July 21, 2000

Mr. L. W. Myers
Senior Vice President
Post Office Box 4
FirstEnergy Nuclear Operating Company
Shippingport, Pennsylvania 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNITS 1 AND 2 - NRC INSPECTION REPORT 05000334/2000-008; 05000412/2000-008

Dear Mr. Myers:

During the period from June 26 to 30, 2000, the NRC performed a supplemental inspection at the Beaver Valley 1 & 2 reactor facilities. The purpose of the inspection was to review First Energy Nuclear Operating Company's (FENOC) evaluation and corrective actions associated with the failed vacuum break check valve and the subsequent water hammer condition in the Unit 2 service water system on November 9, 1999. The NRC had issued a Severity Level III Notice of Violation (NOV) in letter dated May 3, 2000, based on performance issues involving the failure to correct deficiencies with the vacuum break check valve.

Although the failed vacuum break check valve and subsequent water hammer condition occurred before implementation of the NRC's new reactor oversight process (ROP), the NRC followed up this issue with a supplemental inspection under the new ROP. This supplemental inspection was in lieu of a regional initiative inspection that would have been conducted under the previous inspection oversight process. The preliminary results of this inspection were discussed with you and other members of your staff on June 30, 2000. The enclosed report presents the results of the inspection.

The NRC determined that your staff's evaluations of the failed vacuum break check valve were adequate to identify the causes of the water hammer condition and appropriately broad in scope to identify the extent of the problems. The NRC further determined that your completed and planned corrective actions address the causes identified in your evaluations. Based on the adequacy of your evaluations, corrective actions, and the information contained in your letter dated June 2, 2000, Escalated Action (EA) 00-045, item number 01013 associated with the Service Water System vacuum break check valve failure has been closed.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosures will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/NRC/ADAMS/index.html (the Public Electronic Reading Room).

Sincerely,

/RA/

David C. Lew
Performance Evaluation Branch
Division of Reactor Safety

Docket Nos: 05000334; 05000412
License No. DPR-66, NPF-73

Enclosure: Inspection Report 05000334/2000-008; 05000412/2000-008

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REGION I

Docket Nos:	05000334 05000412
License Nos:	DRP-66 NPF-73
Report Nos:	05000334/2000-008 05000412/2000-008
Licensee:	FirstEnergy Nuclear Operating Company
Facility:	Beaver Valley Power Station, Units 1 and 2
Location:	Post Office Box 4 Shippingport, PA 15077
Dates:	June 26 - 30, 2000
Inspector:	M. Gray, Reactor Inspector
Approved by:	David C. Lew Performance Evaluation Branch Division of Reactor Safety

SUMMARY OF FINDINGS

Beaver Valley Power Station, Units 1 & 2
NRC Inspection Report 05000334/2000-008 & 05000412/2000-008

This supplemental inspection was performed by the NRC to assess the licensee's evaluation of the Service Water System (SWS) vacuum break check valve 2SWS-488 failure to open and subsequent water hammer condition that occurred on November 9, 1999. On November 21, 1999 the licensee identified the water hammer had occurred after investigating the discovery of a deformed SWS metal expansion joint.

In NRC inspection Nos. 50-334 & 50-412/1999-010 and 2000-001, the NRC identified an apparent violation involving the licensee's failure to promptly identify and correct conditions adverse to quality that resulted in the vacuum break check valve failure to open and a water hammer condition. On April 13, 2000, the NRC held a pre-decisional enforcement conference in the Region 1office with the licensee to discuss the apparent violation. The NRC subsequently issued a Severity Level III Notice of Violation (NOV) in letter dated May 3, 2000. The NRC received FirstEnergy Nuclear Operating Company's (FENOC's) reply to the NOV in letter dated June 2, 2000, in which FENOC identified the causes and corrective actions taken in response to prevent recurrence.

Although the failed vacuum break check valve and subsequent water hammer condition occurred before implementation of the NRC's new reactor oversight process (ROP), the NRC followed up this issue with a supplemental inspection under the new ROP. This supplemental inspection was in lieu of a regional initiative inspection that would have been conducted under the previous inspection oversight process. The supplemental inspection was performed in accordance with Inspection Procedure 95001.

Cornerstone: Mitigating Systems

- The licensee's evaluations of the failed vacuum break check valve (VBCV) were adequate to identify the causes and appropriately broad in scope to determine the extent of the problems. The licensee's evaluations identified the primary root cause to be less than adequate implementation of the preventive maintenance program. The licensee identified contributing root causes to be previous inadequate corrective actions to address VBCV deficiencies and personnel failure to understand the significance of previously identified VBCV deficiencies. The licensee adequately identified corrective actions to address each root cause.

- The licensee has evaluations planned or in progress to measure the effectiveness of their corrective actions to prevent recurrence. The results of the licensee's periodic monitoring of a corrective action regarding preventive maintenance (PM) task deferrals beyond their limit date indicates that licensee corrective actions have been effective in ensuring preventive maintenance tasks are completed or evaluated before their limit date is reached. However, the results of the licensee's periodic monitoring of a corrective action regarding management approval of PM task deferrals entering their grace period (25% of interval) identified that approximately thirty-four of forty-four PM tasks in the grace period in June 2000 had not received the level of management approval required by the program.

Report Details

01 Inspection Scope

This supplemental inspection was performed by the NRC to assess the evaluation, which the licensee, FirstEnergy Nuclear Operating Company (FENOC), completed in response to the failure of vacuum break check valve (VBCV) 2SWS-488 to open. The failure of this VBCV resulted in a subsequent water hammer condition that occurred in the Unit 2 service water system (SWS) on November 9, 1999. The water hammer condition damaged an expansion joint on the outlet of the C SWS pump. Licensee personnel identified the damaged expansion joint on November 21, 1999. The licensee concluded that the pressure retaining capability of the expansion joint was indeterminate and declared one of two trains of SWS inoperable.

The licensee submitted Licensee Event Report (LER) 99-011-00 to notify the NRC of the water hammer condition and supplemented the report on March 28, 2000. Although the new NRC reactor oversight process (ROP) was not applicable to the licensee at the time, the licensee used the ROP "significance determination process" (SDP) to assess the increase in risk that resulted from operating with one of two SWS trains inoperable for a period of time. The licensee concluded that if the damaged expansion joint was assumed to fail during a SWS pump restart or seismic event, the change in core damage frequency would be slightly above 1E-6 per year. Using the SDP guidelines and this assumption, the licensee characterized this performance issue as a "white" finding in the LER supplement. Under the ROP, this performance issue is associated with the mitigating systems cornerstone in the reactor safety strategic performance area.

Although the failed vacuum break check valve and subsequent water hammer condition occurred before implementation of the NRC's new ROP, the NRC followed up this issue with a supplemental inspection under the new ROP. This supplemental inspection was in lieu of a regional initiative inspection that would have been conducted under the previous inspection oversight process.

02 Evaluation of Inspection Requirements

02.01 Problem Identification

a. Determine that the evaluation identifies who (i.e. licensee, self revealing, or NRC), and under what conditions the issue was identified.

   The licensee's evaluation described in appropriate detail the circumstances and personnel involved in identifying the deformed expansion joint. A tour operator identified the metal expansion joint on the outlet of SWS "swing" pump C was deformed during his normal tour on November 21, 1999. At the time, SWS pump C was in service supplying SWS header B. SWS train B is normally supplied by SWS pump B; however, SWS pump B was out of service for maintenance. When the tour operator identified the deformed metal expansion joint, operators entered the applicable technical specification action statement, started the associated standby SWS pump, and removed the C SWS pump from service. Subsequently, the licensee completed maintenance on the B SWS pump, returned it to service and exited the applicable action statement.

b. Determine that the evaluation documents how long the issue existed, and prior opportunities for identification.

The inspector determined the licensee's evaluation documented that the metal expansion joint on the outlet of SWS pump C was deformed since a water hammer occurred on November 9, 1999, during a pump surveillance test. During the test, the pump was stopped and then restarted. When the pump was stopped, downstream VBCV 2SWS-488 failed to open to allow air inflow to break the vacuum as water drained to the pump intake. This caused the water column on the pump inlet to separate. On the subsequent pump start, a water hammer occurred that deformed the expansion joint.

The licensee determined that a prior opportunity to identify the water hammer condition and resulting deformed expansion joint was missed two days after the water hammer occurred. On November 11, 1999, operators observed a SWS pump C local pressure gauge pointer that was bent and initiated a work request to repair the indicator. Operators did not identify the possibility that the pressure indicator pointer could have been damaged by a water hammer condition.

c. Determine that the evaluation documents the plant specific risk consequences and compliance concerns associated with the issue.

The inspector determined the licensee adequately evaluated the risk associated with operating the SWS with a deformed metal expansion joint and failed VBCV. The licensee tested the damaged expansion joint and concluded that it would maintain pressure integrity under normal operating conditions. However, during a postulated pump restart resulting from Emergency Diesel Generator automatic sequence loading or on a manual pump restart, the licensee concluded the expansion joint may not have maintained pressure integrity. Using the assumption that the expansion joint would always fail during a SWS pump restart or seismic event, the licensee calculated the change in core damage frequency to be slightly above 1E-6 per year. Using the SDP guidelines and this assumption, the licensee characterized this as a "white" finding in LER 99-011.

The Unit 2 SWS pump C and Unit 1 River Water Pump B are located in the same pump cubicle. The licensee considered the risk associated with failure of the deformed expansion joint and flooding potential to affect the Unit 1 River Water System. The licensee concluded the increase in Unit 1 core damage frequency was below 1E-6 per year and therefore the condition would have been characterized as a "green" finding for Unit 1 using SDP guidelines.

The inspector determined the licensee's corrective actions described in their evaluations and listed in their Notice of Violation (NOV) response letter dated June 2, 2000 adequately addressed compliance issues.

02.02 Root Cause and Extent of Condition Evaluation

a. Determine that the problem was evaluated using a systematic method to identify root causes and contributing causes.

The inspector determined the licensee evaluated the VBCV failure to open and subsequent water hammer condition using a systematic method called "TapRoot" to identify root causes and contributing causes. The inspector reviewed the licensee's TapRoot Incident Investigation Manual and determined that this method of investigation

uses an Events and Casual Factors analysis to identify the sequence of events and a barrier analysis to identify root causes.

In condition report (CR) No. 99-3270, the licensee applied the "TapRoot" method to systematically evaluate the failed VBCV and subsequent water hammer condition. This evaluation identified programmatic deficiencies with the preventive maintenance (PM) program. The licensee subsequently formed a multi-disciplined analysis team (MDAT) to further evaluate the PM program deficiencies and missed opportunities to identify the water hammer condition. The MDAT report included two "TapRoot" root cause analyses on these subjects. The inspector verified that these analyses were performed in accordance with the licensees procedures. The analyses included Event & Casual Factor charts, detailed time lines and documented interviews with cognizant personnel.

b. Determine that the root cause evaluation was conducted to a level of detail commensurate with the significance of the problem.

The inspector determined the licensee's evaluations of the VBCV failure to open and subsequent water hammer condition were thorough and identified the primary root cause to be less than adequate PM on the VBCV. The licensee determined that, in accordance with their PM program, VBCV 2SWS-488 was scheduled to be inspected and cleaned on an annual basis. The PM program allows a PM task to be extended 25% of the interval into a grace period up to a limit date. The PM limit date for 2SWS-488 was September 19, 1999. The licensee's evaluation revealed that the PM for VBCV 2SWS-488 had been canceled with the intent to take credit for a work order scheduled to replace the valve before the limit date. However, this work order was subsequently rescheduled due to parts availability issues. The PM task to inspect VBCV 2SWS-488 subsequently exceeded its limit date on September 19, 1999. The VBCV failed to open on November 9, 1999, during a pump surveillance test and a water hammer resulted.

The licensee identified that other contributing root causes were (1) previous corrective actions to address VBCV deficiencies were inadequate, and (2) personnel failed to understand the significance of VBCV deficiencies. The licensee reviewed the work history for the SWS pump VBCVs and determined that repetitive problems regarding valve corrosion and leakage had not been resolved to prevent reoccurrence. Licensee personnel did not reevaluate the PM task frequency considering the repetitive deficiencies. Also, a work package prepared to replace the VBCVs with an improved valve design was not implemented in a timely fashion. The licensee further identified that personnel failed to understand the potential for corrosion to result in failure of the VBCV to open and the resulting potential for a water hammer condition.

These root causes were identified in the licensee's evaluations and listed in the licensee's NOV response dated June 2, 2000.

c. Determine that the root cause evaluation included a consideration of prior occurrences of the problem and knowledge of prior operating experience.

The inspector determined the licensee's evaluation identified prior occurrences of problems with the VBCVs and considered operating experience. The licensee's MDAT reviewed the Unit 1 and Unit 2 VBCV maintenance work history for previous VBCV failures. A detailed time line of each Unit's VBCV work history was included in the MDAT report. The licensee also reviewed inservice test results and related condition

reports and identified two prior occurrences in 1993 and 1995 where a VBCV was found "stuck shut."

The licensee identified a prior missed opportunity to identify the water hammer condition and deformed expansion joint on November 11, 1999, and included this in their evaluation. The licensee's evaluation (CR No. 99-3270) included a search of industry operating experience for information regarding VBCV performance issues.

d. Determine that the root cause evaluation included consideration of potential common causes and extent of condition of the problem.

The inspector determined that the licensee's evaluation considered the potential for common cause and extent of condition of the failed VBCVs and other affected components. The licensee replaced all Unit 1 RWS and Unit 2 SWS pump VBCVs. The licensee inspected other pipe components that may have been affected by the water hammer condition. The licensee found that manual gate valve 2SWS-483 upstream of failed closed VBCV 2SWS-488 had experienced corrosion, and during the water hammer the valve gate separated from the valve stem and lodged in the flow path. The licensee replaced this valve and subsequently inspected, repaired and replaced as needed all other VBCV pump manual isolation valves on both units.

The root cause evaluation determined that the PM for the 2SWS-488 VBCV was beyond the limit date without justification. The licensee expanded their evaluation to review the status of all PM tasks. The licensee identified eighty-eight other PM tasks that were beyond their limit date. The licensee either completed the PM task or deferred the task with documented technical justification and operability reviews. At the end of the inspection, the licensee reported all PM tasks were within their limit date.

The licensee's evaluation determined that previous corrective actions to address VBCV deficiencies were inadequate. A team of licensee engineers reviewed the backlog of work for the ten most risk significant systems on each unit to determine if similar repetitive deficiencies existed where the safety significance of work was not adequately understood and reflected in the work priority. The licensee's review did not identify any safety significant backlog item that required immediate attention and concluded that, in general, the work process appropriately prioritized equipment problems. Some work items were identified as requiring closer management attention.

02.03 Corrective Actions

a. Determine that appropriate corrective actions are specified for each root/contributing cause or that there is an evaluation that no actions are necessary.

The inspector determined that appropriate near and long term corrective actions were specified for each root cause identified in the licensee's root cause evaluations.

The licensee took immediate corrective action to meet technical specification requirements and to restore the SWS train B to operability upon discovering the deformed metal expansion joint. The licensee completed inspections and evaluations of the balance of SWS pump C piping to assess the integrity of other pipe components. The licensee replaced the deformed expansion joint and inspected the metal expansion joints on the Unit 1 RWS and Unit 2 SWS pumps. The licensee replaced all Unit 1 RWS

and Unit 2 SWS pump VBCVs with a new style nozzle VBCV that is less susceptible to corrosion and binding. The licensee also inspected, repaired and replaced as needed all manual isolation valves upstream of the pump VBCVs on both units.

The licensee took corrective action to strengthen the controls on PM task deferral. A memo was issued from the site Senior Vice President to personnel site wide stating management expectations for performing PM tasks and establishing additional management authorization requirements for approving PM task deferrals. The inspector verified that these expectations had since been incorporated into the preventive maintenance program procedure.

The licensee specified appropriate corrective actions to address the contributing root cause of previous inadequate corrective actions to address VBCV deficiencies. The licensee reviewed the backlog of the ten most risk significant systems and did not identify similar occurrences. The licensee revised their work request initiation procedure to clarify the roles and responsibilities of control room and work control operators in performing the initial review of material deficiency work requests. Licensee management also communicated the expectation that system engineers review new work requests on their system each work day to confirm the priority and safety significance. The inspector determined this expectation had subsequently been incorporated into the licensee's system engineering manual.

The licensee specified appropriate corrective actions to address the contributing root cause of personnel failure to understand the safety significance of VBCV deficiencies. These performance issues were reviewed during licensed and non-licensed operator retraining to discuss management expectations regarding a questioning attitude and appropriate actions if a water hammer is suspected. The licensee was tracking a corrective action under CR No. 00-0142-02 to develop additional guidance to assist operators in assessing the significance of material deficiency work requests. Engineering personnel received training similar to the operators via continuing training seminars. Additionally, during the inspection, the licensee had completed a case study of the VBCV failure and other recent site issues to be utilized in further continuing training.

b. Determine that the corrective actions have been prioritized with consideration of the risk significance and regulatory compliance.

The inspector determined the licensee's corrective actions were prioritized considering risk significance and regulatory requirements. Upon discovery of the deformed metal expansion joint the licensee took immediate corrective actions to meet applicable technical specification requirements. Near term the licensee completed inspections of other Unit 2 SWS components and Unit 1 RWS components to verify their capability. The licensee also replaced the VBCVs on both units and inspected and replaced as needed their associated manual isolation valves.

The inspector determined that the corrective actions, which the licensee identified in subsequent evaluations, were prioritized considering risk significance. The licensee completed a review of all PM tasks in December 1999 to address the potential that other PM tasks may have been deferred inappropriately and without technical justification and placed additional controls on PM task deferral in January 2000. The inspector reviewed

the due dates of corrective actions tracked within the licensee's corrective action program and concluded the dates reflected the risk significance of the corrective action.

c. Determine that a schedule has been established for implementing and completing the corrective actions.

The inspector determined that the licensee established a schedule for completing their corrective actions. Prior to the inspection the licensee completed component inspections and material deficiency corrective actions. The inspector verified that the licensee's corrective actions to address PM program deficiencies, repetitive VBCV deficiencies and personnel performance issues were scheduled, tracked and controlled within the licensee's corrective action program. At the time of the inspection, most of the corrective actions had been completed. The inspector did not identify any open corrective actions with inappropriate or repetitively extended due dates.

d. Determine that quantitative or qualitative measures of success have been developed for determining the effectiveness of the corrective actions to prevent recurrence.

The inspector determined that the licensee has evaluations planned or in progress to measure the effectiveness of their corrective actions to prevent recurrence. The results of the licensee's periodic monitoring of a corrective action regarding PM task deferrals beyond their limit date indicates that licensee corrective actions have been effective in ensuring preventive maintenance tasks are completed or evaluated before their limit date is reached. However the results of the licensee's periodic monitoring of a corrective action regarding management approval of PM task deferrals entering their grace period (25% of interval) identified that approximately thirty-four of forty-four PM tasks in the grace period as of June 2000 had not received the level of management approval required by the program.

The licensee established a six month PM frequency for inspecting the new VBCVs. The initial inspection results met acceptance criteria. The licensee tracked a corrective action under CR No. 00-0142-17 to have system engineers perform a follow-up review of backlog work to ensure personnel were recognizing safety significance and correctly prioritizing plant material deficiency work. The licensee tracked a corrective action under CR No. 00-0142-13 and CR No. 99-3581-22 to complete a follow-up effectiveness review of the PM program. In the interim, the inspector observed that the PM program coordinator periodically ran a report listing PM tasks past their due date (within in the 25% "grace" period) and those beyond their limit date. At the end of the inspection the licensee reported that their were forty-four online PM tasks in the grace period and no online PM tasks beyond their limit date.

In reviewing the last two PM task reports, the licensee PM program coordinator identified that personnel had not completed the required management approval form for approximately thirty-four of the PM tasks in their grace period. These increased management approval requirements were instituted as a corrective action for past VBCV PM task deferral problems. The licensee initiated CR No. 00-1986 and CR No. 00-2190 to address these deficiencies. Considering that at the end of the inspection, no PM tasks were beyond their limit date, the inspector concluded that corrective actions have been effective in ensuring PM tasks are completed or evaluated before their limit date is reached. The inspector determined that further monitoring of the effectiveness

of corrective actions regarding management approvals for PM tasks entering the grace period will be addressed by the licensee within their corrective action program.

4. OTHER ACTIVITIES (OA)

4OA4 Other

1. (Closed) EA 00-045, item number 01013: Violation Associated with Inadequate Corrective Actions for SW Vacuum Break Check Valves. Based on the adequacy of the licensee's evaluations, corrective actions, and the information contained in NOV reply letter dated June 2, 2000, Escalated Action (EA) 00-045, item number 01013 associated with the Service Water System VBCV failure has been closed.

ITEMS OPENED, CLOSED, AND DISCUSSED

Opened
None

Opened and Closed
None

Closed

(Closed) EA 00-045, item number 01013: Violation Associated with Inadequate Corrective Actions for SW Vacuum Break Check Valves.

PARTIAL LIST OF PERSONS CONTACTED

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Bob Garver	System Engineer
Richard Hecht	Plant Technical Support Manager
John Humphries	System Engineer, Service Water System
Dan Jones	Beaver Valley Unit 2 IST Engineer
Gene Lauck	Performance Engineering
Dan Mickinac	Licensing Engineer
Lew Myers	Senior Vice President - Nuclear
Brian Sepelak	Senior Licensing Supervisor
Phil Slifkin	Supervisor, Engineering Programs
Jo Ann West	Beaver Valley Unit 1 IST Engineer

PARTIAL LIST OF DOCUMENTS REVIEWED

CR No. 99-3270	Deformed Metal Expansion Joint
CR No. 99-3581	Preventive Maintenance Program Performance Issues
CR No. 99-3588	Evaluation of Over-Ranged Pressure Indicator Gauge
CR No. 00-0142	Opportunities to Assess Safety Significance of Issues Related to Deformed Metal Expansion Joint
CR No. 00-1986	PM Program Paperwork Requirements Not Met
CR No. 00-2047	Vacuum Break Check Valve 2SWS-408 Found To Be Corroded
CR No. 00-2190	PM Program Paperwork Requirements Not Met
FENOC Letter L-00-073	"Reply to Notice of Violation (NOV)," dated June 2, 2000.
FENOC Case Study	"Unit 2 Service Water System Hammer And Expansion Joint Deformation"
LESSON PLAN 04-12-006	"Licensed Operator Retraining Lesson Plan," December 23, 1999
LP-TPT-5211-2000	"Engineering Personnel Continuing Training Module 2000-2
LER-99-011-01	"Inoperability of Service Water System Train B Due to Deformed Discharge Expansion Joint on In-Service Pump," dated March 28, 2000
MDAT Report	"Failure to Evaluate Safety Significance of Equipment Problems."
NPDAP 5.8	"Root Cause Analysis," Revision 2
NPDAP 8.31	"Preventive Maintenance Program", Revision 6, January 27, 2000
NPDAP 7.15	"Initiation of a Work Request," Revision 6, April 28, 2000
SPEAP 2.11	"System and Performance Engineering Administrative Manual," Revision 0, April 28, 2000

LIST OF ACRONYMS USED

ADAMS	Agencywide Documents Access and Management System
CFR	Code of Federal Regulations
CR	Condition Report
EA	Escalated Action
FENOC	FirstEnergy Nuclear Operating Company
IST	In-Service Test
LER	Licensee Event Report
MDAT	Multi-Disciplined Analysis Team
NOV	Notice of Violation
NRC	Nuclear Regulatory Commission
NPDAP	Nuclear Power Division Administrative Procedure
PARS	Publicly Available Records System
PM	Preventive Maintenance
ROP	Reactor Oversight Process
RWS	Beaver Valley Unit 1 River Water System
SDP	Significance Determination Process
SWS	Service Water System
VBCV	Vacuum Break Check Valve