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Gentlemen:

AUTOMATIC LOAD TAP CHANGER
UNRESOLVED ITEM 50-354/92-80-10
HOPE CREEK GENERATING STATION
DOCKET NO. 50-354

On May 28, 1992, the NRC issued the "Electrical Distribution System Functional Inspection of Hope Creek Generating Station" (Report No. 50-354/92-80). In this inspection report, the NRC identified the following as Unresolved Item 50-354/92-80-10.

> "In the past three years, there were four failures on the transformer load tap changers (LTC). Three of the failures were on the non-Class 1E transformers and one on the Class 1E transformer. The cause of these failures remains unknown. Failure of the transformer LTC can affect the time-delayed bus transfer and the available voltage at the 480 V motor control centers."

In response to this Unresolved Item, PSE&G stated in letter NLR-N92094 dated July 10, 1992, that the results of the corrective action plan described below would be transmitted to the NRC by June 30, 1993. This corrective action plan consists of the following:

1. The operation of the LTCs will be observed for any sporadic behavior,

2. The LTC position indicator telltales will be reset whenever required,

3. The actions taken during troubleshooting that could have corrected the problems unknowingly will be reviewed for possible implementation into the preventive maintenance program, and

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4. If the results of the preventative maintenance indicates a probable root cause, this root cause would also be included in this report.

PSE&G has been monitoring LTC operation on a routine basis. This monitoring consists of observing the LTC position indication, both locally and in the control room. Bus voltage indication is also reviewed via the CRIDS screen printouts and are compared with the LTC tap positions. The LTC tap position telltales are checked and reset when appropriate (i.e.,after outages, testing, etc.). PSE&G has also initiated a procedure change request for operations log procedure HC.OP-DL.ZZ-0002(Q) and -0003(Q) to revise the minimum and maximum bus voltage values alerting the control room operators of a potential LTC problem if bus voltage is outside of these new values.

Since the exit of the Hope Creek EDSFI team and prior to March 4, 1993, no abnormal operation of any LTC was experienced. On March 4, 1993, Station Service Transformer (SST) 1AX501 experienced a voltage swing that resulted in a voltage transient on the electrical distribution system busses fed from this transformer. This erratic operation occurred during a severe rain and wind storm. Operations personnel took manual control of the LTC and adjusted bus voltage as required. Comprehensive troubleshooting was undertaken which appears to have led to the determination of the root cause of the various LTC malfunctions.

The troubleshooting that began after the malfunction of the 1AX501 LTC on March 4, 1993, consisted of the following:

1. Meggering the voltage sensing cable from the bus PT.
2. Examining internal components in the LTC control box.
3. Testing the LTC in manual and automatic.
4. Checking correct operation of limit/cam switches.
5. Checking control panel space heaters.
6. Discussions with GE concerning the design.
7. Questions on LTC failures where put out on INPO Notepad.

The initial inspection, checkout and testing of the LTC did not identify any problems with the LTC. The control cabinet was found to be dry and the LTC was returned to the Automatic Mode. A more comprehensive inspection of the LTC electronic components was then performed which discovered the existence of corrosion on the solid state control card. Corrosion was evident on the emitter, base and collector leads of transistor Q2, IC1 and solder traces. One lead from the control power transformer T2 (120 vac) was corroded and stuck to the leads of transistor Q2.

This corrosion could provide a path during damp or wet weather to "turn on" transistor Q2 which, in turn, would "turn on" transistor Q4. Transistor Q4 is the "raise tap" circuit of the LTC.

Corrosion was not evident on any component in the "lower tap" circuit. The discovery of corrosion in the "raise tap" circuit prompted an inspection of all remaining SST LTC control cards. Corrosion was evident on the control card in 1CX501 in approximately the same locations. No corrosion was evident on the remaining SST LTC control cards. These cards appeared to be in a "like new" condition. The control cards in both 1AX501 and 1CX501 were replaced. Even though the other SST LTC control cards appeared to be in a "like new" condition, PSE&G decided to replace all the SST LTC cards since an improved card is supplied from GE.

The improved card design from GE consists of the following changes: relays K1 and K2 are now sealed type relays, the card is solder etched on both sides (greater spacing between circuits), ribbon edge connectors, improved control transformer, and most importantly, the entire card (including components) is covered with a conformal coating that protects against fungus and moisture.

The LTC malfunctions that have occurred are listed below.

11/28/88 - 1BX503
07/13/90 - 1AX501
11/10/90 - 1CX501
03/07/91 - 1CX501
03/04/93 - 1AX501

A review of the work orders show that only transformer 1BX503 had the control card changed out and has not had another malfunction since this change out. Transformers 1AX501 and 1CX501 LTC control cards were the only cards with evidence of corrosion and both transformers experienced two malfunctions each. It is known that at least three of the LTC malfunctions occurred during heavy rain storms. None of the other SST LTCs have experienced any malfunctions.

Earlier root cause analysis suggested that the sporadic LTC malfunctions could be caused by sticking relay contacts or a faulty brake motor. The relay contacts and brake motor were tested and found to be working properly. A visual inspection of the LTC controls did not result in any abnormal conditions being identified and a functional test of the LTC demonstrated that the LTC performed satisfactorily. Since no evidence of any abnormal

conditions existed, the LTCs were restored to automatic operation and PSE&G continued to monitor the LTC operation. PSE&G continued to analyze the LTC malfunctions by performing: 1) a circuit card component failure analysis, 2) discussions with the vendor concerning radio interference and lighting strike voltage surges, and 3) a review of previous failures. During the followup review of the March 4, 1993 failure, a common correlation with rain storms was detected which led to a closer examination of the solid state control card components for evidence of tracking and/or corrosion due to the increase in humidity.

Based on the above facts, PSE&G has concluded that the root cause of the LTC malfunctions was corrosion on the LTC control card. The contributing factors that led to these malfunctions were:

1. Control cards at one time were exposed to the environment,

2. Less than adequate design of the control card, and

3. Less than adequate maintenance procedural guidance on inspection of components inside the LTC control box.

The following corrective actions have been implemented.

1. A walkdown of all control cabinets to verify integrity of door seals/latches and operation of space heaters (these are included in the PM procedure).

2. Replacement of all SST LTC control cards with the improved cards.

3. Initiation of a procedure change to provide direction on internal inspection of the LTC control box.

PSE&G has reviewed the SST preventative maintenance (PM) program and has determined that the SST PM program meets or exceeds the vendor/industry maintenance recommendations. This review not only consisted of a review to the maintenance procedures but it also consisted of a GE service representative observing the 3 year PM practice which was performed during the fourth refueling outage (Fall '92). In light of the root cause determination, a procedure change was initiated to revise maintenance procedure MD-PM.ZZ-001(Z) to inspect the components inside the LTC control box for dirt, dust, corrosion, and heating. Although a section of the procedure specified inspecting the control panel, the procedure did not specifically state inspection inside the LTC control box which is mounted inside the control panel.

If you require any additional information concerning this Unresolved Item, please do not hesitate to contact us.

Sincerely,

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