

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555

September 10, 1991

NRC INFORMATION NOTICE 85-18, SUPPLEMENT 1: FAILURES OF UNDERVOLTAGE OUTPUT
CIRCUIT BOARDS IN THE WESTINGHOUSE-
DESIGNED SOLID STATE PROTECTION
SYSTEM

Addressees

All holders of operating licenses or construction permits for Westinghouse (W)-designed nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice supplement to alert addressees to continuing problems associated with the undervoltage (UV) output circuit boards (driver cards) in the solid state protection system (SSPS) designed by the Westinghouse Electric Corporation (Westinghouse). The failure of one driver card results in the loss of automatic reactor trip redundancy and the failure of both output driver cards would result in the loss of the automatic trip function of the reactor protection system. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On June 3, 1991, the Shearon Harris Nuclear Power Plant, Unit 1, (Harris) experienced an automatic reactor trip from 100 percent power on a spurious low reactor coolant system loop flow signal. The signal was generated as a result of a surveillance test being performed on one of three loop flow transmitters. The licensee attributed the spurious signal to both procedural inadequacies and personnel error.

A control room operator verified that all control rods had fully inserted following the trip signal and that reactor power was properly decreasing. However, about 22 seconds after the automatic trip signal was generated, operators discovered that the "A" reactor trip breaker (RTB) had not opened. The RTB was manually opened using the reactor trip switch on the main control board.

Discussion

After the trip, the licensee's review of this event found that the undervoltage (UV) output driver card for the "A" train of the SSPS had failed. During normal operation, this card maintains the required 48V potential to the coil of

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the undervoltage trip attachment (UVTA) and to the actuating relay associated with the shunt trip attachment (STA). When a reactor trip signal is generated, the output transistor in the driver card circuitry interrupts the current flow thereby deenergizing the UVTA coil and the STA actuating relay. These actions constitute a diverse means of opening the RTB. The failure mode of the card prevented the power supply to the UVTA and the STA relay from being interrupted on a valid automatic trip signal.

The staff discussed this failure mode in NRC Information Notice (IN) 85-18, March 7, 1985. IN 85-18 described three operational events at the North Anna Power Station and one event at the Sequoyah Nuclear Plant. These events resulted from failures of undervoltage output driver cards. The information notice delineated technical advice that Westinghouse had provided to the North Anna licensee to reduce the potential for a repeat of the same failure. Westinghouse later provided this advice to all Westinghouse-designed plants in Westinghouse Technical Bulletin NSID-TB-85-16. In the bulletin, Westinghouse stated that the failures of the cards resulted from errors during maintenance and testing of the RTB UVTA. These errors resulted in the UVTA coil being inadvertently short circuited. This short circuit caused the output transistor of the UV output driver card to fail to a shorted condition. In the technical bulletin, Westinghouse recommended corrective procedural actions and described a modified UV output driver card that could be used to replace the original circuit card.

The recommended procedural actions included removing the card from the system, whenever possible, when maintenance is performed on the switchgear. If the card can not be removed, Westinghouse recommended that plant personnel use extreme caution to prevent inadvertent short circuits. Westinghouse recommended that, in either case, the semi-automatic test feature of the SSPS be performed on each train after any maintenance is conducted on the switchgear.

In the bulletin, Westinghouse also informed licensees of the availability of a modified UV output driver card. The new card included a fusible link in series with the output of the card. The fusible link is designed to open under short circuit conditions to interrupt power to the UVTA coil and deenergize the relay associated with the shunt trip attachment (STA). This action opens the reactor trip breaker if it is closed and prevents closure if the breaker is open. Westinghouse stated that the modified card design significantly reduces the possibility that a failed card would remain undetected.

The staff also discussed the failure mode of the card in NUREG-1341, "Regulatory Analysis for the Resolution of Generic Issue 115, 'Enhancement of the Reliability of Westinghouse Solid State Protection Systems,'" January 1989. The resolution produced no new regulatory requirements. However, the staff set forth certain insights that it had gained in evaluating the issue and that could assist in improving the SSPS reliability. The staff concluded that implementation of the Westinghouse procedural recommendations and hardware modification presented in Bulletin NSID-TB-85-16 would improve the overall reliability of the SSPS.

The Harris licensee responded to the Westinghouse bulletin by adopting the recommended corrective action to perform testing following maintenance using the SSPS semi-automatic test feature. The licensee concluded that the administrative controls were sufficient and, therefore, elected not to install the modified circuit card.

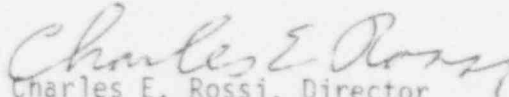
After the June 3 event, the NRC performed an inspection at the Harris plant and determined that the licensee had last functionally tested the failed UV driver card on May 16, 1991, when the "A" train SSPS logic was functionally tested. Subsequent to that test, during plant startup, the "A" RTB failed to close on demand from the control room. The licensee performed troubleshooting and found that both the "A" reactor trip breaker closing coil and the control room reactor trip switch were defective. The licensee replaced the breaker closing coil and the trip switch on May 18, 1991.

During interviews with the electricians who performed the troubleshooting on the "A" reactor trip breaker, the inspectors learned that the licensee had installed various electrical jumpers and test equipment to test the breaker while it was racked out of the breaker cubicle. To facilitate testing, the licensee installed one set of jumpers to provide 48 V to the breaker undervoltage coil so that the breaker could be closed. This jumper was installed in the breaker cubicle on the "A" contacts that were supplied from the SSPS undervoltage output driver card. The electricians stated that visibility and physical clearances for installing the jumpers were limited. Following the June 3 event, the licensee's investigation concluded that during the replacement of the reactor trip switch and breaker closing coil, electrical leads were accidentally grounded or shorted through the use of electrical jumpers. This caused the transistor on the undervoltage output driver card to fail, which caused the card to maintain 48 V output to the breaker undervoltage coil and the shunt trip relay in the presence of the trip signal.

The NRC inspectors found that the post maintenance testing procedure was inadequate to identify the failed UV driver card. The only testing required was to cycle the reactor trip breakers from the main control board twice. The UV output driver card was not functionally tested using the semi-automatic tester as recommended in the Westinghouse bulletin and NRC IN 85-18. Furthermore, the inspectors determined that the licensee's testing procedure did not verify all the contact functions of the reactor trip switch. When informed of this finding, licensee personnel reviewed the testing performed and likewise concluded that the testing would not check both the shunt trip and the undervoltage trip functions of the reactor trip switch. The licensee declared the switch inoperable and began to shut down the plant on June 8, 1991, to test the switch.

The failure of the UV driver card appears to be associated with maintenance activities that were not related to the SSPS. This is the same concern that was identified in the original NRC information notice and the Westinghouse Technical Bulletin. Maintenance conducted on components that are not related to the SSPS can cause undetectable failures of the UV output driver card. The SSPS semi-automatic tester is designed to uncover these potential failures.

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation project manager.


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Attachment: List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
91-54	Foreign Experience Regarding Boron Dilution	09/06/91	All holders of OLs or CPs for pressurized water reactors (PWRs).
89-90, Supp. 2	Pressurizer Safety Valve Lift Setpoint Shift	09/05/91	All holders of OLs or CPs for nuclear power reactors.
91-53	Failure of Remote Shutdown System Instrumentation Because of Incorrectly Installed Components	09/04/91	All holders of OLs or CPs for nuclear power reactors.
91-52	Nonconservative Errors In Overtemperature Delta-Temperature (OTΔT) Setpoint Caused by Improper Gain Settings	08/29/91	All holders of OLs or CPs for Westinghouse (W)-designed nuclear power reactors.
86-14, Supp. 2	Overspeed Trips of AFW, HPCI and RCIC Turbines	08/26/91	All holders of OLs or CPs for nuclear power reactors.
91-51	Inadequate Fuse Control Programs	08/20/91	All holders of OLs or CPs for nuclear power reactors.
91-50	A Review of Water Hammer Events After 1985	08/20/91	All holders of OLs or CPs for nuclear power reactors.
91-49	Enforcement of Safety Requirements for Radiographers	08/15/91	All Nuclear Regulatory Commission (NRC) licensees authorized to use sealed sources for industrial radiography.
91-48	False Certificates of Conformance Provided by Westinghouse Electric Supply Company for Refurbished Commercial-Grade Circuit Breakers	08/09/91	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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