Boston Edison
Pilgrim Nuclear Power Station
Rocky Hill Road
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10 CFR 50.73

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BECo Ltr. #96- 048

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

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

The enclosed Licensee Event Report (LER) 96-004-00, "Low Voltage Power Primary Containment Electrical Penetrations with Degraded Electrical Protection", is submitted in accordance with 10 CFR 50.73.

In this letter, the following commitments are made:

- Complete the root cause analysis investigation.
- Supplement this report after completing the root cause analysis.
- Review electrical engineering design guidance.
- Evaluate approved modifications impacted by revised calculations.

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

E T Boulette
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DWE/dmc/9600400

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

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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)

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FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE(3)
PILGRIM NUCLEAR POWER STATION	05000-293	1 of 9

TITLE (4)
Low Voltage Power Primary Containment Electrical Penetrations with Degraded Electrical Protection

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 N/A	DOCKET NUMBER 05000
04	09	96	96	004	00	05	09	96	FACILITY NAME N/A	DOCKET NUMBER 05000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR: (Check one or more) (11)

OPERATING MODE (9)	N		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)		50.73(a)(2)(v)))		73.71(c)
			20.405(a)(1)(ii)		50.36(c)(2)	x	50.73(a)(2)(vii) C		OTHER
			20.405(a)(1)(iii)		50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(specify in Abstract below and in Text, NRC Form 366A)
			20.405(a)(1)(iv)	x	50.73(a)(2)(ii) B		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)
Douglas W. Ellis - Principal Regulatory Affairs Engineer	508-830-8160

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

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED SUBMISSION DATE(15)	MONTH	DAY	YEAR
X	YES (If yes, complete EXPECTED SUBMISSION DATE)		NO		07	31	96

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

On April 9, 1996, at 1720 hours, primary containment was declared inoperable and a 24 hour technical specification limiting condition for operation (LCO) was entered. This action was taken because the trip settings of magnetic only trip circuit breakers associated with certain 480V ac containment electrical penetrations were set too high to ensure containment integrity. Immediate corrective action taken consisted of decreasing the trip settings to the low/minimum setting, and the LCO was terminated at 2109 hours on April 9, 1996.

The root cause investigation had not been completed when this report was prepared. The circuit breakers and their trip settings were in accordance with approved drawings. This report will be supplemented after the root cause analysis is completed.

Additional corrective action taken included the subsequent replacement of the subject circuit breakers with circuit breakers having a thermal magnetic trip design. Additional corrective action may result from the root cause analysis.

The condition was identified while at 100 percent reactor power with the reactor mode selector switch in the RUN position. The reactor vessel pressure was approximately 1027 psig with the reactor water at the saturation temperature for the reactor vessel pressure.

BACKGROUND

The safety objective of the primary containment system (PCS) is to provide the capability, in conjunction with other safeguards features, to limit the releases of fission products in the event of a postulated design basis accident so that offsite doses will not exceed the guidelines set forth in 10 CFR Part 100. The PCS design employs a low leakage pressure suppression containment system that houses the reactor vessel, the reactor recirculation system loops, and other branch connections of the reactor primary system.

The PCS consists of a drywell, a pressure suppression chamber (torus) that stores a large volume of water, a connecting vent system between the drywell and suppression chamber, isolation valves, vacuum relief system, containment cooling systems, and other service equipment.

In the event of a process piping failure within the drywell, reactor water and steam would be released to the drywell atmosphere. The resulting increased drywell atmosphere pressure would force a mixture of gas, steam, and water through the vent system into the suppression pool. The steam would condense rapidly in the suppression pool and result in a rapid drywell pressure reduction. Non-condensable gas transferred during the blowdown would pressurize the torus atmosphere. The resulting torus atmosphere pressure would subsequently vent to the drywell through the vacuum relief system as the drywell pressure decreases to less than the torus atmosphere pressure.

The drywell cooling system consists of 8 (eight) cooling units located and distributed within the drywell. The units are manually controlled via control switches. Each cooling unit consists of two cooling coils and two motor driven fans. One or both cooling coils may be used for drywell atmosphere temperature control. The drywell cooling system cooling units are non-safety-related. The cooling coils are supplied with water for cooling by the safety-related reactor building closed cooling water system. The motor of each motor driven fan is supplied with 480V ac power via circuitry that includes electrical power conductors and a combination circuit breaker/starter. The starters are located in the reactor building (secondary containment) within safety-related 480V ac MCCs B17 and B18.

In general, primary containment penetrations, both piping and electrical, are designed for the following characteristics:

- The same pressure and temperature conditions as the drywell and torus
- Capability of withstanding the forces caused by impingement of the fluid from the rupture of the largest local pipe or connection without failure
- Capability of accommodating the thermal and mechanical stresses which may be encountered during all modes of operation including environmental events without failure
- Withstanding the maximum reaction of the pipe to which they are attached.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

The electrical penetrations are testable. The test taps are located such that the penetrations can be tested without entering or pressurizing the drywell or suppression chamber.

The electrical penetrations for low voltage electrical power (480V ac), control (120V ac and 125V dc) and instrument cables utilize either aluminum oxide (suppression chamber portion of primary containment) or an epoxy resin (drywell portion of primary containment) to maintain the leak tight integrity of the penetration. The electrical circuits associated with these penetrations are equipped with protective devices, typically combination circuit breakers/starters and fuses. The circuits provide power to safety-related and non-safety-related components inside primary containment. A combination circuit breaker/starter consists of a circuit breaker, contactor, and overload relay. The circuit breaker is normally closed. When closed, the circuit breaker is controlled by its trip setting. The contactor is controlled by a control switch and overload relay. The overload relay is controlled by the size of its heater element. If closed, the contactor opens if the control switch is manually operated or if the overload relay automatically trips.

Procedure 8.Q.3-3,"480V AC Motor Control Center Testing and Maintenance", is used for testing the 480V ac motor control center (MCC) circuit breakers and overload relays. The trip settings for the circuit breakers and overload relays are contained and controlled in drawings.

In the 1987 - 1988 time frame, as part of a circuit breaker overhaul project, the 480V ac MCC molded case circuit breakers were replaced. These molded case circuit breakers were type HFA circuit breakers having either a thermal magnetic or magnetic only trip design. The circuit breakers were replaced with type HFB breakers because molded case type HFA breakers were no longer available. The type HFB circuit breakers also had either a thermal magnetic or magnetic only trip design.

In late 1995, Boston Edison Company contracted the NSSS supplier (General Electric) to calculate the time dependent drywell atmosphere temperature response profile following a range of small steamline pipe breaks based on a service water (ultimate heat sink) temperature of 75°F. In January 1996, preliminary results of the NSSS calculations indicated the drywell atmosphere temperature profile was higher than the August 1987 report. Problem Report 96.9028 was written to document questions raised by the preliminary results. The preliminary results initiated a Boston Edison Company nuclear engineering review to identify affected equipment. The review included primary containment electrical penetrations. During this review, it was discovered that calculation PS-124 used a lower peak drywell atmosphere temperature than existing specifications or analysis. The discovery prompted an electrical engineering operability evaluation, dated January 26, 1996, that concluded the penetrations were operable.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

The January 26, 1996, operability evaluation addressed the following errors contained in calculations and environmental qualification documents involving the primary containment electrical penetrations:

- Calculation PS-119 did not derate the General Electric low voltage power electrical penetration conductors for diversity as required by the General Electric design. This error was non-conservative for electrical penetration conductor temperature for normal and short circuit currents;

- Calculation PS-124 evaluated the electrical penetrations based on a maximum accident temperature of 300° F instead of 330° F identified in the August 1987 drywell temperature analysis report or 340° F identified in addendum 1 to specification E-28 (rev. 2) that pertains to the primary containment electrical penetration assemblies.

- It was not clear that electrical penetration qualification testing (c. 1970), conducted by General Electric, properly qualified the penetrations for accident conditions with the penetration conductors operating at design current conditions.

A corrective action program document (PR96.9092) was written to document the errors.

On February 7, 1996, a problem with a circuit breaker for one of the drywell ventilation area coolers, VAC-205E2, was discovered during a routine operator tour. The problem consisted of a trip of the 480V ac MCC-B18 circuit breaker 52-1834 that occurred during normal operation. An attempt to reset the breaker was made but the breaker tripped during the attempt. The breaker was tagged, and a maintenance request (MR 19600320) was written to correct the problem. A corrective action program document (PR 96.9048) was written to document the problem. On February 7-8, 1996, troubleshooting of breaker 52-1834 was conducted. The troubleshooting included visual inspection of the combination breaker/starter, and an electrical test (meggar) of the power circuit and fan motor for VAC-205E2, located inside the drywell. The electrical test indicated a failure of the fan motor.

On or about April 4-5, 1996, during continued engineering review of the protection for the electrical penetrations, an additional problem was identified. The problem involved the short circuit protection evaluation for the electrical penetrations in calculations PS-119 and PS-124. During review of the electrical penetrations, it was determined that the temperature of the conductors subject to LOCA temperature conditions would increase rapidly, within seconds, from a normal operating pre-fault temperature of 194° F to approximately 374° F.

This higher initial temperature (374° F) will decrease the amount of short circuit current the penetration conductor can carry before exceeding the maximum allowable short circuit conductor temperature. By plotting the revised, accident thermal limits of the penetrations against the existing electrical protection, the plots identified ranges where the electrical protection might not provide the protection previously determined to be adequate. A problem report (PR 96.9159) was written on April 5, 1996, to document the problem. Evaluation concluded the electrical penetrations were operable. The problem, however, with circuit breaker 52-1834 was not known to the engineers who performed the evaluation and was not considered as part of the evaluation.

On April 5, 1996, electrical engineering personnel became concerned that the starter problem for the drywell area cooler might have been due to a problem that could impact penetration protection. On April 8, 1996, engineering personnel inspected the breaker 52-1834 cubicle in the electrical shop and found evidence of thermal damage. Of specific concern was the fusion of the contactor contacts. Such fusion could prevent the circuit from de-energizing. The combination breaker/starter associated with 52-1834 was a molded case magnetic only trip design circuit breaker, model HFB-3480ML, with a size 1 (one) contactor, equipped with a H44 overload relay, all manufactured by the Westinghouse Corporation. Although no root cause had been determined at that time, engineering personnel began a review of the electrical co-ordination of protective devices used to protect the penetration circuits.

On April 9, 1996, a possible unacceptable failure mode of 480V ac MCC circuits supplying power to equipment inside the drywell was identified. The circuits of concern were those supplied via magnetic trip only circuit breakers whose trip settings could be set too high to ensure proper protection of the associated starter. Evaluation of these circuits identified 12 size 1 starters that were unacceptable.

These 12 circuits were for the motors of 12 of the 16 drywell unit coolers fans. These 12 circuits had 10 horsepower motors with size 1 starters and had magnetic only trip design circuit breakers set to trip between 300 amperes and 400 amperes. The circuit conductors are size #10 AWG. Based on the manufacturer catalogue requirements, size 1 starters should have a breaker with a magnetic trip setting of 182 amperes or less to provide proper starter protection. The other four fan motors are 20 horsepower, were not affected, and are supplied via size two contactors.

Operating above 182 amperes and below the 300 to 400 ampere breaker trip setting could damage the starter contactor and prevent clearing a high impedance electrical fault on overload. This, in turn, could damage the breaker's magnetic trip coil which is only designed to carry 50 amperes continuously. A failure of the coil would prevent a trip of the circuit breaker. Under these conditions, the conductor temperature would approach excessively high levels during normal operation in approximately 4 to 8 seconds if the fault did not clear. Under the same conditions the conductor temperature would approach excessively high levels during an accident in approximately 2 to 4 seconds if the fault did not clear. Note that this failure mechanism would be a problem only if a high impedance electrical fault caused currents in the susceptible range. The susceptible range was current greater than 182 amperes and less than 300 to 400 amperes, for a period of 2 to 8 seconds without the fault degrading to a point where the circuit breaker would trip. Based on this mechanism, there would not be sufficient assurance that penetration seal integrity and, consequently, primary containment integrity could be maintained.

Nuclear engineering management was notified and a problem report (PR 96.9169) to document the problem was written and processed.

EVENT DESCRIPTION

On April 9, 1996, at 1720 hours, the senior on-shift licensed operator declared primary containment inoperable and a 24 hour Technical Specification 3.7.A.2.a limiting condition for operation (LCO) was entered. The LCO was entered due to the problem with the trip settings of 12 circuit breakers that are part of the protection for the related containment electrical penetrations.

The penetration number, circuit breaker number, overload heater type, and functional description of the related electrical components were as follows:

Penetration Number (elevation)	Breaker Number (all type HFB-3480ML)	Overload Heater Type	Functional Description	
• Q105 A: (el. 39'-6")				
	52-1716	H44	Drywell unit cooler	VAC-205F1
	52-1726	H44		VAC-205A1
	52-1731	H44		VAC-205B1
	52-1732	FH44		VAC-205C1
	52-1733	H44		VAC-205D1
	52-1734	H44		VAC-205E1
• Q105B: (el. 39'-6")				
	52-1816	H44	Drywell unit cooler	VAC-205F2
	52-1826	H44		VAC-205A2
	52-1831	H44		VAC-205B2
	52-1832	H44		VAC-205C2
	52-1833	H44		VAC-205D2
	52-1834	H44		VAC-205E2

The NRC operations center was notified of the condition in accordance with 10 CFR 50.72 at 1727 hours.

Meanwhile, an engineering modification document (FRN 96-02-22) was written to decrease the trip settings of applicable breakers to less than 182 amperes (the low/minimum trip setting). Maintenance Request 19600856 was written to implement the modification. The trip settings of the above 12 circuit breakers were decreased to the low/minimum trip setting, and the LCO was terminated at 2105 hours on April 9, 1996.

The condition was identified while at 100 percent reactor power with the reactor mode selector switch in the RUN position. The reactor vessel pressure was approximately 1027 psig with the reactor water at the saturation temperature corresponding to the reactor vessel pressure.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

CAUSE

The root cause analysis investigation had not been completed when this report was prepared. The affected circuit breakers and their settings were in accordance with drawings E8-13-8 and E8-15-7. The reasons why previous opportunities did not identify this problem with electrical penetrations will be examined as part of the root cause analysis.

This report will be supplemented after the root cause investigation is completed.

CORRECTIVE ACTION

Immediate corrective action consisted of the following:

A 24 hour LCO was entered at 1720 hours on April 9, 1996. The trip settings of 10 of the 12 affected circuit breakers were decreased to the low/minimum trip setting. This action was taken in accordance with nuclear engineering modification document FRN 96-02-22 and implemented via MR19600856. The trip settings of the other 2 affected circuit breakers, 52-1732 and 52-1834, were not changed because those circuit breakers were not installed or in service at that time. The LCO was terminated at 2105 hours on April 9, 1996.

The integrity of penetration Q105B, that contains the conductors associated with circuit breaker 52-1834, was verified on April 12, 1996, with satisfactory results. This action was taken because of the potential for overheating of the conductor and, hence, the electrical penetration from the same event that damaged circuit breaker 52-1834. The verification consisted of a visual inspection of the penetration test pressure gauge. The gauge is used for leak rate testing of primary containment conducted while shut down. The pressure gauge was found pressurized at a pressure consistent with the last leak rate test pressure and temperature. Based on the satisfactory results of the inspection and ALARA considerations, no additional penetration Q105B inspections were performed.

Additional corrective action taken consisted of the following:

Another engineering modification document (FRN 96-02-23) was issued on April 9, 1996, to replace the 12 affected magnetic trip only design circuit breakers including the 10 that had their trip settings decreased to the low/minimum setting earlier on April 9, 1996. The document was implemented via MR 19600862. The replacement breakers are Westinghouse model HFB-3020L thermal magnetic design circuit breakers that provide better electrical protection than the magnetic trip only design circuit breakers that were replaced. Thermal magnetic type circuit breakers provide better protection because the thermal element in a thermal magnetic breaker provides a backup to the circuit's overload relay. The trip settings of the new installed circuit breakers were tested in accordance with the testing/acceptance criteria specified on the respective drawings, E8-13-8 and E8-15-7, that were issued as part of FRN 96-02-23.

The installation of the new circuit breakers was completed by April 23, 1996.

ACTION TAKEN OR PLANNED TO PRECLUDE RECURRENCE

A Boston Edison nuclear engineering design guide, "Electrical Engineering", (currently Rev. EO) was approved April 1, 1996. The guide provides direction for the preparation of electrical design changes and calculations. The guide will be reviewed for improvement of starter/circuit breaker co-ordination for 480V ac MCCs.

OTHER ACTION TAKEN OR PLANNED

The engineers who performed and reviewed calculations PS-119 and PS-124 were contractors who worked under nuclear electrical engineering supervision. The problems with calculations PS-119 and PS-124 were discussed during two nuclear electrical engineering department weekly meetings, one held in March 1996 and one held on April 17, 1996.

Calculation PS-119 was revised (to rev. 2) and approved on March 19, 1996. The revision included decreasing the trip setting of the magnetic only trip design circuit breakers. The purpose of the revision was to address Problem Report 96.9092. Moreover, the calculation was identified as impacted by the engineering modification (FRN 96-02-23) and will be revised to reflect the new circuit breakers and new trip settings. This action will be separately tracked via the modification process.

Calculation PS-124 was revised (to rev. 1) and approved on March 26, 1996. The purpose of the revision was to address Problem Reports 96.9092 and 96.9159. The revision included derating electrical penetration conductors for short circuit current with drywell temperatures during accident conditions.

Approved modifications will be evaluated for impact due to the revisions of PS-119 and PS-124. The modifications are currently scheduled for the next refueling outage (RFO-11).

SAFETY CONSEQUENCES

The most severe nuclear system effects and the greatest release of radioactive material to primary containment results from a complete circumferential break of one of the recirculation loop pipelines. The accident is described in UFSAR section 14.5.3 and was established as the design basis LOCA.

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

The circuit breakers installed in the 12 identified applications during original plant construction were type HFA circuit breakers. The trip settings while the type HFA magnetic only trip design circuit breakers were installed are generally known to have been set at the high setting. While shut down in the 1987 - 1988 time frame, the HFA circuit breakers were replaced with type HFB circuit breakers. The trip settings of the affected type HFB magnetic only trip design circuit breakers were found to be set to trip at the high setting. Therefore, the problem reported in this report has potentially existed since initial startup of Pilgrim Station. Since initial startup, Pilgrim Station has conducted numerous reactor startups, has operated at various reactor power levels, and has conducted numerous reactor shutdowns. Based on operational experience the risk of a design basis LOCA during the 1972-1996 period was conservatively estimated at approximately 3.3E-05/year. The postulated failure mechanism, a high impedence electrical fault that causes currents in the susceptible range without the fault degrading to a point where the ciruict breaker would trip, although possible, is not likely. Therefore, it is reasonable to expect that the likelihood of a high impedance electrical fault causing currents in the susceptible range for penetration failure in conjunction with a LOCA would be much less than 3.3E-05/year.

This report is submitted in accordance with 10 CFR 50.73 (a)(2)(ii)(B) because the trip settings of the affected magnetic only trip circuit breakers in conjunction with a high impedance electrical fault without the fault degrading to a point where the circuit breaker would trip could have resulted in the failure of at least one low voltage power primary containment electrical penetration during normal plant operation or in the event of a LOCA.

This report is submitted in accordance with 10 CFR 50.73 (a)(2)(vii)(C) because the problem affected more than one primary containment electrical penetration (penetrations Q105A and Q105B).

SIMILARITY TO PREVIOUS EVENTS

A review was conducted of Pilgrim Station Licensee Event Reports (LERs) submitted since 1984. The review focused on LERs involving the primary containment pressure boundary. The review identified LERs 89-008-00, 89-037-01, 91-023-00, and 94-007-00. These LERs did not involve electrical penetrations or electrical systems.

ENERGY INDUSTRY IDENTIFICATION SYSTEM (EIIS) CODES

The EIIS codes for this report are as follows:

COMPONENTS	CODES
Penetration	PEN
Vessel (Primary Containment Vessel/Torus)	VSL
SYSTEMS	
Containment Leakage Control System	BD