Boston Edison

Pilgrim Nuclear Power Station
Rocky Hill Road
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10 CFR 50.73

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BECo Ltr. #96-033

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) 95-011-01, "Reactor Core Isolation Cooling System made Inoperable due to Unplanned Maintenance to Replace Intermittent Tripping Power Inverter," is submitted in accordance with 10 CFR 50.73.

The following commitments are contained within the attached report:

- Evaluate the feasibility of a design change to monitor the input voltage to both the reactor core isolation cooling and high pressure coolant injection inverters utilizing the emergency plant information computer.

- Procure a spare ABACUS inverter for the reactor core isolation cooling system.

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

E.T. Boulette, PhD

RLC/dmc/9501101

cc: Mr. Thomas T. Martin
Regional Administrator, Region I
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Sr. NRC Resident Inspector - Pilgrim Station

Standard BECo LER Distribution

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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 6

TITLE (4)
"Reactor Core Isolation Cooling System Made Inoperable due to Unplanned Maintenance to Replace Intermittent Tripping Power Inverter"

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
12	06	95	95	011	01	04	11	96	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)		50.73(a)(2)(vii)		OTHER
		20.405(a)(1)(iii)	50.73(a)(2)(i)(B)		50.73(a)(2)(viii)(A)		(specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iv)	50.73(a)(2)(ii)		50.73(a)(2)(viii)(B)		
		20.405(a)(1)(v)	50.73(a)(2)(iii)		50.73(a)(2)(x)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
Robert L. Cannon - Senior Compliance Engineer	508-830-8321

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
X	BN	INVT	A631	N						

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

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

On December 6, 1995, at 1445 hours the reactor core isolation cooling system (RCIC) was declared inoperable when RCIC inverter 1340-16 appeared to have failed after being in service for approximately 5 and one-half months. The historical events log (annunciation) indicated multiple alarm/reset occurrences for the RCIC inverter 1340-16, on control room panel C904, from 1445 hours to 1653 hours. The operators observed that the inverter power lamp went off during a few of the alarm conditions indicating a loss of power to the RCIC flow control circuitry. Limiting condition for operation (LCO) 95-219 was entered and the RCIC system was removed from service for unplanned maintenance. Inverter 1340-16 was replaced in kind under maintenance request 19503503. The RCIC system was tested and declared operable at 2030 hours at which time the LCO was exited. Problem report (PR) 95-9608 was written to document the intermittent tripping of the RCIC system inverter. The inverter that was removed from service was fully tested by Pilgrim Station maintenance and engineering support personnel. The testing did not identify any defect or anomaly in the operation of the inverter. This was confirmed with additional testing by the vendor, ABACUS Controls, Inc. The root cause analysis could not establish with certainty the root cause of the inverter trips. The root cause investigation recommended a design change be developed to monitor the input voltage to both the RCIC and HPCI inverters by the emergency plant information computer (EPIC) in order to provide more information during troubleshooting. In addition a spare ABACUS inverter for the RCIC system will be procured.

The event occurred at 100% reactor power with the reactor mode selector switch in the RUN position. The reactor vessel pressure was approximately 1035 psig with reactor vessel water temperature at the saturation temperature for the reactor pressure. This report is submitted in accordance with 10 CFR 50.73(a)(2)(v)(D). The event posed no threat to the public health and safety.

REASON FOR SUPPLEMENT

At the time licensee event report (LER) 95-011-00 was submitted, the root cause analysis had not yet been completed. This supplemental LER provides the results of the completed root cause analysis and resulting corrective actions.

BACKGROUND

The reactor core isolation cooling (RCIC) is designed to provide makeup water to the reactor vessel following reactor vessel isolation in order to prevent the release of radioactive materials to the environs as a result of inadequate core cooling. The RCIC flow control circuitry operates on 115V AC converted from 125V DC by inverter 1340-16. Inverter 1340-16 is located within main control room panel C904 and is manufactured by ABACUS Controls, Inc. Model No. 452-4-120M5. A similar inverter (manufactured by General Electric), 2340-13, performs a similar function for the high pressure coolant injection (HPCI) system and is located within main control room panel C903. Inverters 2340-13 and 1340-16 were replaced and/or modified under plant design changes (PDCs) 91-63, field revision notice (FRN) 95-04-30, and FRN 95-04-32. The former inverters were original plant equipment and advancing technology had rendered them obsolete. Although they are of different design, the current inverters have wider operating ranges and greater high voltage trip setpoints than the former inverters. The current inverters are also equipped with an automatic reset feature for high or low voltage trips and will provide an alarm in the main control room should the inverters trip. The inverter replacements were a portion of the corrective action taken for the conditions described in LERs 50-293/91-006-00, 91-021-00, 91-025-00, and 95-002-01.

EVENT DESCRIPTION

On December 6, 1995, at 1445 hours, the reactor core isolation cooling system (RCIC) was declared inoperable when RCIC inverter 1340-16 appeared to have failed after being in service for approximately 5 and one-half months. The historical events log (annunciation) indicated multiple alarm/reset occurrences for the RCIC inverter 1340-16, on control room panel C904, from 1445 hours to 1653 hours. The operators observed that the inverter power lamp went off during a few of the alarm conditions indicating no power to the RCIC flow control circuitry. Limiting condition for operation (LCO) 95-219 was entered and the RCIC system was removed from service for unplanned maintenance. Inverter 1340-16 was replaced in kind under maintenance request (MR) 19503503. Problem report (PR) 95-9608 was written to document the intermittent tripping of the RCIC system inverter. The inverter was manufactured by ABACUS Controls, Inc. of Somerville, N.J.

The NRC operations center was notified in accordance with 10 CFR 50.72, at 1626 hours, on December 6, 1995.

The event occurred at 100% reactor power with the reactor mode selector switch in the RUN position. The reactor vessel pressure was approximately 1035 psig with reactor vessel water temperature at the saturation temperature for the reactor pressure.

CAUSE

The following potential causes were investigated:

- potential external causes that could result in high/low/transient input voltages to the inverter.
- system maintenance performed that could adversely impact the RCIC inverter.
- potential internal component failures.

After extensive investigation no root cause could definitely be identified. The removed inverter passed all testing. The inverter output quality exceeded the specified requirements in regards to signal quality. The most probable cause of receiving the failure alarm is that the input to the inverter repeatedly spiked/dipped outside of the inverter cutoff voltage. A review of all work activities that were being performed on December 6, 1995, failed to identify the activity that could have caused this event.

In addition, considering previous (recent) failures of this inverter design, there was immediate concern that the current failure might be related through some common cause to the previous failures. Systems engineering reviewed the previous failures and discussed these and current findings with the manufacturer on December 7, 1995, and December 8, 1995. Comparison of the inspections and load testing performed on the previous and current inverter equipment show no evidence of a common cause of failure for the current inverter failure. Previous failures were heat related and showed significant converter power supply circuit board heat damage. Previous failures resulted in failure of output module transistors with accompanying evidence of heat damage to transistor base resistors. Details of the analysis is provided below in the corrective action section. No contributing cause could be identified.

EXTENT OF THE PROBLEM

This is an unique application. This particular model of ABACUS inverter is used only for the 'normal' mode of RCIC system operation. The 'normal' mode of HPCI system operation uses a GE designed ABACUS inverter and both the RCIC and HPCI 'alternate shutdown' inverters are Topaz inverters.

CORRECTIVE ACTION

On December 6, 1995, MR 19503503 was initiated to perform initial troubleshooting to determine if the input to the inverter was interrupted by a loose connection. The inverter had recently been removed to support SBM control switch replacements in panel C904. No loose connections were found. The inverter load was also inspected to verify that the load had not increased. Inverter 1340-16 was then replaced with a spare from the warehouse at approximately 2020 hours on December 6, 1995. No further trips have been experienced.

On December 7, 1995, MR 19503507 was initiated to troubleshoot the inverter removed by MR 19503503. Procedure 3.M.1-34, "Generic Troubleshooting & Maintenance Procedure," was used to document the troubleshooting of the removed inverter. The inverter chassis and electronics were inspected for physical evidence of a malfunction. The visual examinations did not detect any abnormal conditions or heat stress on any components. The inverter was then tested at one half-load and full load (rated) conditions. The inverter passed normal surveillance testing per procedure 8.E.13, "RCIC System Instrument Calibration," at both load conditions. Additional monitoring with an oscilloscope detected a 1500 pulse per second (pps) signal superimposed on the output waveform (120VAC). Initially it was thought that the inverters output filter capacitor (C3) performance had degraded. The vendor ABACUS, was contacted and arrangements were made to bring the vendor on site to assist in additional troubleshooting.

On December 7, 1995, through December 18, 1995, the removed inverter was connected to a load that is identical to its normal in-service load. A strip chart recorder was set up to monitor inverter input and output. The inverter was then monitored for a ten day period with no anomalies noted.

On December 19, 1995, through December 20, 1995, with the vendor present the testing at one-half load and full load (rated) conditions was repeated. Again the inverter passed normal surveillance testing per procedure 8.E.13 at both load conditions. Additional monitoring with an oscilloscope showed the 1500 pps superimposed signal. The vendor stated that the superimposed signal was caused by the inverters switching circuit and is normally present. Total harmonic distortion measurements were taken. These measurements showed that the inverter output quality exceeded specification requirements. The vendor could not identify any malfunction of inverter 1340-16.

On January 26, 1996, the inverter that had been removed from the RCIC system was returned to stock.

During the period December 8, 1995, through February 2, 1996, a review of all maintenance work packages that were being implemented on December 6, 1995, was performed to determine if any of the activities could have caused interruption or degradation of power to the RCIC inverter. No credible activities were identified.

On February 2, 1996, since the investigation failed to identify the external activity that caused this event the inverter was removed from stock since it could not be proven beyond reasonable doubt that there was not an internal problem in the inverter.

In conclusion, no root cause could be identified.

In May of 1995 the HPCI inverter 2340-13 was replaced with a GE designed ABACUS inverter by FRN 95-04-32. At that time the RCIC inverter was not upgraded. This was done to provide diversity of design of these two systems, since there was no operating history for the new GE designed inverter. Although the present RCIC ABACUS inverter design is obsolete the inverter is still available. A new ABACUS design inverter will be procured as a spare for the RCIC system as the evaluation of the new GE design inverter installed in the HPCI system continues. This will provide two unique spares for these systems that are important to the operation of the plant.

The results of the root cause investigation recommended evaluating the feasibility of a design change to monitor the input voltage to both the RCIC and HPCI inverters by the emergency plant information computer (EPIC) in order to provide more information during troubleshooting. In addition a spare ABACUS inverter for the RCIC system will be procured.

SAFETY CONSEQUENCES

This event 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 core cooling, similar to the HPCI System. During the time period RCIC was inoperable, the HPCI system and the other CSCS systems were operable and capable of providing core cooling.

This report is submitted in accordance with 10 CFR 50.73(a)(2)(v)(D) because the RCIC system was removed from service for unplanned maintenance and therefore made inoperable due to the apparent failure of inverter 1340-16 on December 6, 1995.

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 due to similar causes. The review identified previous events reported via LERs 50-293/85-029-00, 91-006-00, 91-021-00, 91-025-00 ,and 50-293.95-002-01

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 inverter 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 Bus A5 via bus B1 and bus B6, respectively. The cause of the inverter trips was a fluctuation of the input DC voltage that resulted when the "B" recirculation pump was started. Final corrective actions were taken under 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 that 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 supplying the RCIC inverter via the 'A' 125 VDC Bus. Final corrective actions were taken under LER 91-025-00.

For LER 91-025-00, the RCIC inverter tripped during efforts by operators to restart RCIC following an overspeed trip on October 30, 1991. The inverter had 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. PDC 91-63 was implemented to replace the RCIC and HPCI inverters with inverters with automatic reset, higher trip setpoints and wider ranges. Additionally, the three 125 VDC battery chargers were replaced under PDC 92-38 with new chargers designed to respond appropriately to expected AC voltage transients.

For LER 95-002-01, the HPCI and RCIC systems became inoperable when the inverters which supply power to the HPCI and RCIC flow control circuitry tripped at different times. The HPCI inverter tripped due to an apparent internal fault on the "converter power supply" board. The RCIC inverter tripped and failed due to an internal fault on the power module. The most 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.

ENERGY INDUSTRY IDENTIFICATION SYSTEM (EIIS) CODES

The EIIS codes for this report are as follows:

COMPONENTS	CODES
inverter (1340-16)	INVT

SYSTEMS

reactor core isolation cooling (RCIC) system	BN