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

March 8, 2016

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

SUBJECT: Licensee Event Report 2015-004-01, 480V Bus B6 Auto Transfer Function Degraded

Pilgrim Nuclear Power Station
Docket No.: 50-293
Renewed License No.: DPR-35

LETTER NUMBER: 2.16.008

Dear Sir or Madam:

The enclosed revision to Licensee Event Report (LER) 2015-004-01, 480V Bus B6 Auto Transfer Function Degraded, is submitted in accordance with 10 CFR 50.73.

This LER revision includes additional information and corrects technical errors discovered in the original LER.

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

This letter contains no new regulatory commitments.

Sincerely,

Michael A. Romeo
Director, Regulatory and Performance Improvement

Attachment 1: Licensee Event Report 2015-004-01, 480V Bus B6 Auto Transfer Function Degraded (7 pages)

IE22
NRR

cc:

Mr. Daniel H. Dorman
Regional Administrator, Region I
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2100 Renaissance Blvd., Suite 100
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NRC Senior Resident Inspector
Pilgrim Nuclear Power Station

Attachment 1

Letter Number 2.16.008

Licensee Event Report 2015-004-01

480V Bus B6 Auto Transfer Function Degraded

(7 Pages)

NRC FORM 366 (11-2015) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 10/31/2018

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LICENSEE EVENT REPORT (LER)

(See Page 2 for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
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4. TITLE: 480 Volt Bus B6 Auto Transfer Function Degraded

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
04	23	2015	2015	- 004	- 01	3	8	2016	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)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
	☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
10. POWER LEVEL	☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
	☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
000	☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
	☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☒ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
	☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(C)	☐ 73.77(a)(1)
	☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☒ 50.73(a)(2)(v)(D)	☐ 73.77(a)(2)(i)
	☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(vii)	☐ 73.77(a)(2)(ii)
		☐ 50.73(a)(2)(i)(C)	☐ OTHER	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
X	ED	2	A109	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 April 23, 2015 with the unit shutdown for refueling outage, while performing plant procedure 3.M.3-27, Attachment 1 "Calibration of Bus B1 Relays," there was indication the time delay Agastat relay 27A-B1X/TDDO contact 3-5 had failed open. The contact never changed state during cycling of the relay. In the event of a degraded voltage condition as detected on bus B1, bus B6 would not have automatically transferred to bus B2 as designed. Bus B6 would have tripped from B1 with degraded voltage and lost power altogether. Bus B6 supplies Class 1E electric power to the Low Pressure Coolant Injection (LPCI) valves (MO-1001-28A/B & MO-1001-29 A/B), Salt Service Water (SSW) Pump C (P208C), 125 and 250 volt direct current (DC) back-up battery chargers (D14 and D15, respectively), Residual Heat Removal Valves (MO-1001-19 and MO-1001-32), Primary Containment Isolation Valves (MO-1001-50, MO-1201-2, MO-1201-80, MO-220-1), and Reactor Recirculation System Valves (MO-202-4A/B and MO-202-5A/B).

The relay was replaced on April 24, 2015. The failed relay was disposed of prior to any failure analysis being performed. Disposal of the relay, without performing the failure analysis, was entered into the corrective action program.

This event was not risk significant and posed no threat to public health and safety.

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BACKGROUND

Bus B6 supplies 480 volt electric power to plant equipment including: low pressure coolant injection (LPCI) valves (MO-1001-28A/B & MO-1001-29 A/B that are also primary containment isolation valves) that open or close to facilitate LPCI injection flow during the plant response to a postulated design basis event; Salt Service Water (SSW) Pump C (P208C); backup battery chargers (D14 and D15) for the 125 volt and 250 volt Battery Systems; Residual Heat Removal (RHR) Loop A & B Cross-Tie Block Valve MO-1001-19 and RHR System Discharge to Radwaste Block Valve MO-1001-32; Primary Containment Isolation Valves (PCIV) MO-220-1, MO-1201-2, MO-1201-80, MO-1001-50; Reactor Recirculation System Suction Valves MO-202-4A and MO-202-4B, and Recirculation System Discharge Valves MO-202-5A and MO-202-5B. Power to bus B6 is normally fed from bus B1 (train A). Bus B2 is the back-up power feed to bus B6 (train B). Bus B6 is designed to automatically transfer power to the opposite train power feed (as long as voltage is adequate) in the event of loss of power or degraded voltage on the feed providing power to bus B6.

The RHR LPCI subsystem provides low-pressure high-capacity cooling water into the reactor via injection into one of the recirculation loops in the event of a design bases accident. Bus B6 supplies electric power to the LPCI injection valves (MO-1001-28A/B & MO-1001-29 A/B). The Core Spray (CS) system also provides low-pressure high-capacity cooling flow directly into the reactor pressure vessel (RPV) via a sparger inside the RPV.

The SSW system is designed to function as the ultimate heat sink for all the systems cooled by the Reactor Building Closed Cooling Water (RBCCW) and Turbine Building Closed Cooling Water (TBCCW) systems during planned operations in all operating states, by continuously providing adequate cooling water flow to the secondary sides of the RBCCW and TBCCW heat exchangers. The SSW system consists of two open loops, A and B. Each loop has two pumps. Pump A and B are in Loop A and Pump D and E are in Loop B. Pump C is a common spare. Bus B6 supplies electric power to SSW Pump C (P208C).

The Pilgrim battery system is comprised of two 125 volt and one 250 volt direct current (DC) systems each normally supplied by a battery charger. In addition, a 125 volt shared back-up battery charger (D14) is supplied, which can be used for either 125 volt battery, and a 250 volt back-up battery charger (D15) is supplied. On loss of a normal battery charger, the back-up battery charger can be used. Bus B6 supplies electric power to both the 125 and 250 volt back-up battery chargers.

Normally open RHR Loop A & B Cross-Tie Block Valve (MO-1001-19) receives power from bus B6.

Normally closed Shutdown Cooling Suction Valve (MO-1001-50) receives power from bus B6 and is also a PCIV with its associated Breaker (2046) kept open to address "hot shorts" concerns. The valve opens to take suction from the Reactor Recirculation System to provide shutdown cooling with the reactor shutdown.

Normally closed RHR System Discharge to Radwaste Block Valve (MO-1001-32) receives power from bus B6.

Normally open Reactor Water Cleanup (RWCU) Pump Suction Inboard Isolation valve (MO-1201-2) is also a PCIV and receives power from bus B6. Normally open RWCU return isolation valve (MO-1201-80) is also a PCIV and receives power from bus B6.

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Normally closed Main Steam Line Drain Valve (MO-220-1) is also a PCIV and receives power from bus B6.

Normally open Reactor Recirculation System Suction Valves MO-202-4A and MO-202-4B receive power from bus B6. Normally open Reactor Recirculation System Discharge Valves MO-202-5A and MO-202-5B also receive power from bus B6.

During normal operation, with bus B6 being powered by bus B1, upon a degraded voltage signal via relays 27A-B1/1 and 27A-B1/2, time delay relay 27A-B1X/TDDO is energized and its normally open contact 3-5 closes to energize relay 27-B1X/TDE. Normally open contact 7-11 of relay 27-B1X/TDE closes to trip breaker 52-601 and normally closed contact 3-5 of relay 27-B1X/TDE opens to prevent closure of breaker 52-601. Normally open contact 2-6 of relay 27-B1X/TDE closes to close breaker 52-602. (Note: Breakers 52-102 and 52-202 which are in series with breakers 52-601 and 52-602, respectively, also transfer in a similar manner; however this transfer is completely independent of the failed 27A-B1X/TDDO relay. Both breakers 52-102 and 52-601 must open and both breakers 52-202 and 52-602 must close to complete the transfer of bus B6 to bus B2.)

EVENT DESCRIPTION

On April 23, 2015 with the unit shutdown for refueling outage, Pilgrim Nuclear Power Station (PNPS) personnel were performing various surveillance tests required to be conducted during shutdown conditions. While performing plant procedure 3.M.3-27, Attachment 1, "Calibration of Bus B1 Relays," there was indication the time delay Agastat relay 27A-B1X/TDDO contact 3-5 had failed open. The contact never changed state (i.e., never changed from open to closed) during testing of the relay.

This condition (contact 3-5 failing open) results in relay 27-B1X/TDE not being energized on a degraded voltage condition (detected by relays 27A-B1/1 and 27A-B1/2) on bus B1.

The problem description in CR-PNP-2015-03454 states "...contact 3 to 5 was found welded closed. The contact never changed state during the cycling of the relay. It measured 2.4K ohms all the time." Contrary to this problem description, the resistance measurement indicates contact 3-5 failed open, not closed. The de-energized condition of relay 27-B1X/TDE is confirmed by the fact that, if the 3-5 contact of relay 27A-B1X/TDDO was closed (welded closed) and caused relay 27-B1X/TDE to be energized, then contact 7-11 of relay 27-B1X/TDE would have tripped breaker 52-601. This breaker trip did not occur and the trip signal was not present.

CAUSE OF THE EVENT

The root cause of this event was not determined because the relay was disposed of prior to any failure analysis being performed. Disposal of the failed relay was entered into the corrective action program (Reference CR-PNP-2015-09853).

A steady resistance of 2.4 kΩ was found across relay 27A-B1X/TDDO contact 3-5 regardless if the relay was energized or de-energized. Since the relay contact was still connected to the circuit at the time of this measurement, this steady resistance is likely the circuit resistance in parallel with the open contact.

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Therefore, the relay contact may have been stuck open and did not change state as the relay was energized and de-energized. As documented in the Equipment Apparent Cause Evaluation (Reference CR-PNP-2015-3454), a review of the failure history of Agastat model E7022PB004 normally de-energized relays at Pilgrim did not identify any previous failures. The evaluation concluded the most probable cause to be a single random failure. The evaluation further indicates that binding of either the contact mechanism or the pneumatic piston could cause the relay contact to not change state when the relay was energized.

ADDITIONAL CONDITIONS

None.

CORRECTIVE ACTIONS

The Agastat time delay relay was replaced, restoring the degraded voltage protection functionality for the condition when bus B6 is being power by bus B1.

SAFETY CONSEQUENCES

Based on the last successful surveillance, it was assumed that the failed relay was inoperable from May 8, 2013, up to the date the relay was replaced and successfully tested on April 24, 2015.

When assessing the safety consequences of the failed relay without degraded voltage detected on bus B1, there are no actual safety consequences because bus B1 will continue to power bus B6.

When PNPS is on line and the 4160 volt busses A5 and A6 are powered from the Unit Auxiliary Transformer (UAT), on a unit trip the 4160 V busses would fast transfer to the Startup Transformer (SUT). This does not result in any loss of voltage to bus B1 and bus B6 stays on B1. Assuming SUT voltage is degraded or starts to degrade, at 95 percent voltage decreasing, the bus A5 undervoltage alarm (C3LC-A3) is received. The alarm response procedure (ARP) directs operators to enter procedure 2.4.144, Degraded Voltage. This procedure provides instructions to do a live bus transfer and put bus A5 on the emergency diesel generator (EDG). Bus B6 continues to receive power from B1 through this transfer. At 93 percent decreasing, the SUT degraded voltage relays operate and trip the SUT from bus A5. Bus A6 will trip independently from the SUT depending on the exact setpoint of the SUT to bus A6 degraded voltage relays. This 93 percent SUT degraded voltage setpoint is higher than the bus B1 degraded voltage relay setpoint of 92 percent and is designed to operate before a B6 transfer occurs. Since the SUT degraded voltage relays operate before the bus B1 degraded voltage relays on decreasing voltage, failed relay 27A-B1X/TDDO has no adverse effect on power to bus B6.

If the EDG's had not started, they will start and re-energize busses A5 and A6 in approximately 10 seconds. If the EDG's were already running, they will re-energize the busses in approximately 4 seconds. This time is determined by the time it takes bus voltage to decay, and EDG breaker close time delay relays to operate. Either way, bus B1 loses voltage for a sufficient length of time for its undervoltage relays to operate and trip bus B6 from bus B1. Once bus B1 and/or bus B2 voltage comes back, bus B6 goes to bus B1 or bus B2 per design. The failed relay will have no effect on this transfer.

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When assessing the failed relay together with postulated EDG degraded voltage detected on bus B1, the potential safety consequences and implications are described below.

Due to the failure of time delay relay 27A-B1X/TDDO, during a postulated EDG degraded voltage condition on bus B1 with normal alignment of bus B1 powering bus B6, bus B6 would not have automatically transferred to bus B2 as designed. This portion of the transfer scheme to transfer bus B6 to bus B2 from bus B1 was not operating completely (with contact 3-5 failed open) and, therefore, failure of time delay relay 27A-B1X/TDDO contact 3-5 to close would result in a loss of bus B6. Breaker 52-102 would open and breaker 52-602 would remain open resulting in a loss of all voltage to bus B6. This occurs on a degraded voltage condition only when the voltage as detected at bus B1 is less than 92 percent but greater than 58 percent.

When the 4160 volt bus A5 is powered from the EDG, if the EDG voltage degrades, at 95 percent voltage decreasing the bus A5 undervoltage alarm is received. Although Alarm Response Procedure (APR-C3LC) directs operators to enter Procedure 2.4.144, Degraded Voltage, this procedure does not provide guidance for when the EDG is supplying the bus, instead, bus B6 will continue to receive power from bus B1. At 92 percent voltage decreasing, bus B1 degraded voltage relays 27A-B1/1 and 27A-B1/2 operate and energize relays 27A-B1X/TDDO and 27A-B1Z/TDDO. Per design, relay 27A-B1Z/TDDO contact 3-5 closes and energizes relay 27-B1Z/TDE. Relay 27-B1Z/TDE in turn trips breaker 52-102 and closes breaker 52-202, if bus B2 voltage is within design. However, due to the failure of relay 27A-B1X/TDDO contact 3-5 to close, relay 27-B1X/TDE would not energize and complete the transfer of B6 to B2 by tripping breaker 52-601 and closing 52-602. Consequently, bus B6 would be in a configuration where there is no connection to either bus B1 or B2, which would leave bus B6 with no voltage. In this configuration, with bus B6 de-energized, there is no potential damage to connected loads from degraded voltage. This condition is immediately self-revealing to the control room operators because a significant portion of control room lighting is powered from bus B6 and will be lost. Based on plant control room indications, operators will enter procedure 2.4.B.6, Loss of Bus B6, to restore power to bus B6 and take other actions, as appropriate.

The PCIVs that are normally closed (MO-220-1 and MO-1001-50) would fail-as-is (closed) on loss of bus B6 and would, therefore, continue to perform their intended isolation safety function. If these valves are in the open position, the redundant isolation valves (MO-220-2 and MO-1001-47, respectively) with a diverse power source would perform the required safety function. The PCIVs that are normally open (MO-1201-2 and MO-1201-80) would fail-as-is (open) and, therefore, would not be able to perform their intended safety function. However, the redundant isolation valves (MO-1201-5 and check valve 6-CK-58A) were operable and available to perform the required safety function.

Normally open low pressure coolant injection (LPCI) valves MO-1001-28A/B would fail-as-is (open) and would not be able to perform their PCIV function. However, normally closed valves MO-1001-29 A/B would fail-as-is (closed) and would perform the PCIV function.

The RHR Loop A & B Cross-Tie Block Valve (MO-1001-19) that is normally open would fail-as-is (open). This has no safety consequence because having the valve in the open position is preferred during LPCI injection. Reactor Recirculation System Suction Valves MO-202-4A and MO-202-5A and Reactor Recirculation System Discharge Valves MO-202-4B and MO-202-5B are normally open and would fail-as-is (open). However, failure to close these valves has no additional adverse effect as the LPCI function would be lost in this

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scenario.

The site specific PRA was used to assess the safety significance of the failure of time delay relay 27A-B1X/TDDO to perform its design function during the identified exposure time. Based on the low probability of the assessed condition, it is not safety significant.

REPORTABILITY

This LER report is submitted in accordance with 10 CFR 50.73(a)(2)(i)(B) – Operation or Condition Prohibited by Technical Specifications; and 10 CFR 50.73(a)(2)(v)(B) and (D) – Condition that could have prevented the fulfillment of the Safety Function of an SSC that is needed to: (B) Remove Residual Heat, and (D) Mitigate the Consequences of an Accident.

Because the degraded voltage protection for bus B6 was compromised when bus B6 was powered from bus B1, this condition rendered the LPCI system injection valves (MO-1001-28A/B & MO-1001-29 A/B); PCIVs MO-220-1, MO-1201-2, MO-1201-80; SSW Pump C (P208C); and the 125 and 250 volt DC back-up battery chargers (D14 and 15 respectively), inoperable.

Technical Specification 3.5.A.3 requires the LPCI system to be OPERABLE during Run, Startup, and Hot shutdown Modes and prior to reactor startup from Cold Shutdown. As specified in the related Surveillance Requirements, LPCI OPERABILITY is contingent on motor-operated valve OPERABILITY. The LPCI system may be INOPERABLE for up to seven (7) days with certain contingent conditions in place or PNPS is to shut down. It is assumed that relay contact 3-5 had been failed for longer than seven (7) days. Therefore, this condition is concluded to be a condition prohibited by Technical Specifications and a condition that could have prevented the fulfillment of the safety function of an SSC that is needed to remove residual heat and mitigate the consequences of an accident.

Technical Specification 3.5.B.4 requires two SSW subsystems to be OPERABLE whenever irradiated fuel is in the reactor vessel, reactor coolant temperature is >212 degrees F, and prior to startup from a cold condition. The action to take with one SSW subsystem inoperable is to restore the SSW subsystem to operable status within 72 hours. If the required action and associated completion time are not met, the reactor must be in cold shutdown within 24 hours. On two occasions during the previous operating cycle one SSW subsystem (Loop A) was inoperable for a time longer than permitted by the Technical Specification. This condition was due to SSW Pump B being out of service for maintenance on those two occasions, while SSW Pump C was inoperable due to the failed relay contact. Therefore, this condition is concluded to be a condition prohibited by Technical Specifications.

Technical Specification 3.7.A.2.b requires at least one containment isolation valve in each line having an inoperable valve to be deactivated in the isolated condition. With bus B6 compromised, when bus B6 was powered from bus B1, this requirement was not met. Therefore, this condition is concluded to be a condition prohibited by Technical Specifications.

Technical Specification 3.9.A.5 requires an operable battery charger for each 125 and 250 volt battery system. In accordance with TS 3.9.B.5, with one of the 125 or 250 volt DC battery systems made or found to

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be inoperable for any reason, continued reactor operation is permissible during the succeeding three days within electrical safety considerations, provided repair work is initiated in the most expeditious manner to return the failed component to an operable state, and Specification 3.5.F is satisfied. If this requirement cannot be met, an orderly shutdown shall be initiated and the reactor shall be placed in the Cold Shutdown Condition within 24 hours. When put in service to substitute for an inoperable or out of service battery charger, the back-up battery charger is relied on to satisfy TS 3.9.A.5 and, therefore, must be operable. On two occasions during the previous operating cycle, the 125 volt back-up battery charger, that was inoperable due to the failed relay contact, was substituting for an out of service normal battery charger for longer than the TS required actions allowed, which is a condition prohibited by TS. The 250 volt back-up charger was not in service longer than the TS required actions.

PREVIOUS EVENTS

A review of Pilgrim Station License Event Reports (LERs) issued since 2005 was performed. The focus of the review was to identify LERs that involved time delay relay failure and degraded voltage transfer functions.

The following LERs were reviewed:

LER 2008-002-00 – Failure to Meet Technical Specification Requirements for Undervoltage Relay Trip Setting
LER 2008-004-00 – High Pressure Coolant Injection System Inoperable Due to Undervoltage Relay Failure in Valve Power Supply Circuit

These LERs were reviewed but did not involve similar relay types or similar relay failure mechanisms (previous failures were associated with relay settings and manufacturing defects).

ENERGY INDUSTRY IDENTIFICAZTION SYSTEM (EIS) CODES

The EIIS codes for Components and Systems referenced in this report are as follows:

Components: Relay, time delay – 2
Systems: Low Voltage Power – ED

REFERENCES:

- Condition Report CR-PNP-2015-3454 – 480 Volt Bus B6 Auto Transfer Test, UV, Degraded Voltage and Timing Relays Calibration
- Condition Report CR-PNP-2015-9853 – Failed Relay Disposed of Without Evaluating Cause of Failure