ENCLOSURE

SEQUOYAH NUCLEAR PLANT UNITS 1 AND 2
AND
WATTS BAR NUCLEAR PLANT UNITS 1 AND 2
MOV CONTROL CIRCUIT FAILURE
NCR 700 AND NCR 714
10 CFR 50.55(e)
REVISED FINAL REPORT

Description of Condition

Failures have occurred in at least 2 MOV control and monitoring circuits at Sequoyah Nuclear Plant, during preoperational testing. The circuits are used for control of essentially all safety systems and isolation MOVS at Sequoyah and Watts Bar Nuclear Plants. Each circuit consists of a transformer acquiring input power from the power supply of the MOV being controlled and subcircuits for valve control, valve position indication, and output to the status monitoring system. A preliminary investigation of the failures indicated a possible cause to be an increase in current flow through solid state relays used in the circuit to provide input to status monitoring instrumentation. The excessive current flow overloaded the circuit power supply transformer, causing failure of the transformer and shorting of the Motor Control Center bus because of the smoke. A sizeable decrease in the driving-circuit-side electrical resistance of the relay could permit the excessive current flow. A cursory resistance check of one relay indicated only about 35 ohms as compared to 40,000 ohms design. The indicated resistance increased as a function of time after removal of the relay from the circuit. The 480/120 volt control transformer had fuses designed to protect against short circuits but not against overloads.

The failure of the relays has been attributed to the surge withstand test that was required by TVA's specification. All of the failures were confined to the relays that had received the test (a random sample of approximately 13%); there were no failures of relays that had not been surge tested. In order to enhance the reliability of the relays the vendor has provided a separate surge suppression network and 1/8 ampere fuse that will be installed later as a design improvement, but which is not required for corrective action.

There are approximately 400 relays installed in each plant unit, the relays being of a single type and model. They are manufactured by Crydon Controls/Division of International Rectifier, 1521 Grand Avenue, El Segundo, California 90245; Type AC Photo-Isolated SPST-NO, Model A1202-1. In construction testing preceding preoperational testing, at least 14 faulty relays were replaced of about 150 tested. Various relays had open input sides, shorted input sides, open output sides, and output voltages only about half of normal. The relay internal circuit components are cast in a solid plastic housing such that the design and possible mode of failure cannot be visually inspected.

Safety Implications

A relay failure, had the nonconforming condition not been corrected, could have caused failure of the control circuit power supply transformer. The transformer failure could, because of the smoke released, result in failure of the motor control center electrical bus, deactivating a substantial portion of one train of safety systems. This loss, while provided for in the design of the plant, would result in a reduction of the defense-in-depth redundancy in the safety systems provided. A common mode failure of one or more relays in each train of safety systems would have resulted in deactivating a substantial portion of the safety systems for the plant unit, jeopardizing the safe operation of the plant.

Corrective Action

TVA has completed its investigation of this problem and has determined that the following corrective actions are required.

(1) Fusing of the control circuits will be changed to meet the requirements of the National Electric Code (NEC), which will result in protection of the control transformers for short circuits and overloads.

(2) All the solid state relays will be subjected to a burn-in period of approximately 96 hours before operation, which will provide the screening to eliminate defective units. This will be accomplished by either (1) verifying that the presently installed relays have been subjected to the burn-in period or, (2) replacing the presently installed relays with relays that have been subjected to the burn-in period.

These corrective actions will be completed for Sequoyah Plant before fuel loading for each plant unit, respectively; and for Watts Bar Plant before preoperational testing for each plant unit, respectively.