



Physics Division

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X-RAYS, POTENTIAL EMPLOYEE EXPOSURE AT LBNL

On February 21, 1997, at Lawrence Berkeley National Laboratory, a group leader suspected that a potential safety deficiency existed on a beam line of the Advanced Light Source synchrotron. Further investigation revealed that this deficiency could expose personnel to low-energy scattered x-ray radiation. The group leader immediately locked out the beam line. On February 28, 1997, the group leader further determined that an engineering support employee was potentially exposed to x-rays while working at the beam line end station. The operations manager convened an internal review of the event. The review concluded that a June 26, 1996, beam line design review failed to recognize the significance of a design change to the end station. Inadequate safety reviews of equipment changes can significantly affect personnel safety. (ORPS Report SAN--LBL-AFRD-1977-0001)

Preliminary estimates indicate that the dose received by the engineering support employee was less than 100 mrem, the same order of magnitude as the dose from a medical x-ray. No other employee received any

exposure above their expected occupational dose.

The operations manager conducted an internal review and determined the end station design changed as the concept evolved from the initial conceptual review to the detailed design review. The original concept envisioned two compartments, isolated from each other during personnel access; the final plans provided for only one compartment. The second design did not prevent scattered x-ray radiation from being present when experimenters removed an access panel. Design reviewers failed to recognize the safety significance of these changes. When operators tested the end station as part of the beam line review process, they conducted radiation surveys with the access panel in place. Based on the internal review, the operations manager determined the engineering support employee was testing the computer-controlled operation of the end station with the access panel removed during beam operation. The operations manager established a process improvement team to recommend improvements to the beam line review process. Subject matter experts at Brookhaven National Laboratory are also reviewing their beam line design guidelines for weaknesses.

NFS reported events involving inadequate design reviews in Weekly Summaries 95-27, 95-19, 94-11, and 94-09.

- Weekly Summary 95-19 reported on March 17, 1995, at the Brookhaven National Laboratory's Alternating Gradient Synchrotron Facility, radioactive contamination was released when a beam target broke during a high-intensity experiment. Four experimenters received internal exposures. Investigators determined the design review associated with the experiment was inadequate. Engineers had not considered the contamination consequences of a target failure. (ORPS Final Report CH-BH-BNL-AGS-1995-0002)
- Weekly Summary 94-11 reported on March 10, 1994, at the Savannah River Site, the removal of a barrier wall caused an air reversal in a building that allowed air flow from a radiological control area to a control room and offices. The air reversal could

have resulted in radiological contamination of occupied work spaces. Investigators determined that engineers should have identified the impact removing the wall had on ventilation system operation during their design review process. (ORPS Report SR-WSRC-HCAN-1994-0033)

This event underscores the importance of engineers and system experts conducting thorough and adequate reviews of proposed designs and revisions. Attention must be paid to engineered safety features that can affect personnel safety at each stage in the review process. Design changes that can affect physical barriers (combining two isolated compartments into one compartment in this case) must be carefully examined. The *Hazard and Barrier Analysis Guide*, developed by the Office of Operating Experience Analysis and Feedback (OEAF), includes a hazard-barrier matrix that shows that physical barriers are among the most effective types of barriers for protection against ionizing radiation. The effectiveness of a barrier is related to how suitable or how comprehensive it is in protecting against a particular hazard. The reliability of a barrier is its ability to resist failure. Brookhaven National Laboratory's review of their beam line design guidelines will help Lawrence Berkeley and Brookhaven Laboratories to develop uniform standards for similar potential hazards.

DOE 4330.4A, *Maintenance Management Program*, specifies a safety review for modifications before implementation; in part, to determine the effect of the modification on equipment safety and reliability. DOE 6430.1A, *General Design Criteria*, specification 0110-5.2, directs evaluating DOE facilities for potential risks to operators. Engineering designs must assure quality of equipment to maintain personnel safety. This includes analysis of effects of changes during the design and fabrication of equipment.

KEYWORDS: design, safety hazard, x-ray, exposure

FUNCTIONAL AREAS: radiation protection

[Return to ESH Bulletin Index](#)