

UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR MATERIAL SAFETY AND SAFEGUARDS  
WASHINGTON, D.C. 20555

June 11, 1996

NRC INFORMATION NOTICE 96-35: FAILURE OF SAFETY SYSTEMS ON SELF-SHIELDED  
IRRADIATORS BECAUSE OF INADEQUATE MAINTENANCE  
AND TRAINING

Addressees

All U.S. Nuclear Regulatory Commission irradiator licensees and vendors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to alert addressees to two incidents where safety interlocks on self-shielded irradiators (Category I) failed to prevent inadvertent exposure. The causes of these exposures stemmed from a lack of appropriate maintenance and/or worker training. The incidents include a broken spring -- possibly causing malfunction of the safety interlock -- and a worker who intentionally bypassed a safety interlock. 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 nor written response is required.

Description of Circumstances

The first incident occurred when an operator may have been able to open the shielded door of an irradiator with the sources in the exposed position. After irradiation of several pocket dosimeters, the operator opened the shielded door of the irradiator to retrieve the dosimeters, but did not perform a radiation survey, as required by the facility's internal procedures, before opening the door. Twice, the operator placed one hand inside the irradiator to retrieve the dosimeters. Subsequently, the operator observed that the unit timer continued to count, indicating that the sources remained in the exposed position. The operator checked his personal pocket dosimeter, but did not note an unusual reading. However, the operator did not report the incident until questioned by the radiation safety officer, who had noted an unusually high dosimetry report of 3.55 millisievert (355 mrem) deep dose equivalent for the worker. The dose to the right hand was calculated to be a maximum of 12.5 millisievert (1.25 rem).

The design of the irradiator includes two interconnected interlock systems, intended to prevent unshielded exposure of the sources. These include a door interlock system -- designed to allow opening of the shielded door only after the sources are placed in the fully shielded position -- and a source exposure interlock system -- designed to secure the sources in the fully shielded

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position whenever the shielded door is open or unlocked. The manufacturer of the irradiator indicated that under normal operations, either system individually would prevent inadvertent access to the unshielded sources.

Following the incident, the manufacturer of the irradiator was requested to perform an onsite inspection of the irradiator and facilities. During the inspection, the manufacturer noted:

- (1) the irradiator was located in an area that was not climate-controlled;
- (2) internal components of the irradiator were in a degraded state;
- (3) maintenance of the irradiator had last been performed approximately 10 years ago; and
- (4) a return spring, integral to the source exposure safety interlock system, was broken. The manufacturer indicated that the lack of environmental control may have accelerated the degradation of the internal components of the irradiator, and that the lack of periodic maintenance of the irradiator may have contributed to the failure of the return spring.

The broken return spring may have caused the source securing mechanism of the source exposure interlock system to malfunction, possibly allowing exposure of the sources after the shielded door was unlocked and opened. However, during the post-incident investigation, neither the manufacturer nor the licensee were able to identify a failed component of either interlock system that could have allowed the shielded door to be opened with the sources in the exposed position. The manufacturer indicated that the design of the source exposure mechanism -- the operator must manually move the sources from the shielded to the exposed position with a lever -- would have provided the operator with a positive indication of source position even if the interlock systems failed. Source position would have been further provided by a series of green and red source position lights on the irradiator.

The operator's actions indicate either a lack of training on the proper functioning and use of the irradiator, a lack of understanding of the training provided, and/or a disregard for following the established operating and safety procedures. The operator indicated that the timer continued to count when the shielded door was opened. However, the manufacturer reported that the timer automatically activates whenever the source lever is manually moved to one of the two source exposed positions and the lever is fully engaged in the source slot, and stops counting as soon as the lever is moved from the fully engaged position. The fact that the timer continued to count indicates that the operator had not moved the sources from the fully exposed and engaged position. The licensee reported that the operator had been trained in the operation of the irradiator and was listed as an authorized user, but that the irradiator was used infrequently and that this was only the operator's second use of the irradiator since being trained.

The second incident occurred when a maintenance worker preparing to perform maintenance on an irradiator bypassed the irradiator door interlock system to observe movement of the inner irradiation chamber. The maintenance was being

performed to correct previous maintenance that resulted in the irradiator not functioning properly. The maintenance worker was unaware that, although the sources remained shielded during movement of the irradiation chamber from the load to irradiate position, high levels of radiation scatter would be present. The maintenance worker, upon hearing the in-room monitor alarm, immediately returned the radiation chamber to the "load" position (maximum shielding).

Although the maintenance worker was familiar with the operation of the irradiator and had been responsible for its maintenance for nearly 15 years, the worker apparently had not been given formal training on radiation safety or the operation and maintenance of the irradiator. The maintenance worker was not aware of the scatter radiation and assumed that since the sources were not directly exposed, radiation from the sources would be contained within the device.

During this incident, another worker, hired to perform contract maintenance on the irradiator, was also in the room near the irradiator. Neither worker wore dosimetry nor had any documented training in radiation safety. Therefore, their doses could only be calculated based on their recollection and were estimated to both be approximately 4 microsievert (0.4 mrem) whole body.

#### Discussion

Although neither incident resulted in doses in excess of regulatory limits, the doses received in both incidents were unnecessary and possibly could have been avoided with proper training and routine equipment maintenance. A similar incident in 1984, where a door interlock failed, resulted in the operator being exposed to 222 terabequerel (6000 curies) of cesium-137.

The first incident clearly demonstrates the need to perform appropriate maintenance on these types of units. Even though these units are designed with interlocks and safety features intended to prevent inadvertent exposures, the components of these systems depend on adequate maintenance to function properly. Failure to properly maintain these systems and provide appropriate training could result in unnecessary exposures. Manufacturers of these types of irradiators frequently provide initial and periodic training on the operation of their units and, in some cases, training on other manufacturers' units, as well. Initial training is typically a condition of the license and, therefore, must be provided to all irradiator users and maintenance personnel. Periodic refresher training is also beneficial as a reminder for working safely around the irradiator and provides for a means to receive or disseminate additional or updated information.

In addition, most manufacturers have a recommended schedule of maintenance and/or recommended preventative/periodic maintenance that should be performed. Users of these types of irradiators should evaluate their usage to determine the applicability of the recommended maintenance to their situation and usage. Users who operate their unit more than usual or who use their units under harsh conditions should consider the need for stepped-up maintenance or

shortened maintenance intervals. In addition, each manufacturer's recommended maintenance may vary according to the specific unit or type of use. Therefore, persons performing maintenance on their unit may require specific maintenance training for their unit.

Users who are not aware of the required training for their unit, or who wish to receive information concerning training in general, should consult their license, licensing authority, or the manufacturer of the unit. Regulatory Guide 10.9, provides additional guidance in this area and may assist persons who wish to develop a training and maintenance program. Users who wish to receive additional information concerning recommended maintenance for their unit should contact the manufacturer of the unit. In addition, third-party service companies may also be available for training and maintenance services for these types of irradiators.

This information notice requires no specific action nor 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 regional office.

**Original signed by Donald A. Cool**

Donald A. Cool, Director  
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Attachments:

1. List of Recently issued NMSS Information Notices
2. List of Recently issued NRC Information Notices

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NAME	DBroaddus*		LCamper		EKraus	KRamsey		DCool	
DATE	4/17/96		5/28/96		4/01/96	5/31/96		6/4/96	

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LIST OF RECENTLY ISSUED  
 NMSS INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-33	Erroneous Data from Defective Thermocouple Results in a Fire	05/224/96	All material and fuel cycle licensees that monitor temperature with thermocouples
96-28	Suggested Guidance Relating to Development and Implementation of Corrective Action	05/01/96	All material and fuel cycle licensees
96-21	Safety Concerns Related to the Design of the Door Interlock Circuit on Nucletron High-Dose Rate and Pulsed Dose Rate Remote Afterloading Brachytherapy Devices	04/10/96	All NRC Medical Licensees authorized to use brachytherapy sources in high- and pulsed-dose-rate remote
96-20	Demonstration of Associated Equipment Compliance with 10 CFR 34.20	04/04/96	All industrial radiography licensees and radiography equipment manufacturers
96-18	Compliance With 10 CFR Part 20 for Airborne Thorium	03/25/96	All material licensees authorized to possess and use thorium in unsealed form
96-04	Incident Reporting Requirements for Radiography Licensees	01/10/96	All Radiography Licensees and Manufacturers of Radiography Equipment
95-58	10 CFR 34.20; Final Effective Date	12/18/95	Industrial Radiography Licensees.
95-55	Handling Uncontained Yellowcake Outside of a Facility Processing Circuit	12/6/95	All Uranium Recovery Licensees.
95-51	Recent Incidents Involving Potential Loss of Control of Licensed Material	10/27/95	All material and fuel cycle licensees.

LIST OF RECENTLY ISSUED  
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-34	Hydrogen Gas Ignition during Closure Welding of a VSC-24 Multi-Assembly Sealed Basket	05/31/96	All holders of OLs or CPs for nuclear power reactors
96-33	Erroneous Data From Defective Thermocouple Results in a Fire	05/24/96	All material and fuel cycle licensees that monitor temperature with thermocouples
96-32	Implementation of 10 CFR 50.55a(g)(6)(ii)(A), "Augmented Examination of Reactor Vessel"	06/05/96	All holders of OLs or CPs for nuclear power reactors
96-31	Cross-Tied Safety Injection Accumulators	05/22/96	All holders of OLs or CPs for pressurized water reactors
96-30	Inaccuracy of Diagnostic Equipment for Motor-Operated Butterfly Valves	05/21/96	All holders of OLs or CPs for nuclear power reactors
96-29	Requirements in 10 CFR Part 21 for Reporting and Evaluating Software Errors	05/20/96	All holders of OLs or CPs for nuclear power reactors
96-28	Suggested Guidance Relating to Development and Implementation of Corrective Action	05/01/96	All material and fuel cycle licensees
96-27	Potential Clogging of High Pressure Safety Injection Throttle Valves During Recirculation	05/01/96	All holders of OLs or CPs for pressurized water reactors
96-26	Recent Problems with Overhead Cranes	04/30/96	All holders of OLs or CPs for nuclear power reactors
96-25	Transversing In-Core Probe Overwithdrawn at LaSalle County Station, Unit 1	04/30/96	All holders of OLs or CPs for nuclear power reactors

OL = Operating License  
 CP = Construction Permit