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

April 8, 1992

NRC INFORMATION NOTICE 92-28: INADEQUATE FIRE SUPPRESSION SYSTEM TESTING

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 to potential inadequate performance of carbon dioxide (CO_2) and Halon fire suppression systems caused by excessive leakage from the protected enclosure or by deficient operation of the system's components. Limited acceptance testing may not be adequate to identify these problems. 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.

Background

In Section 50.48 of Title 10 of the Code of Federal Regulations, the NRC established fire protection requirements for operating nuclear power plants. This rule requires automatic and manual fire suppression systems to function so that the capability to safely shut down the plant is ensured. Many licensees use total flooding CO_2 and Halon fire suppression systems to protect systems necessary for safe shutdown. In Branch Technical Position APCSB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," the staff referenced National Fire Protection Association (NFPA) standards, NFPA 12-1973, "Carbon Dioxide Extinguishing Systems," and NFPA 12A-1973, "Halon 1301 Fire Extinguishing Systems." These standards emphasized the need to minimize leakage from the enclosure in order to retain the fire suppressing agent for the required soak time and the importance of thoroughly inspecting the fire suppression system to ensure that it will operate properly. Licensees frequently use full discharge tests to demonstrate that fire suppression systems perform properly and that leakage from protected enclosures is acceptable.

Description of Circumstances

On February 23, 1988, the Connecticut Yankee Atomic Power Company, the licensee for the Haddam Neck Power Plant, performed a full discharge test of the CO_2 fire suppression system for the containment cable vault. The test results indicated that the CO_2 concentration within the cable vault failed to meet NFPA 12 requirements. Consequently, on February 27, the licensee declared the

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fire suppression system for the cable vault inoperable. The licensee determined that the root cause of the failure was excessive leakage of CO_2 from the enclosure area through numerous unsealed electrical conduits in the lower level of the cable vault. These conduits were in the original plant design, but were not considered in the design of the CO_2 system.

While performing an inspection the week of April 3, 1989, at the Susquehanna Steam Electric Station (Susquehanna), the NRC found a concern regarding the adequacy of initial testing of the plant's CO_2 fire suppression systems. In 1982, the Pennsylvania Power and Light Company (PP&L), the licensee for Susquehanna, had performed a full discharge test for one of seven areas protected by automatic CO_2 fire suppression systems. The test found that the required concentration of CO_2 was not maintained in the enclosure for the required soak time. The test results may have been caused solely by the failure of a temporary seal around an access door. However, the licensee did not perform additional testing to confirm the cause of the test failure. The licensee then performed limited acceptance tests of the CO_2 fire suppression systems.

To address the NRC's concern, PP&L performed testing in the first quarter of 1990 using room pressurization to measure enclosure leakage and to determine a projected agent retention time. The licensee based the testing on the enclosure integrity procedure in Appendix B to NFPA 12A-1989. The test results indicated that three of the seven areas included enclosures with leakage greater than that which would ensure retention of the required CO_2 concentration for the required soak time. The failure of these enclosures was attributed to their small enclosed volume and the corresponding small allowable leakage area. In general, a smaller allowable leakage area should be expected for small enclosures because of the higher ratio of boundary area to enclosed volume.

On April 21, 1990, at the Catawba Nuclear Station (Catawba), an inadvertent steam release actuated a CO_2 fire suppression system. Although the fire suppression system is designed to discharge to only one area at a time, the three selector pilot valves installed in the system directed the CO_2 discharge to all three areas protected by the system. Duke Power Company, the licensee for Catawba, investigated the incident and discovered that the solenoids operating the three selector pilot valves were installed backwards. The licensee determined that the required CO_2 concentration could not be obtained within the protected areas when the system discharged into more than one area at a time. Therefore, the licensee declared the system inoperable. The licensee attributed the improper solenoid installation, in part, to a preoperational test procedure which did not adequately test the system for the incorrectly installed components.

Discussion

Retaining an adequate concentration of fire suppressing agent for the required soak time is important for enclosures containing equipment that could develop "deep seated" fires. In a study of deep seated cable fires, Sandia National Laboratory determined that, for certain configurations of cables qualified to Standard 383 of the Institute of Electrical and Electronic Engineers (IEEE), it

was necessary to retain a 50% concentration of CO_2 for a minimum soak time of 15 minutes to extinguish fully developed fires. Sandia National Laboratory documented the results of the study in NUREG/CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fires," dated October 1986.

Full discharge testing of CO_2 fire suppression systems may present certain hazards at operating nuclear power plants. These hazards include thermal shock to safety-related components, uncontrolled electrostatic discharge, and hazards to personnel from high concentrations of CO_2. Some licensees have used alternative testing methods which avoid these hazards. For example, the licensee for the Vermont Yankee Atomic Power Station responded to the NRC's concern regarding the adequacy of initial tests of the plant's fire suppression systems by performing an alternative test that incorporated methodology from the enclosure integrity procedure in Appendix B to NFPA 12A-1989. That methodology is conservative because the effects of the thermal expansion of the mixture of CO_2 and air are not included and a "worst case" distribution of measured leakage area is assumed. The licensee also performed a rigorous engineering evaluation of the installed CO_2 system to verify that the system would operate as designed to deliver a sufficient amount of CO_2.

The testing described in Section 1-7.4 of NFPA 12A-1989 was developed to alleviate concerns for both the cost and the environmental damage associated with repeatedly performing full discharge tests of Halon fire suppression systems. The testing described in NFPA 12A provides an alternative method to full discharge testing of Halon systems to demonstrate that the fire suppression system and the enclosure function as designed.

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

Charles E. Rossi

Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical contact: S. R. Jones, NRR
(301) 504-2833

Attachment: List of Recently Issued NRC Information Notices

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LIST OF RECENTLY ISSUED
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Information Notice No.	Subject	Date of Issuance	Issued to
92-27	Thermally Induced Accelerated Aging and Failure of ITE/GOULD A.C. Relays Used in Safety-Related Applications	04/03/92	All holders of OLs or CPs for nuclear power reactors.
92-26	Pressure Locking of Motor-Operated Flexible Wedge Gate Valves	04/02/92	All holders of OLs or CPs for nuclear power reactors.
92-25	Potential Weakness in Licensee Procedures for A Loss of the Refueling Cavity Water	03/31/92	All holders of OLs or CPs for nuclear power reactors.
92-24	Distributor Modification to Certain Commercial-Grade Agastat Electrical Relays	03/30/92	All holders of OLs or CPs for nuclear power reactors.
92-23	Results of Validation Testing of Motor-Operated Valve Diagnostic Equipment	03/27/92	All holders of OLs or CPs for nuclear power reactors and all vendors of motor-operated valve (MOV) diagnostic equipment.
92-22	Criminal Prosecution and Conviction of Wrongdoing Committed by A Commercial-Grade Valve Supplier	03/24/92	All holders of OLs or CPs for nuclear power reactors.
92-21	Spent Fuel Pool Reactivity Calculations	03/24/92	All holders of OLs or CPs for nuclear power reactors.
92-20	Inadequate Local Leak Rate Testing	03/03/92	All holders of OLs or CPs for nuclear power reactors.
92-19	Misapplication of Potter & Brumfield MDR Rotary Relays	03/02/92	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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Full discharge testing of CO_2 fire suppression systems may present certain hazards at operating nuclear power plants. These hazards include thermal shock to safety-related components, uncontrolled electrostatic discharge, and hazards to personnel from high concentrations of CO_2. Some licensees have used alternative testing methods which avoid these hazards. For example, the licensee for the Vermont Yankee Atomic Power Station responded to the NRC's concern regarding the adequacy of initial tests of the plant's fire suppression systems by performing an alternative test that incorporated methodology from the enclosure integrity procedure in Appendix B to NFPA 12A-1989. That methodology is conservative because the effects of the thermal expansion of the mixture of CO_2 and air are not included and a "worst case" distribution of measured leakage area is assumed. The licensee also performed a rigorous engineering evaluation of the installed CO_2 system to verify that the system would operate as designed to deliver a sufficient amount of CO_2.

The testing described in Section 1-7.4 of NFPA 12A-1989 was developed to alleviate concerns for both the cost and the environmental damage associated with repeatedly performing full discharge tests of Halon fire suppression systems. The testing described in NFPA 12A provides an alternative method to full discharge testing of Halon systems to demonstrate that the fire suppression system and the enclosure function as designed.

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Original Signed by
Charles E. Rossi

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Document Name: IN 92-28
*SEE PREVIOUS CONCURRENCES

			D/DOEA:NRR CERossi 04/3/92	*C/OGCB:DOEA:NRR CHBerlinger 03/30/92
*OGCB:DOEA:NRR JLBirmingham 02/21/92	*SPLB:DST:NRR SRJones 02/24/92	*C/SPLB:DST:NRR CMcCracken 03/02/92	*D/DST:NRR ACThadani 03/26/92	*RPB:ADM TechEd 02/21/92

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The testing described in Section 1-7.4 of NFPA 12A-1989 was developed to alleviate concerns for both the cost and the environmental damage associated with repeatedly performing full discharge tests of Halon fire suppression systems. The testing described in NFPA 12A provides an alternative method to full discharge testing of Halon systems to demonstrate that the fire suppression system and the enclosure function as designed.

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			D/DOEA:NRR	C/OGCB:DOEA:NRR
			CERossi	CHBerlinger
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*OGCB:DOEA:NRR	*SPLB:DST:NRR	*C/SPLB:DST:NRR	D/DST:NRR	*RPB:ADM
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As noted on Routing Sheet CHB

15 minutes to extinguish fully developed fires. Sandia National Laboratory documented the results of the study in NUREG/CR-3656, "Evaluation of Suppression Methods for Electrical Cable Fires," dated October 1986. Licensees may wish to perform tests which demonstrate that protected enclosures can retain the required concentration of fire suppressing agent for an appropriate minimum soak time and that the fire suppression system functions as designed.

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The testing described in Section 1-7.4 of NFPA 12A-1989 was developed to alleviate concerns for both the cost and the environmental damage associated with repeatedly performing full discharge tests of Halon fire suppression systems. The testing described in NFPA 12A provides an alternative method to full discharge testing of Halon systems to demonstrate that the fire suppression system and the enclosure function as designed.

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