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NP-33-03-003-01

Docket No. 50-346

License No. NPF-3

September 12, 2003

United States Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Ladies and Gentlemen:

LER 2003-003-01
Davis-Besse Nuclear Power Station, Unit No. 1
Date of Occurrence – September 25, 2002

Enclosed please find Revision 1 to Licensee Event Report 2003-003, which is being submitted to provide additional information regarding an issue with the High Pressure Injection (HPI) pumps during postulated very small break loss of coolant accident events. The postulated analytical conditions predict pump operability concerns due to the potential for pump deadheading. An eight-hour immediate notification of this issue was made to the NRC on April 11, 2003 (Event Number 39750). In accordance with the guidance of NUREG-1022, revision bars have been added to the right margin to denote changes from the previous submittal of LER 2003-003 dated June 10, 2003. This LER Revision is being submitted in accordance with 10 CFR 50.73(a)(2)(i)(B), 10 CFR 50.73(a)(2)(ii)(B), 10 CFR 50.73(a)(2)(v), and 10 CFR 50.73(a)(2)(vii).

Very truly yours,

Lew W Myers

PSJ/s

Enclosures

cc: Regional Administrator, USNRC Region III
DB-1 Project Manager, USNRC
DB-1 NRC Senior Resident Inspector
Utility Radiological Safety Board

IE22

COMMITMENT LIST

The following list identifies those actions committed to by the Davis-Besse Nuclear Power Station in this document. Any other actions discussed in the submittal represent intended or planned actions by Davis-Besse. They are described only as information and are not regulatory commitments. Please notify the Manager - Regulatory Affairs (419-321-8450) at Davis-Besse of any questions regarding this document or associated regulatory commitments.

Commitment	Due Date
Review response to Item #2 of DBNPS Letter Serial 568 dated December 28, 1979 and revise as necessary.	Completed. See Corrective Action for LER 2003-003-01
Implement plant modification to install alternate HPI minimum recirculation flowpath.	Completed
Revise Emergency Procedure to provide direction to operators for establishing HPI alternate minimum recirculation flowpath.	Completed
Provide operator training for establishing HPI alternate minimum recirculation flowpath.	Completed

NRC FORM 366 (7-2001)	U.S. NUCLEAR REGULATORY COMMISSION	APPROVED BY OMB NO. 3150-0104	EXPIRES 7-31-2004

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

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4. TITLE
Potential Inadequate HPI Pump Minimum Recirculation Flow Following SBLOCA

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
9	25	02	2003	– 003 –	01	9	12	2003	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE	D
10. POWER LEVEL	000

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

	20.2201(b)		20.2203(a)(3)(ii)	X	50.73(a)(2)(ii)(B)		50.73(a)(2)(ix)(A)
	20.2201(d)		20.2203(a)(4)		50.73(a)(2)(iii)		50.73(a)(2)(x)
	20.2203(a)(1)		50.36(c)(1)(i)(A)		50.73(a)(2)(iv)(A)		73.71(a)(4)
	20.2203(a)(2)(i)		50.36(c)(1)(ii)(A)	X	50.73(a)(2)(v)(A)		73.71(a)(5)
	20.2203(a)(2)(ii)		50.36(c)(2)	X	50.73(a)(2)(v)(B)		OTHER Specify in Abstract below or in NRC Form 366A
	20.2203(a)(2)(iii)		50.46(a)(3)(ii)		50.73(a)(2)(v)(C)		
	20.2203(a)(2)(iv)		50.73(a)(2)(i)(A)	X	50.73(a)(2)(v)(D)		
	20.2203(a)(2)(v)	X	50.73(a)(2)(i)(B)	X	50.73(a)(2)(vii)		
	20.2203(a)(2)(vi)		50.73(a)(2)(i)(C)		50.73(a)(2)(viii)(A)		
	20.2203(a)(3)(i)		50.73(a)(2)(ii)(A)		50.73(a)(2)(viii)(B)		

12. LICENSEE CONTACT FOR THIS LER

NAME	TELEPHONE NUMBER (Include Area Code)
Peter S. Jordan – Regulatory Affairs	(419) 321-8260

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX

14. SUPPLEMENTAL REPORT EXPECTED			15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
YES (If yes, complete EXPECTED SUBMISSION DATE).	X	No				

16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)

The High Pressure Injection (HPI) Pumps are components of the Emergency Core Cooling System which is required to maintain core cooling following postulated accidents. In September 2002, a question was raised regarding the minimum flow protection of the pumps when the recirculation valves are closed upon pump realignment to the containment emergency sump. Application of improved analytical methodology predicted the occurrence of cyclic repressurization of the Reactor Coolant System for a subset of very small break loss of coolant accidents (SBLOCA). Repressurization may exceed the shut-off head of the pumps. Considering the highly conservative assumptions required by 10CFR50.46, a vulnerability with HPI Pumps' minimum recirculation flow protection was discovered. However, highly reliable but non-safety grade equipment is capable of mitigating the consequences of the very SBLOCA sequences. This condition was corrected by installation of a second HPI recirculation flow path to protect the pumps when they are aligned to the Low Pressure Injection Pumps during containment sump recirculation (piggy-back mode). This condition is being reported as operation prohibited by Technical Specifications, an unanalyzed condition, a loss of safety function, and a common mode failure.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE:

Davis Besse Nuclear Power Station (DBNPS) was designed with two fully redundant High Pressure Injection (HPI) [BQ] trains whose function, in conjunction with other components, is to provide reactor core cooling following postulated accidents. Immediately following the onset of a loss of coolant accident (LOCA), the HPI pumps' [BQ-P] suction would be aligned to the Borated Water Storage Tank (BWST) to inject water into the core. In the case of certain small break LOCAs (SBLOCAs), during the initial phase of the accident, the Reactor Coolant System (RCS) [AB] may not be sufficiently depressurized to allow HPI pump injection. To protect the pumps in this shutoff head (and potential pump overheating) condition, a minimum flow line is open to allow recirculation of not less than 35 gallons per minute (gpm) back to the BWST. When the BWST inventory is nearing depletion, procedures require that HPI pumps be realigned to the LPI pump discharge. Prior to this realignment, operators are required to close the valves in the pumps' recirculation lines. This action is to prevent potentially contaminated fluid from the emergency sump from being pumped to the BWST which may result in emergency sump inventory loss and increased offsite dose with respect to 10 CFR 100 limits. When the realignment of pump suction occurs, the HPI pumps are operated in "piggy-back" with the Low Pressure Injection (LPI)/Decay Heat (DH) [BP-P] pumps. In this configuration, the LPI/DH pumps act as booster pumps to the HPI pumps, and RCS pressure should be maintained below approximately 1750 psia in order to ensure that the HPI pumps will have adequate minimum flow rates needed for continuous operation.

In the fall of 2002, the NRC conducted a special inspection of activities described in the "Davis-Besse System Health Assurance Plan." This inspection included an in-depth review of the design and performance capability of the HPI System. During this review, an inspector questioned the spectrum of breaks included in the SBLOCA analyses. This is documented in NRC Inspection Report 50-346/02-14. These analyses are required, in part, to demonstrate compliance with the ECCS performance requirements of 10 CFR 50.46. The existing analyses, as discussed in the Updated Safety Analysis Report (USAR) Section 15.3.1.1, did not appear to the inspector to include a subset of very small break areas. USAR Section 15.3.1.1 states that the SBLOCA analysis covered a spectrum of breaks starting at 0.01 ft^2.

A LOCA is defined as the break area from which the rate of fluid discharged cannot be matched by normal system makeup. The leak rate resulting from the rupture of a ¼-inch schedule 160 instrument line (0.002 ft^2) is the largest break area matched by normal system makeup capability. Therefore, the spectrum of SBLOCA breaks from greater than 0.002 to 0.01 ft^2 was not analyzed based on a conclusion that explicit analyses of breaks smaller than 0.01 ft^2 were not necessary for the DBNPS because break sizes smaller than 0.01 ft^2 resulted in decreasing consequences. This was an erroneous conclusion.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

DESCRIPTION OF OCCURRENCE (continued):

In response to this concern, the licensee contacted the Nuclear Steam Supply System (NSSS) vendor, Framatome ANP (formerly Babcock & Wilcox (B&W)) in the fall of 2002. Break sizes between the capacity of the Makeup (MU) System and up to the 0.01 ft^2 range were not covered by the vendor's existing SBLOCA analyses. Framatome ANP then reexamined the range of break sizes less than 0.01 ft^2.

The application of the NRC-approved EM for very small breaks, which includes very conservative design basis assumptions, indicated a vulnerability of the HPI Pumps' minimum recirculation flow protection. It predicted that cyclic repressurization of the RCS could occur prior to depletion of the BWST and continue following realignment of the HPI pumps to the emergency sump via the LPI pump discharge (piggy-back operation), after the recirculation valves are closed. RCS pressure during this condition was analytically predicted to exceed the shutoff head of the pumps. Without minimum flow through the pumps, they could be damaged from overheating in this potential deadhead operating condition and fail to perform their intended safety function. This condition has existed since the original design of DBNPS.

Notification of this condition was provided to the NRC on April 11, 2003 (Event No. 39750).

This condition is being reported as

- a condition or operation prohibited by plant Technical Specification 3.5.2.a in accordance with 10 CFR 50.73(a)(2)(i)(B),
- an unanalyzed condition that significantly degraded plant safety in accordance with 10 CFR 50.73(a)(2)(ii)(B),
- a condition resulting in a loss of safety function in accordance with 10 CFR 50.73(a)(2)(v), and
- a condition which creates a common mode failure in accordance with 10 CFR 50.73(a)(2)(vii).

LER 2003-003-00 also reported this condition pursuant the requirements of 10 CFR 50.46(a)(3)(ii). This regulation requires a 30-day report be submitted to the NRC describing each significant change or error discovered in an acceptable evaluation model or application of such model that affects the peak fuel clad temperature (PCT) calculation. The application of the EM for very small break sizes determined a vulnerability of the HPI Pumps minimum recirculation flow protection. This is not considered a change or error in the EM or its application that resulted in a calculated PCT change of greater than 50 degrees F. Rather, this application of the EM model resulted in the determination that the HPI Pumps would not perform their function for certain small size breaks using very conservative design basis assumptions.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

APPARENT CAUSE OF OCCURRENCE:

When the DBNPS was originally designed and licensed, a LOCA analysis was performed by B&W to demonstrate compliance with the requirements of 10 CFR 50.46, "Acceptance Criteria for ECCS for Light Water Nuclear Power Reactors." This analysis was based on the application of a May 1972 EM. The computer codes used in this early EM were not sufficiently sophisticated to identify repressurization cycles of the type now understood to occur during very SBLOCA events. The evaluation methodologies met the standards of the time.

As a result of the accident at Three Mile Island Unit 2 in March 1979, the NRC initiated an examination of slow RCS depressurization resulting from SBLOCAs. These SBLOCAs had not previously received detailed analytical studies comparable to those devoted to large breaks. A product of this NRC re-examination was NUREG-0565, "Generic Evaluation of Small Break Loss-Of-Coolant Accident Behavior in Babcock & Wilcox Designed 177-FA Operating Plants." In NUREG-0565, the NRC concluded that "the small break analysis methods used by B&W are satisfactory for the purpose of predicting trends in plant behavior following small break LOCAs and for training of reactor operators," but concerns regarding the small break model were identified. NRC recommendations included that analysis methods should be revised and submitted for NRC approval, and plant-specific calculations using the NRC-approved model for small breaks should be submitted to show compliance with 10 CFR 50.46.

In response, B&W re-examined SBLOCAs to a minimum break area of 0.01 ft^2 for the raised loop design (elevated once-through steam generators (OTSG) relative to the reactor vessel) which DBNPS incorporates. The analysis of the 0.01 ft^2 break predicted that repressurization cycles would occur while the HPI Pumps are aligned to the BWST but rapidly dampened after three cycles due to system heat removal dynamics. Recognizing the lower shutoff head of the DBNPS HPI Pumps, the NRC was concerned with the potential for repressurization. However, based upon mitigative actions provided by B&W, the NRC found "the range of small breaks and small break accident cooling modes are considered appropriate for demonstrating plant response to potential SBLOCAs." This analysis supported establishment of a 0.01 ft^2 break area as the lower limit of the spectrum of breaks analyzed for the DBNPS.

For the DBNPS Operating Cycle 13 and forward, the large and small break LOCA spectrum was reanalyzed using improved computer codes in the EM, Framatome Topical Report BAW-10192PA, July 1998. The DBNPS-specific analysis results are summarized in Framatome ANP 86-5006232-00, "DB-1 LOCA Summary Report." This report was issued in March 2000. This analysis included a break area of 0.01 ft^2 as the lower limit of the break sizes analyzed based on the conclusion that with OTSG heat transfer available, the consequences of the small break transient decrease with decreasing break size. Revision 22 to USAR 6.3.3 discusses the evaluation results of this report. This Summary Report indicates that the repressurization phenomenon would occur during the injection mode of operation when the HPI pumps have minimum flow recirculation. However, Auxiliary

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APPARENT CAUSE OF OCCURRENCE (continued):

Feedwater (AFW) cooling in conjunction with intermittent HPI would result in adequate long-term depressurization of the RCS long before the BWST would be depleted and, therefore, before the recirculation valves would be closed. A revised LOCA Summary Report, Framatome ANP 86-5006232-01 was issued in August 2002. It continued to maintain the 0.01 ft^2 break as the lower limit of break sizes analyzed. It indicated that for this break size, initial repressurization would occur that would be well above the shutoff head of the HPI pumps. Following that, smaller repressurization cycles would occur, but RCS pressure would then drop off continuously. The results of the 0.01 ft^2 break analysis were determined to meet the acceptance criteria of 10 CFR 50.46, and Framatome concluded that with OTSG heat transfer available, the consequences of the small break transient decrease with decreasing break size. Therefore, break sizes smaller than 0.01 ft^2 were not specifically analyzed.

Following the questioning during the fall 2002 NRC inspection of a potential deadhead condition of the pumps and the adequacy of thermal protection for the pumps, Framatome performed a study in November 2002 for the DBNPS, Framatome ANP 86-5022260-00, to determine whether HPI pump operability during post-LOCA sump recirculation could be assured for all break sizes and transient scenarios. This study identified a range of break sizes from 0.00206 ft^2 (leak-to-LOCA transition area) to 0.0045 ft^2 which would result in RCS repressurization cycles that may continue following HPI Pump realignment to the containment emergency sump and closure of the minimum flow recirculation valves. The study concluded that for this new range of break sizes analyzed, past operability of the HPI pumps was a concern from an analytical perspective.

The condition described in this LER has existed since original design of DBNPS, and is a latent issue.

ANALYSIS OF OCCURRENCE:

The following scenario describes an analytical event in accordance with NRC requirements of 10 CFR 50.46 and Appendix K. The Framatome LOCA Summary Report currently contained in the DBNPS USAR includes analysis of SBLOCAs that may allow RCS repressurization while HPI pumps are injecting from the BWST to the RCS. During this operation, thermal protection of the pumps is provided by a minimum flow recirculation line. With continuous heat transfer to AFW in the OTSG, RCS depressurization would be accomplished, and the pressure limit of the HPI pumps would not be challenged. The small break areas analyzed were over the range of 0.01 to 0.75 ft^2. However, based upon the November 2002 reanalysis of possible transient scenarios for break sizes smaller than those typically included in the SBLOCA analysis spectrum range (i.e., less than 0.0045 ft^2), it may be possible for interruption in natural circulation to occur that leads to RCS repressurization above the minimum HPI flow pressure criterion (1750 psia). This repressurization phenomenon can become cyclic as predicted by the analysis, NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

ANALYSIS OF OCCURRENCE (continued):

lasting from 12 hours to several days when the classical 10 CFR 50, Appendix K assumptions are applied. If the minimum flow is not preserved, the pump is vulnerable to damage such that continued operability is no longer assured.

Although operator actions are procedurally directed for actual events, the Appendix K LOCA analyses have substantial prescribed conservatisms, use only safety-related equipment, consider the worst single failure, and make very limited use of operator actions. In the case of DBNPS, no credit is taken in the analysis for the mitigative benefits of highly reliable but non-safety grade equipment such as the Pilot-Operated Relief Valve (PORV) and Makeup (MU) pumps. The MU pumps are capable of providing continuous flow to the RCS from the BWST. Continuous operation of the MU pumps would protect the HPI pumps by assuring that subcooled natural circulation of the RCS could be restored long before the BWST inventory is depleted. Opening of the PORV and its Block Valve increases the RCS equivalent break area by at least 0.01 ft^2. This ensures that the RCS would depressurize below the shutoff head of the HPI pump.

This type of accident is a slowly evolving transient which is included in the plant's emergency operating procedure. Framatome calculated the range of break sizes of interest to be 0.00206 to 0.0045 ft^2. The minimum time to switch the HPI pump suction from the BWST to the emergency sump was calculated to be approximately 24 hours. For the smallest break area simulated, the switchover time was calculated to be approximately 92 hours. Plant operators are trained to recognize and act on the symptoms of this type of event and the actions necessary to mitigate the accident prior to entering an RCS repressurization condition that would challenge HPI pump operability. Based upon the analytical results, substantial time would be available to execute accident mitigative actions.

Additional evaluations determined that potential mitigative actions allowed by design basis assumptions would not eliminate the need for the HPI Pumps to be provided with minimum flow protection after realignment to the emergency sump. An additional protective recirculation flow path is being installed to assure compliance with 10 CFR 50.46 licensing basis requirements. However, Framatome ANP Summary Report 86-5022260-00 indicates that use of a MU Pump or use of the PORV to reduce RCS pressure is a successful mitigative strategy, but these components are not credited ECCS sub-systems, although they are expected to be available and are provided with essential power. The existing Emergency Operating Procedure already utilizes the MU pumps. In addition, the PORV would also be available, and its use would be indicated by the event's symptoms. Therefore, the theoretical repressurization cycles would not occur when existing procedural and elective steps are performed.

The significance of this event was evaluated assuming the unavailability of non-safety grade equipment, consistent with 10 CFR 50.46 methodology. The Core Damage Frequency for this scenario was calculated to be less than 5E-9/year. Overall, this condition represents a very small contribution to the CDF, is mitigated by highly reliable equipment and proceduralized operator actions, and is, therefore, not risk significant.

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CORRECTIVE ACTIONS:

The re-analysis which predicts the cyclic RCS repressurization phenomenon for very SBLOCAs was further evaluated to validate the plant-specific application at the DBNPS. Based on the results of this further evaluation, several corrective actions are being implemented.

An additional minimum flow recirculation line was installed during the present outage for each HPI Pump that taps off the existing minimum flow line through two isolation valves and a non-cavitating pressure breakdown device connecting to the LPI Pump discharge upstream of its respective Decay Heat cooler for the corresponding safety train. These additional recirculation lines are designed to provide adequate minimum flow protection of the HPI Pumps, as required, when aligned to the emergency sump in "piggy back" operation with the LPI Pumps. In this lineup, the DH Coolers will provide cooling for the respective HPI Pumps without loss of sump inventory.

Operator action will be required to open the valves on these additional recirculation lines prior to pump realignment from the BWST to the emergency sump. Because the postulated transient is very slow in developing, ample time would be available for operators to take this action. This action does not replace any existing automatic action.

Revision to DB-OP-02000, "Emergency Procedure," to provide direction to plant operatiors on establishing HPI alternate minimum recirculation flowpath was issued September 8, 2003. Operator training on this procedure was completed August 29, 2003.

Beyond these specific corrective actions being implemented to conform to the licensing basis requirements of 10 CFR 50.46, other plant improvements have been pursued to further enhance the high reliability of non-safety grade equipment that can be used to realistically mitigate the effects of SBLOCA sequences. Previous upgrades to the PORV and MU Pumps were described in DBNPS responses (Serial 1836 dated September 18, 1990, and Serial 1884 dated December 21, 1990) to NRC Generic Letter 90-06, "Resolution of Generic Issue 70, 'Power-Operated Relief Valve and Block Valve Reliability' and Generic Issue 94, 'Additional LTOP Protection for Light Water Reactors.'" In addition, during the current outage, MU Pump 1 motor was rewound to safety grade requirements. Both MU Pumps are supplied with Class 1E electrical power and are seismically qualified. The PORV was upgraded to install a rewound solenoid that meets safety-grade requirements. The PORV cut-in switch was replaced with a switch upgraded from commercial grade to safety grade, and its power cable, previously qualified to safety grade and EQ standards, was replaced.

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

CORRECTIVE ACTIONS (continued):

The DBNPS is unique among B&W pressurized water reactors in requiring EM application at these very small break sizes. The predicted pressure transients were not identified in previous applications of the existing EM because the very SBLOCA break sizes were not explicitly analyzed. A finite number of break sizes is selected to be analyzed per the EM. Because of the continuity of predicted response throughout the balance of the break spectrum, there is no indication that there is any other range of break sizes that require additional application of the EM.

As a related issue, the NRC requested on November 21, 1979, additional information regarding protection of HPI pumps should RCS repressurization occur causing the pumps to deadhead. The DBNPS response was provided on December 28, 1979 (Serial Letter 568). The response to Item #2 of this letter has been reviewed in light of the newly identified analytical prediction of HPI pump operation and plant modification. The following revised response is provided.

Response:

The DBNPS HPI Pumps are protected against deadheading should the RCS repressurize by its design. During post-accident injection phase operation when the pumps are aligned to the BWST, a recirculation path is provided downstream of each HPI Pump back to the BWST. No operator action is required to initiate this protection because the valves in this recirculation line are normally open.

Since the original response to this NRC request for additional information was provided in 1979, improvements in analytical methodology have occurred with respect to the 10 CFR 50.46 EM. With the current understanding of the predicted potential for repressurization, a recirculation flow path from the HPI Pumps' discharge to the discharge piping of the LPI Pumps upstream of the DH Coolers was installed during 13RFO. This recirculation flow path is designed to protect the HPI Pumps against the effects of deadheading. Operator action is required to open the valves in this new recirculation flow path prior to closing of the valves in the recirculation piping to the BWST. Since the RCS repressurization is a slowly evolving transient, ample time will be available to perform these actions. This operator action is being incorporated into the plant emergency procedure.

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FAILURE DATA:

In the previous two years, two conditions of non-conservative LOCA analysis were identified. These are documented in CR 01-1538 and CR 00-1921. Neither of these CRs addressed issues regarding the EM that were similar to the issues involved with this LER. In addition, one LER (LER 2003-002) was submitted to the NRC involving potential inoperability of the HPI Pumps. LER 2003-002 addressed the potential harmful effects to the pumps of debris entrained in the pumped fluid which is a different issue than addressed in this LER. During this same time period no condition was identified and no LER was submitted with respect to the 10 CFR 50.46 accident analysis.

Energy Industry Identification System (EIIS) codes are identified in the text as [XX].

NP-33-03-003-01	CR 02-06702	CR 02-08915	CR 02-09159
	CR 03-02876	CR 03-03848	CR 03-04868
	CR 03-04912		