U.S. NUCLEAR REGULATORY COMMISSION

REGION I

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Report No:	50-293/96-07
Licensee:	Boston Edison Company
Facility:	Pilgrim Nuclear Power Station
Location:	Plymouth, Massachusetts
Dates:	July 8-12, 1996; July 22-26, 1996 August 28 - September 3, 1996 (in-office)
Inspectors:	Leonard Cheung, Senior Reactor Engineer
Approved by:	William H. Ruland, Chief, Electrical Engineering Branch Division of Reactor Safety

EXECUTIVE SUMMARY

Pilgrim Nuclear Power Station
NRC Special Inspection Report 50-293/96-07

This special inspection was conducted: (1) to review licensee's corrective actions after the licensee had identified potentially inoperable primary containment as documented in Licensee Event Report (LER) 96-04; (2) to review licensee' corrective actions in the environmental qualification (EQ) program in response to the post-accident environment changes in the primary containment because of elevated service water temperature. Also included in this inspection was the review of licensee's corrective actions for resolving two previously identified electrical unresolved items.

Engineering

On April 9, 1996, the licensee declared the Pilgrim primary containment inoperable and entered a 24-hour limiting condition for operation (LCO). The deficient condition was due to improper trip-setting of the circuit breakers that provided protection for two containment penetrations. The licensee promptly corrected the trip setting and later replaced the magnetic-trip-only breakers with thermal magnetic type breakers which provided better protection for the penetrations. The licensee postulated that this deficient condition might have existed since the initial startup of Pilgrim Station in 1972. There were at least four opportunities between 1991 and 1993 that this deficient condition should have been identified and corrected earlier. The inspector determined this to be an apparent violation of 10 CFR 50, Appendix B, Criterion XVI, Corrective Actions, which required the deficient conditions to be promptly identified and corrected.

The inspector reviewed three EQ packages, two were determined to be acceptable. For the EQ of General Electrical containment penetrations, the tested temperature did not envelope the required peak temperature (352°F vs. 379°F). The licensee used thermogravimetric methodology to justify the qualification for the peak-temperature. The inspector requested NRR review to determine if this methodology would be acceptable for this application. This item is unresolved pending the NRR review.

The inspector's review of licensee's corrective actions for two electrical unresolved items (93-80-03 and 95-09-02) resulted in the closure of these two items.

E2 Engineering Support of Facility and Equipment

E2.1 Objectives (92903)

The objectives of the inspection were: 1) to review licensee's corrective actions in response to the identification of potentially inoperable primary containment as documented in licensee event report (LER) 96-04; 2) to review the licensee's corrective actions in their environmental qualification (EQ) program in response to the post-accident environment changes in the primary containment because of elevated service water temperature, and General Electric (GE) calculation errors and 3) to review the licensee's corrective actions for resolving two previously identified electrical unresolved items and to determine whether these corrective actions were adequate to close those items.

E2.2 Degraded Electrical Protection for Containment Penetration

On April 9, 1996, the licensee declared the Pilgrim primary containment inoperable and entered a 24-hour technical specification limiting condition for operation (LCO). This action was taken because the trip setting of the protection circuit breakers for two electrical containment penetrations were too high to provide proper protection of containment integrity. The licensee promptly corrected the trip setting and terminated the LCO within 4 hours.

E2.2.1 Failure Mechanism Due to Improper Circuit Breaker Setting

There were 16 drywell-unit-cooler fans inside Pilgrim drywell, all driven by 480V 3-phase motors. Twelve of these fans were equipped with 10 HP motors and size 1 starters. The remaining four fans had larger motors and size 2 starters. For the 12 fans with size 1 starters, the 480V power circuits passed through two containment penetrations (Q105A and 2105B), six circuits for each penetration. Each of these power circuits was protected by a single magnetic-trip-only circuit breaker. There was no backup breakers for Pilgrim's electrical penetration circuits. The breakers and starters used at Pilgrim were Westinghouse model HFB-3480ML molded-case breaker/starter combination units, with H44 overload relays. These combination units were located in two motor control centers (MCC-B17 and MCC-B18) outside the primary containment. The contacts for size 1 starters were rated for a maximum current carrying capacity of 182 amperes. An electrical current higher than this rating could cause the contacts to be welded.

On February 7, 1996, a plant operator noticed that circuit breaker 52-1834 in MCC-B18 was in a tripped condition. An attempt to reset the breaker was made, but the breaker tripped during the attempt. Subsequent troubleshooting of the circuit identified that the fan motor inside the drywell had failed and the motor circuit was shorted. The licensee later examined the breaker/starter unit and found that the contacts for two of the three phases were welded. Further investigation by the licensee revealed that the breaker had a magnetic-trip-only coil (no thermal trip), and that the trip setting was too high (300 to 400 amperes). Under this condition, a

current magnitude between 182 amperes and 400 amperes for short duration could cause the contacts to weld because the thermal overload trip in the starter could not react quickly enough to interrupt the fault. Once welded, the contacts would not open even if the thermal overload later tripped. The licensee calculated that if the current of this magnitude continued for 2 to 4 seconds during an accident, enough heat might be generated to damage the containment penetration seals, causing the containment to lose its integrity. In addition, a current of this magnitude could also damage the breaker's magnetic trip coil which was only designed to carry 50 amperes continuously. If the magnetic coil was damaged, both the breaker and the contactor would not be able to interrupt a higher short circuit current if this occurs.

The licensee later found that another breaker (52-1732), also for a size 1 starter, was also tripped due to a short circuit at another failed drywell unit cooler fan motor.

The size 2 starters were not affected by the above condition.

E2.2.2 Licensee's Immediate Corrective Actions

After the identification, the licensee promptly reduced the trip setting of 10 of the 12 affected circuit breakers to a minimum trip setting (about 160 amperes). The other two breaker/starter circuits were still inoperable at that time. The licensee later replaced all 12 affected magnetic-trip-only breakers with Westinghouse model HFB-3020L thermal-magnetic molded-case circuit breakers. This type of breaker provided better protection for the circuit because the thermal part of the breaker would trip at a much lower current and quick enough to prevent contact welding.

The licensee also visually inspected the penetration test pressure gauge of the affected penetration (Q105B). The pressure gauge was found to be pressurized with a proper reading.

E2.2.3 Root Cause Evaluation and Duration of Deficient Condition

At the time of the inspection, the licensee had not yet completed the root cause evaluation, and had not determined when the deficient condition had started. Preliminary document review by the licensee indicated that the deficient condition existed at least from 1987-1988 timeframe when the existing Westinghouse type HFB circuit breakers were installed to replace the original Westinghouse type HFA breakers. The licensee postulated that the deficient condition might have existed since the initial startup of Pilgrim Station in 1972 because Westinghouse type HFA breakers were generally known to have been set at the high setting at Pilgrim.

E2.2.4 Event Reporting

The licensee reported the above event on May 9, 1996, by issuing LER 96-04 in accordance with 10 CFR 50.73. In the May 9, 1996 cover letter that transmitted the LER, the licensee made the following commitment as a result of this event:

- Complete the root cause analysis investigation
- Supplement LER 96-04 after completing the root cause analysis
- Review electrical engineering design guidance
- Evaluate approved modification impacted by revised calculations

E2.2.5 Review and Verification of Corrective Actions

The inspector reviewed the following corrective action packages:

a. FRN No. 96-02-22 to reset the variable trip setpoint to the lowest magnetic trip setting on each of the breakers listed (B1716, B1726, B1731, B1733, B1734, B1816, B1826, B1831, B1832, B1833), dated April 9, 1996.

b. Maintenance Request Dispatch MR No. 19600856, page 4 of 10 showed that all 10 breakers were set to the "LO" position on April 9, 1996.

c. FRN No. 96-02-23 to replace existing HFB3480ML breakers with HFB3020L breakers and test tripping in accordance with testing/acceptance criteria as specified on Drawings E8-13-8 and E8-15-7.

d. Maintenance Request Dispatch MR No. 19600862, page 5 of 9 showed that all affected breakers were replaced April 10, 1996, to April 23, 1996.

e. Electrical Drawings E8-13-8 for MCC B17 (Revision E18, dated July 1996) and E8-15-7 for MCC B18 (Revision E14, dated July 1996) had been updated to reflect the new breakers and breaker trip setting.

The inspector also walked down motor control centers MCC B17 and MCC B18 and verified the replacement of the 12 affected breakers. The inspector noticed that the new contactor installed in MCC cubicle 1834 looked different than other contactors. The licensee explained that the new contactor was the same model number as the existing Westinghouse contactor it replaced. Several years ago, Westinghouse changed the outside appearance of this type of contactor without changing the model number. The licensee further stated that they had contacted the manufacturer, who confirmed that the internals of the new contactor was identical to the "old" one it replaced. The inspector had no further questions.

E2.2.6 Previous Opportunities for Identifying and Correcting the Deficiency

The inspector reviewed licensee provided documents and interviewed licensee representatives to determine whether the licensee should have identified and corrected the penetration protection deficiency earlier. This document review revealed that there were at least four opportunities that the licensee should have identified and corrected the deficient condition earlier:

1. The licensee had performed a self-assessment of Pilgrim's electrical distribution system in 1991 before the NRC's electrical distribution system functional inspection (EDSFI). During this self-assessment, the licensee identified a potential electrical penetration protection deficiency. This issue was subsequently documented in PCAQ No. 91-165 on July 31, 1991. An engineering assessment was made on August 1, 1991, in response to this PCAQ. This engineering assessment stated the potential problem as:

   a) Electrical penetration protection for potential electrical faults within the primary containment had not been addressed for Pilgrim Station.

   b) Electrical faults within the primary containment might result in electrical penetration seal failure due to excessive heat generation in the cable if the electrical fault was not cleared by a circuit protective device in a timely manner.

2. During the 1991 EDSFI, extensive questions had been asked by the team for the electrical penetration protection problems, the licensee had reviewed the design documents and the electrical penetration circuit breaker trip curves to answer those questions;

3. Following the 1991 EDSFI, the licensee revisited the design documents and electrical penetration circuit breaker trip curves to address EDSFI unresolved item 91-80-04, and identified about 50 penetration circuits that need to be modified, the 12 affected circuit breakers were among them. In addition, the licensee completed two calculations: (1) PS-119, entitled, "Containment Electrical Penetrations; and (2) PS-124, entitled, "Adequacy of Electrical Penetrations Under "LOCA" Conditions," to address the penetration protection issue. Appendix 3 to Calculation PS-119 was the calculation of penetration ampacity. The inspector's review of Appendix I, Revision 0, dated December 1, 1992, (sheet 7 of 27) indicated that the excessively high trip setting of the magnetic-trip-only breakers was known to the licensee. The statement from Appendix I was as follows:

   > "Analysis of the existing penetration ampacities shows that they are adequate for the normal circuit loads. In several cases, however, conductor ampacities are below protection setting current values, which means that these ampacities may be exceeded in the case of an undetected continuous overload or high-impedance fault.

Some of the circuits, protected from overload by thermal relays, are not adequately protected from short-circuits (the settings of magnetic-only breakers exceed NEC limits)."

4. During the June 1993 EDSFI followup inspection (93-11), unresolved item 91-80-04 was closed based on the assumption that the licensee would evaluate additional modifications to address the penetration problems. However, the modification for replacing the 12 affected magnetic-trip-only circuit breakers with thermal-magnetic type breakers was not completed until April 1996 after the Technical Specifications LCO was declared.

E2.2.7 Conclusion

The inspector concluded that the licensee responded appropriately following the identification of failure of protection for electrical penetrations. The licensee entered a 24-hour LCO in accordance with Pilgrim Technical Specifications requirements. The licensee promptly reset the incorrect trip settings of the affected breakers and subsequently replaced the existing breakers (with magnetic-trip only coils) with thermal-magnetic type breakers. The licensee later issued LER 96-04 in accordance with the 10 CFR 50.73 requirement.

The inspector's review of licensee documents indicated that there were at least four opportunities that this deficient condition should have been identified and corrected earlier as discussed in Section 2.6 of this report. The inspector determined that the above condition constituted an apparent violation of 10 CFR 50, Appendix B, Criterion XVI, Corrective Actions. This criterion requires licensees to identify and correct deficient conditions promptly. Contrary to this requirement, the licensee failed to promptly identify and correct the deficient condition involving 12 improperly set breakers that provided protection to the electrical containment penetrations. This improper breaker setting rendered the electrical penetrations to be unprotected. Under certain high impedance fault conditions, this improper setting could cause the primary containment to lose its integrity. This condition also constitutes a violation of Pilgrim technical specifications, Section 3.7.A, which requires primary containment integrity be maintained at all times when the reactor is critical. **(50-293/96-07-01)**

E2.3 Environmental Qualification of In-Containment Electrical Equipment

E2.3.1 Post-DBA Containment Temperature Profile Change

The licensee contracted General Electric (GE) for an analysis to establish the new post-DBA (design basis accident) containment temperature profile due to service water temperature increase from 65°F to 75°F. The GE analysis result indicated that the new profile differed substantially from the previous one. The licensee later found out that the unexpected difference was due to GE's calculation error in the previous containment temperature profile. In response to licensee's question concerning 10 CFR Part 21 requirement, GE stated that this calculation error affected Pilgrim only due to Pilgrim's unique containment spray flow pattern following a postulated DBA.

Because of these containment temperature profile changes, the licensee established a program to requalify their in-containment electrical equipment. The affected equipment included electrical penetrations, cable (Okonite, Kerite, Rockbestos SIS), cable splices, Limitorque components, and some instrumentation. The requalification program involved evaluating existing test reports against the new temperature profile. The result of the evaluation indicated that most in-containment equipment could be qualified using existing test reports, except certain Limitorque motor-operated valve (MOV) components, which were required to provide long term post-accident monitoring function (Regulatory Guide 1.97 items). The licensee used a contractor for the EQ test of the Limitorque components, which was completed in March 1996. The inspector's review of the test report is discussed in Section 3.2.2 of this report.

E2.3.2 Review of EQ Documents

The inspector selected three EQ packages for review to determine the adequacy of the licensee's EQ documents. For each of these EQ packages, the inspector reviewed the Equipment Qualification Evaluation Sheets (EQES), which provided service conditions and qualification data for the equipment and identified the equipment type and the qualification test reports. The inspector also reviewed the EQ master list and confirmed that the equipment were on the list. The EQ packages reviewed were: 1) GE electrical penetrations 2) Limitorque MOV components; and 3) safety relief valve flow monitor.

E2.3.2.1 General Electric Electrical Containment Penetrations

This package provided qualification for nine containment penetrations. The EQES indicated that these penetrations were qualified to "DOR Guidelines." These penetrations were originally qualified to a peak temperature of 330°F, using a GE test report entitled, "Prototype Testing Qualification Report," dated March 16, 1970. This test report covered a peak temperature of 352°F.

For the latest qualification requirement, the licensee also included the temperature increase due to electrical heating (45°F) to the post-DBA temperature profile, resulting in a much higher post-DBA peak temperature of 379°F. Because the 1970 GE test report did not have sufficient post-DBA duration to cover the new temperature profile, the licensee used another GE test report entitled, "Qualification Test for F01 Electrical Assembly," dated November 9, 1971, to qualify the new post-DBA condition. The 1971 GE test report only covered a peak temperature of 340°F.

To justify the qualification for the higher peak temperature, the licensee used thermogravimetric (TGA) methodology based on another GE test report, "GE Proprietary Document NEDC-32123P, entitled, "Report PIR-CPD92045 Service Life Estimate for the Epoxy Sealant in the Penetration Assemblies at the Browns Ferry Nuclear Plant, Unit 3," dated August 20, 1992. This report discussed an isothermal test of a penetration sealant specimen at 200°C. The specimen lost 10% of its weight after 2.3 hours. The licensee considered this 10% weight loss to be a

conservative approach. The basis for using TGA result for this application was not addressed in detail in the licensee's analysis, such as the mechanical strength of the epoxy sealant and the containment pressure condition which could cause stress in the epoxy sealant. Since this was a new methodology for justifying the peak temperature for environmental qualification, the inspector requested NRR to determine its acceptability for this application. This item is unresolved pending review result from NRR and further inspection as needed (96-07-02).

On August 15, 1996, the licensee supplied additional information for the inspector's review. The licensee indicated that they had found another GE test report entitled, "Low Voltage Power and Control Nuclear Containment Loss of Coolant Accident Qualification Test 100 Series Electrical Penetration F02 Program," dated September 13, 1973, that they intended to use to qualify, by similarity, Pilgrim's F01 penetrations. According to GE, both types of penetrations used the same epoxy sealant, and the tested conditions were comparable to Pilgrim post-DBA conditions. The licensee stated that the complete qualification package would not be ready for several weeks.

E2.3.2.2 Limitorque Component Qualification

The components included in this EQ package were: Limitorque limit switches, Marathon terminal blocks, Kerite cable, and Rockbestos cable. These components were used for post-accident monitoring (Regulatory Guide 1.97 items) only, which required the components to be functional for 30-day post-DBA. These components were located inside the Limitorque actuator switch housing. The switch housing also contained other components which were used for valve controls. However, those components had been qualified together with the valve actuator for short-term post-DBA function. Therefore, those components were not included in this EQ package.

The Limitorque components were tested at Wyle Laboratories in February and March 1996. The test results were documented in Wyle Report 45238-1, "Nuclear Environmental Qualification Test Report on Limitorque Components," dated March 21, 1996. The inspector's review of this report resulted in several concerns/questions as follows:

1. Section 9.0 of the report outlined the requirements of the test. Acceptance Criteria No. 1 stated that insulation resistance less than 1.0×10^6 ohms or contact resistance (IR) greater than 1 ohm shall be investigated. The test report data sheet showed that eight readings of insulation resistances of the limit switch, the Kerite cable, and the Rockbestos cable were below 1.0×10^6 ohms; six of these readings were actually below the reading capability of the meter (5.0×10^4 ohms). Yet, these readings were not addressed in the report;

2. Section 11.0 of the test report indicated that several cracks were observed in the Kerite cable insulation following the thermal aging test. At least one of these cracks was caused by aging and not by handling. The report failed to explain why the cracked cable insulation was acceptable;

3. Since the qualified lives of most of the tested components were less than 20 years and Pilgrim had operated for 24 years, had these components been replaced before their qualified lives expired?

For the first question, the licensee stated that during the entire test, the leakage current was being monitored and was within the acceptable range, less than 10 milliamperes. Since the function of the test components was for valve position indication only (on/off type), the reduced IR values during LOCA testing would not impact the component's ability to perform their design function. The licensee agreed that this explanation would be retained in the EQ file.

For the second question, the licensee EQ engineer stated that he personally observed the crack that was caused by aging; the crack appeared to be a very thin lateral mark extending approximately halfway around the cable. Because the leakage current of the tested circuit was continuously monitored during testing and was found to be low for on/off function, the inspector had no further questions.

For the above two responses, the licensee revised Wyle Report 45238-1 (Revision B) on August 5, 1996, to reflect the above statements.

For the third question, the licensee provided evidence to the inspector which indicated that the components were replaced before their qualified lives expired.

E2.3.2.3 Safety Relief Valve Flow Monitor

The inspector reviewed the EQES and the test report for this equipment, which was supplied by TEC Corporation. The test report indicated that this equipment was tested to a peak temperature of 510°F. The inspector determined the qualification of this equipment to be acceptable.

E2.3.2.4 Conclusion

The inspector concluded that the licensee had established an acceptable program to requalify their in-containment electrical equipment because of containment temperature profile changes due to elevated service water temperature and GE calculation error. The inspector's review of three EQ packages resulted in an unresolved item (use of thermogravimetric method to justify peak temperature). The quality of the Wyle test report could be improved as numerous test anomalies were not properly addressed until after the inspection.

E.8 Miscellaneous Engineering Issues (92903)

E.8.1 (Closed) Unresolved Item 93-80-03, pertaining to lack of degraded voltage protection when emergency buses were powered by the 23 kV source. During the 1993 station blackout (SBO) inspection, the team was concerned with the ability of the degraded voltage protection to protect safety-related loads when powered from the 23 kV supply. This concern was identified because the degraded voltage relays were found to be located on the startup transformer side of the emergency 4.16 kV bus incoming breaker. This relay would not be capable of sensing a degraded

voltage condition on the 23 kV supply. The team was concerned that the Class 1E loads could be damaged by a degraded voltage condition before a SBO condition was declared.

This item was updated during the August 1995 station blackout (SBO) followup inspection (95-16). During that inspection, the inspector reviewed the Pilgrim 4160V single line, meter, and relay diagrams and confirmed that the control room annunciation was provided for a degraded voltage condition when the 23 kV source was being used. The licensee stated that if this degraded condition occurs, the operator would manually load the SBO diesel generator per station procedure PNPS 2.2.146, "Station Blackout Diesel Generator."

Following the above inspection, the licensee completed two additional evaluations: 1) Calculation No. PS-161, "20 kV Offsite Source Load Flow Study," dated September 8, 1995; and 2) Evaluation RC94-0003, which discussed the proper resolution of the 23 kV source degraded voltage issue, dated August 2, 1995.

In the first document, the licensee used the "DAPPER" program to calculate the load flow for the 23 kV offsite source under six assumed conditions. These calculations indicated that sufficient voltage existed at each safety-related load.

The second document discussed the procedures to be used in the unlikely event that a degraded voltage condition exists when the 23 kV offsite source is used during an SBO condition.

The inspector reviewed these two documents and concluded that this issue was sufficiently addressed. This item is closed.

E8.2 (Closed) Unresolved Item 50-293/95-09-02 pertained to the safety evaluation of a recirculation pump speed control modification. The inspector reviewed Pilgrim document FRN-35-24 which provided a revised safety evaluation concerning the recirculation pump control analog-to-digital upgrade.

The revised safety evaluation included an analysis for the major classes of internal failure modes unique to the digital recirculation pump control equipment and showed that the corresponding system failure effects were bounded by existing analyses. The digital failures covered electronic module failures, major software failure of the input, output, control, and display functions of the digital equipment.

The revised evaluation provided affirmative answers to the following questions:

a. If the digital speed control system stops functioning, will the operators know it, either by observing the panel displays and/or observing an annunciation?

b. If the operators know the system has failed, can they take remedial actions in time to prevent challenges to any safety system?

c. If the system fails in a way such as to present false information, do the operators have the means to determine this information is actually false?

d. Under the given failure effects, are the operators able to take manual control of the process?

The inspector noted that the licensee's analysis for the above questions was noteworthy. The inspector concluded that the revised safety evaluation included the major failure effects unique to the digital recirculation pump speed control equipment and showed that these failure effects were bounded by existing analyses. Therefore, Unresolved Item (URI) 50-293/95-09-02 is closed.

E3 UFSAR Reviews

A recent discovery of a licensee operating their facility in a manner contrary to the updated final safety analysis report (UFSAR) description highlighted the need for a special focused review that compares plant practices, procedures and/or parameters to the UFSAR descriptions.

While performing the inspections discussed in this report, the inspector reviewed the applicable portions of the UFSAR that related to the areas inspected. Pilgrim UFSAR Section 5.2.3.4.3 discussed electrical penetrations. The inspector noted that the information provided in this section had not been updated for a long time (more than two years) to reflect the more recent environmental conditions. Discussion with the licensee revealed that this issue had been identified by the licensee and was documented in Pilgrim Problem Report 96-0134, dated April 19, 1996. The licensee stated that this UFSAR section would be updated and submitted to the NRC in the next update cycle, scheduled for July 1997. This failure to update the UFSAR in accordance with 10 CFR 50.71, Section 3 constitutes a violation of minor significance and is being treated as a non-cited violation, consistent with Section IV of the Enforcement Policy. The inspector verified that other reviewed sections of the UFSAR wording were consistent with the observed plant practices, procedures and/or parameters.

XI Exit Meeting

The inspector met with the licensee personnel at the conclusion of the site inspection on July 26, 1996, and summarized the scope of the inspection and the inspection results. During this inspection, several EQ test reports containing GE proprietary information were provided by the licensee for the inspector's review. No proprietary information was knowingly included in this report from those documents. The licensee acknowledged the inspection findings at that meeting.

This inspector amended the exit meeting in a September 3, 1996, telephone call to Mr. T. Boulette, and other licensee representatives. The inspector stated that after NRC review of additional licensee supplied documents, an apparent violation and an unresolved item were identified.

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