BOSTON EDISON
Pilgrim Nuclear Power Station
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10 CFR 50.73
10 CFR 21.21

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Senior Vice President – Nuclear

April 21, 1995
BECo Ltr. #95-051

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

Docket No. 50-293
License No. DPR-35

The enclosed supplemental Licensee Event Report (LER) 95-002-01, "High Pressure Coolant Injection System and Reactor Core Isolation Cooling System Separately Inoperable on Different Dates Due to Failed Power Inverters", is submitted in accordance with 10 CFR Part 50.73 and Part 21.

In this report we made the following commitments:

- The RCIC inverter in the Control Room will be replaced with a refurbished inverter having additional design margin, prior to restart from RFO-10.
- A diverse design for the HPCI inverter in the Control Room is planned for implementation and installation prior to restart from RFO-10.
- We are reviewing the CGI procedure for changes due to this event.

Please do not hesitate to contact me if there are any questions regarding this report.

E T Boulette

E.T. Boulette, PhD

JPC/lam/9500201

JE22

cc: Mr. Thomas T. Martin
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Sr. NRC Resident Inspector - Pilgrim Station

Standard BECo LER Distribution

NRC Form 366 (5-92)

U.S. NUCLEAR REGULATORY COMMISSION

LICENSEE EVENT REPORT (LER)

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

APPROVED BY OMB NO.3150-0104
EXPIRES 5/31/95

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE(3)
PILGRIM NUCLEAR POWER STATION	05000-293	1 of 7

TITLE (4)
High Pressure Coolant Injection System and Reactor Core Isolation Cooling System Separately Inoperable on Different Dates Due to Failed Power Inverters

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
									N/A	05000
02	02	95	95	002	01	04	21	95	FACILITY NAME N/A	DOCKET NUMBER 05000

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (Check one or more) (11)					
		20.402(b)		20.45(c)		50.73(a)(2)(iv)	73.71(b)
POWER LEVEL (10)	100	20.405(a)(1)(i)		50.36(c)(1)	X	50.73(a)(2)(v)(D)	73.71(c)
		20.405(a)(1)(ii)		50.36(c)(2)	X	50.73(a)(2)(vii)(D)	X OTHER PART 21
		20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)	(specify in Abstract
		20.405(a)(1)(iv)		50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)	below and in Text,
		20.405(a)(1)(v)		50.73(a)(2)(iii)		50.73(a)(2)(x)	NRC Form 366A)

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Marie T. Lenhart - Senior Licensing Engineer	508-830-7937

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NPRDS
B	BJ	INVT	A631	Y						
B	BN	INVT	A631	Y						

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

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

On February 2, 1995, at 2159 hours, the High Pressure Coolant Injection (HPCI) System became inoperable when the inverter which supplies power to the HPCI flow control circuitry tripped. The inverter automatically reset at 2159 hours, however, the inverter tripped and would not reset ten minutes later at 2209 hours. The HPCI Inverter tripped and failed due to an apparent internal fault on the "Converter Power Supply" board. The inverter was replaced and the HPCI System was tested and declared operable on February 3, 1995. On February 14, 1995, at 1255 hours, the Reactor Core Isolation Cooling (RCIC) System became inoperable when the inverter which supplies power to the RCIC flow control circuitry tripped. The RCIC Inverter tripped and failed due to an internal fault on the power module. The inverter was replaced and the RCIC System was tested and declared operable on February 14, 1995.

Corrective action taken included sending the failed inverters to the manufacturer for further evaluation. We have determined, through root cause analysis, that a probable common cause failure existed due to the inverter power supply resistors not being sufficiently elevated above the circuit boards to provide adequate heat dissipation capability.

The events occurred during power operation with the reactor mode selector switch in the RUN position. The Reactor Vessel pressure was approximately 1038 psig for the HPCI event and 1037 psig for the RCIC event with Reactor Vessel water temperature at the saturation temperature for the noted pressures. This report is submitted in accordance with 10 CFR 50.73 subparts (a)(2)(v)(D) and (a)(2)(vii)(D), and 10 CFR 21.21(c)(3)(ii). These events posed no threat to the public health and safety.

REASON FOR SUPPLEMENT

This supplemental report is submitted because the root cause analysis and related corrective actions had not been finalized when the initial report was submitted. The initial report committed to a supplement by June 30, 1995.

BACKGROUND

The High Pressure Coolant Injection (HPCI) System is designed to provide high pressure reactor core cooling in the event of a small break loss of cooling accident. The Reactor Core Isolation Cooling (RCIC) System is designed to provide high pressure makeup water to the reactor vessel following reactor vessel isolation. The HPCI flow control circuitry operates on 120V AC converted from 125V DC by inverter 2340-13. Inverter 2340-13 is located within Main Control Room Panel C903 and was manufactured by Abacus Controls Inc. (ACI), Model 452-4-120M5. An identical inverter, 1340-16, performs a similar function for the Reactor Core Isolation Cooling (RCIC) System and is located within Main Control Room Panel C904. Inverters 2340-13 and 1340-16 were replaced via Plant Design Change (PDC) 91-63 in November of 1991. These inverters have wider operating ranges and greater high voltage trip setpoints than the former inverters. The inverters are also equipped with an automatic reset feature for a high or low voltage trip. Each inverter is connected to an alarm in the Main Control Room. The inverter replacements were a portion of the corrective action taken for events described in Licensee Event Reports (LERs) 50-293/91-006-00, 91-021-00, and 91-025-00. A further description of these events is located in the 'Similarity to Previous Events' section of this LER.

EVENT DESCRIPTION

On February 2, 1995, at 2159 hours, plant operators received an alarm on Main Control Room Panel C903 annunciator I-4, "HPCI Inverter Circuit Failure". The alarm immediately cleared indicating the inverter had automatically reset. The shift licensed operators investigated the alarm and found the HPCI Inverter 2340-13 hot to the touch when compared to the RCIC Inverter 1340-16. Ten minutes after the first alarm, at 2209 hours, plant operators received the "HPCI Inverter Circuit Failure" alarm again and the alarm did not clear. At that time, the licensed operators determined the HPCI System was inoperable upon the receipt of the first alarm at 2159 hours.

Problem Report (PR) 95.9048 and Maintenance Request 19500429 were written on February 2, 1995, to document and correct the problem. The NRC Operations Center was notified in accordance with 10 CFR 50.72, at 2234 hours on February 2, 1995.

On February 14, 1995, at 1255 hours, and with the HPCI system operable, plant operators received an alarm on Main Control Room Panel C904 for "RCIC Inverter Circuit Failure". The alarm did not clear. The Licensed Operators determined the RCIC System was inoperable upon receipt of the alarm.

PR95.9073 and Maintenance Request 19500552 were written on February 14, 1995, to document and correct the problem. The NRC Operations Center was notified in accordance with 10 CFR 50.72 at 1325 hours on February 14, 1995.

These separate events occurred during 100 percent reactor power operation with the reactor mode selector switch in the RUN position. The Reactor Vessel pressure was approximately 1038 psig for the HPCI event and 1037 psig for the RCIC event with Reactor Vessel water temperature at the saturation temperature for the noted pressures.

CAUSE

The direct cause of the inoperability of the HPCI System and RCIC System was the separate failure of inverters 2340-13 and 1340-16.

Maintenance personnel replaced Inverter 2340-13 with an identical, spare inverter on February 3, 1995. The HPCI System was tested and declared operable at 1320 hours on February 3, 1995. Engineering personnel inspected the failed inverter and found the converter power supply board had apparently failed. The engineers contacted the inverter manufacturer, Abacus Controls Inc. (ACI). The manufacturer reported being unaware of similar failures of inverters manufactured by the company. The failed HPCI inverter was sent to the manufacturer for failure analysis.

The failed RCIC inverter 1340-16 was replaced with an identical, spare inverter and the RCIC System was tested and declared operable at 2238 hours on February 14, 1995. Because of the HPCI inverter failure on February 2, 1995, which occured on the "Converter Power Supply Board", the failed RCIC inverter "Converter Power Supply board" was inspected. Although the RCIC "Converter Power Supply Board" was heat discolored, resistance measurements of key components resulted in expected, satisfactory readings. There was no visual evidence of heat related discoloration of any of the remaining three circuit boards of the inverters.

With the occurrence of failure of the HPCI and RCIC inverters within two weeks of each other, potential common cause failure due to external cause(s) was evaluated. The input DC voltages to the HPCI and RCIC inverters are independent and have both been in a normal range at approximately 133 VDC. The ambient temperatures in the vicinity of the inverters are within the specified operating temperatures of the inverters. No system modifications have been performed that have the potential to directly or indirectly affect HPCI or RCIC inverter performance. The electrical loading on the HPCI and RCIC inverters is approximately the same. We concluded that there was no potential for external common cause failure.

Inspection of the failed HPCI and RCIC inverter internals indicate one potential common element. Both failed inverters had significant discoloration of the converter power supply board. This discoloration is indicative of possible excess heat loading of this circuit board which could cause an age related failure. The RCIC inverter was also sent to the manufacturer for further evaluation. Since the failures appear to be age related and it took over three years for the failures to develop, the HPCI and RCIC replacement inverters, identical to the failed inverters, were evaluated operable for a minimum of 45 days (i.e., until the 1995 refueling outage).

The root cause analysis determined a probable common cause failure may exist on Abacus Controls Inc. Model 452-4-120M5 inverters. The inverter power supply power resistor was not sufficiently elevated above the circuit board to provide adequate heat disipation. These inverters were purchased as commercial grade items (CGI) and subsequently dedicated by BECo for use in safety-related applications.

Inspection and testing of the failed inverters was completed by the manufacturer (ACI) with selected BECo oversight at the manufacturers facility. Information provided in discussions with ACI identified a possible cause/effect relationship between the circuits that were found to have failed or degraded. The circuits involved are the Power Module (RCIC) and the Converter Power Supply (HPCI). The RCIC inverter power module had 4 failed power transistors which typically fail when driven (triggered) by faulty timing signals. Since this type of failure is inherent to the "H" Bridge Inverter design, special circuits (Power Module reverse DC biasing and rapid turnoff) are included in the design to prevent power transistor failure. The HPCI inverter Converter Power Supply was found significantly degraded (heat damage to the circuit card), and power resistors were not mounted for optimum heat dissipation. The Converter Power Supply provides 5.0 VDC logic power to the integrated circuit board which provides the above mentioned timing signals to the Power Module transistors. It is known that a degraded converter power supply can affect the timing circuit integrated circuits to the extent that faulty timing signals can be generated. Therefore, a degraded Converter Power Supply could potentially cause a failure of the Power Module under certain conditions.

It is therefore our belief that a potential common cause failure of HPCI and RCIC inverters existed.

CORRECTIVE ACTION

Corrective actions taken included the following:

- The HPCI and RCIC inverters were replaced with inverters identical to the failed inverters, on 2/3/95 and 2/15/95, respectively.

- The failed HPCI and RCIC Inverters were sent to the manufacturer for further evaluation. An operability evaluation of the installed replacements concluded the inverters were operable for a minimum of 45 days (i.e., until the 1995 refueling outage).

- A Part 21 evaluation, completed on March 17, 1995, concluded the inverters contained a hardware deviation that could have created a substantial safety hazard. Executive Management was notified on March 23, 1995. The 10 CFR 50.72 notifications to the NRC Operations Center on February 2, 1995 and February 14, 1995 and the submittal of LER 95-002-00 on March 3, 1995 met the initial reporting requirements of Part 21.

- A review of records determined these inverters are not used in any other application at Pilgrim Station. The HPCI and RCIC inverters in the Alternate Shutdown Panels were supplied by a different manufacturer and are not affected.

- The records review also determined we have not supplied these inverters (commercial grade or as a dedicated component) to any other facility covered by Part 21 requirements.

- The failed inverters were refurbished. The refurbishment included additional design margin by increasing the distance (elevation) of the power resistors above the circuit board. The elevation enhances power resistor heat dissipation.

- Commercial Grade Item (CGI) document 569 which is currently used for the HPCI and RCIC control room inverters was revised (to Rev. 4). The focus of the revision was to include an inspection of all power resistors greater than 2 watts. This inspection point agrees with the manufactures design change as a result of the failures documented in this report. It was also revised to clarify a capacitor reforming recommendation provided by the manufacturer.

Corrective actions planned include the following:

- The RCIC inverter in the Control Room will be replaced with a refurbished inverter having additional design margin, prior to restart from RFO-10.

- A diverse design for the HPCI inverter in the Control Room is planned for implementation and installation prior to restart from RFO-10.

- We are reviewing the CGI procedure for changes due to this event.

SAFETY CONSEQUENCES

These separate events posed no threat to the public health and safety.

The Core Standby Cooling System (CSCS) consists of the HPCI System, Automatic Depressurization System (ADS), Core Spray System, and Residual Heat Removal/Low Pressure Coolant Injection (LPCI) mode. Although not part of the CSCS, the RCIC System is capable of providing water to the reactor vessel for high pressure core cooling, similar to the HPCI System. During the time period HPCI was inoperable, the other CSCS Systems and the RCIC System were operable. During the time period RCIC was inoperable, the CSCS Systems including the HPCI System were operable. In the unlikely event the HPCI System and RCIC System were to become inoperable and core cooling was necessary, an ADS actuation (automatic or manual) would function to reduce reactor vessel pressure for low pressure core cooling provided independently by the Core Spray System and/or the RHR System/LPCI mode.

The initial report was submitted in accordance with 10 CFR 50.73(a)(2)(v)(D) because the HPCI System became inoperable due to the failure of Inverter 2340-13 on February 2, 1995. The initial report was also submitted in accordance with 10 CFR 50.73(a)(2)(v)(D) because the RCIC System became inoperable due to the failure of Inverter 1340-16 on February 14, 1995. The two events are reported in a single LER due to the guidance provided in NUREG 1022 Supplement 1 Section II (answer to question 6.12).

This supplemental report is also being submitted in accordance with 10 CFR 50.73(a)(2)(vii)(D) and 10 CFR 21.21(c)(3)(ii) because the root cause analysis determined there was a probable common cause failure.

SIMILARITY TO PREVIOUS EVENTS

A review was conducted of Pilgrim Station Licensee Event Reports (LERs) issued since January 1984. The review focused on LERs involving RCIC or HPCI System inverter problems. The review identified previous events reported via LERs 50-293/85-029-00, 91-006-00, 91-021-00, and 91-025-00. These previous events involved inverters manufacturered by Topaz Electronics.

For LER 85-029-00, the HPCI inverter tripped during power operation on October 18, 1985. The most probable cause of the HPCI inverter trip was fluctuation of the inverter input DC voltage. The inverter was reset within 60 seconds restoring the HPCI System operability.

For LER 91-006-00, the RCIC inverter and the HPCI inverter tripped during power operation on March 26, 1991. The inverters tripped when the Recirculation System Loop 'B' motor-generator set/pump was restarted. At the time of the event, the 125V DC Battery 'A' and Battery Charger 'A' were supplying power to the RCIC Inverter via 125 VDC Bus 'A'. The 125 VDC Battery 'B' and the 125 VDC backup battery charger were supplying power to the HPCI Inverter via 125 VDC Bus 'B'. The 125 VDC battery charger 'A' and backup battery charger were being powered from Safety-Related 4160 VAC Bus A5 via Bus B1 and Bus B6, respectively. Final corrective actions taken are described in the following summary of LER 91-025-00.

For LER 91-021-00, the RCIC System was declared inoperable on October 9, 1991. The RCIC System was declared inoperable because sufficient test data for the backup 125 VDC battery charger was not available to assure the RCIC Inverter would not trip if a 125 VDC Bus 'A' voltage transient were to occur. At the time the RCIC System was declared inoperable, the 125 VDC backup battery charger was powering the RCIC Inverter via the 'A' 125 VDC Bus. Final corrective actions taken are described in the following summary of LER 91-025-00.

For LER 91-025-00, the RCIC Inverter tripped while the RCIC System was being restarted following an overspeed trip on October 30, 1991. The inverter had previously tripped when the 'A' Residual Heat Removal (RHR) Pump was started. The RHR pump start caused an AC voltage transient that resulted in a DC voltage transient which caused the RCIC Inverter to trip. Corrective Action taken included the following. PDC 91-63 was implemented to replace the RCIC and HPCI Inverters (Topaz Electronics) in the Control Room with new inverters (ACI Model 452-4-120M5) having automatic reset, higher trip setpoints and wider ranges. Additionally, the three 12[illegible]VDC Battery Chargers were replaced via PDC 92-38 with new chargers designed to respond appro[illegible] expected AC voltage transients.

ENERGY INDUSTRY IDENTIFICATION SYSTEM (EIIS) CODES

The EIIS codes for this report are as follows:

COMPONENTS	CODES
Inverter (2340-13, 1340-16)	INVT

SYSTEMS

High Pressure Coolant Injection (HPCI) System	BJ
Reactor Core Isolation Cooling (RCIC) System	BN