

March 1, 2002

Mr. Bruce Williams  
Vice President, TMI Unit 1  
AmerGen Energy Company, LLC  
Three Mile Island Nuclear Station  
PO Box 480  
Middletown, PA 17057-0480

SUBJECT: THREE MILE ISLAND STATION, UNIT 1 - NRC INSPECTION REPORT  
50-289/01-14

Dear Mr. Williams:

On December 28, 2001, the NRC completed a supplemental inspection at the Three Mile Island Unit 1 facility. The enclosed report presents the results of this inspection which were discussed with you and other members of your staff on February 1, 2002.

This inspection was an examination of your activities associated with a white inspection finding. The white inspection finding involved the 'A' emergency feedwater pump and a lengthy period of inoperability. The white inspection finding was documented in NRC Inspection Report 50-289/01-02. The inspectors reviewed the individual and collective assessments your staff completed in response to the inoperable emergency feedwater pump and the associated corrective actions.

In general, your root cause evaluation report, completed in response to the white inspection finding, was of sufficient detail to identify broad causes and appropriate corrective actions. Notwithstanding, we noted that corrective actions were not successfully implemented for two later safety-related equipment problems. In these two instances, degraded equipment conditions were not identified, evaluated and corrected in a timely manner. These issues are examples of a substantive cross-cutting issue in the human performance area regarding weaknesses in procedure adherence and equipment monitoring that is discussed further in the NRC's Annual Assessment Letter (Report 50-289/02-01).

The two examples of ineffective corrective action implementation were determined to be issues of very low safety significance (Green) and to also involve violations of NRC requirements. However, because of the very low safety significance and because the problems have been entered into your corrective action process, 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 deny these non-cited violations, you should provide a response with the basis for your denial, within 30 days of the date of this inspection report, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555-0001; with copies to the Regional Administrator, Region I; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001; and the NRC Resident Inspector at the Three Mile Island Unit 1 facility.

Mr. B. Williams

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Sincerely,

**/RA/**

Brian E. Holian  
Deputy Director  
Division of Reactor Projects

Docket No. 50-289  
License No. DPR-50

Enclosure: Inspection Report 50-289/01-14  
Attachment: Supplemental Information

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**U.S. NUCLEAR REGULATORY COMMISSION**

REGION 1

Docket No: 50-289  
License No: DPR-50

Report No: 50-289/01-14

Licensee: AmerGen Energy Company, LLC (AmerGen)

Facility: Three Mile Island Station, Unit 1

Location: PO Box 480  
Middletown, PA 17057

Dates: December 10-28, 2001

Inspectors: J. Daniel Orr, Senior Resident Inspector  
Craig W. Smith, Resident Inspector

Approved by: John F. Rogge, Chief  
Projects Branch 7  
Division of Reactor Projects

## SUMMARY OF FINDINGS

IR 05000289/01-14, on 12/10-28/2001, AmerGen Energy Company, LLC, Three Mile Island Unit 1. Supplemental inspection of white inspection finding; corrective actions.

This supplemental inspection was conducted by resident inspectors and reviewed AmerGen's evaluations and corrective actions in response to an equipment problem that resulted in a white inspection finding for an inoperable emergency feedwater pump. The white inspection finding was documented in NRC Inspection Report 50-289/01-02. The resident inspectors reviewed the individual and collective assessments that AmerGen completed in response to the inoperable emergency feedwater pump. The inspectors also reviewed the associated corrective actions. This inspection was conducted in accordance with NRC Inspection Procedure 95001 and the NRC's program for overseeing the safe operation of commercial nuclear power reactors, which is described at its Reactor Oversight Process website at <http://www.nrc.gov/NRR/OVERSIGHT/index.html>.

The inspectors concluded that, in general, AmerGen's root cause evaluation in response to the inoperable emergency feedwater pump was of sufficient detail to identify broad causes and appropriate corrective actions. Notwithstanding, the inspectors determined that implementation of some emergency feedwater pump corrective actions was not successful for two later risk significant equipment degraded conditions. Those implementation problems involved the 'B' decay heat closed cycle cooling water pump (DC-P-1B) and the 'A' decay heat removal pump (DH-P-1A). The DH-P-1A problems lingered because the inservice test program was not effectively used. The DC-P-1B excessive oil leak condition was not evaluated in a timely manner because the oil monitoring and trending program data was not being adequately reviewed by operation's shift management.

Due to AmerGen's acceptable performance in evaluating the root causes and establishing adequate corrective actions for the inoperable emergency feedwater pump, the white inspection finding associated with this issue will only be considered in assessing plant performance for a total of four quarters in accordance with the guidance in IMC 0305, "Operating Reactor Assessment Program." The inspectors reviewed implementation of the associated corrective actions and as stated, identified two findings of very low safety significance (Green).

### Cornerstone: Mitigating Systems

- **Green.** An emergency feedwater corrective action was not successfully implemented and allowed a significant oil leak on the 'B' decay heat closed cycle cooling water pump (DC-P-1B) to go unevaluated for fifteen days. Increased oil additions to DC-P-1B were known and recorded in an operator database, but were not evaluated in a timely manner against established acceptance criteria for excessive loss.

The safety significance of this finding was very low (Green) because DC-P-1B was ultimately determined to remain operable with the increased oil leakage. 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," requires that measures shall be established to assure that conditions adverse to quality, such as deficiencies, are promptly identified and corrected. The operators' failure to identify a significant oil leak

on DC-P-1B was a violation of 10 CFR 50, Appendix B, Criterion XVI, “Corrective Action.” (Section 02.03a.(1))

- **Green.** An emergency feedwater corrective action was not successfully implemented and allowed increased inservice testing (IST) vibration results on the ‘A’ decay heat removal pump (DH-P-1A) to go unevaluated for four days. The increased vibration was also observed during a post-maintenance test. DH-P-1A was returned to service and declared operable without establishing or evaluating new IST reference vibration values. An AmerGen investigation later determined that an improperly installed bearing support assembly was the cause for the increased pump vibration.

The safety significance of this finding was very low (Green) because the redundant decay heat removal pump, DH-P-1B, remained operable for the duration. One decay heat removal pump satisfied technical specification requirements for the pertinent plant conditions. Technical Specification (TS) 4.2.2 required, among other requirements, that IST of ASME Code Class 2 pumps, such as DH-P-1A, shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as required by 10 CFR 50, Section 50.55a(f). AmerGen’s failure to establish new IST reference values after DH-P-1A maintenance was a violation of TS 4.2.2. (Section 02.03a.(2))

## Report Details

### 01 Inspection Scope

This supplemental inspection was performed by the NRC to assess AmerGen's evaluations and corrective actions associated with the inoperability of the 'A' emergency feedwater (EFW) pump. This performance issue was previously characterized as "White" in NRC Inspection Report 50-289/01-02 and is related to the mitigating systems cornerstone in the reactor safety strategic performance area.

### 02 Evaluation of Inspection Requirements

#### 02.01 Problem Identification

- a. Determination of who (i.e., licensee, self-revealing, or NRC) identified the issue and under what conditions.

The NRC inspectors identified that AmerGen had failed to consider all operability aspects of a significant oil leak on the 'A' EFW pump (EF-P-2A) outboard pump bearing. Auxiliary operators and control room operators had noticed the increased oil condition on EF-P-2A. The control room operators made a non-conservative operability determination that only considered standby pump conditions. The NRC inspectors also identified an empty oil reservoir condition.

- b. Determination of how long the issue existed, and prior opportunities for identification.

AmerGen determined that EF-P-2A was inoperable from January 6, 2001, to February 14, 2001, a period of 39 days. On January 6, 2001, EF-P-2A was operated for an EFW system automatic start circuit surveillance. AmerGen's investigation determined that the oil leak was through the bearing housing cover plate. The bearing housing cover bolts loosened over time due to the torque experienced during pump starts resulting in oil leakage from the bearing reservoir. An inservice pump vibration test, performed two pump starts prior, yielded a small increase in axial vibration. On February 1, 2001, pump inservice testing (IST) vibration results were in the IST alert range. AmerGen concluded that any successive pump start after the January 6, 2001, test would have initiated the significant oil leak on that date. AmerGen also realized that the IST surveillance performed on February 1, 2001, was another missed opportunity for identification. Several corrective actions were established to improve IST surveillance review.

- c. Determination of the plant-specific risk consequences (as applicable) and compliance concerns associated with the issue.

AmerGen's evaluation assigned a core damage frequency impact of greater than 1.0E-6, but less than 1.0E-5. The inspectors reviewed, and confirmed the validity of, AmerGen's evaluations and assumptions. The failure to promptly correct the significant EF-P-2A oil leak was a violation of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," and was described in NRC Inspection Report 50-289/2001-002.

AmerGen promptly repaired EF-P-2A once the significance of the oil leak was properly characterized.

## 02.02 Root Cause and Extent of Condition Evaluation

- a. Evaluation of method(s) used to identify root cause(s) and contributing cause(s).

AmerGen used event and causal factor charting, and barrier analysis. AmerGen evaluated human performance issues, programmatic weaknesses and equipment issues associated with the extended inoperable condition for EF-P-2A. The inspectors determined that AmerGen appropriately followed 1000 ADM - 7216.02, "Root Cause Evaluation Procedure."

- b. Level of detail of the root cause evaluation.

AmerGen's root cause evaluation was thorough. The primary human performance issue was a failure to consider all the available information regarding the status of EF-P-2A against its design basis requirements. Another root cause, related to the equipment failure, was a lack of programmatic barriers in place to detect or prevent the bearing housing cover bolts from loosening. AmerGen's root cause evaluation also listed two contributing causes associated with the inoperable EF-P-2A.

- c. Consideration of prior occurrences of the problem and knowledge of prior operating experience.

AmerGen's evaluation included a review to see if similar problems occurred involving incorrect operability determinations. The review identified two problems in 1999 involving a main steam isolation valve and the 'B' EFW pump. Although some similarities existed in the previous problems, AmerGen concluded that the corrective actions associated with those problems would not likely have prevented the EF-P-2A problem and incorrect operability determination. AmerGen also reviewed industry operating experience for the equipment root cause associated with a failure to periodically check fastener tightness. The industry operating experience review did not identify any issues involving fastener tightness and bearing housings.

- d. Consideration of potential common cause(s) and extent of condition of the problem.

AmerGen's evaluation considered the potential for common cause and extent of condition associated with loose bearing covers and low oil conditions. AmerGen completed several actions to ensure that loose fasteners were not adversely affecting other risk significant pumps and that known oil leaks were accurately quantified. AmerGen also reviewed all recent IST vibration results for safety-related pumps and equipment. All open corrective maintenance tasks and all open corrective action program issues were reviewed for operability. AmerGen did not identify any additional problems. The inspectors considered AmerGen's extent of condition to be extensive and timely.



### 02.03 Corrective Actions

#### a. Appropriateness of corrective action(s).

AmerGen took immediate corrective actions to make EF-P-2A operable. The bearing housing cover bolts were tightened and the oil leak stopped. AmerGen implemented several corrective actions to improve human performance regarding operability determinations, equipment monitoring, and IST program implementation.

AmerGen also initiated corrective actions to periodically check the bearing housing fastener tightness on all safety-related pumps with similar bearing design. However, the inspectors determined that AmerGen overlooked corrective maintenance activities as another potential for loose bearing housing fasteners. A recent example involved the 'B' EFW pump (EF-P-2B). The EF-P-2B outboard bearing assembly was disassembled for corrective maintenance and the bearing housing bolts were reinstalled without any torque criteria. The significance of the EF-P-2B problems was very low (Green) and was described in NRC Inspection Report 50-289/01-07.

The inspectors also identified that AmerGen did not effectively implement corrective actions involving two risk significant pumps. Effective implementation of some corrective actions could have earlier identified degraded conditions on a decay heat closed cycle cooling water pump and a decay heat removal pump.

#### (1) 'B' Decay Heat Closed Cycle Cooling Water Pump Oil Leak

AmerGen determined that a contributing cause in the inoperable 'A' EFW pump issue was a failure to appropriately respond to increased pump oil leakage and was the result of an inadequate oil monitoring and trending program. AmerGen established an oil trending database as a corrective action for this contributing cause. The oil trending database was established in April 2001. Control room supervisors updated the oil trending database by reviewing auxiliary operator logs. Auxiliary operators maintained all oil reservoir bowls on safety-related equipment greater than one-half full. Oil additions were recorded within the auxiliary operator logs. The oil trending database contained acceptance criteria specific for each equipment. The acceptance criteria for excessive oil leakage was established in August 2001.

On November 20, 2001, auxiliary operators added oil to the 'B' decay heat closed cycle cooling water pump (DC-P-1B) coupling. One-fourth of an oil bowl was added. On November 21, 2001, auxiliary operators again added one-fourth of an oil bowl to DC-P-1B coupling. The oil trending data base included instructions to initiate a correction action process (CAP) item for more than one-half cumulative bowl additions within 30 days. A CAP was not initiated on November 21, 2001. Oil additions also occurred on November 24 and 30, 2001, and were one-half bowl each. The CAP was initiated on November 30, 2001. However, the CAP initiation was still not prompted by the required control room supervisors' database review, but rather by an operations support staff who was present in the main control room when the oil additions were being updated. The CAP also did not evaluate the continued operability of DC-P-1B until December 6, 2001.

On December 6, 2001, system engineers evaluated the increased oil addition on the operating DC-P-1B. The DC-P-1B coupling oil bowl was marked with calibrated level indications. After about nine hours of operation, the system engineers determined that the leak rate was in excess of the DC-P-1B mission time during a design basis accident. The engineers also initially and conservatively considered that oil additions during a design basis accident would be precluded by high radiation levels. Control room operators subsequently declared DC-P-1B inoperable. The DC-P-1B coupling oil seal was repaired and DC-P-1B was returned to service on December 8, 2001.

On January 9, 2002, AmerGen convened a plant operations review committee (PORC) to ascertain the past operability of DC-P-1B. The PORC also considered the potential for an excessive oil leak to have existed even before the plant shutdown on October 9, 2001, prior to the refueling outage. The inspectors were present during the PORC discussions and the inspectors also reviewed the supporting operability documentation. The PORC considered oil additions recorded in the oil trending database, and they also considered 298 hours of DC-P-1B operation that occurred between October 9, 2001, and November 20, 2001. AmerGen determined that DC-P-1B would have successfully operated for twelve continuous days without any oil addition. Radiological calculations determined that an operator inspecting and oiling DC-P-1B would have received about 3.5 rem on day five after a design basis accident. The PORC concluded that auxiliary operator rounds on equipment important during an accident would likely be made at these radiation levels. Radiation levels would also decrease over time. Therefore, the PORC determined that DC-P-1B was never inoperable with the oil leak that existed.

This finding was more than minor and had an actual impact on safety. Compensatory measures by equipment operators would have been required to maintain DC-P-1B operable during its design basis mission time. AmerGen did not evaluate the significance of the increased oil consumption and its impact on continued operability for several days. The inspectors used phase 1 of the at-power significance determination process (SDP) and the mitigating systems cornerstone to determine the significance of this finding. This issue screened to Green in phase I because DC-P-1B was ultimately determined to remain operable. The inspectors considered the necessary oil additions would have likely occurred even if DC-P-1B were operating during accident conditions.

10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," requires, in part, that measures shall be established to assure that significant conditions adverse to quality, such as deficiencies, are promptly identified and corrected. Contrary to this requirement, operators did not promptly identify a significant oil leak on DC-P-1B. The failure to identify the problem was noteworthy because programmatic AmerGen requirements were also not followed. The AmerGen requirements were established after an earlier problem with untimely identification of a significant oil leak on another safety-related pump, EF-P-2A. This violation of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," is being treated as a non-cited violation because of the very low safety significance and because AmerGen has entered this problem into its CAP (CR86594). **(NCV 50-289/01-14-01)**

- (2) 'A' Decay Heat Removal Pump Elevated Vibration

AmerGen determined that a contributing cause in the inoperable EFW pump issue was a failure to appropriately respond to increased pump vibration and was the result of an inadequate IST program. AmerGen implemented several corrective actions to strengthen the vibration monitoring program. Specifically, the IST program administrative procedure (AP) 1041, "IST Program Requirements," was revised to include guidance for prompt investigation or repair if a component falls into the IST alert or required action range. Guidance was also established for vibration data changes of greater than 50 percent (increase or decrease) from the last vibration performance test.

On October 29, 2001, an IST was performed on the 'A' decay heat removal pump (DH-P-1A) as a post-maintenance test. AmerGen intended to establish new vibration reference values during the post maintenance test. A pump seal repair had just been completed on DH-P-1A. Initial vibration results were in the alert range when compared to previous vibration reference values. Operators performed the IST an additional time. Vibration results the second time were not in the alert range, but were about 100 percent greater than the previous vibration reference values. The operators declared DH-P-1A operable after the second IST.

On November 2, 2001, operators noticed that DH-P-1A was operating louder than expected. The operators secured the pump and declared it inoperable. AmerGen immediately investigated the source of the noise and determined that a bearing housing support was improperly installed during the seal maintenance. The improper installation had placed additional stresses on the pump bearing and increased the vibration results. The loud noise was also attributed to the increased pump vibration. The maintenance problems associated with the bearing support assembly were treated as a licensee identified non-cited violation and were described in NRC Inspection Report 50-289/01-08, Section 4OA7.

The inspectors determined that IST engineers had missed earlier opportunities to promptly investigate abnormal vibration results after the DH-P-1A maintenance, a contributing cause in the EFW pump bearing problem. Reference values were not validated prior to returning DH-P-1A to an operable status. Independent from AP 1041 requirements and ASME code requirements for establishing new reference values, IST engineers and operators also did not follow other AP 1041 requirements for investigating vibration results above a 50 percent change, a corrective action established for the EFW pump bearing problem.

This finding was more than minor and had an actual impact on safety. Corrective maintenance to ensure the long term reliable operation of a risk significant pump, DH-P-1A, was delayed for several days because elevated IST vibration results were not promptly investigated. The necessary corrective actions on the DH-P-1A bearing support assembly were completed after operators noticed loud noises. Operators and IST engineers did not follow required programmatic investigations that could have identified the degraded DH-P-1A condition earlier. The inspectors used phase 1 of the shutdown SDP and considered the finding in the mitigating systems cornerstone. During the time the degraded condition existed on DH-P-1A, the core was fully offloaded, or core reload was in progress with the reactor coolant system level greater than 23 feet above the reactor vessel flange. The applicable shutdown SDP core heat

removal guidelines for these plant conditions were maintained and so this issue screened to Green, very low safety significance.

Contrary to ASME code requirements and AmerGen procedure AP 1041, operators declared DH-P-1A operable based on outdated vibration reference values. The operators' and IST engineers' failure to establish new reference values prior to declaring the DH-P-1A operable is also contrary to the ASME code and is a violation of TMI technical specification (TS) 4.2.2. TS 4.2.2 requires, in part, that IST of ASME Code Class 2 pumps, such as DH-P-1A, shall be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable Addenda as required by 10 CFR 50, Section 50.55a(f). This TS violation is being treated as a non-cited violation due to the issue's very low safety significance and because AmerGen has entered this problem into its CAP (CR87376). **(NCV 50-289/01-14-02)**

b. Prioritization of corrective actions.

AmerGen implemented immediate corrective actions to repair EF-P-2A and to also verify that similar inoperable conditions did not exist on other safety-related pumps and equipment. Short-term corrective actions were completed to improve operability determinations and equipment monitoring. Equipment monitoring was specifically addressed through an oil consumption trending program and the IST program. Long-term corrective programs were developed to address all root causes and contributing causes.

c. Establishment of schedule for implementing and completing the corrective actions.

The inspectors reviewed AmerGen's progress to date on all EF-P-2A corrective actions. The corrective actions were scheduled appropriately, completed on schedule, or reasonably extended through AmerGen's CAP.

d. Establishment of quantitative or qualitative measures of success for determining the effectiveness of corrective actions to prevent recurrence.

AmerGen established two corrective action effectiveness reviews: an interim review performed in August 2001, and a final effectiveness review performed in December 2001. The effectiveness reviews included specific corrective action items with established criteria for success. The DC-P-1B problems described in section 02.03a. of this inspection report were considered in the final effectiveness review and used by AmerGen to conclude that there were instances where implementation of the EF-P-2A associated corrective actions were not fully effective. AmerGen initiated CAP item CR86594 to continue its evaluation and resolution of problems related to non-conservative operability determinations and untimely identification of degraded equipment conditions.

03. Management Meetings

Exit Meeting Summary

On February 1, 2002, the inspectors presented the inspection results to members of AmerGen management led by Mr. Bruce Williams. AmerGen acknowledged the findings presented. AmerGen did not indicate that any of the information presented at the exit meetings was proprietary.

ATTACHMENT  
SUPPLEMENTAL INFORMATION

a. Key Points of Contact

D. Atherholt, Shift Operations Superintendent  
 G. Gellrich, Plant Manager  
 J. Stanley, Acting Director, Site Engineering  
 J. McElwain, Manager, Regulatory Assurance  
 S. Queen, Senior Manager, Plant Engineering  
 J. Robertson, Plant Operations Director

b. Items Opened, Closed, and Discussed

Opened and Closed

50-289/01-14-01	NCV	Inadequate Oil Monitoring and Trend Program
50-289/01-14-02	NCV	Inadequate Inservice Test Program

c. Acronyms

ADAMS	Agencywide Documents and Management System
AmerGen	AmerGen Energy Company, LLC
AP	Administrative Procedure
ASME	American Society of Mechanical Engineers
CAP	Corrective Action Process
CFR	Code of Federal Regulations
EFW	Emergency Feedwater
IMC	Inspection Manual Chapter
IR	Inspection Report
IST	Inservice Testing
NCV	Non-cited Violation
NRC	Nuclear Regulatory Commission
PORC	Plant Operations Review Committee
SDP	Significance Determination Process
TMI	Three Mile Island, Unit 1
TS	Technical Specification

d. Partial List of Documents Reviewed

- Corrective Action Program No. T2001-0305
- AmerGen's Root Cause Evaluation, "EF-P-2A Inoperable Beyond Tech Spec Allowance"
- Condition Report, CR86594
- Condition Report, CR84653
- Condition Report, CR81907
- 1000 ADM - 7216.02 "Root Cause Evaluation Procedure"
- AP 1041, "IST Program Requirements"