UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

March 8, 1999

NRC INFORMATION NOTICE 99-05: INADVERTENT DISCHARGE OF CARBON DIOXIDE FIRE PROTECTION SYSTEM AND GAS MIGRATION

Addressees

All holders of licenses for nuclear power, research, and test reactors, and fuel cycle facilities.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential personnel safety hazards and operational complications associated with discharge of carbon dioxide (CO_2) fire protection systems. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response to this notice is required.

Background

At Duane Arnold Unit 1 on March 22, 1992 (LER 331/92-004), the licensee performed a special test of the CO_2 fire suppression system in the cable spreading room. This test was conducted to check corrective actions taken following a CO_2 discharge in 1990. At the time of this test, the reactor had been shutdown and defueled. As a result of this test, CO_2 had intruded into the control room; this intrusion led to an unacceptable reduction in area oxygen level within a few minutes. Oxygen levels of 17 percent (at chest level) and 15 percent (at floor level) were recorded; these levels were below the plant acceptance criterion of 19.5 percent. Essential control room personnel donned self-contained breathing apparatus (SCBA) and were able to remain in the control room. The lowered oxygen levels were caused by increased pressure in the cable spreading room which is directly beneath the control room. Sealed penetrations between the two rooms leaked under the high differential pressure.

On July 28, 1998, at the Idaho National Engineering and Environmental Laboratory, during preparation for electrical system preventive maintenance, a high-pressure CO_2 fire suppression system unexpectedly actuated. The room in which workers were located was filled instantly with CO_2, creating whiteout conditions. Workers did not have the means of escaping safely. Emergency exit training was not provided; exit pathways were not clear; and, emergency breathing apparatus, exit pathway lighting, and emergency ventilation were not available. The accident resulted in one fatality, several life-threatening injuries, and significant risk to the safety of the initial rescuers. The Accident Investigation Board determined that since 1975 there have been a total of 63 deaths and 89 injuries resulting from accidents involving the discharge of CO_2 fire suppression systems.

Description of Circumstances

On January 15, 1999, at 5:49 p.m., with the plant at full power, an inadvertent discharge of the CO2 fire suppression system occurred in the Millstone Unit 3 cable spreading room. At Millstone 3, the cable spreading room is located in the control building directly below the control room. The actuation was caused when a non-licensed plant equipment operator trainee in the service building blew dust off a printed circuit board located in the cable spreading room CO2 control panel. The panel is located in the service building, not the control building. There were no plant personnel in the cable spreading room at the time of the discharge. Shortly after the discharge, CO2 was found to have migrated down into the switchgear rooms located directly below the cable spreading room. Approximately 37 minutes after initiation, the licensee used a portable instrument to measure the concentration of CO2 in one of the Control Building stairwells (which allows access to the control room, the cable spreading room and the switchgear rooms). The reading was off-scale high indicating that the CO2 concentration was in excess of 50,000 parts per million (ppm). The current NRC Regulatory Guide 1.78 recommended toxicity limit for CO2 is 10,000 ppm[1]. On the basis of this indication, the licensee declared the area uninhabitable.

Approximately 2 hours after the CO2 discharge, operators aligned the control building purge system to remove CO2 from the switchgear rooms. The switchgear rooms were selected for purging first because they contained important plant equipment, such as the auxiliary shutdown panel. The purge system is a non-safety-related system designed to remove CO2 and smoke from various control building areas. Placing the purge system in service diverted air from the control room to the switchgear rooms which lowered the pressure in the control room relative to the cable spreading room. This lowering of pressure in the control room may have allowed CO2 from the cable spreading room to migrate up through penetrations into the control room. When the concentration of CO2 reached 5000 ppm in the control room, the operators donned self-contained breathing apparatus (SCBA) as required by their procedures. The concentration of CO2 in the control room reached a peak level in excess of 17,000 ppm before it began to decrease. The operators wore SCBA for approximately 6 hours until the CO2 was successfully purged from the control room.

Discussion

A review of this event by the licensee identified several design and personnel safety issues. The cable spreading room CO2 system is designed to automatically actuate in response to a fire. The system is equipped with alarms to warn personnel in the cable spreading room of an impending discharge of CO2 to allow time to evacuate the cable spreading room. In response

[1] The current NRC toxicity limit for CO2, specified in Reg. Guide 1.78, is 10000 ppm. Plant personnel exposed to CO2 need to be protected by self contained breathing apparatus before this concentration is reached. In the proposed revision to Reg. Guide 1.78, the toxicity limit for CO2 was raised to 40000 ppm. This new limit is based on the Immediately Dangerous to Life and Health (IDLH) concentration of CO2, established by the National Institute for Occupational Safety and Health (NIOSH).

to several previous inadvertent actuations, the licensee had previously modified automatic CO2 fire protection systems in other areas of the plant so that they could only be actuated manually. After the January 15, 1999 event, the licensee disabled the automatic function of the CO2 system for the cable spreading room and implemented appropriate compensatory measures. The licensee is evaluating permanent changes to avoid future inadvertent CO2 discharges.

The migration of CO2 into three separate fire zones may have adversely affected the operators' ability to shut down the plant during a fire in the cable spreading room. A severe fire in the cable spreading room may adversely affect the operators' ability to safely shut down the plant from the control room. In the event that the operators are required to evacuate the control room, plant procedures require operators to shutdown the plant from the auxiliary shutdown panel and other panels which are located in the switchgear rooms. During this event, the CO2 concentration at the auxiliary shutdown panel would prohibit access without SCBA.

In 1996 the licensee established a site wide fire brigade. In 1997, the licensee suspended the formal SCBA training and qualification program for plant operators except those who were members of the fire brigade. This determination was based on projected post-accident radiation levels and intrusion of toxic gases into the control room from outside sources. However, this determination failed to consider CO2 a toxic gas as recommended in NRC Regulatory Guide 1.78. Fortunately, during this event, SCBA were available in the control room area and at various other locations around the site. Although training and qualifications for all plant operators were not current, all the plant operators that were on shift during the event had previously been trained and qualified with the SCBA and consequently they were able to perform their duties using the SCBA. To improve communication between the operators, the licensee replaced the Unit 3 SCBA with SCBA from Unit 2 which had an improved type of radio communication system. In addition, some of the operators did not have corrective lenses which were compatible with the SCBA face masks. As an immediate corrective action the licensee re-qualified all plant operators for SCBA use. The licensee is evaluating the need to reinstate the SCBA qualification program for plant operators on a permanent basis. This suspension of SCBA qualification was for plant operators only and did not affect fire brigade members who were trained and qualified.

The discharge of CO2 set off a security alarm on the cable spreading room door. A security officer was instructed to check the door alarm but to not open the door. The guard entered the stairwell and ascended the stairs to the cable spreading room. Upon approaching the cable spreading room, the officer smelled wintergreen (which is discharged with the CO2 to produce an odor for personnel safety) and was engulfed in a mist that he concluded was CO2. The officer held his breath and rapidly exited the building. The licensee's root cause team recommended that procedures for isolating areas potentially affected by CO2 be reviewed.

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, the appropriate regional office, or the appropriate office of Nuclear Reactor Regulation (NRR) Project Manager.

David B. Matthews, Director
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Technical contacts: Beth Korona, Region I
860-447-3170
E-mail: bek@nrc.gov

Frank Arner, Region I
610-337-5194
E-mail: fja@nrc.gov

Chuck Petrone, NRR
301-415-1027
E-mail: cdp@nrc.gov

Peter S. Lee, NMSS
301-415-8111
E-mail: psl1@nrc.gov

Attachments:
1. List of Recently Issued NMSS Information Notices
2. List of Recently Issued NRC Information Notices

LIST OF RECENTLY ISSUED NMSS INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
99-04	Unplanned Radiation Exposures to Radiographers, Resulting From Failures to Follow Proper Radiation Safety Procedures	3/1/99	All radiography licensees.
99-03	Exothermic Reactions Involving Dried Uranium Oxide Powder (Yellowcake)	1/29/99	All operating uranium recovery facilities that produce oxide powder (U_3O_8) (yellowcake)
99-02	Guidance to Users on the Implementation of a New Single-Source Dose-Calculation Formalism and Revised Air-Kerma Strength Standard for Iodine-125 Sealed Sources	1/21/99	All medical licensees authorized to conduct brachytherapy treatments.
99-01	Deterioration of High-Efficiency Particulate Air Filters in a Pressurized Water Reactor Containment Fan Cooler Unit	1/20/99	All holders of licences for nuclear power, research and test reactors; and fuel cycle facilities.
98-33 Regulatory	NRC Regulations Prohibit Agreements that Restrict or Discourage an Employee from Participating in Protected Activities	8/28/98	All holders of a Nuclear Commission license
98-30	Effect of the Year 2000 Computer Problem on NRC Licensees and Certificate Holders	8/12/98	All material and fuel cycle licensees and certificate holders
97-91 Supp. 1	Recent Failure of Control Cables Used on Amersham Model 660 Posilock Radiography Systems	8/10/98	All industrial radiography licensees.
98-20	Problems With Emergency Preparedness Respiratory Protection Programs	6/3/98	All holders of operating licenses for nuclear power reactors; non-power reactors; all fuel cycle and material licensees required to have an NRC-approved emergency plan.

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98-45	Cavitation Erosion of Letdown Line Orifices Resulstin in Fatigue Cracking of Pipe Welds	12/15/98	All holders of operating licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor.
98-44	Ten-year Inservice Inspection (ISI) Program Update for Licensees that Intend to Implement Risk-Informed ISI of Piping	12/10/98	All holder of operating licenses for nuclear power reactors, except those that have permanently ceased operations and have certified that fuel has been permanently removed from the reactor

OL = Operating License
CP = Construction Permit

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orig /s/'d by

S. F. Newberry FOR
David B. Matthews, Director
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Technical contacts: Beth Korona, Region I
860-447-3170
E-mail: bek@nrc.gov

Frank Arner, Region I
610-337-5194
E-mail: fja@nrc.gov

Chuck Petrone, NRR
301-415-1027
E-mail: cdp@nrc.gov

Peter S. Lee, NMSS
301-415-8111
E-mail: psl1@nrc.gov

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David B. Matthews, Director
Division of Reactor Program Management
Office of Nuclear Reactor Regulation

Technical contacts: Beth Korona, Region 1
860-447-3170
E-mail: bek@nrc.gov

Frank Arner, Region 1
610-337-5194
E-mail: fja@nrc.gov

Chuck Petrone, NRR
301-415-1027
E-mail: cdp@nrc.gov

Peter S. Lee, NMSS
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