Entergy

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
600 Rocky Hill Road
Plymouth, MA 02360

David E. Noyes, Director
Regulatory & Performance Improvement

July 21, 2015

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D.C. 20555

SUBJECT: Licensee Event Report 2015-005-00, Degrading Condenser Vacuum Resulting in Manual Reactor Scram

Entergy Nuclear Operations, Inc.
Pilgrim Nuclear Power Station
Docket No.: 50-293
License No.: DPR-35

LETTER NUMBER: 2.15.054

Dear Sir or Madam:

The enclosed Licensee Event Report (LER) 2015-005-00, Degrading Condenser Vacuum Resulting in Manual Reactor Scram, is submitted in accordance with 10 CFR 50.73.

This letter contains no commitments.

Please do not hesitate to contact Mr. Everett P. Perkins, Jr. (508) 830-8323, if there are any questions regarding this submittal.

Sincerely,

DE Noyes

David E. Noyes
Director, Regulatory and Performance Improvement

Attachment 1: Licensee Event Report 2015-005-00, Degrading Condenser Vacuum Resulting in Manual Reactor Scram (6 pages)

IE22
NRR

cc:

Mr. Daniel H. Dorman
Regional Administrator, Region 1
U.S. Nuclear Regulatory Commission
2100 Renaissance Blvd., Suite 100
King of Prussia, PA 19406-2713

Mr. Richard V. Guzman
Senior Project Manager
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Mail Stop O-8C2A
11555 Rockville Pike
Rockville, MD. 20852

USNRC Senior Resident Inspector
Pilgrim Nuclear Power Station

Attachment 1

Letter Number 2.15.054

Licensee Event Report 2015-005-00

Degrading Condenser Vacuum Resulting in Manual Reactor Scram

(6 Pages)

NRC FORM 366 (01-2014) U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 01/31/2017

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
Pilgrim Nuclear Power Station	05000293	1 OF 6

4. TITLE

Degrading Condenser Vacuum Resulting in Manual Reactor Scram

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	N/A
05	22	2015	2015	005	00	07	21	2015	FACILITY NAME N/A	DOCKET NUMBER N/A

9. OPERATING MODE	11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*			
N	☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
10. POWER LEVEL	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☑ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
004	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
	☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

LICENSEE CONTACT	TELEPHONE NUMBER *(Include Area Code)*
Mr. Everett P. Perkins, Jr. - Regulatory Assurance Manager	508-830-8323

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
E	SE	HX	S290	Y					

14. SUPPLEMENTAL REPORT EXPECTED	15. EXPECTED SUBMISSION DATE	MONTH	DAY	YEAR
☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☑ NO				

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

On Friday, May 22, 2015 at 10:02 hours EDT, with the Reactor Mode Select Switch in the Start-Up position and the reactor at approximately 4 percent core thermal power, a manual reactor scram was inserted due to degrading Main Condenser vacuum due to high air in-leakage from a crack on a feedwater heater expansion bellows and plant conditions caused by extended operation on the Main Turbine bypass valves.

Following the reactor scram, all rods were verified to be fully inserted and no Emergency Operating Procedure entry conditions existed. All plant systems responded as designed.

The cause of the event is that the design limitations of the Offgas System were exceeded by the unusual combination of plant conditions resulting in degrading main condenser vacuum. Corrective action was taken to mitigate the air in-leakage from the crack on a feedwater heater expansion bellows. In addition, guidance and limitations have been provided for operation with elevated air in-leakage conditions.

This event posed no threat to public health and safety.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Pilgrim Nuclear Power Station	05000293	2015	005	00	2 OF 6

BACKGROUND

The Main Condenser Vacuum System is designed to remove non-condensable gases from the condenser including air in-leakage and disassociation products originating in the reactor, and exhaust them through the Augmented Offgas (AOG) System to the main stack. The size of the gas removal system is determined by taking into consideration potential air in-leakage, the oxygen and hydrogen formed by disassociation of water in the reactor, and the water vapor contained in the gas mixture.

The AOG System reduces the amount of gas to be treated by recombining disassociated hydrogen and oxygen. The AOG System delays the release of radioactive gases to the atmosphere, to permit their decay to an acceptable release level. This system also filters out radioactive gas particulate daughter products, minimizing their release to the atmosphere.

Elevated air in-leakage was first observed during the startup on February 8, 2015 following the forced outage caused by winter storm Juno. AOG System flowrate (air in-leakage) increased by approximately 40-50 standard cubic feet per minute (scfm) above baseline to a new value of 70 scfm. Total Offgas system flow correspondingly rose by about the same amount to 200 scfm. Actions were taken to inspect the Main Condenser boot seal trough for signs of leakage and to ensure adequate trough flow. However, these actions had no effect. A Failure Modes Analysis (FMA) team was established to identify possible sources. Valve lineups and system leak checks were conducted using acoustic equipment that can detect the sound of air leakage. A troubleshooting plan was also written and implemented to cycle low pressure feedwater heater operating and startup vents while monitoring key parameters. The troubleshooting identified a change in air in-leakage of 6 scfm and 4 scfm when the operating vents were individually cycled for E-101B, 5th Point Feedwater Heater-B. The FMA team recognized this as a source of air in-leakage but did not believe it to be the major contributor because the leakage observed (10 scfm combined for the E-101B operating vent lines) did not account for the 40 scfm change that had been observed after the forced outage. A walkdown of the E-101B operating vent piping using an ultrasonic microphone did not identify evidence of leakage that would require additional testing during the upcoming outage. All actions identified by the FMA team to be performed online were completed without identifying the source of elevated air in-leakage. The next action was to perform helium testing in the condenser bay while at reduced power during the shutdown process. However, problems with the test equipment during the shutdown prevented effective leak detection. Since helium testing can only be performed with vacuum in the Main Condenser, the testing was rescheduled to be performed during the power ascension plan. The source of air in-leakage was not found during the plant shutdown for RFO 20, resulting in the leak remaining active during the plant startup from the outage.

Following RFO 20, helium testing eventually located the source of air in-leakage to be an expansion joint crack on heater E-101B.

EVENT DESCRIPTION:

During the plant startup from Refueling Outage 20 (RFO 20) on May 22, 2015, Main Condenser vacuum degraded and caused the crew to initiate an unplanned shutdown and eventual manual reactor scram. At the time of the transient, the Main Turbine roll was in progress, the Augmented Offgas (AOG) system had been bypassed due to high moisture content, and Main Sea Water Pump-B was secured due to chloride intrusion into the 1-1 Waterbox. Additionally, air in-leakage to the Main Condenser was elevated with troubleshooting in progress to find the source.

More specifically, during the plant startup following RFO-20, the Main Turbine roll was commenced on May 21, 2015 at 20:10 hours but was aborted at 20:32 hours due to a report of abnormal noise at the generator end. The Reactivity Maneuver plan was suspended at 21:00 hours in order to support the investigation and was not resumed until May 22, 2015 at 04:10 hours. During the time that the startup was on hold, reactor power was 18-20% with pressure maintained by the bypass valves. The steam from the bypass valves enters the Main Condenser below the level of the tubes. The steam flow from below the tubes results in less effective removal of non-condensable gases compared to turbine exhaust steam flow from above the tubes. While controlling pressure with the bypass valves, a volume of non-condensable gases accumulates in the area above the tubes. This accumulated volume is later sent to the Offgas system when the Main Turbine and area above the tubes are evacuated during the turbine roll.

The Operational Decision Making Issue (ODMI) "Condenser Sea Water Leak" remained active from before RFO20. Evidence of continued leakage was observed during the plant startup. The hotwell conductivity had exceeded Trigger Point #2 which is > 0.10 micro-Siemens/centimeter (micro-S/cm) during the dayshift on May 21, 2015. Chemistry was performing increased sampling per the ODMI. During the turbine roll, the condensate pump suction conductivity had degraded to > 0.10 micro-S/cm, and the crew entered procedure PNPS 2.4.33, Condenser Chloride Intrusion. Rising Hotwell Conductivity was observed on the Outlet of Condenser Waterbox 1-1 and sawdust was added to the Seawater Pump bays to mitigate the leak. Condensate pump suction conductivity levels stabilized between 0.1 – 0.3 micro-S/cm. Procedure PNPS 2.4.33 would require the affected waterbox to be isolated if Condensate Pump suction conductivity were to exceed 0.3 micro-S/cm. When the plant startup was placed on hold to investigate the Main Generator abnormal noise, the decision was made to secure Sea Water Pump-B and isolate Waterbox 1-1 for tube inspection and repair. When Sea Water Pump-B was secured at 21:26 hours, Main Condenser parameters degraded but then stabilized:

- Condenser Hotwell temperature rose from 80 degrees-Fahrenheit (F) to 97 degrees-F
- SJAE Offgas flowrate rose from 170 scfm to off-scale above 200 scfm
- SJAE temperature rose from 125 degrees-F to 138 degrees-F
- Condenser vacuum degraded from 28.3 inches of Mercury (in-Hg) to 27.8 in-Hg

The crew was aware of the degraded condenser performance and established a vacuum benchmark of 26.5 in-Hg, but did not see an immediate operational threat once parameters had stabilized. Operators had difficulty placing the AOG system in service during the startup due to high moisture in the system. The system was placed in service on dayshift but was then bypassed at 17:45 hours in order to go back into air purge to attempt to dry the system. It was noted that the Offgas Holdup Line Loop Seal Level Control Valve, AO-3750, was not opening (Level Switch issue) as expected which contributed to the high moisture in the system. A troubleshooting plan for the level controller was developed while Operations took action to place the system into service per the system startup sections of procedure PNPS 2.2.106, Augmented Offgas System.

Main Condenser air in-leakage is measured on AOG process flow indicator, FI-9247, which is only available while the system is in service. When AOG was placed back in service on May 22, 2015 at 02:28 hours, the air in-leakage flowrate varied between 110-120 scfm. Indications of water in the AOG system continued (high adsorber vessel temperatures, high dew-point, and high filter differential pressure). The system was bypassed again at 04:26 hours which reduced the air removal capacity of the Offgas system because the AOG Steam Jet Compressors were no longer providing additional motive force to the intercondenser and aftercondenser. The abnormal noise from the Main Generator brush rigging was determined to have been due to brush cartridge 2T having been in contact with the commutator. The condition was corrected and the Main Turbine roll was re-commenced at 05:27 hours. When steam was admitted to the Main Turbine, the volume of non-condensable gases that had accumulated in the condenser while using bypass valves was exhausted to the Offgas system in a short time interval. The surge of air exceeded the reduced capacity of the Offgas system, which was operating with AOG out of service and elevated hotwell temperatures due to Main Seawater Pump-B secured. The Offgas System process flow temperature began to rise due to air blanketing the heat exchanger surfaces in the intercondenser and aftercondenser. As the turbine was brought to rated speed, vacuum slowly degraded from 27.8 in-Hg to 27.4 in-Hg.

At 06:16 hours, with the Main Turbine rotating at 1800 RPM, the crew prepared to synchronize to the grid. However, the Main Generator Field Breaker failed to close (Main Transformer Ground Disconnect Switch misaligned). At this time, the nightshift crew began shift turnover to the oncoming dayshift crew and it was noted that vacuum was slowly degrading. Off-normal operating procedure PNPS 2.4.36, Decreasing Condenser Vacuum, was entered.

Turnover to the dayshift crew was completed, and the action to trip the Main Turbine was established if the benchmark of 26.5 in-Hg was reached. That action was taken when the benchmark was reached at 07:26 hours, however, conditions continued to degrade. The crew commenced lowering power using established instructions. New condenser vacuum benchmarks were established as follows:

- a reactor shutdown would be commenced at 20 in-Hg, and
- a manual scram would be inserted at 12 in-Hg.

The crew lowered power and monitored condenser parameters. Personnel were dispatched to fill the aftercondenser and intercondenser loop seals due to alarm "After Condenser Loop Seal Level High/Low" (CP600L-A8). Waterbox 1-1 had already been tagged and opened for inspection which removed the option of restoring Sea Water Pump-B to service. Hotwell water temperature continued to rise rapidly which prompted the crew at 08:00 hours to raise hotwell level to the high end of the normal control band in an effort to introduce cooler water from the Condensate Storage Tanks. This action temporarily improved vacuum as hotwell water temperature lowered from 140 degrees-F to 135 degrees-F, but the Offgas system remained overloaded. At 08:18 hours it was noted that vacuum had started to degrade again. At 08:21 hours, vacuum reached the benchmark of 20 in-Hg requiring the crew to commence a reactor shutdown per procedure PNPS 2.1.5, Controlled Shutdown from Power. Vacuum continued to degrade toward the scram benchmark of 12 in-Hg as the crew inserted control rods to shutdown the reactor. At 09:36 hours, the crew aligned the Sea Water system for three Waterbox operation per procedure PNPS 2.4.36, in an effort to improve Sea Water cooling to the Hotwell. However, with the plant in the current configuration, this action further over-loaded the Offgas System. Vacuum continued to degrade. At 10:02 hours, a manual reactor scram was inserted due to reaching the benchmark of 12 in-Hg.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Pilgrim Nuclear Power Station	05000293	2015	005	00	5 OF 6

CAUSE OF THE EVENT

The cause of the event is that the design limitations of the Offgas System were exceeded by the unusual combination of plant conditions resulting in degrading main condenser vacuum.

CONTRIBUTING CAUSE:

The organization did not find and repair the source of air in-leakage prior to the completion of RFO-20.

CORRECTIVE ACTIONS

The 5th Point Feedwater Heater-B, E-101B, expansion joint crack air in-leakage was mitigated by performing a temporary repair. (COMPLETE)

An ODMI was issued to provide operational guidance and limitations for elevated air in-leakage conditions. (COMPLETE)

The corrective action to preclude recurrence is to revise operating procedures to incorporate the limitations of the Offgas System to process elevated air in-leakage.

Additional corrective actions are captured in the corrective action program in Condition Report CR-PNP-2015-05197.

SAFETY CONSEQUENCES

The Turbine Trip Without Bypass Transient analyzed in the PNPS Updated Final Safety Analysis Report (UFSAR) assumes:

- the reactor and turbine generator are initially operating at full power when the load rejection occurs, and
- the turbine bypass valve system is failed in the closed position

Since this event occurred at a low reactor power condition with the turbine generator not in service and the turbine bypass valves available to remove the decay heat, this degrading condenser vacuum event was within the analyzed conditions.

During the evolution a benchmark for condenser vacuum was set and properly executed. The manual scram was a conservative action taken in anticipation of reaching the main turbine bypass valve closure setpoint. The reactor scram was initiated and successfully completed. The plant operated in accordance with design

There was no adverse impact to the safety of the public, nuclear safety, industrial safety, or radiological safety. During and prior to the event all emergency core cooling systems were available. Following the event, the residual heat removal system was available. Since no systems were impacted that contribute to Core Damage Risk, there was no appreciable change in Core Damage Frequency as a result of this event.

Throughout these events there was no adverse impact on the public health or safety.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
		YEAR	SEQUENTIAL NUMBER	REV NO.	
Pilgrim Nuclear Power Station	05000293	2015	005	00	6 OF 6

REPORTABILITY

This report is submitted in accordance with 10CFR50.73(a)(2)(iv)(A) – System Actuation, Any event or condition that resulted in manual or automatic actuation of any of the systems listed in paragraph (a)(2)(iv)(B). The Reactor Protection System is included in 10CFR50.73(a)(2)(iv)(B). The Reactor Protection System was manually actuated.

PREVIOUS EVENTS

The most recent reactor scrams resulting from degrading condenser vacuum events at PNPS reported as LERs are as follows:

LER 1999-009-00 – Pilgrim, Manual Reactor Scram Due to Degrading Main Condenser Vacuum, dated October 13, 1999
On September 13, 1999, at 6:25 p.m., Pilgrim was manually scrammed from 27 percent power due to degrading condenser vacuum. The degrading condenser vacuum was caused by failure of the augmented off-gas (AOG) system train B condenser level control system in conjunction with an AOG air purge. The failure created a flow path for the purge gas to enter the main condenser. The 24 SCFM purge gas was greater than the capacity of the main condenser air ejector system to maintain condenser vacuum.

LER 2012-002-00 – Manual Reactor Scram Due to Degraded Condenser Vacuum, dated July 20, 2012
On Tuesday, May 22, 2012 at 1311 hours, with the reactor at approximately 35% core thermal power, during a planned power reduction to support thermal backwash of the main condenser, a manual reactor scram was inserted due to degrading main condenser vacuum. The direct cause of the degraded vacuum is attributed to loss of the Steam Jet Air Ejector (SJAE) inter-condenser loop seal due to a partially open SJAE steam supply valve (1-HO-163). The root cause of the 1-HO-163 valve being partially open was due to inadequate processing of an emergent work order related to the reach rod position indication versus the actual valve position.

ENERGY INDUSTRY IDEBTIFICATION SYSTEM (EIIS) CODES

COMPONENTS	CODES
Heat Exchanger	HX

SYSTEMS	CODES
Condenser Vacuum System	SH
Steam Extraction System	SE

REFERENCES

Condition Report CR-PNP-2015-05197, Reactor Scram Initiated Due to Degrading Condenser Vacuum