the inadequate correction actions taken for the root cause of the AFW/IA issue is a violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," as cited in the enclosed Notice of Violation (Notice). This violation is associated with a previously identified Red finding (EA-02-031). The circumstances surrounding the violation are described in detail in the subject inspection report. You are required to respond to this letter and should follow the instructions specified in the enclosed Notice when preparing your response.

In accordance with NRC Inspection Manual Chapter 0305, "Operating Reactor Assessment Program," Section 06.06.d, the original performance issue (AFW/IA Red finding, EA-02-031) will remain open and will not be removed from consideration in the assessment program until the corrective action violation has been corrected.

Based on the results of these inspections, the NRC has also identified two issues that were evaluated under the risk Significance Determination Process as having very low risk significance (Green). The two findings also involved violations of NRC requirements; however, because the violations were non-willful and non-repetitive and because the findings were entered into your corrective action program, the NRC is treating these issues as Non-Cited Violations, in accordance with Section VI.A.1 of the NRC's Enforcement Policy.

If you contest the violation in the Notice or the subject or severity of the Non-Cited Violations, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Regional Administrator, U.S. Nuclear Regulatory Commission - Region III, 801 Warrenville Road, Lisle, IL 60532-4351; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the Resident Inspector Office at the Point Beach Nuclear Plant facility.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter, its enclosures, and your response will be available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.usnrc.gov/reading-rm/adams.html (the Public Electronic Reading Room). To the extent possible, your response should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction.

Sincerely,

/RA/

J. E. Dyer
Regional Administrator

Docket Nos. 50-266; 50-301
License Nos. DPR-24; DPR-27

Enclosures: 1. Notice of Violation
2. Inspection Report 50-266/02-15; 50-301/02-15

See Attached Distribution

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*** OE concurrence via telephone with J. Dixon-Herrity 4/1/03**

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NOTICE OF VIOLATION

Nuclear Management Company, LLC
Point Beach Nuclear Plant

Docket Nos. 50-266; 50-301
License Nos. DPR-24; DPR-27
EA-03-059

During two NRC inspections conducted between September 23, 2002, and March 24, 2003, a violation of NRC requirements was identified. In accordance with the "General Statement of Policy and Procedure for NRC Enforcement Actions," NUREG-1600, the violation is listed below:

Criterion XVI, “Corrective Action,” of 10 CFR Part 50, Appendix B, requires, in part, that conditions adverse to quality be promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition.

Contrary to the above, as of December 12, 2002, the licensee failed to implement corrective actions to preclude repetition of a significant condition adverse to quality associated with an AFW system potential common mode failure. Specifically, the licensee failed to identify potential common mode failures that existed involving power supplies to the recirculation line air-operated valve and other system components. In addition, the licensee’s corrective actions for the potential common mode failure associated with a loss of instrument air did not preclude repetition. Specifically, the licensee’s corrective actions, to upgrade the safety function of the air-operated recirculation valve, failed to ensure that successful operation of the recirculation line air-operated valve was dependent only on safety-related support systems. Following the corrective actions, successful operation of the valve was still dependent upon nonsafety-related power to an interposing relay.

This violation is associated with a previously identified Red SDP finding (EA-02-031).

Pursuant to the provisions of 10 CFR 2.201, Nuclear Management Company, LLC, is hereby required to submit a written statement or explanation to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555, with a copy to the Regional Administrator, Region 3, and a copy to the NRC Resident Inspector at the facility that is the subject of this Notice, within 30 days of the date of the letter transmitting this Notice of Violation (Notice). This reply should be clearly marked as a "Reply to a Notice of Violation; EA-03-059" and should include: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Your response may reference or include previous docketed correspondence, if the correspondence adequately addresses the required response. If an adequate reply is not received within the time specified in this Notice, an order or a Demand for Information may be issued as to why the license should not be modified, suspended, or revoked, or why such other action as may be proper should not be taken. Where good cause is shown, consideration will be given to extending the response time.

If you contest this enforcement action, you should also provide a copy of your response, with the basis for your denial, to the Director, Office of Enforcement, United States Nuclear Regulatory Commission, Washington, DC 20555-0001.

Because your response will be made available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (ADAMS), accessible from the NRC Web site at http://www.usnrc.gov/reading-rm/adams.html, to the extent possible, it should not include any personal privacy, proprietary, or safeguards information so that it can be made available to the public without redaction. If personal privacy or proprietary information is necessary to provide an acceptable response, then please provide a bracketed copy of your response that identifies the information that should be protected and a redacted copy of your response that deletes such information. If you request withholding of such material, you must specifically identify the portions of your response that you seek to have withheld and provide in detail the bases for your claim of withholding (e.g., explain why the disclosure of information will create an unwarranted invasion of personal privacy or provide the information required by 10 CFR 2.790(b) to support a request for withholding confidential commercial or financial information). If safeguards information is necessary to provide an acceptable response, please provide the level of protection described in 10 CFR 73.21.

In accordance with 10 CFR 19.11, you may be required to post this Notice within two working days.

Dated this 2nd day of April 2003

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos:	50-266; 50-301
License Nos:	DPR-24; DPR-27
Report No:	50-266/02-15(DRP); 50-301/02-15(DRP)
Licensee:	Nuclear Management Company, LLC
Facility:	Point Beach Nuclear Plant
Location:	6610 Nuclear Road Two Rivers, WI 54241
Dates:	September 23 - 26, 2002 October 31, 2002 - March 24, 2003
Inspector:	M. Kunowski, Project Engineer P. Louden, Senior Resident Inspector (Clinton) Z. Dunham, Resident Inspector (Kewaunee) M. Morris, Resident Inspector (Point Beach) K. O'Brien, Senior Reactor Engineer S. Burgess, Senior Reactor Analyst P. Krohn, Senior Resident Inspector (Point Beach)
Approved by:	Kenneth Riemer, Chief Branch 5 Division of Reactor Projects

SUMMARY OF FINDINGS

IR 05000266-02-15(DRP); 05000301-02-15(DRP), on 9/23/2002 - 9/26/2002 and 10/31/2002 - 3/24/2003, Nuclear Management Company, LLC; Point Beach Nuclear Plant, Unit 1 and Unit 2. Special inspections to evaluate a Red inspection finding for old design issue consideration and to review potential common mode failure of auxiliary feedwater pumps due to plugging of recirculation line orifices - Mitigating Systems Cornerstone.

Cornerstone: Mitigating Systems

The Nuclear Regulatory Commission (NRC) performed a special inspection to assess a Red inspection finding, regarding a potential common mode failure of the auxiliary feedwater (AFW) system involving the instrument air (IA) system, for consideration as an old design issue. A second special inspection was conducted to review the plugging of the pressure reduction orifice in the AFW recirculation line during post-maintenance testing of the P-38A motor-driven AFW pump on October 24, 2002, and the subsequent determination by the licensee on October 29, of the potential for the common mode failure of all four AFW pumps due to plugging of the associated orifices. The second special inspection also reviewed the relationship between the AFW/IA Red inspection finding and the orifice plugging issue.

Inspector-Identified Findings

Cornerstone: Mitigating Systems

- To Be Determined. An apparent violation was identified, in part, through a self-revealing event when decreased auxiliary feedwater pump recirculation flow was noted during post-maintenance testing. Subsequent licensee and NRC review of the event determined that the licensee had installed incorrectly designed orifices in each of the pump recirculation lines. The orifices, due to small clearances, were susceptible to plugging. The primary causes of this finding were inadequacies in the licensee's design process and the licensee's implementation of the process, including the identification of system design requirements and the development of supporting safety evaluations.

  The issue has been preliminarily determined to have high safety significance (Red). Following installation of the inadequately designed orifices, the entire auxiliary feedwater system was susceptible to a common mode failure during operations using service water. Failure of auxiliary feedwater during several initiating events could lead to core damage. The installation of the incorrectly designed orifices in the recirculation lines is an apparent violation of 10 CFR Part 50, Appendix B, Criterion III, “Design Control.” (Section 3.4)

- Green. The inspectors identified two issues that were treated as one Non-Cited Violation of 10 CFR Part 50, Appendix B, Criterion VI, “Document Control.” First, emergency and abnormal procedures in two emergency response facilities were not included as part of the temporary change distribution process. Second, no controls were in place to ensure that the scope of distribution of temporary procedure changes was appropriate.

The finding was of very low risk significance because the licensee distributed the documents to the facilities prior to any facility activation and the need to use the procedures. (Section 3.3)

- Green. The inspectors identified a Non-Cited Violation of 10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," for a procedure which directed the use of a flow instrument for the turbine-driven AFW pump recirculation line in a range for which it was not calibrated.

  The finding was of very low risk significance because follow-up calibration indicated that the instrument was reliable in the range in which it was to be used, and the inspectors concluded that it could have been used to accurately determine the AFW flow. (Section 3.3)

Cross-Cutting Area: Problem Identification and Resolution

- A violation was identified for the licensee's failure to implement adequate corrective actions to effectively address a previous Red finding and preclude recurrence (Inspection Report 50-266/01-17; 50-301/01-17). Specifically, the licensee failed to identify potential common mode failures that existed involving power supplies to the recirculation line air-operated valve and other system components. In addition, the licensee's corrective actions for the potential common mode failure associated with a loss of instrument air did not preclude repetition. Specifically, the licensee's corrective actions, to upgrade the safety function of the air-operated recirculation valve, failed to ensure that successful operation of the recirculation line air-operated valve was dependent only on safety-related support systems. Following the corrective actions, successful operation of the valve was still dependent upon nonsafety-related power to an interposing relay. Additionally, the corrective actions failed to discover a single failure mechanism involving a system orifice modification.

  The issue was more than minor because the failure to implement appropriate corrective actions resulted in the auxiliary feedwater system continuing to rely on nonsafety-related support systems and to be susceptible to a single event causing a total system failure. The failure of nonsafety-related support systems and single event failures are an expected condition during several design basis accidents and should not cause a safety system to fail. The failure of the licensee to implement adequate corrective actions is a violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action." (Section 3.4)

Licensee-Identified Findings

None.

Report Details

1 BACKGROUND

In 2001, the licensee conducted a voluntary upgrade of its Probabilistic Risk Assessment (PRA) and initially identified a concern about a common mode failure of its four auxiliary feedwater (AFW) pumps for accident scenarios involving the loss of instrument air (IA). The concern was entered into the corrective action program on July 6, 2001, as Condition Report (CR) 01-2278. After detailed evaluation, the licensee determined on November 29, 2001, that the potential existed for a common mode failure to occur and informed the NRC. Subsequently, the licensee provided a written report to the NRC on January 28, 2002, in Licensee Event Report (LER) 266/2001-005-00. The LER stated that the identified failure mechanism was associated with inadequate operator actions using emergency operating procedures (EOPs) in response to the loss of IA to the AFW recirculation line flow control air-operated valves (AOVs). From December 3, 2001, through February 28, 2002, an NRC special inspection team reviewed the AFW/IA issue. The report of this inspection (50-266/01-17; 50-301/01-17) documented a preliminary finding of high safety significance (Red) and two apparent violations of 10 CFR Part 50, Appendix B. On April 29, 2002, a Regulatory Conference was conducted and the Point Beach licensee (the Nuclear Management Company, LLC (NMC)) agreed that the finding was Red, but proposed that it was an old design issue (ODI). The ODI designation referred to the exemption in NRC Inspection Manual Chapter 0305, "Operating Reactor Assessment Program," that allowed the NRC to not take actions specified in the Action Matrix for certain findings.

In a letter dated July 12, 2002, the NRC issued a Final Significance Determination, classifying the AFW/IA issue as a Red finding. In addition, a Notice of Violation was issued, citing both Criterion V, "Instructions, Procedures, and Drawings," and Criterion XVI, "Corrective Action," in one violation of 10 CFR Part 50, Appendix B. The July 12th letter also discussed the NRC's decision to perform additional inspection to determine whether the issue should be treated as an ODI. An initial inspection was conducted, by two inspectors, from September 23 to September 26, 2002, and a preliminary meeting to discuss the tentative results of the inspection was held on October 2.

On October 29, 2002, while the results of the September inspection were being reviewed by Region III management, the licensee notified the NRC of a potential for a common mode failure of the AFW pumps from the plugging by debris of the pressure reduction orifices in the AFW minimum flow recirculation lines. Flow through the recirculation lines is required to prevent damage to the pumps when flow to the steam generators ("forward flow") is stopped or significantly reduced by reactor operators. The licensee came to this conclusion after evaluating the failure of recirculation flow on October 24 to meet an acceptance criterion during post-maintenance testing of the "A" motor-driven AFW (MDAFW) pump–the "A" pump feeds the "A" steam generators in Unit 1 and Unit 2 and the "B" MDAFW pump feeds the "B" steam generators in Unit 1 and Unit 2. A special inspection team, consisting of five inspectors, was dispatched to Point Beach on October 30 to review this latest AFW issue and its relation to the earlier problem associated with the vulnerability of the AFW pumps upon a loss of IA. During this inspection, the licensee identified rust-like debris in the "A" pump orifice and in the

"B" pump orifice after reduced flow was observed during post-maintenance testing on November 6. The licensee concluded that the source of the rust-like debris was discharge piping high-point vent valves and pump casing vent valves that had been manipulated during system maintenance. A discussion of the preliminary results of the NRC inspection were held with the licensee on December 12, 2002. A subsequent discussion was held on March 24, 2003, after the NRC reviewed the results of orifice testing conducted on February 21, 2003, for the licensee by an independent laboratory. These studies indicated that the sand, silt, and zebra mussel shell debris normally found in plant service water (SW) would quickly plug the orifices.

2 INSPECTION SCOPE

For the inspection from September 23-26, 2002, and the inspection from October 31, 2002, to March 24, 2003, the inspectors interviewed licensee personnel; reviewed the documents listed at the end of this inspection report; walked down the IA, AFW, and related systems; observed licensed operator performance during simulator scenarios related to the loss of IA and to the plugging of the orifices; and observed licensee inspections and evaluations of various components during the search for a source of the rust-like debris found in the orifices.

The results of the initial inspection (from September 23-26) are combined in this report with the results of the second inspection (from October 31 to March 24), which was chartered with eight focus areas:

1. Timeline development relating to contributors and discovery of the potential common mode failure of the AFW system due to the plugging of the AFW recirculation line orifices.

2. Assess the adequacy of the licensee's risk assessment.

3. Assess the adequacy of the licensee's operability evaluation, and assess the adequacy of the immediate compensatory actions, including the length of time the actions are intended to be in place. Review and validate the new procedure revisions associated with the interim corrective actions to ensure adequacy.

4. Evaluate the adequacy of the modification, and its associated safety analysis, that installed the current recirculation line orifices.

5. Evaluate the licensee's efforts in determining and eliminating the source of the foreign material found in the recirculation line orifice of "A" MDAFW pump on October 24, 2002. Additionally, evaluate the licensee's efforts in determining other potential sources of foreign material that could plug the orifices.

6. Evaluate the licensee's efforts in determining if other plant components are susceptible to the same fouling concern.

7. Evaluate the licensee's re-design options and priority assignments.

8. Identify prior opportunities to have identified the orifice plugging issue.

3 INSPECTION RESULTS

3.1 Timeline for the AFW/IA Red Finding and Recirculation Line Orifice Plugging Issue

1979-1986	Numerous correspondence between NRC and Point Beach regarding post-TMI (Three Mile Island) initiative to make critical portions of the AFW system safety-related.
1991	Higher flow replacement orifices installed in AFW recirculation lines per modification MR 88-099*A-D, developed beginning in 1988 in response to NRC Bulletin 88-04, "Potential Safety-Related Pump Loss."
1996-1997	Corrective action program documents (condition reports) written for high noise during AFW operation on recirculation.
March 1997	The licensee identified that a loss of instrument air to the discharge flow control valves for the MDAFW pumps could cause AFW system failure. The licensee reported the problem in LER 266/97-014-00.
October 1997	The licensee identified a discrepancy with its inservice testing program and a design basis document concerning the open safety function of the AFW recirculation valves. The issue is documented in Condition Report 97-3363.
November 2, 2000	New design pressure reduction orifice installed in the recirculation line of the P-38A ("A") MDAFW pump, which provided flow to the "A" steam generator in Unit 1 and Unit 2. The new design was intended to solve a noise and vibration problem associated with the previous design.
November 10, 2000	New orifice installed in the recirculation line of the P-38B ("B") MDAFW pump, which provided flow to the "B" steam generator in Unit 1 and Unit 2. Additional holes drilled in the orifice to increase flow.
March 14, 2001	Additional holes drilled in new orifice for the P-38A pump to increase flow.
April 13, 2001	The licensee reviewed foreign material control for the March 14, 2001, modification after post-modification flow did not meet expectations. The issue was documented in CAP013812 (CAPs were corrective action program documents that replaced condition reports).

July 6, 2001	Licensee initially identified a concern about the effect of the loss of IA on AFW pumps.
November 29, 2001	Licensee reported in accordance with 10 CFR 50.72 the potential for a common mode failure of the AFW pumps because of the loss of IA (AFW/IA issue).
December 3, 2001	NRC special inspection to review the AFW/IA issue began.
January 28, 2002	The licensee submitted LER 266/2001-005-00, discussing the AFW/IA issue.
February 28, 2002	NRC special inspection concluded. A preliminary Red inspection finding was documented in report 50-266/01-17(DRS); 50-301/01-17(DRS), dated April 3, 2002.
April 29, 2002	Regulatory Conference held to discuss two apparent violations and the Red preliminary significance determination associated with the AFW/IA finding.
May 11, 2002	New orifice installed in the recirculation line of the 2P-29 turbine-driven AFW (TDAFW) pump, which provided flow to the Unit 2 “A” and “B” steam generators.
May 14, 2002	Licensee issued its root cause evaluation (RCE) of the AFW/IA issue.
July 12, 2002	Final Significance Determination letter and Notice of Violation for the AFW/IA finding was issued by NRC.
August 12, 2002	Licensee responded to the Notice of Violation in a letter describing corrective actions.
September 12, 2002	As part of corrective actions for the AFW/IA issue, the licensee reclassified the open function of the AFW recirculation line AOVs as safety-related.
September 26, 2002	Licensee submitted a clarification of its response to the Notice of Violation.
September 26-29, 2002	NRC special inspection conducted to determine if the AFW/IA Red finding was an ODI.
October 14, 2002	New orifice installed in the recirculation line of the 1P-29 TDAFW pump, which provided flow to the Unit 1 “A” and “B” steam generators.

October 24, 2002	During post-maintenance testing of the P-38A MDAFW pump, recirculation flow of 64.5 gallons per minute (gpm) was below the 70-gpm acceptance criterion. Rust-like debris found in 24 of 54 outer holes of the pressure reduction orifice. The orifice was subsequently cleaned and the pump re-tested. Recirculation flow was 75 gpm.
October 25, 2002	The P-38B MDAFW pump and the 1P-29 and 2P-29 TDAFW pumps were tested. Recirculation flows met acceptance criteria.
October 29, 2002	Licensee completed an engineering evaluation and declared all four AFW pumps inoperable because of the potential for service water borne-debris to plug the recirculation line orifices. The pumps were declared operable about 2½ hours later after special training was given to reactor operators, temporary information tags were placed on AFW equipment, and procedure changes were initiated.
October 31, 2002	NRC special inspection began at Point Beach to review orifice plugging issue and its relation to the AFW/IA finding.
November 6, 2002	Boroscopic exam of the P-38B MDAFW pump and discharge piping was conducted by the licensee. No problems identified. Subsequent post-maintenance testing identified that recirculation flow was 68 gpm (70-gpm acceptance criterion). Rust-like debris found in the orifice. The orifice was cleaned and the test was re-run on November 7. Flow was 73 gpm, satisfying the acceptance criterion.
December 12, 2002	Preliminary exit meeting for the special inspection was held.
December 20, 2002	Licensee contractor completed evaluation of debris found in the orifices and issued its report.
December 26, 2002	Licensee submitted LER 266/2002-003-00, discussing the possible common mode failure of AFW due to partial clogging of the recirculation orifices.
January 27, 2003	Contractor laboratory began study of plugging potential of a pressure reduction orifice for the licensee.

February 13, 2003	NRC conducted a Significance and Enforcement Review Panel and concluded that based on the preliminary results of the most recent special inspection the AFW/IA Red finding was not an ODI.
February 21, 2003	Final testing of an orifice at the contractor laboratory indicated that the orifices would plug in less than one minute when subjected to service water flow with a typical debris load of sand, silt, and crushed zebra mussel shells.
March 20, 2003	NRC conducted a Significance and Enforcement Review Panel. The Panel assessed the significance of the potential plugging of the AFW pump recirculation lines during operation of AFW with service water. The issue was preliminarily determined to be Red, an issue with high safety significance.

3.2 The Licensee's Risk Assessment of the Orifice Plugging Issue

Initially, in late October and early November 2002, the licensee assessed plant risk after making temporary procedure changes (discussed further in Section 3.3) to ensure AFW forward flow or stopping of an AFW pump in lieu of relying on recirculation flow. The procedure changes essentially replaced the function of the recirculation line and the flow control AOV with an operator action to maintain forward flow above the minimum value required for pump cooling (50 gpm for the MDAFW pumps and 75 gpm for the TDAFW pumps) or to shut off the pump. The risk assessment changed (improved) daily as the human error probabilities (HEPs) changed with the completion of procedural changes, operator aids, and operator training. The on-line risk as calculated by the licensee's risk program changed from a high yellow risk to a low yellow risk once all of the procedures had been revised and operators had been trained. Review by the inspectors determined that the risk analysis was performed in a systematic and methodical manner and that appropriate HEP values were used. The HEP analysis was reviewed by a corporate risk analyst and by an independent contractor throughout the process.

The orifice plugging issue affected all initiating event scenarios, except large-break loss-of-coolant accident (LLOCA). While the licensee was trying to determine the source of the rust-like material in the orifices, changes were made to the PRA model that (1) accounted for the plugging probability from debris in condensate storage tank (CST) water–the nonsafety-related, normal source of water for AFW–from debris in service water–the safety-related source for AFW–and from fire water, (2) fine-tuned HEP values for feed and bleed actions (feed and bleed would be required if the AFW pumps could not be used for cooling the reactor coolant system; HEP values for feed and bleed were typically very conservative and were the same for all scenarios even though it is different for each scenario), and (3) added the water treatment system to the PRA model since the system could be used for initiating events where loss of offsite power (LOOP) or loss of instrument air (LOIA) was not involved and make-up to the CST was needed.

For determining a plugging probability, the licensee considered using Point Beach operating experience with these orifices, because orifices, in general, do not have generic plugging probabilities and use of this type of orifice was not widespread. In late December 2002, the licensee concluded that the source of the rust-like material found in the orifices of the two MDAFW pumps was pump casing and discharge line high-point vent valves and associated carbon steel piping, where rust-buildup from infrequent use of the valves would be dislodged during fill and venting operations of the pumps (Section 3.5). Whereas all four pumps had similar vent valves, it was considered unlikely that all four pumps would be filled and vented at the same time, potentially plugging the recirculation line orifices of the four pumps simultaneously.

In late January and in February 2003, a specially fabricated orifice was tested at a contractor laboratory in an effort to determine a plugging probability with SW. Definitive testing occurred on February 21 when a debris mixture of sand, silt, and zebra mussel shells representative of what would exist in the Point Beach SW system was injected into a closed loop configuration of piping, an orifice, and a centrifugal pump. The orifice plugged in much less than one minute of debris being injected into the loop. These results were contrary to those of a previously performed computational particle fouling model analysis that indicated that plugging was unlikely because of the particle size distribution of debris in SW and the shear forces in the holes and channels of the orifices developed with the minimum flow required through the orifice for pump cooling.

Based upon the test results, the licensee's PRA staff determined that a plugging probability of 1.0 was appropriate for the use of SW as an AFW water supply. The normally cross-tied CSTs had limited capacity; therefore, for all scenarios within the 24-hour mission time, the licensee eventually had to use another water source. Using the test results, the licensee's PRA credited accident sequences where the reactor coolant pumps were available for forced recirculation and the switchover from AFW to residual heat removal (RHR) cooling occurred before the CSTs emptied. This was based upon proceduralized operator actions to go to cold shutdown in lieu of switching over to SW. As mentioned previously, the licensee was also able to credit accident sequences where the water treatment system would be used to refill the CSTs. With this credit given in their PRA model, the licensee's preliminary risk analysis determined that the plugging of the orifices resulted in a risk significant change in core damage frequency.

3.3 Corrective Actions for the AFW/IA Red Finding and the Orifice Plugging Issue

A. AFW/IA

The licensee determined the root cause for the AFW/IA issue (RCE 01-069) was deficiencies in the original emergency operating procedure (EOP) validation process, which was completed in 1985. The EOP validation method used at that time met industry guidelines and focused specifically on event mitigation responses, but failed to thoroughly assess the procedure/design/human interface for a loss of IA transient.

Two significant contributing causes were identified: limitations in the PRA model fault trees which evaluated system performance on design basis functions and only considered operator actions to mitigate a failure, and earlier evaluations that only focused on minimum AFW flow requirements to the steam generators to provide decay heat removal.

Other contributing causes identified in the root cause evaluation included failure to consider human actions during failure modes and effects analysis review on the design control process; failure to effectively integrate human error reduction methods in operations; failure to include human error reduction methods into the EOP development process; and inconsistencies between AFW system descriptions in the Final Safety Analysis Report, AFW system Design Basis Document, and the In-service Testing Program document pertaining to the recirculation line AOVs.

In the letter dated August 12, 2002, which responded to the Notice of Violation (NOV) associated with the Red AFW/IA finding, the licensee described several corrective actions that had been taken. These included immediate actions to alert operators of the AFW minimum recirculation flow requirements with control board tags; supplemental briefings of operators; procedure changes to ensure that AFW minimum recirculation flow was maintained; and the installation of pneumatic backup supplies for the recirculation line AOV for each AFW pump.

Many of the corrective actions taken to prevent recurrence of the root cause and those taken to address the contributing causes had been completed by the date of the NOV response and more had been completed by the time of the September 23-26 inspection. However, from the indepth review of AFW design during the orifice plugging inspection and the resultant identification of other problems with the AFW system (discussed in Section 3.4), the NRC inspectors determined that the corrective actions taken for the root cause of the AFW/IA issue as described in RCE 01-069 were inadequate. The AFW/IA issue, the self-revealing AFW orifice plugging issue, and the other problems discussed in Section 3.4, were caused by a fundamental lack of understanding of the design basis of the AFW system that were not adequately addressed by the corrective actions.

B. Orifice Plugging Issue

The licensee formed an event resolution team to determine a root cause for the orifice plugging issue and develop corrective actions. In addition, a large number of procedures were revised; operators were trained on the issue and on compensatory measures, including procedure revisions; and components and systems were examined and evaluated to identify the source of the debris in the orifices. Industry experts were also contracted with to provide assistance with AFW design basis revalidation, review of the Point Beach engineering organization and processes, PRA evaluation of the plugging issue, metallurgical analyses of the debris, and analyses of the plugging potential of the orifices.

Two findings of very low safety significance (Green) were identified by the inspectors. One finding involved insufficient distribution of abnormal and emergency procedure temporary changes to all emergency response facilities. The second finding involved the use of a flow instrument for the TDAFW pump recirculation line in a range for which it had not been calibrated. These findings are discussed in detail below. Several corrective actions, such as the AFW design basis revalidation and review of the engineering organization and processes, had not been completed by the end of the inspection and will be reviewed during future inspections. Other actions, such as the evaluation of a replacement design for the orifice and the training of operator crews through simulator scenarios requiring the use of the revised procedures, were satisfactorily completed.

Because the loss of IA to the AFW recirculation line AOV was a part or a result of an initiating event, and not considered a separate event, only 4 procedures were revised in November 2001: EOP-0, Reactor Trip or Safety Injection; EOP-0.1, Reactor Trip Response; Emergency Contingency Action ECA-0.0, Loss of All AC [Alternating Current] Power; and Abnormal Operating Procedure AOP-5B, Loss of Instrument Air. These procedures were changed immediately and a longer term project was undertaken to systematically evaluate and revise, as necessary, other procedures. However, because the risk significance of the orifice being plugged was independent of the accident scenario, 117 procedures (AOPs, EOPs, ECAs, CSPs [Critical Safety Procedures], and several normal operating procedures) required revision. Also, a factor in the number of procedure revisions was a change in philosophy after the October 24, 2002, plugging event whereby operators would be required to stop the AFW pumps when forward flow was less than 50 gpm for the MDAFW pumps and less than 75 gpm for the TDAFW pumps. Normally, the operators would close the discharge valves to throttle or stop AFW flow. Because of the risk of plugging the recirculation line, the operators were instructed in October 2002 to stop the pumps if there was no dedicated operator observing recirculation flow, which was only indicated on instruments near the pumps. The licensee determined that the most effective way to implement the change was to have just-in-time training and change the fold-out page of the procedures along with specific procedure changes.

The inspectors reviewed the changes to procedures made by the operations department in response to the orifice plugging issue and identified four problems:

- Procedure AOP-10, “Control Room Inaccessibility,” was revised to reflect the changes in operational requirements for the TDAFW pumps in the “Action/Expected Response” column, but did not include changes in operational requirements for the MDAFW pumps in the “Response Not Obtained” column.

- Nuclear Plant Business Unit Procedure (NP) 1.2.3, “Temporary Procedure Change,” required the initiator of the temporary change to determine the procedure locations that would receive the change. The operations department selected the following locations:

  - Document Control Distribution Lead for Master File,
  - Main Control Room,
  - Primary Auxiliary Building Operator Station,
  - Operations Department Office,
  - Operations Shop,
  - Control Room Simulator, and
  - Work Control Center.

  However, the changes were not distributed to the Technical Support Center (TSC) and Operations Support Center (OSC) emergency response facilities. As a result, during an emergency, personnel in these facilities would not have had the same procedure revisions as the main control room crew, possibly complicating licensee response to an emergency.

- During the recovery phase of an event, operators would exit the emergency and/or abnormal procedures and return to the normal operating procedures (OPs). The OPs were not revised to include information about the AFW flow requirements. The licensee stated that operating instruction (OI)-62 for AFW operations would be used after leaving the abnormal or emergency procedures. However, by excluding the AFW orifice information from the OPs, the licensee failed to provide the Duty Shift Supervisor, the person with overall control of plant operations, with information that may be needed for decisions affecting plant operations.

- The inspectors compared the AFW "Information Tags" on the control boards and the local instruments and observed that the tags were not the same. The control board tags referenced AFW flow, which would include any indication of flow, while the local instrument tags referenced flow using the AFW pump discharge flow meter. The tags on the local instruments specified the recirculation flow instrument to be used because there were no other indications that could have been used in the area. Since plant operating philosophy in response to the AFW/IA finding was to consider recirculation flow not available, the instruction to operators was to secure the AFW pump if forward flow was less than 50 gpm for the MDAFW pumps and less than 75 gpm for the TDAFW pumps. Given the specific indications available at each operating station, the inspectors concluded that the difference in information tags was acceptable.

  However, the inspectors noted that the first increment for the TDAFW pump local discharge flow indicator was 100 gpm and then continued upward in increments of 20 gpm to 400 gpm. This raised a question about the licensee's ability to accurately read 75 gpm when the first increment was 100 gpm. The inspectors also reviewed past calibration records for the instrument and determined that, up until December 12, 2002, it had been calibrated from 150 gpm to 400 gpm. The instrument was subsequently calibrated from 50 gpm to 150 gpm during the weekend of December 13. The inspectors determined that the instrument had not been calibrated for use in the range in which it was required to be used in the emergency and abnormal procedures. Therefore, the instrument calibration and range was not considered as part of the engineering and operations evaluation when the procedures were revised.

Analysis

The inspectors determined that two orifice-related procedure issues warranted a significance evaluation in accordance with NRC Inspection Manual Chapter 0612, "Power Reactor Inspection Reports," Appendix B, "Issue Disposition Screening," dated April 29, 2002.

First, the inspectors determined that the issue of not having the procedures updated in all of the emergency facilities was a performance deficiency in that: 1) the temporary procedure changes were not distributed to all of the facilities that would be required to use them during a plant emergency, and 2) no controls were in place to ensure that the scope of distribution of temporary procedure changes was appropriate.

Second, the inspectors determined that the issue of insufficient calibration of the AFW recirculation flow instrument was a performance deficiency in that: 1) the instrument being relied upon to perform emergency and abnormal actions had not been verified to be accurate for the range in which it was used, and 2) the instrument calibration procedure was not designed to assure that the instrument would perform in accordance with the procedural requirements of maintaining minimum flow through the pump.

These findings were more than minor since they affected the availability, reliability, and capability of the AFW system, a mitigating system. Using NRC Inspection Manual Chapter 0609, Appendix A, "SDP Phase 1 Screening Worksheet for IE, MS, and B [Initiating Events, Mitigating Systems, and Barrier Integrity] Cornerstones," the inspectors used the "Mitigating Systems" column. Based on the answers to the screening questions, the inspectors concluded that these two orifice-related procedure issues were findings of very low safety significance (Green).

Enforcement

Appendix B, Criterion VI, of 10 CFR Part 50, "Document Control," requires, in part, that measures be established to control the issuance of documents and that these measures assure that the documents are distributed to and used at the location where the prescribed activity is performed. Contrary to this, the inspectors determined that the emergency and abnormal procedures in emergency response facilities had not been included as part of the temporary procedure change distribution process. Because this violation was of very low safety significance and was entered into the licensee's corrective action program, this violation is being treated as a Non-Cited Violation (NCV 50-266/02-15-01; 50-301/02-15-01) consistent with Section VI.A of the NRC Enforcement Policy. The issues did not represent an immediate safety concern.

Appendix B, Criterion V, of 10 CFR Part 50, "Instructions, Procedures, and Drawings," requires, in part, that the activities affecting quality be prescribed by documented instructions, procedures, and drawings, including changes thereto. Contrary to this, the procedure for the calibration of the AFW flow instrumentation was not revised to include calibration of the instrumentation in the range for which it was required. Since follow-up calibrations indicated that the instrument was reliable in the range in which it was to be used, the inspectors determined that the AFW instrument could have been used to accurately determine the AFW flow and prevent damage to the pump. Because this violation was of very low safety significance and was entered into the licensee's corrective action program, this violation is being treated as a Non-Cited Violation (NCV 50-266/02-15-02; 50-301/02-15-02) consistent with Section VI.A of the NRC Enforcement Policy. The issue did not represent an immediate safety concern.

3.4 Adequacy of the Safety Analysis and Modification for Recirculation Line Orifices

The inspectors reviewed modification packages associated with replacement of each AFW pump recirculation line orifice and those associated with upgrading the recirculation line AOV safety classification. As a part of the assessment, the inspectors also reviewed the associated safety analyses and the plant process for implementing modifications.

The inspectors identified an apparent violation associated with the AFW system modifications and a cited corrective actions violation for current and historical system deficiencies. One finding for design control was preliminarily determined to be a Red finding. The second finding for inadequate corrective actions was associated with the AFW/IA Red finding.

A. Description

A.1 AFW Pump Recirculation Line Orifice Modification (Modifications 99-029*A, B, C, and D)

Background

In 1999, the licensee initiated the development of a modification to replace the pressure reduction orifices located in the AFW pump recirculation lines. The modification was developed, in part, to reduce flow noise (cavitation) during routine AFW system operation. The modification was also expected to preclude the recurrence of small leaks in recirculation line welds that the licensee had concluded were caused by cavitation-induced vibration.

Prior to the proposed 1999 modification, the licensee had replaced the original construction orifices in 1991, through a modification initiated in 1988. The 1991 replacement effort was undertaken to increase the individual pump recirculation flow following the licensee's evaluation of NRC Bulletin 88-04, "Potential Safety-Related Pump Loss." The original (1970's) system design included the automatic initiation of pump recirculation flow, at approximately 30 gpm, following pump startup and whenever pump forward flow decreased below a setpoint.

After the modification packages were developed in 1999 - 2000, the licensee staggered the installation of the orifices. The two MDAFW pump recirculation orifices were installed in November 2000. The two TDAFW pump orifices were installed in May and October 2002.

Design Inputs

The inspectors reviewed and compared the modification packages for each pump and noted only minor differences. One difference was that a full safety evaluation had been prepared for the MDAFW pump orifice modifications and only a safety screening had been prepared for the TDAFW pump orifice modifications. This difference was primarily a result of a change in NRC regulations in the interval between the licensee's implementation of these two versions of the modification package. Also, the inspectors noted that the MDAFW pump modification packages included additional paperwork to document a further modification to the orifice design, by drilling additional flow holes, to increase the available flow rate. The TDAFW pump orifice design already included an adjustment mechanism and did not require the drilling of additional flow holes.

The inspectors noted that the new (1999) orifice design differed from both the 1970's original and the 1991 replacement orifice designs. Specifically, both the original and 1991 orifice designs consisted of a series of orifice plates, located within the recirculation piping and with approximately 0.375-inch-diameter holes in the plate to permit the passage of

recirculation flow. The new orifice design consisted of a series of concentric cylinders with approximate 0.125-inch-diameter holes and varying-sized flow channels. The smallest dimension of the smallest channels was 0.015-inch.

In the final design description for the 1999 modifications, the licensee concluded that the mechanical and flow performance characteristics of the new orifice design were equal to or better than those of the installed orifice. This conclusion appeared to be based upon the licensee's analysis of the pressure drop characteristics of the new orifice design. However, the inspectors noted that the modification package did not include a summary of the parameters compared to support this general conclusion. In addition, the inspectors noted that the modification package design inputs section did not include a reference to or discussion of the SW strainer mesh size and its impact on the proposed new orifice design. The strainer maximum mesh size of approximately 0.125-inch-diameter was significantly larger than the smallest flow dimension for the new orifice design. As a result, the inspectors concluded that debris passing through the strainers could have been expected to plug the narrower flow channels of the orifice when SW was used for AFW system operation instead of water from the CSTs, the normal but nonsafety-related source for AFW. The smallest flow channel diameter of the previous orifice design was 0.375-inch.

The inspectors also noted that the design inputs for the orifice installed on October 14, 2002, for the 1P-29 Unit 1 TDAFW pump, the last of the AFW pumps to be modified with the new design, had not but should have been updated to include or consider recent clarifications to the documented AFW system design and safety functions. On September 12, 2002, the licensee, as a corrective action for the previous AFW/IA issue, modified the documented recirculation line AOV design function to overtly require the valve to be able to open automatically during accident conditions. Previously, the AFW system design had required a minimum recirculation flow to dissipate pump heat but only designated the close function of the AOV as safety-related. Furthermore, this design function was not required throughout an accident, only at the beginning. As a result, the licensee staff had not considered, in the orifice modification package, the potential for orifice plugging to be a significant safety impact, although the potential for plugging was recognized.

Safety Evaluations

The licensee performed a full safety evaluation (SE 2000-0055) for the MDAFW pump orifices and a safety screening (SS 2001-0981) for the TDAFW pump orifices to assess the acceptability of the proposed modifications. Because of a change in the NRC's regulations after the safety evaluation was written, only a safety screening was written for the TDAFW pump orifices.

For both the full safety evaluation and the safety screening, the licensee identified the current licensing basis design functions of the orifices to include:

(1) ensure adequate flow and pressure drop through the AFW pumps when they were operated in recirculation mode, thus preventing low flow instabilities and high pump temperatures;

(2) serve to restrict the recirculation flow for the pumps to ensure adequate AFW flow to the steam generators if the recirculation AOVs failed to close; and

(3) passively maintain the AFW system pressure boundary integrity.

The inspectors reviewed the licensee's assessment of the modification's impact on these design features and concluded that neither the safety evaluation nor the safety screening correctly determined the impact of the new design orifices on these functions. Specifically, in the safety evaluation, the licensee incorrectly concluded: 1) that the new orifice's mechanical and performance characteristics were identical to or better than those of the existing orifice; and 2) that the new orifice design would not result in an increased possibility of decreased recirculation flow. The inspectors also concluded that the safety evaluation did not include sufficient detail to objectively compare the mechanical and performance characteristics of the existing (1991) orifices and the new (1999) orifices. The safety evaluation also did not appear to consider the potential for the pump to require recirculation flow at any point during a design basis event. Instead, the licensee conjectured that forward flow from the AFW pumps to the steam generators would always be available to fulfill the recirculation line design functions. In addition, although the licensee identified the possibility that debris entrained in SW could reduce the recirculation flow, the licensee concluded that the new orifice design would "reduce" this potential. Therefore, based upon a perception that the recirculation flow path was not necessary to support AFW flow to the steam generators, the licensee concluded that the possibility of reduced flow was acceptable.

The inspectors identified similar deficiencies with the safety screening. Of note was the licensee's conjecture that the "orifices are not explicitly required in an accident analysis to be able to pass service water, since the recirculation control valve would be closed when the pump is aligned to a steam generator." The inspectors determined that this conclusion did not consider the full range of operator actions, allowed during a design basis accident, concurrent with the dual automatic open and closed design functioning of the recirculation AOV.

A.2 AFW Recirculation Line AOV Safety Upgrade (Modification 02-029)

Background

As a corrective action for the AFW/IA Red finding, the licensee committed to "upgrade" the design of the recirculation AOV to include a safety-related function to open (licensee letters to the NRC, dated August 12 and September 26, 2002). The licensee implemented this commitment through the development and completion, in part, of Modification 02-029.

Design Inputs

The inspectors reviewed the design inputs for the modification package and determined that the adequacy of the electrical power for the design change had not been properly assessed. Specifically, the licensee staff, in the modification package design inputs section, indicated that the modification did not include any electrical or instrumentation and control aspects. However, the inspectors determined that proper operation of the

recirculation AOV required the availability of safety-related 120-volt alternating current (Vac) to a relay located electrically between the AFW pump discharge flow sensor and the AOV solenoid. The current system design powered this relay using nonsafety-related 120-Vac. As a result, under certain design and licensing accident scenarios, the nonsafety-related power supply to this relay could be lost and the AOV might not be able to be remotely directed to open.

The inspectors discussed this issue with licensee staff who validated the issue and identified immediate compensatory measures. As a followup, the inspectors questioned if the current AFW system design included other non-realized electrical inadequacies. In response, the licensee reviewed the current electrical design and identified several additional design issues: 1) three of the four recirculation AOVs had a single, direct current, electrical bus dependency; 2) three of the four SW supply valves to the AFW pumps, had a single, alternating current, electrical bus dependency during certain plant configurations; 3) manual AFW system-related valves would be necessary following a loss of a direct current bus concurrent with a faulted steam generator; and 4) one of the four discharge flow sensors was wired assuming an opposite logic of the other three. In addition, the licensee determined that a loss of some of the direct current electrical busses could also result in the control room staff losing some AFW system-related valve position and flow indications. In response to these additional findings, the licensee staff initiated appropriate compensatory measures pending final comprehensive corrective actions.

The inspectors also identified that the modification design did not include an assessment of the compatibility of the proposed design change to designate the AOV open position as a safety-related function with the recently installed orifice design. Specifically, the modification design did not evaluate the implications of AFW system recirculation operations using service water with the AOV in the open position and the presence of decreased flow passages in the newly installed orifice.

A.3 Design Change Process

Based upon the licensee's failure to develop modification packages that adequately considered recent changes in the plant design, the inspectors reviewed current and past plant design change process procedures. Specifically, the inspectors reviewed procedures NP 7.2.1, "Plant Modifications"; NP 7.2.2, "Design Control"; NP 7.2.3, "Engineering Change Requests"; NP 7.2.6, "Engineering Change Process"; and NP 7.7.10, "Safety-Related and QA Scope Classification." Through discussions with the cognizant licensee staff and review of procedures, the inspectors determined that the design change process permitted and encouraged the early development of modification packages; however, the associated procedures did not include adequate provisions to ensure that the design remained appropriate at the time the modification was installed, which could have been several years after the package was prepared. In addition, the inspectors determined that the design change process did not include adequate measures to ensure that concurrently developed design changes on a single or related systems would be coordinated to ensure consistent assumptions and interfacing requirements. For the examples discussed previously, the inspectors determined that some of the design change packages were developed as much as two years prior to installation and were not reviewed at the time of installation to confirm that the assumed plant design had not been

changed. In one case, the final recirculation line orifice was installed only one month after the recirculation line AOV upgrade modification was implemented.

A.4 Corrective Actions

As a corrective action to the AFW/IA Red finding, the licensee performed a root cause evaluation (RCE 01-069). As a result of the inspectors' findings documented in Sections A.1 through A.3, a limited review of the RCE and associated corrective actions for the AFW/IA issue was conducted.

RCE 01-069

The inspectors determined that the corrective actions taken for the root cause identified in RCE 01-069 were not adequately implemented to prevent recurrence. The inspectors noted that the RCE problem statement appeared to assume a specific failure mode. That is, the RCE only questioned why emergency operating procedures existed and contributed to the AFW/IA issue. As a result, the RCE focused almost exclusively on the emergency procedure development process and did not assess the adequacy or staff understanding of the current AFW system design.

The licensee had an independent review of the RCE performed. As a result, the independent reviewer posed numerous questions regarding the scope and depth of the RCE. The inspectors reviewed the licensee's responses to these questions, which were included as an addendum to the RCE, and determined that the response to many of the questions did not directly address the underlying question. In several cases, the questions appeared to be directly related to the issues and findings discussed in Sections A.1 - A.3 above regarding the licensee's lack of a clear understanding of the AFW system design, application of single failure analysis, extent of condition for a similar failure mode (that is, system operations reliance upon nonsafety-related support systems), and design configuration control differences.

The independent reviewer also questioned why the RCE did not specifically include corrective actions associated with upgrading the recirculation AOV open function. The inspectors determined that integration of the reasoning and rationale for this corrective action into the RCE would have necessitated a change to several other conclusions reached in the report.

Although the licensee upgraded the recirculation line AOV open function to safety-related as a corrective action for the AFW/IA issue, the inspectors determined that the modification package inadequacies outlined in Section A.2 and the other similar design deficiencies outlined in Section A.1 were indications that the corrective actions were not effective in preventing recurrence of this significant condition adverse to quality. While inadequacies in the RCE may have precluded the identification of the single failure design deficiencies outlined in Section A.1, the licensee's failure to successfully implement the upgraded safety function for the AOV was a further indication of a current lack of understanding of the AFW system design.

B. Analysis

The inspectors identified two issues warranting a significance evaluation in accordance with Inspection Manual Chapter 0612, "Power Reactor Inspection Reports," Appendix B, "Issue Disposition Screening," issued April 29, 2002.

(1) The first issue involved the licensee's failure to establish and properly implement measures to ensure that applicable regulatory requirements and the design basis for structures, systems, and components important to safety were correctly translated into specifications, drawings, procedures, and instructions. Specifically, the plant design change procedures did not establish measures to ensure that modifications, at the time of installation, would correctly translate applicable regulatory and design requirements. Further, Modification Packages 99-029*A, B, C, and D (AFW orifice replacement) and Modification Package 02-029 (AFW recirculation line AOV safety upgrade), and the associated safety evaluation or safety screening, did not ensure that the AFW design requirements for the recirculation lines were appropriately translated into specifications, drawings, procedures, and instructions. This performance deficiency was determined to be more than minor consistent with Example 3.a of Appendix E of NRC Inspection Manual Chapter 0612. That is, the performance deficiency represented multiple failures of the design change and safety evaluation process that resulted in modifications to the AFW system that required immediate compensatory measures to ensure continued system operability and further modifications to correct.

The Region III staff performed a Phase 2 risk assessment, in accordance with NRC Inspection Manual Chapter 0609, Appendix A, "At Power Operations," using the Revision 1 benchmarked Point Beach significance determination process (SDP) worksheets with the following assumptions:

Assumptions:

a. Based on the AFW orifice test results, as further described in Section 3.6 of this report, the failure probability of the AFW pumps when SW is used as a water supply is 1.0. There is no recirculation flow indication in the control room and no procedural guidance to indicate a potential problem with the recirculation line if instrument air is still available. AFW pump recovery is not credited.

b. One CST (of the normally cross-tied two CSTs) is designed for at least 1 hour with a dual unit event at technical specification (TS) minimum level; however, the plant normally keeps the CST above TS minimum. The licensee's best estimated evaluations determined that the CSTs should last between 4 and 8 hours, depending upon the scenario (single unit vs. dual unit).

c. Since the CSTs have limited capacity, for all scenarios within the 24-hour mission time, the plant eventually has to use another water source. The Phase 2 SDP credits two alternatives to using raw SW as an AFW pump suction source.

- For those scenarios where the reactor coolant pumps are available for forced recirculation, credit has been given to switchover from AFW to RHR cooling before the CSTs empty based upon the operator's preference to go to cold shutdown in lieu of switching over to SW (Initiating Events: TRANS–Transients, TPCS–Transients Without Power Conversion System, SGTR–Steam Generator Tube Rupture).

- For those scenarios where the water treatment system is available for CST refill, credit has been given (TRANS, TPCS, LCCW–Loss of Component Cooling Water, LDC1–Loss of Single 125Vdc Bus, SLOCA–Small Loss-of-Coolant Accident, SORV–Stuck-Open Power-Operated Relief Valve/Safety Relief Valve, MLOCA–Medium LOCA, SGTR, MSLB–Main Steam Line Break, ATWS–Anticipated Transient Without Scram). The water treatment pumps are instrument air dependent and are fed from Unit 2. Therefore, a LOOP on Unit 1 would still be risk significant; however, about 1 order of magnitude lower. The use of the water treatment system is proceduralized (always was) with a dedicated operator assigned.

d. Duration of condition was 166 days for Unit 2. This is based on the timeline where both the MDAFW pump orifices were already installed (train dependent for each unit) and then the unit-specific TDAFW pump orifice was installed on May 11, 2002. Both units were susceptible to the common-cause failure of the AFW pumps for a 10-day duration. Since the SDP worksheets are for single unit assessments, the worst case, Unit 2 duration was used.

SDP Worksheet Results

Based on the Phase 2 SDP worksheet results, this issue is considered to be of substantial safety significance, potentially Red ($>10^{-4}$). The three most dominant accident sequences highlighted by the worksheets include the LOIA with the failure of AFW (due to recirculation line plugging), and the LOOP with a failure of AFW (due to recirculation line plugging), and the failure to feed and bleed or the failure of containment sump recirculation. Using the SDP counting rule would indicate that the change in core damage frequency (ΔCDF) is in the 10^{-3} range.

A flood that renders instrument air unavailable would also have a direct impact on the safety significance of this performance deficiency. The scenario would be LOIA and the loss of AFW. The licensee performed a flood analysis in support of the previous AFW/IA Red finding and determined that the risk was 8.5E-6 crediting AFW. Since AFW cannot be credited for this performance deficiency, the associated risk would be in the high 1E-5 to low 1E-4 range, Yellow to Red.

The potential risk contribution due to LERF (Large Early Release Fraction) was determined not to affect the ΔCDF since steam generator tube rupture sequences were not determined to be significantly associated with this finding.

The potential risk contribution due to external events (earthquakes) was also determined to be of high safety significance. The postulated scenario is associated with an earthquake followed by loss of secondary cooling (AFW). Using the licensee's analysis from its Individual Plant Examination of External Events (IPEEE), it was determined that an initiating event frequency of an earthquake of sufficient magnitude to damage the CSTs would also result in the loss of offsite power and instrument air. The loss of AFW, due to the recirculation line plugging, would result in a ΔCDF in the 1E-4 range, Red.

Fire will also be a significant contributor to the ΔCDF because any fire that could affect the water treatment system would have to be considered. However, because the water treatment system is not safety-related, the cables are not traced and would take considerable resources to evaluate. Based on the lack of cable information, a Region III senior reactor analyst determined that further expenditure of resources to refine the risk contribution due to fire was not necessary to determine that the performance deficiency was of high safety significance. The licensee's preliminary fire risk analysis estimated a ΔCDF in the low 1E-3 to high 1E-4 range, Red.

In summary, the internal events, seismic event, flood, and fire analyses indicate that this finding is of high safety significance (i.e., greater than 10^{-4}, Red).

(2) The second issue involved the licensee's failure to implement corrective actions to prevent recurrence of the AFW/IA issue, a significant condition adverse to quality. The licensee's inadequate understanding and implementation of the design basis was demonstrated by the installation of the AFW orifice replacements in 2000 and 2002. The licensee's inadequate corrective actions for the issue did not prevent recurrence as demonstrated by additional examples of AFW system operations relying upon nonsafety-related support systems and single failure system vulnerabilities. This performance deficiency was determined to be more than minor consistent with Example 4.g of Appendix E of NRC Inspection Manual Chapter 0612. That is, the performance deficiency resulted in a Red issue not being promptly corrected and in additional examples of inadequate implementation of the AFW design not being identified until being self-revealed during an unrelated post-maintenance test and an NRC inspection.

C. Enforcement

(1) Criterion III, "Design Control," of 10 CFR 50, Appendix B, requires, in part, that design control measures be established and implemented to assure that applicable regulatory requirements and the design basis for structures, systems, and components are correctly translated into specifications, drawings, procedures, and instructions. As of December 12, 2002, the inspectors identified three examples of the licensee not meeting these requirements.

- The licensee failed to establish adequate measures to assure that AFW system design bases were correctly translated into specifications, drawings, procedures, and instructions (modification packages) for the installation of the 1P-29 TDAFW pressure reduction orifice. Specifically, Modification Packages 99-029*A, B, C, and D to install the revised orifice design were prepared in 1999. By May 2002, three of the four new orifices had been installed. Subsequently, the licensee developed Modification Package 02-029, "Safety Upgrade of the AFW System Recirculation

Line Air-Operated Flow Control Valve," to change the design basis of the AFW system to require that the recirculation line, including the orifice, be able to pass flow during all required operating conditions. This Modification Package, which was a design basis change, was implemented on September 12, 2002. On October 14, the fourth of the four new orifices was installed into the 1P-29 TDAFW recirculation line (per Modification Package 99-029*C); however, the licensee failed to establish adequate measures to assure that the design basis change requiring flow during all operating conditions (Modification Package 02-029) was translated into Modification Package 99-012*C prior to the installation of the new orifice.

- The licensee failed to correctly translate the AFW system design basis recirculation line flow requirements into modification packages. Specifically, SW strainer mesh size was not considered when the new orifice design using 0.125-inch diameter holes and smaller-sized, inscribed flow channels was incorporated into Modification Packages 99-029*A, B, C, and D. The SW strainer mesh size of 0.125-inch was significantly larger than the smallest limiting flow dimensions of the new orifice design. Consequently, a common mode failure of all AFW trains could have occurred because debris passing through the SW strainers could plug the holes and flow channels of the AFW restricting orifices.

- The license failed to correctly translate the AFW system design basis power supply requirements into Modification Package 02-029, the safety classification upgrade of the recirculation AOV open function. Specifically, the licensee did not assure that the upgraded safety design relied only upon a safety-related power source for a relay associated with the AOV. Instead, the inspectors identified that the AFW system relied on a single train of nonsafety-related power supply for all trains of the AOV relays. As a consequence, a common mode failure could have occurred during a loss of the nonsafety-related power supply.

These three examples of the licensee's failure to establish the appropriate design control measures are considered as one apparent violation of Criterion III (AV 50-266/02-15-03; 50-301/02-15-03). Appropriate interim corrective actions have been taken.

(2) Criterion XVI, "Corrective Action," of 10 CFR 50, Appendix B, requires, in part, that conditions adverse to quality, such as failures, malfunctions, deficiencies, deviations, defective material and equipment, and non-conformances be promptly identified and corrected. Criterion XVI further requires that the cause of significant conditions adverse to quality be determined and corrective actions taken to preclude recurrence. As of December 12, 2002, the licensee failed to implement corrective actions to preclude repetition of the associated AFW system potential common mode failure, a significant condition adverse to quality. Specifically, the licensee failed to identify that the previous AFW system potential common mode failure, on a loss of instrument air to the recirculation line AOV concurrent with operator actions (the AFW/IA Red finding), was the result of system design inadequacies in addition to the identified procedural development inadequacies. As a result, the licensee failed to identify potential common mode failures that existed involving power supplies to the AOV and other system components, and improperly sized orifices. In addition, the licensee's corrective actions for the potential common mode failure of the AFW/IA Red finding did not preclude repetition. Specifically, corrective actions to upgrade the safety function of the recirculation line AOV failed to

ensure that successful operation of the AOV was dependent only on safety-related support systems. Following implementation of the corrective actions, successful operation of the AOV was still dependent upon nonsafety-related power to an interposing relay. The failure to implement adequate corrective actions for the AFW/IA Red finding is considered a violation of Criterion XVI (VIO 50-266/02-15-04; 50-301/02-15-04). Appropriate interim corrective actions have been taken.

3.5 Source of the Debris in the Orifices

As discussed in Section 3.2, the licensee concluded that the source of the rust-like debris in the orifices of the two MDAFW pumps was pump casing and discharge line high-point vent valves and associated carbon steel piping. Because of infrequent use of these valves, rust would build-up and enter the AFW system when the valves were used for filling and venting the AFW pump trains after maintenance. This conclusion was reached, in part, after:

- boroscopic examination of the vent valves and other AFW system components;
- scanning electron microscopy (SEM) characterization of orifice and vent valve debris size and elemental composition (to determine whether iron, for example, was present);
- x-ray diffraction analysis (XRD) characterization of orifice and vent valve debris (to determine, for example, which form of iron was present, such as magnetite, hematite, or goethite);
- draining and inspection of the two CSTs (the cross-tied, normal source of water for the AFW pumps). In addition, debris from the tanks were subjected to SEM and XRD;
- a computational analysis of particle fouling behavior in an orifice; and
- flushing of the SW/AFW interface deadlegs. Debris removed by flushing was characterized by SEM and XRD.

Although the licensee correlated the maintenance-related manipulation of the pump casing and discharge high point vent valves with reduced flow through the “A” MDAFW pump orifice on October 24, 2002, and the “B” MDAFW pump orifice on November 6, 2002, AFW pump operating and maintenance history had not been reviewed to establish if these valves had been manipulated, at other times since the orifices were installed in November 2000, and recirculation was unaffected.

The licensee concluded (in Engineering Evaluation 2002-0031) that the small quantity of debris found in the CSTs would likely not have affected the ability of the AFW pumps to perform their safety function because resin and other debris found on the bottom of the CSTs was not streaming towards the AFW pump suction line (which is about 8" off the bottom of the tanks) or toward the tank drain when the two tanks were drained, and the debris found did not float. The licensee also suggested that the many hours that the MDAFW pumps were operated with CST water during the Unit 1 refueling outage in

September 2002 without instances of low recirculation flow supported the contention that debris in the CSTs was not affecting AFW recirculation line flow. However, information reviewed by and observations made by the inspectors indicated that the CSTs could not be definitely ruled out as a source of debris that could affect operation of the AFW pumps by plugging the associated recirculation orifices:

- The relative large size and quantity of some of the debris, including fragmented and intact resin beads in one CST and pieces of paint from the inner coating of the other CST, found at the bottom of the CSTs.

- The turbulence likely created in the CST(s) during the refueling outage performance of Operating Instruction (OI)-150, Heating the Condensate Storage Tanks, in support of IT-300/305 (refueling outage surveillance tests of steam generator main feed line check valves). This OI involved multiple fillings (to overflow) of a CST from the feedwater system of the operating unit.

- The identification of titanium in some of the debris from the AFW system; titanium is a constituent of the coating used on the lining of the CST tanks.

- The line used to fill the CSTs from the water treatment system is common with the suction line of the AFW system from the CSTs. The water treatment system was the likely source of resins found in the "A" CST.

3.6 AFW Recirculation Line Testing

The initial testing, performed at Southwest Research Institute in San Antonio, Texas, used a volume of sand, zebra mussel shells, and silt that was expected to accumulate during the 30-day period between routine flushings of the SW headers near the AFW pump suctions. The first test configuration consisted of a positive displacement pump and a once-through flow scheme. Each of the materials were tested individually and in combination. The testing showed that when zebra mussel shells hit the orifice, they broke, pulverized, and clogged the orifice passages.

The initial test configuration demonstrated that the orifices would plug much more quickly than predicted by the computational analysis. In order to reconcile the differences between the analytical predictions (i.e., the orifices would not plug since the high differential pressures would force material through the small orifice passages) and the initial test configuration results, the licensee modified the test configuration and re-performed testing on February 21, 2003.

The revised test configuration included a single-stage centrifugal pump in a closed-loop flow system. The impeller tip velocities and impeller/casing clearances of the pump were similar to those of the Point Beach AFW centrifugal pumps. The same mix of sand, zebra mussel shells, and silt as used in the initial configuration was used in the revised test, but the quantity was reduced to 25 percent of the original amount to reflect that there were four AFW pumps that could be taking suction on SW. In addition, to address a concern that the size of the zebra mussel shell fragments in the initial test were larger than what would normally pass through the Point Beach AFW pumps, and thus more readily plug the test orifice, the revised test was run after the zebra mussel shells were run through the

pump about nine times to approximate the comminution of the nine-stage Point Beach AFW pumps.

Testing with the revised configuration showed that the orifice plugged more quickly than with the initial test configuration. According to the licensee, the orifice plugged almost immediately following the introduction of debris into the test loop.

The initial and revised test loop configurations demonstrated that a small amount of material could plug the orifices. Neither the initial or revised test results supported the results of the computational particle fouling model analysis performed for the licensee in December 2002.

3.7 Susceptibility of Other Plant Components

The pressure reducing orifices in the recirculation lines of the MDAFW pumps consisted of several nested cylinders installed in a valve body. Each cylinder had holes and channels spread throughout the cylinder wall. The opening of the channels was smaller than the opening of the holes. The design was intended to, and successfully did, reduce the cavitation and noise that was inherent in the design of the previously installed orifice. The orifices for the TDAFW pumps were similar, but consisted of fewer cylinders and had an adjustment mechanism to cover or uncover holes, as needed.

Following the partial plugging of the orifice in the "A" MDAFW pump recirculation line, the licensee evaluated other equipment to determine if a similar potential problem existed. The evaluation included a search of the plant equipment database, a review of piping and instrument drawings (P&IDs), interviews with knowledgeable plant personnel, and a limited walkdown of components. The evaluation identified 61 components that functioned as flow restriction devices, of which 48 were in safety-related applications. However, none of the orifices associated with safety-related applications were of similar design and none were experiencing problems with plugging. In nonsafety-related applications, a similar design orifice was installed in the outlet of each of the steam generator blowdown heat exchangers to the steam generator blowdown tank. According to the licensee, operators reported that these orifices routinely (up to weekly) needed to be cleaned because of plugging.

3.8 Orifice Re-Design Options

The inspectors reviewed the design of the replacement AFW recirculation line orifice. The licensee incorporated lessons-learned for the incorrect modification efforts completed in 1991, 2000, and 2002 into the new design. Specifically, the inspectors noted that the engineering staff identified critical design input assumptions that were not included in the previous design including: 1) a need to correlate the SW strainer mesh opening size (0.125-inch) and the orifice opening size, 2) the maximum flow rate that would ensure an adequate ongoing flow to the steam generators and proper closing of the recirculation line AOV, 3) a minimum flow rate allowed that would ensure pump stability and heat up during all response scenarios, and 4) the correct maximum pressure drop across the orifice to preclude cavitation and to limit flow noise.

The new orifices were a 9-stage plate design with a 0.281-inch minimum opening size in the orifice for the MDAFW pumps and a 0.313-inch minimum opening size in the orifice for the TDAFW pumps. A carbon-steel version of the new orifice was laboratory tested under the same conditions as the previous orifice. Whereas the old orifice plugged almost immediately when subjected to debris-laden flow (Section 3.6), the replacement orifice did not plug. The replacement orifices were installed at Point Beach and successfully tested in early March 2003. Also, the appropriate procedures were revised to reflect the new orifices. With the change in orifices and the revision of the procedures, the normal baseline daily risk level as calculated by the licensee returned from slightly elevated yellow risk to green risk.

3.9 Prior Opportunities to Have Identified the Problem With the Orifices

The inspectors determined that the licensee had several prior opportunities to identify the self-revealed problem with the AFW recirculation orifices. Recent opportunities included: 1) during development of the AFW/IA RCE, 2) during investigation and resolution of comments made by an independent reviewer of the RCE, and 3) during development of the modification package to upgraded the safety function of the recirculation AOV. There were also earlier opportunities during development of the 1999 orifice modification packages. The inspectors identified that a lack of clear understanding of the system design was evident during preparation of the modification packages. In addition, plant staff and outside reviewers raised issues regarding the AFW system design throughout the 1990's which could have served as a prior opportunity, including the 1991 initial modification of the orifice. Also, as part of its root cause evaluation of the orifice plugging issue (RCE000191), the licensee identified a more recent prior opportunity. After additional holes were drilled on March 14, 2001, into the orifice in the P-38A recirculation line in an attempt to increase flow, the resultant increase in flow was lower than expected by the licensee. Suspecting foreign material exclusion (FME) control problems during the hole drilling, the licensee wrote a corrective action document (CAP013812) and reviewed the controls that had been in-place. The controls were found acceptable and no debris was identified in the orifice upon disassembly. The CAP was closed without further action. In its root cause evaluation, the licensee concluded that the focus of the CAP on FME had been too narrow and should have addressed the low flow condition in general.

One other opportunity was in June 2001, when an alewife (small fish) bloom resulted in fish parts in the SW system. As part of the response to this problem, the licensee inspected the Y-strainers on the SW supply lines to the AFW pump bearing coolers; however, the vulnerability of components other than the AFW pump bearing coolers, such as the orifices of the MDAFW recirculation lines, apparently was not evaluated.

4 CONCLUSIONS

4.1 Old Design Issue Evaluation

The inspectors evaluated the AFW/IA Red finding against the four criteria (questions) contained in NRC Inspection Manual Chapter 0305, "Operating Reactor Assessment Program," for consideration of a finding as an old design issue, as stated below:

- Was the issue licensee identified as a result of a voluntary initiative such as a design basis reconstitution?

  Yes. The AFW system issue was identified by the licensee in 2001 while conducting a voluntary update of its PRA model.

- Was or will the performance issue be corrected, including immediate corrective actions and long-term corrective action to prevent recurrence, within a reasonable time following identification?

  No. As discussed in Section 3.3, corrective actions taken for the AFW/IA issue were not adequate and should have included a detailed review of the AFW system design basis. As a result of the orifice plugging problem, the licensee had undertaken such a review. This review has already identified potential concerns with excessive localized temperatures for components of the TDAFW pump overspeed trip starters and with the setpoint tolerances for the main steam safety valves not being included in an AFW ISI acceptance criteria calculation (the safety valve issue is discussed further in Inspection Report 50-266/03-02; 50-301/03-02, Section 1R15.1).

- Was it not likely that the issue would have been identified by routine licensee efforts, such as normal surveillance or quality assurance activities?

  Yes. The inspectors determined that this issue would not likely have been identified by routine licensee efforts. The issue was identified through integrated PRA modeling techniques that used procedures, system design, human error, and timing elements not previously analyzed at the station.

- Does the finding reflect a current performance deficiency associated with existing licensee programs, policy, or procedure?

  Likely. Some of the problems in the engineering and corrective action programs that contributed to the AFW/IA issue appeared to have factored into the more recent orifice issue, including the lack of understanding of AFW design and narrowly focused evaluation of corrective action program items, and limited implementation of corrective actions.

The inspectors concluded, based on the results of the two special inspections, that the AFW/IA Red finding did not meet all of the four criteria in NRC Inspection Manual Chapter 0305, and, as such, was not an old design issue.

4.2 Orifice Plugging Issue

Laboratory tests conducted for the licensee demonstrated that the orifices in the recirculation lines of the AFW pumps would quickly plug if the service water system was the source of water for the pumps, as it would be during various accidents. The two examples of orifice plugging after AFW system maintenance and the identification of debris in the AFW system that may have come from the CSTs indicated the possibility that the orifices may also have been vulnerable to plugging with water from the CSTs, the nonsafety-related, normal source of water for the AFW system.

5 OTHER

5.1 (Closed) LER 266/2001-005-00: PRA Assessment of Auxiliary Feedwater System Reveals Procedural Vulnerability Related to Loss of Instrument Air. The LER described the identification by the licensee of the potential inoperability of multiple AFW pumps upon loss of instrument air due to inadequate recirculation (pump cooling) flow. Licensee corrective actions listed in the LER were reviewed as part of the initial NRC response to this issue (Inspection Report 50-266/01-17(DRS); 50-301/01-17(DRS) and as part of the current inspections. As discussed in Sections 3.3 and 4.1, NRC inspectors during the current inspections concluded that inadequate corrective actions were taken for the AFW/IA issue, discussed in both the LER and RCE 01-069. Subsequent licensee corrective actions for this problem, which included a revalidation of AFW design basis, will be reviewed as part of VIO 50-266/02-15-04; 50-301/02-15-04.

5.2 (Closed) LER 266/2002-003-00: Possible Common Mode Failure of AFW Due to Partial Clogging of Recirculation Orifices. The LER described the initial event, the immediate compensatory actions to ensure AFW system operability, and interim and long-term corrective actions. As part of the investigation of the problem, the licensee conducted a root cause evaluation (RCE), which preliminarily concluded that the design of the orifice was inadequate for the specific application in the AFW recirculation lines and was the result of erroneous conclusions in the safety evaluation written, as part of the plant modification process, for the installation of the orifices. These erroneous conclusions resulted in information on important design functions of the AFW recirculation lines being omitted from the safety evaluation. The RCE also discussed the reclassification of the open function of the AFW recirculation line AOVs as safety-related on September 12, 2002, done as part of the corrective actions for the AFW/IA Red finding. The RCE concluded that the reclassification, done through the modification process, was another unavailed opportunity to evaluate the susceptibility of the recirculation line orifices to plugging. Time pressures resulting from inadequate planning, combined with an infrequently performed activity–the safety function upgrade of the AOV opening–may have contributed to the inadequate review of recirculation line components conducted as part of the upgrade. In the LER, the licensee stated that a supplement would be submitted to provide the results of ongoing analysis and evaluation of the susceptibility of the orifices to plugging and to provide an assessment of the safety significance of the plugging issue.

6 MANAGEMENT MEETINGS

Exit Meeting Summary

The inspectors presented the preliminary results of the September 23-26 inspection to Messrs. J. P. Cowan and A. J. Cayia, and other members of licensee management on October 2, 2002. The preliminary results of the October 31st inspection were presented to Mr. Cayia and other members of licensee management on December 12. A final exit meeting was held with licensee management on March 24, 2003. The licensee acknowledged the findings presented. Information related to the design of the plugged AFW flow orifice was identified by the licensee as possibly proprietary; this information was not included in the inspection report.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

R. Amundson	Operations Training Specialist
G. Arent	Kewaunee/Point Beach Regulatory Affairs Manager
L. Armstrong	Design Engineering Manager
A. Cayia	Site Vice President
J. Cowan	Senior Vice President - Operations (NMC)
B. Day	Performance Assessment Manager
F. Flentje	Senior Regulatory Compliance Specialist
J. Flessner	Engineering Projects Supervisor (Root Cause Team Leader)
J. Freels	Engineering Director
D. Hettick	Performance Improvement Manager
R. Hopkins	Kewaunee-Point Beach Oversight Supervisor
J. Jensen	Plant Manager (current)
T. Kendall	Engineering Analysis Supervisor
J. Masterlark	PRA Engineer
L. Peterson	Engineering Projects Manager
K. Peveler	Kewaunee-Point Beach Nuclear Oversight Manager
S. Pfaff	Corrective Action Program Supervisor
J. Pruitt	Nuclear Oversight Assessor
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P. Smith	Operations Training Coordinator
D. Schoon	Operations Manager
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R. Wood	Engineering Programs Supervisor
T. Taylor	Plant Manager/Site Assessment Manager
S. Thomas	Radiation Protection Manager
T. Webb	Regulatory Affairs Manager
E. Weinkam	NMC Director of Regulatory Services
W. Zipp	System Engineering Supervisor

NRC

J. Dyer	Regional Administrator
G. Grant	Director, Division of Reactor Projects
P. Krohn	Point Beach Senior Resident Inspector
R. Lanksbury	Chief, Reactor Projects Branch 5
K. Riemer	Chief, Reactor Projects Branch 5
D. Spaulding	Project Manager, Office of Nuclear Reactor Regulation

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

50-266/02-15-01; 50-301/02-15-01	NCV	NCV of 10 CFR Part 50, Appendix B, Criterion VI, for the failure to distribute temporary procedure changes to procedure sets in emergency response facilities. (Section 3.3)
50-266/02-15-02; 50-301/02-15-02	NCV	NCV of 10 CFR Part 50, Appendix B, Criterion V, for inadequate procedure for calibration of auxiliary feedwater flow meter. (Section 3.3)
50-266/02-15-03; 50-301/02-15-03	AV	Apparent violation of 10 CFR Part 50, Appendix B, Criterion III, for the failure to establish the appropriate design control measures for the installation of orifices to the AFW recirculation lines. (Section 3.4)
50-266/02-15-04; 50-301/02-15-04	VIO	Violation of 10 CFR Part 50, Appendix B, Criterion XVI, for the failure to identify the root cause and implement corrective actions for the AFW/IA issue, a significant condition adverse to quality, so as to prevent recurrence. (Section 3.4)

Closed

50-266/02-15-01; 50-301/02-15-01	NCV	NCV of 10 CFR Part 50, Appendix B, Criterion VI, for the failure to distribute temporary procedure changes to procedure sets in emergency response facilities. (Section 3.3)
50-266/02-15-02; 50-301/02-15-02	NCV	NCV of 10 CFR Part 50, Appendix B, Criterion V, for inadequate procedure for calibration of auxiliary feedwater flow meter. (Section 3.3)
266/2001-005-00	LER	PRA Assessment of Auxiliary Feedwater System Reveals Procedural Vulnerability Related to Loss of Instrument Air. (Section 5.1)
266/2002-003-00	LER	Possible Common Mode Failure of AFW Due to Partial Clogging of Recirculation Orifices. (Section 5.2)

Discussed

None

LIST OF ACRONYMS USED

AFW	Auxiliary Feedwater
AOV	Air-Operated Valve
AV	Apparent Violation
ΔCDF	Change in Core Damage Frequency
CAP	Corrective Action Program
CR	Condition Report
CSP	Critical Safety Procedure
CST	Condensate Storage Tank
ECA	Emergency Contingency Action
EOP	Emergency Operating Procedure
DRP	Division of Reactor Projects
DRS	Division of Reactor Safety
FME	Foreign Material Exclusion
gpm	Gallons Per Minute
HEP	Human Error Probability
IA	Instrument Air
I&C	Instrument and Control
IT	Inservice Test
LER	Licensee Event Report
LLOCA	Large-Break Loss-of-Coolant Accident
LOIA	Loss of Instrument Air
LOOP	Loss of Offsite Power
MC	Manual Chapter
MDAFW	Motor-Driven Auxiliary Feedwater
NMC	Nuclear Management Company, LLC
NP	Nuclear Plant Business Unit Procedure
NPM	Point Beach Memorandum
NRC	Nuclear Regulatory Commission
ODI	Old Design Issue
OI	Operating Instruction
OP	Operating Procedure
PARS	Publicly Available Records System
PBNP	Point Beach Nuclear Plant
P&ID	Piping and Instrumentation Diagram
PRA	Probabilistic Risk Assessment
RCE	Root Cause Evaluation
RHR	Residual Heat Removal
SDP	Significance Determination Process
SE	Safety Evaluation
SEM	Scanning Electron Microscopy
SEN	Significant Event Notice
SGTR	Steam Generator Tube Rupture
SS	Safety Screening
SW	Service Water
TDAFW	Turbine-Driven Auxiliary Feedwater
TRANS	Transients
TPCS	Transients Without Power Conversion System

TS	Technical Specification
Vac	Volts Alternating Current
Vdc	Volts Direct Current
VIO	Violation
XRD	X-Ray Diffraction Analysis

LIST OF DOCUMENTS REVIEWED

AFW Pump Normal Operation and Testing Pre-Job Briefing Requirements

Abnormal Operating Procedure AOP 3, Steam Generator Tube Leak, Unit 1, Revision 4

AOP 5B, Loss of Instrument Air, Revision 21, June 3, 2002

AOP 10, Control Room Inaccessibility, Unit 0, Revision 0

AOP 10A, Safe Shutdown - Local Control, Unit 0, Revision 33

AOP 10B, Safe to Cold Shutdown in Local Control, Unit 1, Revision 3

AOP 23, Establishing Alternate AFW Suction Supply, Unit 1, Revision 0

Bechtel Corporation Auxiliary Feedwater Pumps Bid Specification, May 4, 1967

Calculation N-91-063-00-A, P38A and B Recirc Line System Characteristics, July 2, 1991

Calculation N-91-069-00-A, Impact of Higher Capacity Recirculation System for Electric Motor Driven AFW Pumps, June 6, 1991

Calculation 2001-0056, TDAFP Mini Recirc Valve Instrument Air Accumulator Sizing, March 20, 2002

Calculation 2002-002, Nitrogen Backup System for MDAFP Discharge Valves and Minimum Flow Recirculation Valves, January 28, 2002

Calculation 2002-0044, AFW Pump Required Recirculation Flow, November 13, 2002

Control Room Log Entries (2002): October 23, 4:00 a.m. to October 30, 11:18 p.m.
November 5, 2:07 p.m. to November 7, 6:15 a.m.;
November 6, 12:25 p.m. to November 7, 5:00 a.m.

Corrective Action Program (CAP) 004254, Blockage of Service Water Line, May 10, 2000

CAP001625, SCAQ Action - Potential Common Mode Failure Mechanism Affecting Welds in AFW Pump, May 24, 1999

CAP001763; ISI Scoping of AF-117, AF-4035, Classification of AFW Recirc Lines; January 2, 2002

CAP005091, Cooling Flow to P-38B AFP [Auxiliary Feedwater Pump] Inadequate, April 8, 2001

CAP005432, Blockage of Emergency Diesel Generator Cooler Tubes, July 23, 2001

CAP013812, Foreign Material Exclusion (FME) for Aux Feed Work, April 13, 2001

CAP014171, Unit 2 First Off Check Valve Flow Indicator Failure, July 3, 2001

CAP017144, Six-inch Elbow Removed From West Service Water Header Had Approximately 60-70 percent Blockage Due to Silt Buildup, April 2, 1997

CAP023470, Service Water Piping Blockage, June 14, 1996

CAP026633, Zebra Mussels Cause FME [Foreign Material Exclusion] Problems in Service Water System, September 13, 1999

CAP026917, Review of QA-Scope Flow Restricting Devices at PBNP

CAP028186, Biofouling Inspection Discrepancies Identified in Response to GL [NRC Generic Letter] 89-13, Action 1, May 26, 1999

CAP028370, PORVs Ability to Limit RCS Pressure Response During an ATWS Event Questioned, June 3, 2002

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CAP029335, AFW Red Finding Assist Visit, September 16, 2002

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