U.S. NUCLEAR REGULATORY COMMISSION
REGION I

Report No. 50-293/85-14

Docket No. 50-293

License No. DPR-35 Priority -- Category C

Licensee: Boston Edison Company
800 Boylston Street
Boston, Massachusetts 02199

Facility Name: Pilgrim Nuclear Power Station

Inspection At: Plymouth, Massachusetts

Inspection Conducted: May 28-31, 1985

Inspectors: c/a for F Paulitz — 7/30/85
F. Paulitz, Reactor Engineer — date

Approved by: C J Anderson — 7/30/85
C. J. Anderson, Chief Plant Systems Section, DRS — date

Inspection Summary: Inspection on May 28-31, 1985 (Inspection Report No. 50-293/85-14)

Areas Inspected: Routine, unannounced inspection of licensee action on previous inspection findings. The inspection involved 30 hours on site by one region based inspector.

Results: No violations or deviations were identified.

DETAILS

1. Persons Contacted

1.1 Boston Edison Company

C. J. Mathis, Station Manager
J. Crowder, Compliance
N. Brosee, Chief Maintenance Engineer
R. Sherry, Assistant Chief Maintenance Engineer
P. Smith, Chief, Technical Engineer
T. McLoughlin, Senior Electrical Engineer

1.2 U.S. Nuclear Regulatory Comission

M.H.D. Mc Bride Resident Inspector

2.0 Licensee Action on Previous Inspection Findings

2.1 (Closed) Inspector Follow-up Item (83-17-02) Reactor Mode Switch Failure Causes Reactor Scram

Background

The reactor mode switch has a position handle. This handle, through gearing, operates four (one per reactor protection channel) General Electric type SB-1 switches. Certain plant process variables which could provide a scram input in the "run" position are bypassed (blocked from a scram input) in the "startup" position. This bypass is provided by contact closure of the SB-1 switches.

Event

The reactor mode switch had been moved from the "run" position to the "startup" position. Five hours later with the reactor in the hot standby mode (following a controlled shutdown and with all rods fully inserted for approximately two hours) a low condenser vacuum reactor scram signal was received.

Analysis

The Operation Review Committee (ORC) determined that this failure of the mode switch was in the safe direction (reactor scram).

The Nuclear Engineering Department reviewed the possible causes for the inadvertent scram and determined that the problem could be related to the following:

-- Mode switch main-drive gear

-- Excessive play in the switch position

-- SB-1 switch contact adjustment

Corrective Action

The licensee issued a maintenance request and inspected the mode switch for crossed wires, loose wires and contact positions. A lack of contact closure in the "startup" position was noted for one of the four SB-1 switches. The switch was not properly coordinated with the position handle. Adjustment was made for proper coordination and all contacts checked in all mode positions.

Findings

The licensee has identified and corrected this mode switch problem. The correct switch contact position for all modes of operation was verified by the licensee. This item is closed.

2.2 (Closed) Unresolved Item (85-03-07) "A" Recirculation Motor Generator (MG) Set Field Breaker Failed to Open on Demand

2.2.1 Background

On February 21, 1980, the NRC issued an Order requiring the installation of a recirculation pump trip (RPT) by December 31, 1980. This RPT is a diverse means, from the reactor trip system (RTS) of making the reactor subcritical should there be an anticipated transient without scram (ATWS). The ATWS-RPT/Alternate Rod Insertion (ART) modification was completed during the 1980 refueling outage.

The method of terminating the recirculation pump flow is to deenergize the pump motors by opening up the MG set generator field breaker associated with each pump. A second shunt trip assembly was installed in each MG set field breaker, and when used with the existing shunt trip, it would provide a one-out-of-two shunt trip for the ATWS-RPT function.

The GE type AK-F-2-25 is a "field switch". It does not have an over-current protection feature. The AK-F-2-25 has two poles that interrupt the d.c. field excitation current and a center pole that connects a resistor that dissipates the stored energy in the field when the excitation is removed. The center pole of the AK-F-2-25 is operated by a special cam arrangement intended to connect the field discharge resistor before the main d.c. poles open. On closing the breaker the field discharge contact open after the main breaker contacts close. This contact overlap allows the excitation circuit to open without inducing excessively high voltage in the field winding.

2.2.2.0 First Event

A reactor trip occurred at 3:48 p.m. on April 2, 1983, due to a turbine runback. The licensee performed preventative maintenance on the Recirculation Motor Generator (MG) set generator brushes while the reactor was shutdown. At 12:40 a.m. on April 3, 1983, the "B" MG set was secured by the control room operators (this should have tripped the generator field breaker). Twenty minutes later plant personnel smelled smoke in the MG set room and observed that the "B" MG set generator field breaker had not opened and the shunt trip coil had burned out.

2.2.2.1 First Event Analysis

The licensee maintenance personnel found mechanical binding of the breaker unit which required partial disassembly in order to free the breaker.

A discussion between the NRC:NRR and General Electric Company, Plainville, Connecticut about this event revealed the following:

-- The shunt trip device correctly rotated the trip shaft and thereby started the trip action. However, the cam arrangement failed to complete its intended action, and hence, the trip action was interrupted.

-- GE indicated that the cam arrangement has a poor mechanical advantage (i.e. less than unity). Because of the poor cam arrangement, GE stopped the manufacture of this design several years ago.

The open circuit of the shunt trip was caused by the breaker auxiliary switch "a" contact being unable to interrupt the trip coil current. This shunt trip coil is only rated for short duty. Had the breaker operated correctly the "a" contact, which opens when the breaker main contacts open, would have stopped the trip current going through the coil and the coil would not have burned up.

2.2.2.2 First Event Corrective Action/Evaluation

The licensee replaced the trip coil, lubricated the beaker, and exercised it numerous times during bench testing and following reinstallation.

The licensee's Onsite Review Committee (ORC) was convened and reviewed the event. No definitive cause for the original mechanical binding was identified but the ORC determined that repairs and testing were adequate to insure proper breaker function. The reactor startup continued and the reactor taken critical at 6:37 p.m. on April 3, 1983.

2.2.3.0 Second Event

The reactor power was decreased for a planned main steam isolation valve maintenance and investigation of a hi/low oil level alarm on the "A" recirculation pump (RP) when the "A" RP tripped at 12:43 a.m. on February 9, 1985. Further investigation found no cause for the RP trip as there were no relay targets shown. An attempt was made to restart the pump, but the motor generator (MG) set tripped on generator differential overcurrent phase 2. The reactor was shutdown at 12:40 a.m. the next day in accordance with Technical Specification requirements. The "A" RP MG set field breaker did not open on demand.

2.2.3.1 Second Event Analysis

The control/ATWS shunt trip coil was found burned out and open circuited. In addition the auxiliary switch that was connected to the breaker trip shaft had loose mounting bolts and was damaged. The licensee believed that the loose auxiliary switch housing may have caused the switch to partially jam.

Since similar auxiliary switches are used on other AK class breakers, including series 25 and 50 breakers, in 480 volt safety busses the licensee inspected all auxiliary switches on these breakers and found no problems.

2.2.3.2 Second Event Corrective Action/Evaluation

Other than repair of the auxiliary switch the corrective action was the same as for the "B" RP MG set field breaker.

The licensee determined that mechanical binding and/or auxiliary switch problems caused the failure of the breaker to trip on demand. The LER 85-003-00 did not described the failure of the "A" RP MG set field breaker to open. The cause of this trip demand was determined later on February 11, 1985 to be pump motor bearing failure. Although there was a relay target on the generator differential relay there were no electrical problems with the generator.

2.2.3.3 Third Event

On March 15, 1985, during "high risk I&C surveillance, the reactor scrammed. The turbine generator normally receives a time delay trip after the reactor trip. This did not occur due to a blown fuse in the turbine DC trip circuit. The operator then manually tripped the turbine and generator output breakers. Subsequently, it was discovered the generator field breaker (GE model AKF-2-25) had failed to open when it received a trip signal from its manual control switch.

2.2.3.4 Third Event Analysis

The breaker is the same design as those used for the A and B RP MG set field breakers which had also failed to trip on demand. The licensee discovered that there was insufficient lubrication of the link and cam on the center pole and that the eccentric bushing was improperly installed; both factors contributed to the breaker failure to trip.

2.2.3.5 Third Event Corrective Action/Evaluation

The licensee performed the following action on the breaker:

-- Cleaned

-- Eccentric bushing installed correctly

-- Lubricated

-- Adjustment and replacement of the trip coil

-- Tested successfully through 25 open-close cycles.

Six months prior to this event, the turbine generator field breaker had undergone preventive maintenance which included the recommended OEM maintenance.

The licensee review of GE instruction manual (GEI-93863A supplement to GEI-50299) "AK Power Circuit Breakers Electrically and Manually Operated Types AKF-2-25 and AKF-2A-25" identified the following:

-- The manual, Figure 2, on page 3, part number 12 does show the correct eccentric bushing orientation.

-- The fact that improper orientation of this bushing will cause mechanical binding and breaker trip failure was not identified in the manual.

-- The spare GE AKF breaker which was installed as a main generator field breaker was a later model which does not have eccentric bushings, rather, it has no offset. This difference between breakers with the same model number is not shown in the referenced GE breaker manual.

2.2.4 Follow up by Licensee of RP MG Set Field Breakers

The licensee issued Maintenance Request No. 85-209 and 85-210 on March 17, 1985 to inspect the RP MG set A&B field breakers. The 480 load center Breaker Maintenance Procedure, 3.M.3-6-1, Rev. 5, dated February 11, 1985, was used.

The recirculation pump MG set field breakers were inspected and found to have improperly installed eccentric bushings. The bushings were removed and reinstalled in the correct orientation.

2.2.5 Findings

Failures of the RP MG set field breaker was attributed to improper installation the center pole eccentric bushing. The licensee proposes to revise procedure 3.M.3-G-1 to assure correct orientation of the eccentric bushing. For these breakers, the licensee removed the bushings and reinstalled them in the correct orientation. This item is closed.

2.3 (Open) Inspector Followup Item (84-26-01) Bus Transfer for Planned Maintenance Caused a Reactor Scram

2.3.1 Background

Each of the class IE 480 volt load centers has a bus tie breaker which can connect the class IE load center bus to a non class IE load center bus. Both the class IE and the non class IE load centers are supplied power through a stepdown transformer. The primary sides of the transformers are connected through breakers to the 4,160 volt busses. The secondary sides of the transformers are connected through breakers to the 480 volt load center busses. The breakers involved in this event are designated as follows:

-- A608; 4,160 volt breaker on class IE bus A6, supply to the load center transformer.

-- B201, 480 volt breaker supply to class IE Bus B2, from the load center transformer.

-- B410, 480 volt breaker bus from the non class IE Bus B4, to class IE Bus B2

-- B401, 480 volt breaker supply to non class IE Bus B4 from load center transformer connected to non class IE 4160 volt bus A4 via breaker A406.

2.3.2 Event

On September 28, 1984 at 2:15 p.m., while shutdown for refueling with the reactor vessel defueled, an unplanned reactor scram signal was generated through the Reactor Protection System (RPS). Prior to the initiation, maintenance was being performed in the Scram Discharge Volume (SDV), which resulted in SDV level trips being present in the RPS. A reactor scram signal was received when the 480 volt bus B4 was deenergized.

The deenergizing occurred while maintenance electricians were attempting to remove from service the B401 supply breaker to bus B4. Bus B4 was to be supplied 480V power from class IE Bus B2 by closing tie bus breaker B410. There was a built in interlock which was to prevent having both the incoming supply breaker B401 and tie bus breaker 410 closed at the same time. This interlock was not removed prior to closing breaker B410. As a result, the feeder breaker B401 and the bus tie breaker B410 tripped open and the 480 volt bus B4 became deenergized. This loss of power to Bus B4 removed power from the "B" RPS motor generator set which, when coupled with the SDV trips, completed the RPS logic for a full reactor scram signal.

Not described in LER 84-014-00 issued in October 24, 1984 was the tripping open of the class IE breakers A608 and B201. Opening of either breaker deenergized the 480 volt class IE bus B2.

2.3.3 Analysis

The LER stated that the cause of the event was a procedural inadequacy. The breakers A608 and B201 were tripped by overcurrent devices. The overcurrent could be the result of either 4160 volt bus A6 being connected to a different source than the 4160 volt bus A4 or the protective relay settings of breakers A608 and B201 were not set to account for the load on bus B4. The licensee stated that both busses A4 and A6 were connected to the same source at the time of this event thus there should have been no circulating current through breakers A608 and B201. Another indication is the 4160 volt breaker A406 supply to the load center transformer which supplies 480 volt bus B4 did not trip open. It was concluded that the protective trip devices for breakers A608 and B201 did not account for the load pickup of bus B4.

2.3.4 Corrective Action

The licensee proposed to develop a procedure that would define when, where and how bus switching could take place.

2.3.5 Findings

The LER did not identify the loss of power to the class IE bus B2 via tripping of breakers A608 and B201 nor the cause of this loss of power. Also the LER did not state the function of the interlock trip mechanism and exactly which breakers were interlocked to be tripped. A brief review of the draft procedure indicates that class IE buses B1 and B2 would only be tied to their respective non class IE busses under the following conditions:

-- Plant off the line

-- No fuel in vessel

-- Emergency condition if the safety bus has already been lost

-- No fuel is being moved either in the fuel pool or in the vessel.

The remaining non class IE 480 volt busses, B5, B7 and B8 could be tied together for either plant maintenance or emergency conditions.

The inspector noted that there were provisions for numerous bus conditions where there were no connections shown on the plant one line diagram. The licensee stated that the procedure would account for any possible bus tie using spare breakers and temporary connecting cables if necessary.

The licensee further stated that this procedure would be in place prior to the next refueling outage. This item remains open pending a review of the approved procedure.

2.4.0 (Open) Noncompliance Item (81-22-01) Inadvertant defeat of Engineered Safety Features due to control power removal

2.4.1 Event

An electrical ground was noted on the "A" 125 volt DC battery bus on September 12, 1981, at about 1830 hours. Trouble shooting by the licensee revealed that the ground was in the Reactor Core Isolation Cooling (RCIC) system turbine control circuit. At 2238 hours on September 12, 1981, breaker 3 on 125 volt dc panel D4 was opened and tagged for the repair and replacement of an failed inverter. Although the purpose of the deenergization, by opening breaker 3 of panel D4, was to deenergize fuse panel C930 (RCIC Turbine Controls) to provide a hazard free repair it also deenergized fuse panel C904 (RCIC Turbine Instrumentation and RCIC System Isolation valves). The above deenergization resulted in the following conditions:

-- Loss of redundant high temperature auto isolation of RCIC steam.

-- Loss of redundant high steam flow rate auto isolation of RCIC steam

-- Total loss of low pressure auto isolation of RCIC steam.

The above condition continued until 1519 hours an September 16, 1981 (4 days) when the licensee was advised by the NRC Senior Resident Inspector that requirements of the Technical Specification were being violated.

2.4.2 Analysis

Technical Specification 3.2.B, Core and Containment Cooling System Initiation and Control, requires that if the minimum number of operable instrument channels per trip system cannot be met for one of the trip systems, that system shall be repaired or the reactor shall be placed in the cold shutdown condition within 24 hours after this trip system is made or found to be inoperable. This specification also requires closing of the isolation valves in the RCIC subsystem when the required number of trip systems are not operable. In addition Technical Specification 3.7.D, Primary Containment Isolation Valves, requires that the reactor be placed in cold shutdown condition within 24 hours if at least one primary containment isolation valve is not shut in a line which has an inoperable isolation valve.

Neither the maintenance nor the operation personnel understood the system effect and the resulting Technical Specification violation which resulted from opening up breaker 3 panel D4.

General Electric design in many Engineered Safety Features Systems such as Emergency Core Cooling or Primary Containment Isolation utilize a one half taken twice logic. The components in the circuits require energization to function. This logic matrix which is identical appears in two separate division output circuits. However two channels are associated with each separate division output circuit. When control power is removed from either division output circuit not only is the division output lost but the two channels are also lost. The logic for the remaining division now requires two of two channels to function if the remaining division is to function.

2.4.3 Corrective Action

2.4.3.1 Short Term

The operations personnel were given the details of this event and those involved were informed that they must review isolations more thoroughly. The LER 81-050 telecopy message stated that a corrective policy by special order on or before September 26, 1981 would be in place and the inspection/Trouble Shooting - Electrical Circuit procedure 3.M.3-8 would be revised.

The LER 81-050 dated September 29, 1981, BECo letter 81-226 stated that the corrective action revision of procedure 3.M.3-8 would be completed by October 11, 1981.

The inspector reviewed procedure, 3.M.3-8, revision 6, dated November 16, 1984, for this corrective action and noted that paragraph six contained precautions which applied to this corrective action as follows:

-- The approach and areas of investigation must be thoroughly discussed with the Watch Engineer and documented on the checklist Attachment A.

-- Special note must be taken in those areas where redundant equipment cross interlocks are involved. There is a potential especially in AC distribution panels Y6, Y2, Y3 and Y4 and DC distribution panels D4, D5, and D6 breakers for disabling redundant safety related systems. Isolation of these loads other than momentary shall be on a component only basis, unless reviewed and approved by the Onsite Review Committee.

2.4.3.2 Long Term

BECo letter 82-87 dated March 19, 1982 stated the short term corrective action as discussed above, in addition the system procedures which deal with electrical distribution would be revised. These revisions would include format changes to include the effects of de-energizing power sources and identification of applicable Technical Specification requirements.

2.4.4 Findings

Before the licensee can determine the effect of circuit deenergization he must first verify if the actual field wiring conforms to the drawings. A walkdown of all wires associated with distribution panels Y1, Y2, Y3, Y4, D4, D5, D6 and D19 is to be made and drawings revised if necessary to agree with the as built plant conditions. This walkdown includes fuse size verification. The guidelines for this work are contained in the Nuclear Engineering Work Instruction Number 272 Revision 0, entitled "Wiring Verification for Power Distribution Panels PERD E203".

The walkdowns have been completed for panels:

-- 120 volt AC safeguard power supply Y3 and Y4

-- 125 volt DC Battery System Panels D4 and D5

The analysis of the effect of deenergization have been completed on Panels Y3 and Y4. However, the effect on the Technical Specification has not been completed.

A discussion with the licensee indicates that the long term corrective action will not be complete until the year 1995. This item is open pending licensee completion of long term corrective actions.

3. Exit Interview

The inspector met with the licensee personnel denoted in Detail Paragraph 1 at the conclusion of the inspection on May 31, 1985. The inspector summarized the scope and findings of the inspection. The licensee acknowledged the inspector's findings. At no time during this inspection was written material provided to the licensee by the inspector.