SSINS No.: 6835
IN 85-18

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

March 7, 1985

IE INFORMATION NOTICE NO. 85-18: FAILURES OF UNDERVOLTAGE OUTPUT CIRCUIT BOARDS IN THE WESTINGHOUSE-DESIGNED SOLID STATE PROTECTION SYSTEM

Addressees:

All Westinghouse-designed pressurized water reactor power facilities holding an operating license (OL) or a construction permit (CP).

Purpose:

This information notice is provided to alert recipients of a potentially generic problem pertaining to short-circuit failures of the undervoltage (UV) output circuit boards in the Westinghouse-designed solid state protection system (SSPS). The failure of one UV output circuit would result in the loss of automatic reactor trip redundancy; the unavailability of both UV output circuits would result in the loss of the automatic trip function of the reactor protection system and hence make the plant susceptible to an anticipated transient without scram (ATWS) event.

It is expected that recipients will review the information contained in this notice for applicability to their facilities and consider actions, if appropriate, to preclude similar failures from occurring at their facilities. However, suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

During a 4½-year period, three UV output circuit failures have occurred at North Anna Unit 2. As described later, Virginia Electric Power Company (VEPCO) attributes these failures to inadequate surveillance, maintenance, or modification procedures for the reactor trip breaker (RTB) switchgear cubicle associated with the failed UV output circuit. The first failure occurred in April of 1980, the second in May of 1983 and the third in October of 1984. The first failure was detected and repaired before the plant received an operating license. The second and third failures were detected and repaired during refueling outages and prior to returning to power operation. Post-maintenance testing led to the timely detection of these last two failures.

In April of 1980, a short-circuit failure was detected in the B train UV output circuit board at North Anna Unit 2. The Unit 2 maintenance history for 1980 is no longer available, thus VEPCO cannot state with certainty that this failure was maintenance related. However, because the UV coil for RTB-A was replaced

April 3, 1980 just before the B train UV output circuit failure, VEPCO indicated that it is likely that some surveillance was performed on the B train after the A train UV coil was replaced.

On May 13, 1983, a short-circuit failure was detected on the B train UV output circuit board at North Anna Unit 2. In this instance, the failure was preceded by maintenance activities on the bypass breaker for RTB-A. Because the UV trip coil for the bypass breaker for RTB-A is powered from the B train UV output circuit, VEPCO has attributed this failure to a maintenance action that inadvertently short-circuited the B train UV output circuit.

On October 29, 1984, another short-circuit failure was detected on a UV output circuit board at North Anna Unit 2. In this instance, the failure was preceded by the installation of the shunt trip relay, the relay that actuates the automatic shunt trip feature of the RTBs; therefore, VEPCO attributes this failure to inadequate plant procedures for implementing the automatic shunt trip feature of the RTBs.

On January 12, 1985, while the plant was operating at approximately 96 percent power, RTB-A failed to open automatically on a valid reactor trip signal at Sequoyah Unit 2; however, RTB-B opened automatically, causing the control rods to insert. The failure was recognized immediately by the operator who then followed up the automatic scram demand with a manual scram which opened RTB-B. This failure to trip was the direct result of a pre-existing short-circuit failure on the A train UV output circuit. Sequoyah's staff initially believed that maintenance had not been performed on external components associated with the A train UV output circuit prior to this event. The failure, therefore, was originally considered to have been a random failure rather than a maintenance-related failure. However, a subsequent investigation revealed that surveillance activities had been performed on the UV trip attachment of RTB-A prior to the event. As a result, Sequoyah management now believes that a multimeter was being used to check the voltage across the UV coil of RTB-A, and that the meter was set on a current setting rather than on a voltage setting, thereby shorting out the A train UV output circuit. In this regard, the Sequoyah failure appears to be similar to those at North Anna.

Discussion:

The UV output circuit (see Attachment 1, UV Output Circuit) is designed so that in the absence of a reactor trip signal from the universal logic boards or switched inputs, the Darlington pair transistors Q3 and Q4 in the UV output circuit will conduct current and energize the UV trip coil of the associated RTB. A reactor trip input will result in the turning off of the Darlington pair transistors Q3 and Q4, thereby interrupting current flow to the UV trip coil of the associated RTB and causing the RTB to open. Similarly, if the automatic shunt trip feature has been implemented, the turning off of transistors Q3 and Q4 would also deenergize the associated shunt trip relay, thereby tripping the same RTB by a diverse mechanism.

Failures of the type experienced at North Anna and Sequoyah have resulted in the shorting of transistors Q3 or Q4. Such short-circuit failures are not only

not fail-safe (i.e., they do not cause a reactor trip) but they also would prevent the functioning of any subsequent automatic reactor trip signal because the failure would continuously maintain power to the UV trip coil of the associated RTB. Since the Darlington pair transistors Q3 and Q4 are also being used to control the automatic shunt trip feature of the RTBs, failures of the type experienced at North Anna and Sequoyah would also incapacitate the automatic shunt trip feature of the associated RTB. Thus, the coincident failures of both the A and B train UV output circuits would disable both automatic trip functions (UV trip and shunt trip) of both RTBs, thereby exposing the plant to a potential ATWS event.

Because the UV output circuits are not continuously monitored for failures and because each UV output circuit is functionally tested on a 60-day cycle, one of the two redundant UV output circuits could be inoperable for as long as 60 days before the failure was detected. Thus, although the probability of an ATWS event occurring due to failed UV output circuit boards is very low, the most likely scenario for such an event appears to be one where a reactor trip demand occurs while one SSPS train is being tested and the other train has a short-circuited UV output circuit board. For example, if the Sequoyah Unit 2 reactor trip of January 12, 1985 had occurred while the B train SSPS was being tested, an automatic reactor trip would not have occurred.

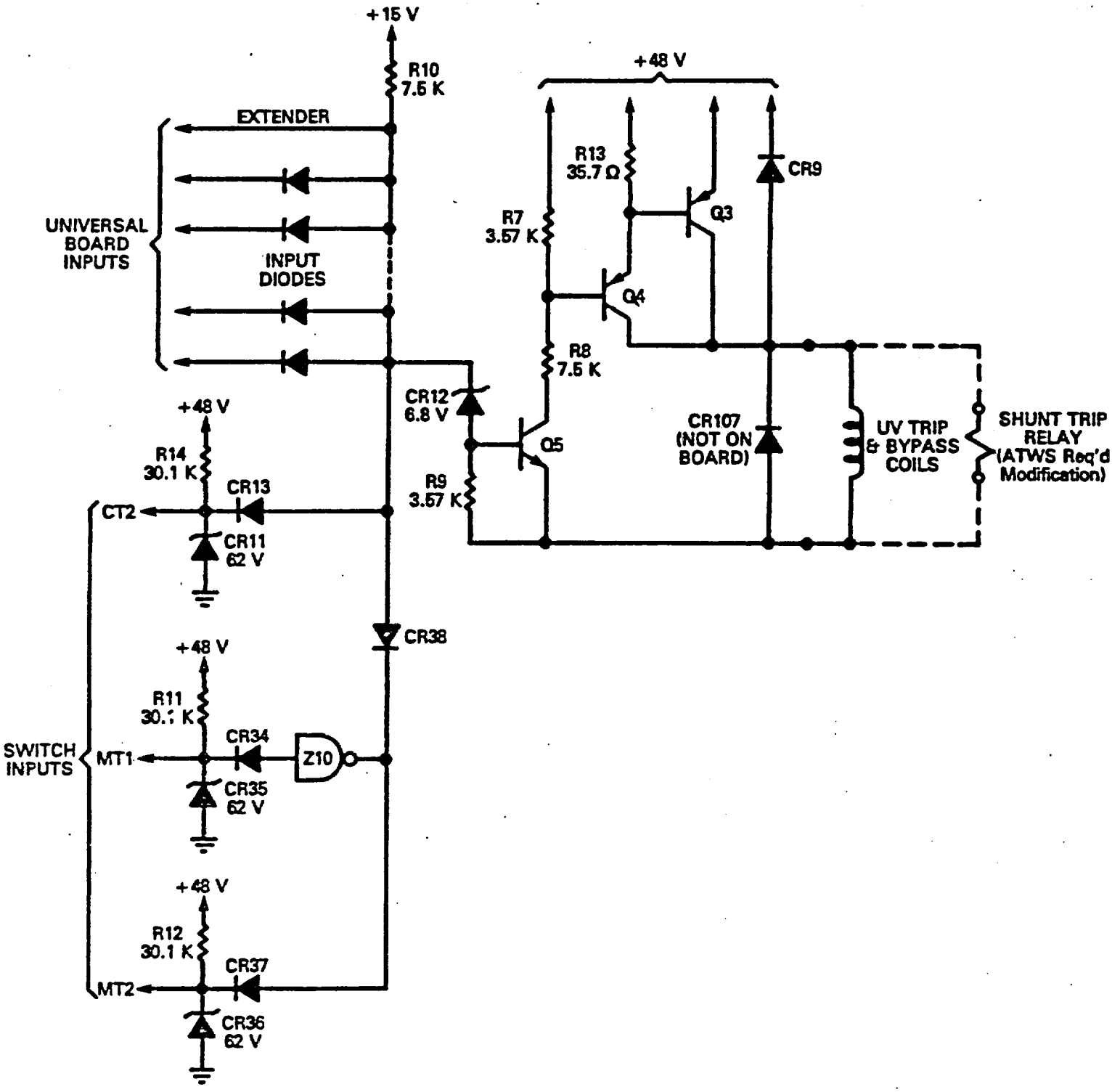
The described failures appear to be associated with maintenance activities external to the SSPS, including the implementing of the automatic shunt trip features of the RTBs. To preclude potential failures of the UV output circuit boards while implementing the shunt trip feature, Westinghouse informed North Anna that it is imperative that the SSPS UV output circuit card be removed before performing such work. Prudent actions also would include testing the UV output circuit by using the SSPS semiautomatic testor after any maintenance work is performed on the associated RTB cubicle.

No specific action or written response is required by this information notice; however, if you have any questions regarding this notice, please contact the Regional Administrator of the appropriate NRC regional office or the technical contacts listed below.

Edward H. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contacts: I. Villalva, IE (301) 492-9007
N. Merriweather, RII (404) 221-5577

Attachments:
1. UV Output Circuit
2. List of Recently Issued IE Information Notices



UV OUTPUT CIRCUIT

Attachment 2
IN 85-18
March 7, 1985

LIST OF RECENTLY ISSUED
IE INFORMATION NOTICES

Information Notice No.	Subject	Date of Issue	Issued to
83-70 Sup. 1	Vibration-Induced Valve Failures	3/4/85	All power reactor facilities holding an OL or CP
85-17	Possible Sticking Of ASCO Solenoid Valves	3/1/85	All power reactor facilities holding an OL or CP
85-16	Time/Current Trip Curve Discrepancy Of ITE/Siemens-Allis Molded Case Circuit Breaker	2/27/85	All power reactor facilities holding an OL or CP
85-15	Nonconforming Structural Steel For Safety-Related Use	2/22/85	All power reactor facilities holding an OL or CP
85-14	Failure Of A Heavy Control Rod (B4C) Drive Assembly To Insert On A Trip Signal	2/22/85	All power reactor facilities holding an OL or CP
85-13	Consequences Of Using Soluble Dams	2/21/85	All BWR and PWR facilities holding an OL or CP
85-12	Recent Fuel Handling Events	2/11/85	All power reactor facilities holding an OL or CP
85-11	Licensee Programs For Inspection Of Electrical Raceway And Cable Installation	2/11/85	All power reactor facilities holding a CP
85-10	Posttensioned Containment Tendon Anchor Head Failure	2/6/85	All power reactor facilities holding an OL or CP
85-09	Isolation Transfer Switches And Post-Fire Shutdown Capability	1/31/85	All power reactor facilities holding an OL or CP

OL = Operating License
CP = Construction Permit