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

January 20, 1995

NRC INFORMATION NOTICE 95-05: UNDERVOLTAGE PROTECTION RELAY SETTINGS OUT OF TOLERANCE DUE TO TEST EQUIPMENT HARMONICS

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees that undervoltage relay settings could be out of tolerance because of test equipment harmonics. 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

The following occurrences indicate that test equipment harmonics could result in undervoltage relay actuation settings that are out of tolerance.

Dresden Nuclear Power Station

On April 11, 1994, during routine calibration of the Dresden Unit 3 Asea Brown Boveri (ABB) Model ITE 27N undervoltage relays, both relays were found to be out of tolerance. Additional testing of the 27N relay showed that the relay operating point was influenced by the polarity of the lead wires from the voltage test source (power supply) producing the sinusoidal voltage signal. The test source was diagnosed and verified, using an oscilloscope, as having a distortion on the positive side of the single-phase 120-Vac sine wave. In addition, further evaluation showed that the Unit 2 degraded voltage relays had also been calibrated using the same power supply in October 1992 and April 1993.

The Dresden 27N relays were originally equipped with a harmonic filter and time delay circuit. However, in 1992, ABB notified the NRC, pursuant to Part 21 of Title 10 of the *Code of Federal Regulations*, that the relay time delay circuit could fail to initiate the appropriate time delay when exposed to radiation levels between 22.5 and 45 Gray (Gy) (2.25E03 and 4.5E03 rad). In addition, ABB indicated that the harmonic filter option could cause the pickup/dropout operating points to shift high at radiation levels above those

affecting the time delay, but below 630 Gy (6.3E04 rad). In response to the notification, the licensee modified the 27N relays in accordance with the instructions of the manufacturer to remove the harmonic filter and time delay components. The licensee is now replacing the 27N relays with 27N-R relays for second-level undervoltage protection. The 27N-R relay is equipped with radiation-resistant harmonic filter and time delay circuitry.

Before this event, the voltage test source was classified as a "general usage" piece of test equipment; its electrical output characteristics, therefore, were not periodically verified. After this event, as a corrective action, the licensee added the ac voltage test source to a general surveillance program. The test source output characteristics are now verified annually to meet manufacturer specifications. In addition the licensee is performing a review of electrical and electronic measuring and testing equipment for both certified and general usage to determine if other vulnerabilities exist.

Comanche Peak Steam Electric Station

On May 23, 1994, Comanche Peak Unit 2, was in Mode 5 during its mid-cycle outage. During the performance of the Train A undervoltage relay calibration and response time surveillance testing, 14 of 16 relays were found to be outside their respective allowable technical specification values. The relay dropouts were found to be 1 to 3 V outside the expected values. These relays were adjusted to correct setting values. Following this discovery and corrective action, the licensee performed a comprehensive root cause evaluation. This evaluation showed that the testing device used to calibrate the undervoltage relays did not provide accurate as-found data, because of harmonic distortion that affected peak values of the ac testing voltage waveform. From May 26 to May 28, 1994, the licensee reverified both Train A and Train B relay actuation settings using a clean (low harmonic distortion) ac power supply. On May 28, 1994, during the reverification process, it appeared that five of the Train A relays, Types ITE-27N and ITE-27H, were outside the technical specification values using the most conservative data.

To preclude recurrence, the corrective action taken by the licensee was to implement a procedural change to require the use of a power source with low harmonic distortion for testing these types of relays.

Point Beach Nuclear Plant

In February 1994, the Point Beach licensee replaced the installed Type 27D degraded voltage relays with Type 27N. The 27N relays were more accurate and had an adjustable reset. These relays were recently recalibrated, and all 12 were found to have "drifted" approximately 0.5 V high (120-V base). Although the drift did not exceed calibration tolerances, the licensee had not previously experienced similar calibration shifts for the 27D relays. A further investigation by the licensee showed that the calibration shift was attributed to harmonics present in the ac test voltage power source. The licensee noted that the relays were not sensitive to harmonic frequencies,

but were sensitive to harmonic amplitudes. The licensee measured the harmonic distortion attendant to the ac voltage test source and the safeguards buses, and concluded that the relay operating point was affected by the harmonic distortion of both the ac voltage test source and the safeguards buses when supplied by the offsite power system. Because the system harmonics may vary, the licensee is installing the harmonic filters in all of the 27N degraded voltage relays. The harmonic filters will attenuate harmonics attendant to the ac voltage test source and the offsite power system.

Discussion

All three occurrences were attributed to test equipment harmonics. When the harmonic filters were removed from the 27N relays at Dresden, harmonic distortion in an ac voltage source waveform had a noticeable effect on relay operating point. The 27N relay uses a peak detector circuit. This peak detector circuit samples half of the voltage source waveform and measures its peak value. Although the peak detector circuit is very accurate, it is sensitive to harmonic distortion. The relay manufacturer (ABB) recommends an ac voltage test source with less than 0.3 percent harmonic distortion. As indicated above, the licensees used ac voltage test sources which were subsequently found to have high harmonic distortion. During relay calibration, a calibrated digital voltmeter (DVM) was used to measure the relay input voltage to determine its trip setpoint. The DVM measures the root mean square (RMS) value of the ac voltage test source sinusoidal waveform. A change in the peak voltage of the ac voltage test source sinusoidal waveform caused by harmonic distortion does not result in an equivalent change in the RMS voltage as indicated by the DVM. The relay operating point is significantly influenced by its peak voltage detection circuitry. Therefore, if the voltage test source power supply is not included in a calibration program, the DVM may not accurately reflect the setpoint of the solid-state relay.

Using harmonic filters in the 27N relays will attenuate both ac voltage test source harmonics and system harmonics. However, ABB pointed out that the harmonic filter option could cause the pickup/dropout operating points to shift high at radiation levels below the testing end point of 630 Gy (6.3E04 rad). In addition, ABB documentation indicates that using the harmonic distortion filter option increases the repeatability tolerance of the relays as a function of temperature variations. As documented in ABB Instructions IB 7.4.1.7-7 Issue D for Type 27N relays, temperature variations, such as -20 to +70°C (-4 to 158°F), increase the relay repeatability tolerance from ±0.7 to ±1.5 percent of relay pickup and dropout settings. Therefore, adding the harmonic filter option may necessitate revising the undervoltage relay setpoint calculations. If harmonic filters are not used, system harmonics can be determined and the test source harmonic distortion matched to the system harmonic distortion within the tolerance band to ensure that relays pick up and drop out at required system setpoints.

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 (NRR) project manager.

Brian K. Grimes, Director
Division of Project Support
Office of Nuclear Reactor Regulation

Technical contacts: D. Nguyen, NRR
(301) 504-3202

D. Butler, RIII
(708) 829-9720

F. Ashe, NRR
(301) 504-2785

D. Skeen, NRR
(301) 504-1174

Attachment:
List of Recently Issued Information Notices
Attachment filed in Jacket

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 (NRR) project manager.

Original signed by Brian K. Grimes
Brian K. Grimes, Director
Division of Project Support
Office of Nuclear Reactor Regulation

Technical contacts: D. Nguyen, NRR
(301) 504-3202

D. Butler, RIII
(708) 829-9720

F. Ashe, NRR
(301) 504-2785

D. Skeen, NRR
(301) 504-1174

Attachment:
List of Recently Issued Information Notices

DOCUMENT NAME: 95-05.IN

* PREVIOUS CONCURRENCE

OFC	OECB:DOPS	SC/OECB:DOPS	PUB:ADM	EELB:DE
NAME	DSkeen*	RDennig/EFG*	MMejac*	DNguyen*
DATE	12/19/94	12/21/94	12/13/94	12/19/94

OFC	EELB:DE	R-III:DRS	C/EELB:DE	OECB:DOPS
NAME	FAshe*	DButler*EMAIL	CBerlinger*	RKiessel*
DATE	12/20/94	12/20/94	12/21/94	12/22/94

OFC	C/OECB:DOPS	D/DOPS
NAME	AChaffee*	BGrimes
DATE	12/27/94	01/12/95

[OFFICIAL RECORD COPY]

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 (NRR) project manager.

Brian K. Grimes, Director
Division of Project Support
Office of Nuclear Reactor Regulation

Technical contacts: D. Nguyen, NRR
(301) 504-3202

D. Butler, RIII
(708) 829-9720

F. Ashe, NRR
(301) 504-2785

D. Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued Information Notices

DOCUMENT NAME: S:\DOPS_SEC\IN94-XX.DST

* PREVIOUS CONCURRENCE

OFC	OECB:DOPS	SC/OECB:DOPS	PUB:ADM	EELB:DE
NAME	DSkeen*	RDennig/EFG*	MMejac*	DNguyen*
DATE	12/19/94	12/21/94	12/13/94	12/19/94

OFC	EELB:DE	R-III:DRS	C/EELB:DE	OECB:DOPS
NAME	FAshe*	DButler*EMAIL	CBerlinger*	RKiessel*
DATE	12/20/94	12/20/94	12/21/94	12/22/94

OFC	C/OECB:DOPS	D/DOPS
NAME	AChaffee*	BGrimes
DATE	12/27/94	/ /94

ATB, 12/30

[OFFICIAL RECORD COPY]

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 (NRR) project manager.

Brian K. Grimes, Director
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation

Technical contacts: D. Nguyen, NRR
(301) 504-3202

F. Ashe, NRR
(301) 504-2785

D. Butler, RIII
(708) 829-9720

D. Skeen, NRR
(301) 504-1174

Attachment: List of Recently Issued NRC Information Notices

* PREVIOUS CONCURRENCE

OFC	OECB:DOPS	SC/OECB:DOPS	PUB:ADM	EELB:DE
NAME	DSkeen	RDennig	MMejac*	DNguyen
DATE	12/19/94	12/21/94	12/13/94	12/19/94

OFC	EELB:DE	R-III:DRS	C/EELB:DE	OECB:DOPS
NAME	FAshe	DButler E-mail from D Butler	CBerlinger	RKiessel w/comment
DATE	12/30/94	12/20/94	12/2/94	12/22/94

OFC	C/OECB:DOPS	D/DORS
NAME	AChaffee	BGrimes
DATE	12/27/94	/ /94

[OFFICIAL RECORD COPY]
DOCUMENT NAME: G:\DLS\IN94-XX.DST

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
95-04	Excessive Cooldown and Depressurization of the Reactor Coolant System Following a Loss of Offsite Power	01/19/95	All holders of OLs or CPs for nuclear power reactors.
95-03	Loss of Reactor Coolant Inventory and Potential Loss of Emergency Mitigation Functions While in a Shutdown Condition	01/18/95	All holders of Ols or CPs for nuclear power reactors.
95-02	Problems with General Electric CR2940 Contact Blocks in Medium-Voltage Circuit Breakers	01/17/95	All holders of OLs or CPs for nuclear power reactors.
95-01	DOT Safety Advisory: High Pressure Aluminum Seamless and Aluminum Composite Hoop-Wrapped Cylinders	01/04/95	All U.S. Nuclear Regulatory Commission licensees.
94-90	Transient Resulting in a Reactor Trip and Multiple Safety Injection System Actuations at Salem	12/30/94	All holders of OLs or CPs for nuclear power reactors.
94-89	Equipment Failures at Irradiator Facilities	12/28/94	All U.S. Nuclear Regulatory Commission irradiator licensees.
94-88	Inservice Inspection Deficiencies Result in Severely Degraded Steam Generator Tubes	12/23/94	All holders of OLs or CPs for pressurized water reactors.

OL = Operating License
CP = Construction Permit