SSINS No.: 6835
IN 86-23

UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D.C. 20555

April 9, 1986

IE INFORMATION NOTICE NO. 86-23: EXCESSIVE SKIN EXPOSURES DUE TO CONTAMINATION WITH HOT PARTICLES

Addressees:

All nuclear power reactor facilities holding an operating license (OL) or a construction permit (CP).

Purpose:

This information notice is provided to alert recipients of a potentially significant problem pertaining to skin contamination incidents. It is expected that recipients will review this information for applicability to their facilities and consider action, if appropriate, to preclude a similar problem occurring at their facilities. However, suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

Three reactor licensees recently have reported excessive skin exposures to individuals as a result of contamination from single hot particles of radioactive material. (See Attachment 1 for a more detailed description of these events.) Hot particles are small (in some cases microscopic) particles of radioactive material with a high specific activity.

All three licensees have concluded that the hot particles in those contamination events most probably were transferred to the individual from "clean" protective clothing (which are intended to prevent skin contamination). Review of the events discussed in Attachment 1 indicates the following additional common considerations:

1. Plants with hot particle problems experience multiple contamination events. Once hot particles are loose in the plant they are difficult to detect and control. Plants with a potential for generating hot particles (those with stellite components or poor fuel performance) should consider additional contamination control measures such as providing temporary containment for "hot" jobs, where feasible. The INPO Significant Event Report (SER) 42-85, "Personnel Skin Contaminations Due to Activated Stellite Particles," includes a discussion on minimizing the introduction of stellite to a reactor system.

2. It is believed that the insides of protective clothing are being contaminated in the laundry system. Reliance on the laundry process monitors in the cleaning fluid path and/or bulk gamma surveys of "clean" protective clothing is ineffective for detecting hot particles. Licensees may want to segregate highly contaminated clothing from potentially contaminated clothing and launder each group separately to reduce the chance of transferring hot particles.

3. In all the reported events, a need for more vigilance in personnel contamination control (self-frisking, protective clothing removal procedures, etc.) is evident.

A hot particle on the skin produces a very steep dose gradient with the dose dropping off rapidly as distance from the particle increases. The NCRP dose limit recommendations in NBS Handbook 59 (which provide the basis for the current NRC regulations) assumes that the critical area of the skin is 1.0 $cm^2$ and that the radiosensitive basal layer of cells is at a depth of 7mg/$cm^2$ below the surface. For purposes of showing compliance with 10 CFR 20.101(a), calculating a skin dose averaged over 1.0 $cm^2$ at a depth of 7 mg/$cm^2$ is appropriate.

No specific action or written response is required by this information notice. If you have any questions about this matter, please contact the Regional Administrator of the appropriate regional office or this office.

Edward L. Jordan, Director
Division of Emergency Preparedness
and Engineering Response
Office of Inspection and Enforcement

Technical Contacts: Roger L. Pedersen, IE
(301) 492-9425

James E. Wigginton, IE
(301) 492-4967

Attachments:
1. Description of Events
2. List of Recently Issued IE Information Notices

DESCRIPTION OF EVENTS

McGuire:

On June 5, 1985, a contractor employee supporting the plugging operation of a steam generator at Duke Power Company's McGuire Station discovered a small area of skin contamination under the arm. The contamination was detected by a contamination portal monitor when the individual exited the controlled area after removal of three sets of protective clothing. Further detailed surveys of the contaminated skin area showed the following results: 0.5 mR/hr gamma, 58 mrad/hr beta, and greater than 50,000 cpm with a pancake G-M detector. The contamination was successfully removed using adhesive tape. Further evaluation showed that the contamination was a single particle 40 microns in diameter with an activity of 1.2 microcuries (uCi) of Co-60. Calculation of the absorbed dose to 1 $cm^2$ of skin resulted in a skin dose of 10.6 rad. This exceeded the maximum allowable dose of 7.5 rem in a quarter [10 CFR 20.101(a)].

Prior to the June event, a number of similar contamination incidents with hot particles of cobalt-60 had occurred but with lesser dose consequences. The licensee's investigation led to the preliminary conclusion that the cobalt-60 particles were transferred to the individual from the "clean" protective clothing. The licensee has identified other Co-60 particles in the plant laundry area. The licensee thus far believes the source of contamination to be stellite valve seats with high cobalt content in the primary coolant system. Small particles of stellite may have been dislodged and transported to the core, where they would have been activated to Co-60. Subsequently, these particles became trapped in protective clothing during maintenance activities and were not removed during normal laundering.

The licensee subsequently initiated the following protective measures:

1. Disposal of all cotton protective clothing in use at the time of the event;

2. Increased surveillance of protective clothing after laundering (including comprehensive surveys of both the inside and outside of laundered protective clothing using pancake probe G-M meters);

3. Increased vigilance in self-frisking procedures when exiting contaminated area and when traversing between frisking locations within contamination control zones; and

4. Further evaluations to determine where stellite valve seats are used and where they could possibly be eliminated.

San Onofre:

On October 30, 1985, a firewatch employee found contamination while "frisking out" of the radwaste building (RWB). Investigation showed the contaminant to be a small speck of material attached to the outside back of the individual's

modesty garment worn under protective clothing. Frisker readings near the particle were in excess of 50,000 cpm beta-gamma. An alpha count with a SAC-4 survey instrument yielded 2,000 cpm. Gamma spectrometric analysis showed about 4 uci of material made up of Nb-95, Zr-95, Ru-103, Ru-106, Ba-140, La-140, Ce-141 and Ce-144. This composition suggests that the hot particle is a tiny fragment of fuel rather than the normal mix of activation and fission products which originate within the reactor coolant system. Careful frisking by personnel at the RWB exit point turned up a few more hot particles on modesty garments and shoes. Extensive surveys pointed to the fuel reconstitution equipment and work area in the Unit 3 FHB as the most significant sources of hot particles. Unit 3 has experienced significant fuel integrity problems. Recently San Onofre performed fuel reconstitution in the spent fuel pool by replacing defective fuel pins in the affected fuel assemblies.

On November 19, two additional instances of personnel contamination with hot particles were detected. On November 21, a similar personnel contamination was detected. Additionally, two more hot particles were found in the FHB. Work was halted and the FHB was isolated. Access to the FHB is presently limited to required operator surveillances with constant HP coverage. The licensee determined that these skin contaminations resulted from hot particles transferred from "clean" protective clothing. Checks of protective clothing on the ready-to-issue shelves revealed two cases where protective clothing (which met the "return to normal service" criteria of less than 5,000 cpm/probe area) were found, upon very slow and careful frisking (15 minutes), to have hot particles with activities that exceeded this value. Accordingly, a program is being implemented to withdraw all protective clothing presently in use for thorough survey under more restrictive criteria. The clothing will be replaced with protective clothing that has been out of service since Unit 3 fuel reconstitution was initiated or with one-time-use disposal garments.

A preliminary assessment of the dose received by the two individuals involved in the November 19 events indicates 1.3 rem to the skin of the whole body and 7 rem to the skin of an extremity. These are below the dose limits set in 10 CFR 20.101(a). However, these dose calculations are currently under review by the NRC.

Other actions taken by the licensee include:

1. An extensive, special survey program (of workplace and protective clothing) is being maintained to assure the prompt detection and removal of additional hot particles.

2. Full face respirators are required in FHB during work involving the removal of reconstitution tools.

3. A special instruction was given to station personnel stressing the importance of good frisking practices, use of protective clothing, contamination control, and other H.P. practices.

Dresden:

On December 11, 1985, a hot particle was found near the abdomen area on the outside of an individual's undershirt. The contamination was initially found by a portal monitor. On analysis, the hot particle was determined to contain 110 nanocuries (nCi) of Co-60. The licensee concluded that the particle was most likely transferred from protective clothing to this undershirt. Based on the individual's work activities an exposure time of 7 hours was estimated resulting in a skin dose of less than 1 rem.

On January 4, 1986, a hot particle (44 nCi CO-60 and 1 nCi Cs-137) was found on a contract worker's abdomen while passing through a whole body frisker. The licensee performed instrument response checks on the whole body friskers, postal monitors, and laundry monitors using the collected hot particle. The licensee concluded that the particle was transferred from protective clothing to the worker's skin. During interviews the worker admitted that he routinely omitted frisking after removing his protective clothing at step-off pads. With the particle replaced near its original position the licensee had the worker pass through whole body friskers several times; an alarm was received about 50 percent of the time. The licensee estimated the maximum probable time of exposure to be 16 hours, resulting in a calculated skin dose of less than 5 rems.

Actions taken by the licensee to prevent reoccurrence include:

1. Initiating a more aggressive laundry monitoring program; and

2. Emphasizing to contractors the need for worker compliance with radiological controls.

# LIST OF RECENTLY ISSUED IE INFORMATION NOTICES

| Information Notice No. | Subject | Date of Issue | Issued to |
|---|---|---|---|
| 86-22 | Underresponse Of Radition Survey Instrument To High Radiation Fields | 3/31/86 | All power reactor facilities holding an OL or CP and research and test reactors |
| 86-21 | Recognition Of American Society Of Mechanical Engineers Accreditation Program For N Stamp Holders | 3/31/86 | All power reactor facilities holding an OL or CP and all recipients of NUREG-0040 (white book) |
| 86-20 | Low-Level Radioactive Waste Scaling Factors, 10 CFR Part 61 | 3/28/86 | All power reactor facilities holding an OL or CP |
| 86-19 | Reactor Coolant Pump Shaft Failure At Crystal River | 3/21/86 | All power reactor facilities holding an OL or CP |
| 86-18 | NRC On-Scene Response During A Major Emergency | 3/26/86 | All power reactor facilities holding an OL or CP |
| 86-17 | Update Of Failure Of Automatic Sprinkler System Valves To Operate | 3/24/86 | All power reactor facilities holding an OL or CP |
| 86-16 | Failures To Identify Containment Leakage Due To Inadequate Local Testing Of BWR Vacuum Relief System Valves | 3/11/86 | All power reactor facilities holding an OL or CP |
| 86-15 | Loss Of Offsite Power Caused By Problems In Fiber Optics Systems | 3/10/86 | All power reactor facilities holding an OL or CP |
| 86-14 | PWR Auxiliary Feedwater Pump Turbine Control Problems | 3/10/86 | All power reactor facilities holding an OL or CP |

OL = Operating License
CP = Construction Permit