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

July 27, 1990

NRC INFORMATION NOTICE NO. 90-47: UNPLANNED RADIATION EXPOSURES TO PERSONNEL EXTREMITIES DUE TO IMPROPER HANDLING OF POTENTIALLY HIGHLY RADIOACTIVE SOURCES

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors, holders of licenses for permanently shutdown facilities with fuel onsite and research and test reactors.

Purpose:

This information notice is intended to alert addressees to the hazards of unplanned radiation exposures, especially to the extremities, resulting from improper handling of potentially highly radioactive sources. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

FitzPatrick Events

On March 8, 1990, a radiation control technician (RCT) at the James A. FitzPatrick Nuclear Power Plant contaminated himself with sodium-24 (Na-24), at a level of at least 120 mR/hr, after picking up a contaminated cap to put it back on the empty source vial. Instead of using handling tools as specified in procedures, the RCT used his gloved right hand. Later, during the removal of his gloves, the RCT contaminated his left hand. This event occurred after the preparation of approximately 400 mCi of Na-24 radioactive solution for injection into the reactor primary system as part of a system flow check. Calculations performed by the licensee showed that the skin of the left thumb had been exposed to approximately 48.8 rems (using 7 mg/cm^2 as the thickness of the skin as specified in Form NRC-5). The NRC staff has taken escalated enforcement action against the licensee because of this event. See NRC Inspection Report 50-333/90-12 for more details.

Aside from the skin exposure, this event is significant because the corrective actions taken for a similar event that occurred at the same plant in February 1987 failed to prevent the occurrence of the above event.

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Regarding the February 1987 event at the FitzPatrick plant, NRC Inspection Report 50-333/87-07 reported that an irradiated instrument dry tube was inadvertently removed from the spent fuel pool (SFP) and dropped onto the floor. A worker picked up the tube and threw it into the SFP, thereby receiving an overexposure to one hand. As a result of a licensee and NRC review, five violations were identified: (1) failure to control extremity exposure, (2) failure to instruct individuals as to the radiological hazard, (3) failure to perform an adequate survey, (4) failure to follow radiation protection procedures, and (5) failure to follow operating procedures.

As a result of the 1987 event, the licensee issued standing orders requiring radiation protection supervisory personnel to monitor and review radiologically sensitive work. In addition, the licensee required that procedure reviewers use a checklist to address radiological concerns while reviewing new or temporary procedures. Those actions were appropriate, however it is necessary for each worker to understand the hazard of radiation exposure to the extremities that may result from the improper handling of objects of high potential radioactivity. Listed below are items from the licensee's checklist which, if properly addressed, would have emphasized to personnel the hazards associated in working with a highly radioactive source and could have prevented the 1990 Na-24 event:

- Are personnel qualified and trained to perform the job? - In both events, a common weakness was that the personnel did not understand the magnitude of the hazard associated with the work. Since Na-24 flow testing is not commonly used at nuclear power plants, better training of workers on the proper handling of radionuclides for flow testing could help prevent unnecessary exposures.

- Do the work procedures have radiological hold points to help initiate proper radiological job coverage/oversight? - In both events, hold points were not established to request a survey of unidentified, potentially highly radioactive objects prior to handling the objects.

- Do all workers understand what controls have been established for limiting radiation exposure and contamination? - The protective clothing requirements on the Radiation Work Permit (RWP) did not reflect the true nature of the contamination hazard associated with the performance of the Na-24 flow testing. In addition, at no time during the mock-up training or the pre-job ALARA meeting was there any specific mention of the disposition of the highly contaminated Na-24 source vial and cap. This contamination incident could have been avoided if the worker had treated the outside of his gloves as contaminated during removal. For the Na-24 flow test, the absence of more specific contamination information may have resulted in the RCT being less vigilant in his contamination control work practices.

Pilgrim Events

Other examples of improper handling of highly radioactive sources occurred at the Pilgrim plant. In January 1984, during maintenance work on a control rod drive (CRD), CRD parts and miscellaneous debris from the bottom of the reactor

vessel were placed in a five-gallon bucket of water and left unposted in the area for five days. On the fifth day, after the CRD parts were removed for decontamination, a RCT identified the bucket as a source of high radiation and proceeded to survey the objects by picking them up to perform the measurements.

Subsequent thermoluminescence dosimeter (TLD) measurements of the objects indicated contact dose rates as high as 2880 R/hr, resulting in an exposure to the RCT's hand of about 4.5 rem.

Evidently, lessons learned from this event were not effectively communicated to all workers at the plant. On August 18, 1984, a RCT identified a highly radioactive chip of metal in a CRD tool tray (later evaluation indicated a contact dose rate of 1120 R/hr). This information, however, was not immediately disseminated to all workers in the area, (i.e., the area was not posted). Later, when a group of workers began to work in the area around the CRD tool tray, the RCT, while pointing at the chip with the survey meter, yelled through his respirator for the workers to move away from the CRD. One worker, believing that he was being directed by the RCT to remove the chip, picked up the chip and threw it away from the CRD. The extremity dose to the worker's hand was estimated to be 1.1 rem for the three seconds he was holding the chip.

The above events indicate that the hazards of extremity exposure are not well understood by all radiation workers and that lessons learned from the occurrence of a higher than normal exposure to one worker are not effectively integrated into the work habits of other workers. Attachment 1 gives additional examples in which unplanned exposures occurred due to improper handling of potentially highly radioactive sources.

Discussion:

Although it may appear obvious that common sense should prevent radiation workers from picking up potentially highly radioactive sources, the number of identified unplanned radiation exposures of this type indicates that "common sense" has not been effective. Radiation workers have traditionally been well indoctrinated in the control of radiation exposures to the whole-body. However, this knowledge is not well translated into the control of radiation exposures to the extremities (i.e. hands, forearms, feet and ankles). Because the contact dose rates of radioactive sources can be extremely high, handling these objects even for a few seconds can result in very high extremity exposures. The use of remote handling tools can reduce the magnitude of unplanned exposures without hindering the completion of the tasks involved. Most licensees evaluate the need for such tools during the planning for specific aspects of each job; however their use for an unanticipated situation has not always been effectively communicated to the workers.

Because an unidentified highly radioactive object can be picked up with little or no advance notice, the presence of a RCT or a line supervisor may not prevent an unplanned exposure. In several events, the RCTs themselves erred by directly handling the objects and receiving unplanned exposures. Therefore, it is important that all radiation workers understand the hazards of high extremity exposures associated with unidentified and possibly highly radioactive objects and be well trained in the proper handling of these objects. With

proper training, a worker is more likely to survey or request timely surveys of suspect objects that could harbor highly radioactive sources. For these types of localized hot sources, including beta sources, routine general area radiation survey maps may not be useful in protecting the worker.

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 NRR project manager.

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Attachments:
1. Summaries of Other Events
2. List of Recently Issued NRC Information Notices

Summaries of Other Events:

TMI-2 (September 1989)

Two workers handled a piece of material believed to be fuel debris. The radiological controls technician (RCT) monitoring the work was unaware that the workers had handled the object. After the RCT surveyed the object, it was returned to the reactor vessel because of its high dose rate. The licensee initiated an inquiry when the first worker, on the following day, asked another RCT about the health implications of handling fuel debris. The calculated skin dose to the left hand of one of the workers was 55 rem. (NRC Inspection Report 50-320/89-11, February 8, 1990)

Point Beach (April 1989)

An inservice inspection (ISI) engineer received a dose to the hand of 4.7 rem during a closeout inspection of the Unit B steam generator. The exposure occurred when the engineer picked up an object and passed it outside the steam generator without knowing that the radiation level of the object read 200 R/hr at near contact. (NRC Inspection Report 50-266/89-15, June 21, 1989)

Rancho Seco (July 1984)

After the completion of a tube plugging job, a worker entered the steam generator to vacuum loose debris. The worker picked up an object that was too large to be vacuumed and tossed it out of the steam generator. The object had been earlier identified as part of a high pressure injection nozzle thermal sleeve. The radiation level of the object read 28 R/hr at six inches. A licensee radiation protection investigation concluded that no overexposure had occurred. (NRC Inspection Report 50-312/84-25, October 19, 1984)

Sequoyah (August 1982)

Two flow tests of reactor systems performed in August 1982, using Na-24 as a tracer, resulted in an extremity exposure to one worker of 10 rem. Because this exposure was higher than those incurred during past flow tests, the licensee initiated an investigation to determine the cause of the high exposure. The licensee concluded that because of the high contact dose-rate (1.5 R/sec) of the Na-24 source vial, its cap should not be removed by hand as was the case in previous tests; instead remote handling tools should be used. The licensee also concluded that, because Na-24 is not commonly used at nuclear power plants, health physics management should provide better training and pre-job planning to both RCTs and radiation workers with regard to the handling of radionuclides, such as Na-24, used in flow testing. Based on this event, the licensee determined that prior to 1982, extremity dose evaluations for flow testing had underestimated the actual doses, and that the extremity monitoring program for the plant should be upgraded. However, no overexposures have been reported to the NRC as a result of flow testing at Sequoyah.

Peach Bottom (October 1981)

A maintenance worker received an unplanned exposure to the hand while visually inspecting the inservice fuel inspection platform at the Unit 2 spent fuel pool (SFP). This exposure occurred when the worker picked up fuel channel clips from the fuel elevator with his hand. The area radiation monitors alarmed. A nearby radiation control technician immediately instructed the maintenance worker to put down the fuel channel clips. The clips were then placed into a bucket in the spent fuel pool. Subsequent radiological survey of the fuel channel clips indicated a gamma dose rate of 3.2 R/hr at 1.8 inches. Exposure to the worker's hand was estimated at 527 mrem. (NRC Inspection Report 50-277/82-11, July 13, 1982.)

LIST OF RECENTLY ISSUED
NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
90-46	Criminal Prosecution of Wrongdoing Committed by Suppliers of Molded-Case Circuit Breakers and Related Components	7/16/90	All holders of OLs or CPs for nuclear power reactors.
90-45	Overspeed of the Turbine-Driven Auxiliary Feedwater Pumps and Overpressurization of the Associated Piping Systems	7/6/90	All holders of OLs or CPs for nuclear power reactors.
89-79, Supp. 1	Degraded Coatings and Corrosion of Steel Containment Vessels	6/29/90	All holders of OLs or CPs for nuclear power reactors.
90-44	Dose-Rate Instruments Underresponding to the True Radiation Fields	6/29/90	All NRC licensees.
90-43	Mechanical Interference With Thermal Trip Function in GE Molded-Case Circuit Breakers	6/29/90	All holders of OLs or CPs for nuclear power reactors.
90-32, Supp. 1	Surface Crack and Subsurface Indications in the Weld of a Reactor Vessel Head	6/19/90	All holders of OLs or CPs for nuclear power reactors.
90-42	Failure of Electrical Power Equipment Due to Solar Magnetic Disturbances	6/19/90	All holders of OLs or CPs for nuclear power reactors.
90-41	Potential Failure of General Electric Magne-Blast Circuit Breakers and AK Circuit Breakers	6/12/90	All holders of OLs or CPs for nuclear power reactors.
90-40	Results of NRC-Sponsored Testing of Motor-Operated Valves	6/5/90	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit