U.S. NUCLEAR REGULATORY COMMISSION

REGION III

REPORT NO. 50-456/95016

FACILITY
Braidwood Nuclear Plant, Unit 1

License No. NPF-72

LICENSEE
Commonwealth Edison Company
Opus West III
1400 Opus Place
Downers Grove, IL 60515

DATES
October 23 through November 21, 1995

INSPECTORS
E. Duncan, Resident Inspector
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APPROVED BY

L. Miller, Chief — 12-11-95 (Date)
Reactor Projects Section 1A

AREAS INSPECTED

A special reactive safety inspection to review the circumstances surrounding the inoperability of both Unit 1 diesel generators from October 3 to October 19, 1995.

RESULTS

Three apparent violations were identified involving: 1) the failure to meet Technical Specification 3.8.1 by having both Unit 1 diesel generators inoperable in Modes 5 and 6 during core alterations, movements of irradiated fuel, positive reactivity changes, and crane operations with loads over the spent fuel pool, 2) the failure to meet 10 CFR 50, Appendix B, Criterion V, by not having adequate inspection requirements for the 4160V breaker levering-in device, and 3) the failure to meet 10 CFR 50, Appendix B, Criterion V, by not including appropriate acceptance criteria in the 4160V breaker racking-in procedure.

INSPECTION DETAILS

1.0 Summary of Events

On October 2, the 1B diesel generator (DG) output breaker was racked in following safety injection system surveillance testing which had required it to be racked out. The breaker was not functionally tested after it was racked in. On October 3, with Unit 1 in Mode 5, the 1A DG was taken out of service for scheduled maintenance which rendered it incapable of being readily returned to service. The 1A DG remained out of service beyond October 19. On October 19, with Unit 1 in Mode 6, during performance of the 1B DG monthly operability surveillance, the diesel generator output breaker failed to close. The operations staff determined that the breaker chassis did not appear to be fully racked into the switchgear cubicle, which rendered the diesel inoperable, although breaker indicating lights indicated that the breaker was open and ready (available) to be closed. As a result, with Unit 1 in Modes 5 and 6 for refueling, both Unit 1 emergency diesel generators were inoperable for about 16 days during which core alterations, positive reactivity changes, movements of irradiated fuel, and crane operations with loads over the spent fuel pool occurred.

On October 19, following their discovery, operations personnel racked the breaker out, checked for obstructions, and then re-racked the breaker into the cubicle noting that the breaker had inserted farther into the switchgear cubicle than it was found. The breaker was then closed successfully.

Technical Specification 3.8.1 requires, in part, that a minimum of one diesel generator be operable in Modes 5 and 6. With less than the minimum required electrical power sources operable, the licensee is required to immediately suspend all operations involving core alterations, positive reactivity changes, movement of irradiated fuel, or crane operations with loads over the spent fuel pool. The 16 day condition described above is an apparent violation of this requirement (Violation No. 456/95016-01).

2.0 Safety Significance

The inspectors were concerned that having both Unit 1 diesel generators inoperable potentially impacted the licensee's ability to adequately remove reactor decay heat during a loss of offsite power (LOOP). From October 4 through October 9, the steam generators (SGs) were isolated from the reactor as a method of decay heat removal. In addition, reactor water level was lowered approximately one foot below the reactor vessel flange in preparation for refueling activities. A LOOP with both diesel generators inoperable would have resulted in no Unit 1 source of power to the residual heat removal pumps (the other method commonly used for decay heat removal). The licensee estimated that the time to boil in the core if the residual heat removal pumps were not used for cooling in the period from October 4 through October 9 was about 23 minutes, and the time to core damage was estimated at about 3.75 hours. However, if a loss of offsite power had occurred in this period, other methods to restore cooling using the residual heat removal pumps existed. These were:

- <u>Restore the 1B Diesel Generator by Racking in the Output Breaker.</u>

  When the licensee discovered that the 1B diesel generator output breaker would not close, they were able to troubleshoot and rack in the output breaker in about 34 minutes.

- <u>Crosstie a Unit 2 Engineered Safety Feature (ESF) Bus to a Unit 1 ESF Bus.</u>

  In the event of a complete loss of offsite power, 1BwCA-0.0, "Loss of All AC Power," directed operators to manually energize and load at least one ESF bus on a running diesel generator. If this cannot be accomplished, as would have initially been the case between October 3 and October 19, the procedure directed operators to crosstie an energized Unit 2 ESF bus to a Unit 1 ESF bus.

  In order to crosstie both trains of Unit 1 and Unit 2 ESF buses (train A and B on each unit), operators would be required to close two crosstie breakers, one between each unit's corresponding train ESF bus, in accordance with BwOA ELEC-3, "Loss of 4KV ESF Bus." These crosstie breakers can be closed remotely from the control room provided direct current (DC) control power is available. The availability of DC control power is discussed below. The licensee estimated the time required to crosstie ESF buses from the control room to be about 10 minutes.

  In the event that DC control power was not available, the cross-tie breakers could be closed manually at the breaker, located in the ESF switchgear room of the turbine building. However, this would require approximately 10 minutes additional time.

  Licensee personnel stated that following successful completion of actions to crosstie Unit 1 and Unit 2 ESF buses, a short additional period of time would be required to start a residual heat removal pump and re-establish shutdown cooling.

  DC control power to crosstie both ESF buses from the control room existed throughout the majority of the period that both diesel generators were inoperable. However, the 125V DC battery 111 was disconnected from DC bus 111 for surveillance testing for 23 hours from October 4 through October 9, and 72 hours from October 10 through October 13. During those periods, in the event of a loss of offsite power, DC control power to the A train ESF bus crosstie breakers would not have been immediately available. As a result A train ESF bus loads would have been deenergized for some period. However, the DC control power to the train B ESF bus crosstie breakers would have been available, and the B train ESF bus loads could have been reenergized quickly.

The licensee had two options available to restore power to DC bus 111, thereby restoring the control power to the A train ESF bus crosstie breakers:

- Crosstie Unit 2 DC bus 211 to Unit 1 DC bus 111, or

- Manually close temporary breakers from battery 111 in the Unit 1 miscellaneous electrical equipment room staged for battery 111 surveillance testing.

Either method would require a short period of time to accomplish once the condition was recognized.

Based upon a probabilistic risk assessment, the licensee estimated the probability of remotely crosstieing an energized ESF bus on one unit to an unenergized ESF bus on the other unit was estimated to be about 98 percent.

From October 10 through October 19 the steam generators were isolated as a source of decay heat removal but the reactor head was removed and the reactor cavity was flooded. Pool convective cooling of the reactor was sufficient in this case so that it was unlikely that any core damage would occur before forced cooling could have been restored, according to the licensee's analysis.

After reviewing and assessing the licensee's analysis, the inspectors concluded that the unavailability of both diesel generators had [illegible] that increased the probability of losing the capability of removing decay heat from the reactor (in the event that offsite power had been lost while both diesel generators were out of service).

3.0 Root Cause Investigation Results

A licensee investigation concluded that the apparent root cause of the failure of the breaker to close was an excessively worn breaker levering-in device. The worn breaker levering-in device resulted in the stoppage of breaker movement into the cubicle before the "floor tripper" mechanism was disengaged. This prevented the 1B DG breaker from closing.

The licensee also concluded that inadequate identification and resolution of the levering-in device problem was a contributing cause of the failure.

In addition, the licensee identified that the operator failed to identify that the breaker was not fully racked in, and that functional testing was not on the breaker after racking it in. The inspectors concluded that these were also contributing causes to the problem.

3.1 Levering-In Device Description

The 1B DG breaker is a 4160V Westinghouse Type DHP Air Circuit Breaker. The purpose of the levering-in device was to allow the circuit breaker to be racked in to and out of the breaker cubicle. The major components of the device included:

- The levering nut
- The guide tube
- The levering-in shaft

These parts are installed as part of the breaker chassis assembly. The levering nut is fastened to the guide tube and is loosely retained in a housing fastened to the extreme rear of the chassis.

Operation of the levering-in device consists of engaging the rotatable levering nut on the circuit breaker with the levering screw mounted on the rear wall of the switchgear cubicle cell. By traversing the levering nut along the levering screw, the breaker is moved within the switchgear housing.

The guide tube is slotted lengthwise for a distance about equal to the travel distance of the breaker. The levering-in shaft has two rectangular keys which slide in the guide slot. Therefore, as the levering-in shaft is rotated, the guide tube and nut are also rotated.

As the breaker is levered in by clockwise rotation, the keys on the levering-in shaft move toward the end of the guide tube slot. As the rear key comes out of the slot, the levering-in shaft turns freely (free wheels) and the breaker moves no further.

3.2 Levering-in Device Inspection

During the root cause investigation, the licensee removed the breaker levering-in device and identified that the levering-in device guide tube and guide key were worn (rounded off). Also, a through-wall crack of about 1 inch in length was identified on the guide tube.

In addition, the licensee conducted follow up testing in which the observations on October 19 described above were successfully duplicated using a mock up breaker chassis and switchgear cubicle.

Based on these observations, the licensee concluded that the deficiencies noted on the levering-in device resulted in free wheeling of the device before the breaker was fully racked into the switchgear cubicle.

3.3 Missed Identification Opportunities

The inspectors determined that the licensee had previous opportunities (discussed below) to identify that the 1B diesel generator output breaker was not fully racked in following surveillance testing which racked it out. These missed opportunities included identification of problems with the levering-in device, failure of the operator to identify that the breaker was not racked in, and not performing confirmatory functional testing.

3.3.1 Levering-in Device Material Condition

The inspectors determined that the licensee was aware of numerous problems with the levering-in devices associated with 4160V Westinghouse Type DHP Air Circuit Breakers. Several operators interviewed by the inspectors and the licensee indicated that, in general, Westinghouse Type DHP Air Circuit Breakers were becoming increasingly more difficult to rack in, and that breaker chassis and switchgear cubicle frame misalignments had become more frequent. However, the operators stated they had not documented these discrepancies. Historically, the inspectors noted that similar failures had been documented, and some licensee corrective actions for the worn levering-in devices had been taken:

- On November 29, 1984, the licensee received information which discussed a Westinghouse Type DHP Air Circuit Breaker which failed to rack in due to a cracked guide tube. The licensee reviewed the information in 1984, considered it applicable to Braidwood, and concluded that their preventive maintenance program addressed the concerns. No additional actions were taken.

- On November 11, 1993, a cracked guide tube was replaced on a 4160V Braidwood breaker. The work request for the replacement indicated that the root cause was an inadequate design.

- On April 28, 1994, the licensee received a letter from Westinghouse which discussed breaker levering-in device inspection and lubrication recommendations and breaker racking in and racking out design limits.

  The letter, dated April 28, 1994, responded to a systems engineer's request for vendor recommendations on inspections of the levering-in device. The letter stated that it would be prudent to include the inspection and lubrication of the levering-in device in the preventive maintenance procedures. The letter further stated that the levering-in device guide tube should be inspected for any evidence of cracking and a small amount of lubricant should be present on the levering-in nut.

- On July 31, 1994, a 4160V Westinghouse Type DHP Air Circuit Breaker at Braidwood failed to close during a surveillance. The breaker was racked out and racked in and then closed successfully. No root cause was identified.

- On February 10, 1995, a crack was identified on the levering-in device for a 4160V Westinghouse Type DHP Air Circuit Breaker at Braidwood, and was documented on a problem identification form (PIF). However, the PIF was closed without any action to identify the root cause of the problem.

- On June 2, 1995, the licensee responded to the April 28, 1994 Westinghouse letter by revising their inspection procedure, BwHS 4002-07, Revision 4, "Inspection of Type DHP Switchgear and Switchgear Cubicles." However, this revision did not include adequate inspection requirements for the breaker levering-in device. Section 17.2 required that the levering-in device operating shaft be pulled out only halfway from the circuit breaker for inspection. The inspectors noted that in order to perform a detailed inspection of the levering-in device for cracks, worn, broken, or damaged parts and adequate lubrication, the levering-in device must be completely removed for inspection and lubrication.

The inspectors noted that the last time an inspection of the 1B DG breaker was performed was May 1992. The licensee inspection program provided for an inspection every other refueling outage. An inspection of the breaker was scheduled for the Unit 1 refueling outage but the failure occurred before it was accomplished.

The failure to promptly identify and correct the defective breaker and to incorporate a procedural requirement to adequately inspect the levering-in device, as described above, is an apparent violation of the requirements of 10 CFR 50, Appendix B, Criterion V "Instructions, Procedures, and Drawings," and Criterion XVI, "Corrective Action" (Violation No. 50-456/95016-02).

3.3.2 Operator Failed To Identify The Breaker Was Not Fully Racked In

Licensee personnel found the 1B DG breaker with its front steel barrier about one inch from the cell frame angles. The operator that racked the breaker in had not identified this as a problem when he racked the breaker in. Westinghouse Instruction Book 32-253-4A, "Type DHP Magnetic Air Circuit Breakers" states, in part:

> "Continue cranking until crank turns freely and breaker stops moving. When breaker is fully engaged, front steel barrier should be 1/4 inch or less from cell frame angles."

However, Braidwood procedure BwOP AP-6, "Racking-in a 4KV or a 6.9KV Air Circuit Breaker," failed to include this measurement to ensure that a breaker was fully racked in. In addition, the inspectors determined that operations and maintenance personnel were not trained to verify this measurement after racking in a breaker. The inspectors noted that the breaker indication lights could show that the breaker was open, available, and ready to be closed; however, if the breaker was not fully racked in (less than 1/4 inch from cell frame angles) the floor tripping device would not allow the breaker to close.

10 CFR Part 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," requires, in part, that activities affecting quality be prescribed by documented procedures of a type appropriate to the circumstances. Procedures shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily accomplished. The failure to incorporate a provision to ensure the breaker was fully racked in, as described above, is an apparent violation of this requirement (Violation 50-456/95016-03).

3.3.3 Functional Testing

On October 2, the 1B diesel generator output breaker was racked out of the switchgear cubicle to support safety injection surveillance testing. Following completion of the surveillance, the breaker was racked back into the switchgear cubicle. A functional test to verify that the output breaker would close was not scheduled or performed until October 19 to meet monthly operability surveillance requirements.

The licensee determined, after the event, that a functional test to close the output breaker following re-installation on October 2 would have identified that the breaker was not operable.

The inspectors concluded that by not performing a functional test of the 1B diesel generator output breaker after it was racked in, a significant opportunity to identify the problem had been missed.

4.0 Licensee Corrective Actions

4.1 Immediate Corrective Actions

The licensee's immediate corrective actions included:

- Following completion of maintenance on the 1A DG, the 1B DG levering-in device was replaced with a new Westinghouse design.

- Operators were trained on how to recognize through visual inspection when a breaker was fully racked in.

- A visual inspection was performed on all 4160V and 6900V breakers used in safety-related applications to verify that they were fully racked in.

- BwOP AP-5, "Racking-Out a 4160V or 6900V Air Circuit Breaker to the Disconnect Position," was revised to include actions to be taken if the breaker is being racked out due to not closing on demand.

- BwOP AP-6, "Racking-In a 4160V or 6900V Air Circuit Breaker," was revised to include methods to verify that a breaker is fully racked in, and actions to be taken in the event that the breaker appears abnormal or the expected indications are not present when the breaker is racked in.

- BwHS 4002-07, "Inspection of Type DHP Switchgear and Switchgear Cubicles," was revised to require that the levering-in device be completely removed for inspection and lubrication.

4.2 Longterm Corrective Actions

The licensee's planned longterm corrective actions included:

- Operators and electrical maintenance personnel will be trained on the function and operation of the breaker levering-in device.

- Future breaker inspections will include the complete removal of the levering-in device for inspection and lubrication.

- A functional test of the diesel generator and other safety-related equipment will be performed following breaker removal for surveillance testing to ensure that the breaker will close on demand.

5.0 Management Debriefing and Persons Contacted

At the conclusion of the inspection on November 17, 1995, the inspectors met with licensee representatives (denoted by *) and summarized the scope and findings of the inspection activities. The licensee did not identify any of the documents or processes reviewed by the inspectors as proprietary.

*K. Kaup, Site Vice President
*T. Tulon, Station Manager
A. Haeger, Executive Assistant
W. McCue, Support Services Director

R. Flessner, Site Quality Verification Director
*G. Groth, Maintenance Superintendent
D. Skoza, Engineering Superintendent
R. Byers, Work Control Superintendent
*D. Miller Technical Services Superintendent
K. Bartes, Regulatory Assurance Supervisor
*A. Checca, System Engineer Supervisor
*J. Meister, Engineering Manager
*D. Cooper, Operations Manager
*L. Weber, Shift Operations Supervisor
*C. Dunn, Site Quality Verification
*E. Adams, Electrical Group Leader
*M. Pavey, Licensing
*J. Lewand, Regulatory Assurance - NRC Coordinator