



UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION II
101 MARIETTA STREET, N.W., SUITE 2900
ATLANTA, GEORGIA 30323-0199

Report Nos.: 50-400/93-15

Licensee: Carolina Power and Light Company
P. O. Box 1551
Raleigh, NC 27602

Docket Nos.: 50-400

License Nos.: NPF-63

Facility Name: Harris 1

Inspection Conducted: June 28 - July 2, 1993

Inspector: Steven B. Rudisail
S. Rudisail

7/15/93
Date Signed

Accompanying Personnel: N. Salgado

Approved by: C. Julian for
M. Shymlock, Chief
Plant Systems Section
Engineering Branch
Division of Reactor Safety

7/20/93
Date Signed

SUMMARY

Scope:

This routine announced inspection was conducted in the area of electrical maintenance to assess the adequacy of the corrective action for the 480V ASEA Brown Boveri (ABB) LK circuit breaker failures.

Results:

The licensee has thoroughly investigated the circuit breaker problem and exhausted possible solutions to correct the circuit breaker failures. The licensee has concluded that the breaker design was marginal resulting in inadequate design margin in the opening forces. The licensee has scheduled replacements for all safety related and frequently cycled non-safety related 480V ABB LK circuit breakers. It was noted that no safety related circuit breakers have experienced the failure to open problem. The increased maintenance for the frequently cycled breakers was considered an appropriate interim measure. The licensee's proposed corrective actions were satisfactory. The modifications to replace the circuit breakers were at the developmental stage and progressing as scheduled. In the areas inspected, violations or deviations were not identified.

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REPORT DETAILS

1. Persons Contacted

Licensee Employees

- H. Avinger, Systems Engineer, Technical Support
- *R. Biggerstaff, Regulatory Compliance
- *J. Cagle, Senior Specialist, HPAS
- *T. Cockerill, Manager, Nuclear Engineering Department
- M. Darden, Systems Engineer, Technical support
- R. Floyd, Engineer, Technical Support
- *D. Halker, Senior Specialist, HPAS
- *D. McCarthy, Regulatory Affairs
- *G. Michie, Manager, Mechanical Maintenance
- *J. Morris, Manager, Instrumentation and Control/Electrical
- *W. Robinson, General Manager, Harris Plant
- *D. Rodden, Specialist, Maintenance
- K. Russell, Onsite Nuclear Safety.
- B. Schenton, Systems Engineer, Technical Support
- D. Tibbits, Manager, Operations
- *T. Wagoner, Engineer, Maintenance
- *M. Wallace, Senior Specialist, Regulatory Compliance
- *R. Zula, Manager, Engineering Support

Other licensee employees contacted during this inspection included craftsmen, engineers, technicians, and administrative personnel.

Other NRC Employees:

- *D. Roberts, Resident Inspector

*Attended exit interview

2. Background of ASEA Brown Boveri LK-16 Circuit Breaker Failures

Shearon Harris Nuclear Plant has experienced ABB LK series circuit breaker failures since initial start-up testing. Licensee personnel and the vendor began investigating these failures and proposing solutions since the original failures. In an effort to correct the circuit breaker failures, several modifications to the circuit breakers have been accomplished. Maintenance frequencies have also been increased. Continuing failures and a lack of confidence in previous vendor proposed corrective action, resulted in the licensee forming a task force in October 1989. The task force was to further investigate and determine the root cause of the circuit breaker failures. The task force completed the results of their investigation in September 1990 and concluded that the circuit breaker problems were resulting from inadequate design margin in the circuit breakers. The factors contributing to the inadequate design margin were defective stationary arcing contact compression springs, inappropriate washers on the arcing contact springs, and ineffective booster spring application. Corrective



action proposed included removal of the arcing contact spring washer, replacement of the arcing contact spring, and removal of the opening booster spring. These corrective actions were implemented in plant modification PCR-3510. Circuit breaker failures continued to occur after the modifications were implemented, although the failure rate was reduced. Due to the continued failures of the circuit breakers, the Nuclear Engineering Department (NED) was tasked with providing a permanent solution to the problem: Additional detail on this subject was documented in NRC inspection report 50-400/92-26.

3. Proposed Corrective Action for the Circuit Breaker Problem

In October 1992, the NED began developing a proposal to replace the ABB LK circuit breakers. The proposal to replace all safety related ABB LK series circuit breakers and frequently cycled non-safety related circuit breakers was recommended on December 15, 1992. The inspectors reviewed the specifications that were sent to various vendors for adequate requirements. The specification provided the requirements for replacement of all safety related circuit breakers and associated switchgear components. The specification outlined the requirements for the design, construction, testing, and performance of the circuit breakers. After deliberation of vendor quotes, the licensee awarded the purchase order on April 2, 1993, for non-safety circuit breakers, and on April 29, 1993, for safety-related circuit breakers to Wyle Laboratories/Siemens. Wyle Laboratories will be certifying the Siemens circuit breakers for nuclear applications. The existing 800 and 1600 ampere frame size breakers will be replaced with the Siemens RL-1600 circuit breaker; the 2500 and 3200 ampere frame size breakers will be replaced with the Siemens RL-3200 circuit breaker. A special replacement cradle will be installed into the switchgear to provide access to the existing terminal blocks. Overall, 44 safety related circuit breakers will be replaced. This includes 19 per train including 6 spares. Thirty-four non-safety related circuit breakers will be replaced including 4 spares. The inspectors did not identify any deficiencies with the licensee selection of replacement circuit breakers.

4. Status of Modification

The inspectors reviewed the status of the modification for replacement of the LK circuit breakers. The replacement of the safety related circuit breakers will be accomplished during the next two refueling outages (RFO). Safety Train A will be replaced during RFO 5. Safety Train B will be replaced during RFO 6. The non-safety related breakers will be replaced prior to or during the RFO's with all replacement breakers installed by the completion of RFO 6 (September 1995). The modification effort was progressing as scheduled with procurement efforts and certification efforts at Wyle Laboratories meeting target dates. The inspectors reviewed the modification scope and progress with the lead engineer. No concerns were identified.



The inspectors reviewed temporary modification PCR-6797 which provided the necessary instructions and controls to remove two spare breaker cradles from Power Center 1-4B6. The licensee removed two model LK breaker cradles in order to facilitate Siemens personnel in installing a prototype circuit breaker cradle and taking measurements for the replacement circuit breaker design. The inspectors reviewed the associated 10 CFR Part 50.59 evaluation for PCR 6797, and no concerns were noted.

5. Interim Corrective Action

The inspectors reviewed the licensee's interim corrective action. The periodicity of the PM for the frequently cycled circuit breakers was increased from an annual to a quarterly basis. Additional interim corrective action was the replacement of frequently cycled circuit breakers with the highest number of failures with spares breakers. These spare circuit breakers have had low cycling histories. The licensee considers the replacement of the frequently cycled circuit breakers with the spares would enhance reliability. The inspectors considered these interim measures appropriate.

The inspectors reviewed the licensee procedure, PM-E0012, 480 VAC Load Center Breaker and Cubicle P.M. for conducting periodic maintenance on LK circuit breakers. The purpose of the procedure was to inspect, clean, align, and calibrate 480V breakers and the associated solid state trip unit. The same procedure provides guidance for inspecting and cleaning the 480V switchgear cubicle.

The inspectors observed maintenance conducted on ABB LK-16 circuit breaker, 1-4A6-5A, for the Water Treatment Building Power Panel C Cubicle. Maintenance was conducted and proper adherence to PM-E0012 was observed including proper utilization of independent verification as required. The inspectors assessed that the licensee was administering adequate PM. No deficiencies were identified by the inspectors.

6. Failure to Close Problem

The inspectors reviewed another problem associated with the ABB LK circuit breakers. A recent failure of the P4 Pump (Essential Chilled Water Pump) occurred when the breaker failed to close. The licensee investigated this failure and determined that the circuit breaker closing coil had failed to re-latch when the circuit breaker had previously closed. The closing coil had mechanically bound in the energized position not allowing it to re-latch. The cause of the close coil binding was preliminarily determined to be frictional forces in the linkages and plunger. The inspectors discussed this preliminary determination with the engineers and observed worn areas on the coil assembly which could have introduced additional frictional forces in the operation of the coil assembly. The coil assembly failure will be reviewed by the Carolina Power and Light Environmental and Energy Center

for further failure analysis. Maintenance Engineering will consider revision to maintenance procedure PM-E0012, 480 VAC Load Center Breaker and Cubicle P.M. to provide additional monitoring or maintenance for the closing coil mechanism.

7. Exit Interview

The inspection scope and results were summarized on July 2, 1993, with those persons identified in paragraph 1. The inspectors described those areas inspected. Proprietary information is not contained in this report. Dissenting comments were not received from the licensee.

8. Acronyms and Abbreviations

ABB - ASEA Brown Boveri
CFR - Code of Federal Regulations
PCR - Plant Change Request
PM - Preventive Maintenance
RFO - Refueling Outage
NED - Nuclear Engineering Department
V - Volts
VAC - Volts Alternating Current

