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

June 20, 1997

NRC INFORMATION NOTICE 97-36: UNPLANNED INTAKES BY WORKER OF TRANSURANIC AIRBORNE RADIOACTIVE MATERIALS AND EXTERNAL EXPOSURE DUE TO INADEQUATE CONTROL OF WORK

Addressees

All holders of operating licenses and construction permits. All licensees of nuclear power reactors in the decommissioning stage and fuel cycle licensees.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert licensees to inadequate radiological work controls in highly contaminated areas. These inadequate controls created a substantial potential for personnel radiation exposures in excess of NRC limits and resulted in unplanned intakes by workers of airborne radioactive materials, including transuranics (alpha emitters). It is expected that recipients will review the information in this notice 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 or written response is required.

Description of Circumstances

On November 2, 1996, the Haddam Neck plant was in a refueling and maintenance outage. Before flooding the reactor cavity, the fuel transfer canal (FTC), the fuel transfer cart and tracks, and the upender needed to be inspected and debris removed to ensure cleanliness.

In preparation for the inspection and entry to the FTC, two workers (a maintenance supervisor and a reactor vendor representative) met with health physics (HP) supervisors and HP technicians (HPTs) to discuss the entry. As this work was not on the master outage schedule, this was the first notice to HPTs of the work. The governing work procedure provided no work scope detail. The meeting was not effective; there was no common understanding between the workers and the HPTs as to what work was to be done and the radiological conditions in the work area. The HPTs mistakenly believed that the workers would principally walk along the FTC tracks but could periodically leave the tracks to pick up debris (e.g., tie wraps) that had fallen down from the charging floor. The HPTs did not know that the workers would collect, by hand, paint chips, metal rust, and dried, dirtlike materials from the floors and walls.

Just before the entry, the HPTs briefed the workers on the radiological conditions. Since the FTC was decontaminated in August 1996, the workers were led to believe that the canal was generally "clean." The licensee had not performed any prework contamination or radiation surveys to support the job. Surveys later found that the FTC contained removable contamination of up to 800 microgrey/h [80 millirad/hr] (beta/gamma) and 500 Bq [30,000 disintegrations per minute] per 100 square centimeters (dpm/100 cm^2) alpha contamination. In addition, a local hot spot on the canal floor, readily accessible to the workers, exhibited external radiation levels of 250 mSv/h [about 25 R/h] on contact and 80 mSv/h [about 8 R/h] at waist level. The prework briefing of the workers was inadequate, and the workers were not informed of the actual radiological conditions. Additionally, the work was allowed to commence under an invalid (because it did not allow FTC entry) radiation work permit (RWP), rather than a specific RWP for the FTC. As a result, no comprehensive, prework radiation or contamination surveys were performed. The decision not to issue respiratory protection was based on previous air sample results (after the August 1996 reactor cavity decontamination to support worker tours of the area). However, this dated sampling was not representative of the extensive debris cleanup activity on November 2, 1996.

While in the FTC, the workers scraped up debris from the FTC and placed it in a plastic bag. Unknown to the workers, this activity generated significant airborne radioactive materials and created a high-intensity external radiation source.

After completion of the work, one worker's dosimeter alarmed upon exiting the reactor cavity. The plastic bag of debris was surveyed for the first time and read 200 mSv/h [about 20 R/h] on contact (it was placed in shielded storage). A later survey of the bag indicated 600 mSv/h [about 60 R/h] on contact and about 40 mSv/h [about 4 R/h] about 30 centimeters away. The workers wore no additional dosimetry other than their electronic alarming and standard chest thermoluminescence dosimeters (TLDs). The workers found significant contamination, while whole-body frisking. Nasal smears of the workers indicated 3333 Bq [200,000 dpm] (beta/gamma) shortly after exiting the cavity. Subsequent to the event, the licensee determined (by analysis and reconstruction) the workers' deep-dose equivalent (DDE), the shallow-dose equivalent (SDE, whole body), the maximum doses to the extremities, and the lens dose equivalent (LDE) from the collection and handling of the debris. None of the worker's external doses were in excess of the limits, with the maximum assigned doses (mSv) of 4.73 [473 mrem], DDE; 4.73 [473 millirem], SDE; 11.6 [1164 mrem], extremity; and 3.97 [397 mrem], LDE.

With the workers out of the cavity, an HPT checked the FTC air sample using a hand-held frisker and found that the sample exhibited an elevated count rate, indicating the presence of potential airborne radioactive material. This air sample later indicated about 0.8 derived air concentration (DAC) beta and 24 DAC alpha. The general area air sample was not representative (not in the breathing zone of the workers) of the concentrations encountered by the workers during the debris cleanup.

A backup air sample of the reactor cavity was started, well away (non-representative) from the FTC. The sample was also checked in the field with a different (but defective) hand-held

frisker, which erroneously indicated no airborne radioactive materials were present. Other HPTs in the area were then notified (misinformed) that the air within the reactor cavity was clean. The inspector later found that the licensee had failed to establish and implement an effective program to adequately check for proper operability of the frisker in containment. On the basis of the erroneous negative air sample result, HPTs authorized two other workers to enter the reactor cavity and clean the reactor vessel stud holes. These workers unknowingly spent about 15 minutes in an area with elevated airborne radioactive material levels and subsequently exited the reactor cavity. Their subsequent whole-body counts showed no significant intakes.

The licensee's subsequent counting of the backup air sample prompted identification of the inoperable frisker and subsequent evacuation of the reactor cavity and initiation of an investigation. The backup air sample was found to indicate airborne radioactivity concentrations of 3.5 DAC beta and 108 DAC alpha. The air sample collected near where the two workers were working on the reactor vessel studs was later found to indicate 1.5 DAC beta and 53 DAC alpha. In spite of these air sample results (high alpha DACs), their non-representative nature (not near the FTC), and the stay-times of the workers and their work practices in the FTC (handling contaminated debris), the licensee did not recognize the potential for excessive personnel exposure until about a week after the event.

Discussion

In the Haddam Neck event, inadequate radiological evaluations and controls led to unplanned internal exposures with a substantial potential for worker overexposures. Of more concern was that until identified by an NRC inspector five days after the event, the licensee failed to recognize the potential for significant internal doses from transuranic radionuclides known to be present in the FTC. The presence of these alpha-emitting nuclides was evident from loose surface contamination sampling (smears) and air samples. This failure led to untimely initiation of in-vitro bioassays (fecal sampling) for the transuranic material intake to assess personnel exposures. While the whole-body counting (WBC) indicated a relatively low intake/dose from cobalt-60, the licensee failed to use the high alpha-to-beta gamma ratios (from the air and smear samples) to identify the potential for significant internal doses to workers from the transuranic component. When the NRC inspector noted the WBC result for the gamma emitters (power plant WBC's do not detect alpha radiation) and took into account the relative workplace abundance and typical DAC alpha-to-beta gamma nuclide ratios, he informed the licensee of the transuranic concern.

The licensee then initiated fecal sampling to account for doses from all nuclides (including alpha emitters). The licensee contracted outside consultants to perform a detailed analysis of the event and calculate the workers' internal dose. On the basis of this effort, the licensee reported a maximum 9.13 mSv [913 mrem] committed effective dose equivalent (CEDE) and 58.7 mSv [5873 mrem] total organ dose equivalent (TODE) to the bone surface. None of the reported doses are in excess of regulatory limits. However, the NRC staff is still reviewing the licensee's methods, assumptions and models for the internal dose assessment.

For reactor facilities that have experienced fuel defects, experience has shown that long after the defective fuel has been removed, significant alpha contamination may remain in generally inaccessible locations, such as the FTC equipment drains and sumps, and other refueling areas. Even minor disturbance of the contaminated surfaces can result in the release of alpha-emitting radionuclides, whose DACs are orders of magnitude more restrictive and limiting (at much lower concentrations) compared with the normal beta-emitting and gamma-emitting isotopes usually encountered in reactor plant environments (fission, corrosion, and wear products). Additionally, alpha contamination may be incorporated into a contamination/corrosion layer on the interior surfaces of system components that carry primary fluids or steam. Surveys for loose surface contamination may not identify the fixed alpha contamination, but abrasive work (e.g., grinding or welding) may result in alpha-emitting airborne radioactive materials. This latter characteristic may be particularly important at reactor facilities undergoing decommissioning.

As a result of this event, the licensee performed root cause analyses. On the basis of these analyses and the findings of an independent review team, the licensee has initiated certain corrective actions, which include the following:

1. All work presenting a significant radiological challenge (within designated high-risk areas) was suspended until a work approval program was instituted. This program now requires review of all RWPs by the plant Radiation Protection Manager (RPM) and the Work Services Director, and RWP approval by the RPM or the Radiological Protection Supervisor.

2. The work control program now includes an RWP procedure requiring clear descriptions of authorized work and controls, improved procedures for high-risk evolutions, and representative prework surveys.

3. The license stopped the use of in-field counting and checks for air samples as a basis for reducing or relaxing radiological work controls.

4. All work in high alpha-intake risk areas requires the use of respirators until representative air sampling justifies work without respiratory protection.

Events involving unplanned intakes of airborne radioactivity at nuclear power plants occur generally during maintenance and refueling outages, are infrequent, and typically result in intakes by workers of radioactive material that are well within the limits of 10 CFR Part 20. However, as indicated in the event describe in this notice, the potential for significant unplanned personnel exposures does exist at nuclear power plants (see related correspondence).

Related Communications and Correspondence

The following related communications and correspondence are noted:

- NRC Inspection Report No. 50-219/96-12, dated December 19, 1996.

- NRC Information Notice 90-47, "Unplanned Radiation Exposures to Personnel Extremities Due to Improper Handling of Potential Highly Radioactive Sources," dated July 27, 1990.

- NRC Information Notice 92-75, "Unplanned Intakes of Airborne Radioactive Material by Individuals at Nuclear Power Plants," dated November 12, 1992.

This information notice does not require any 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.

Seymour H Weiss for

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LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
97-35	Retrofit to Industrial Nuclear Company (INC) IR100 Radiography Camera to Correct Inconsistency in 10 CFR Part 34 Compatibility	06/18/97	All industrial radiography licensees
97-34	Deficiencies in Licensee Submittals Regarding Terminology for Radiological Emergency Action Levels in Accordance With the New Part 20	06/12/97	All holders of OLs or CPs for test and research reactors
97-33	Unanticipated Effect of Ventilation System on Tank Level Indications and Engineering Safety Features Actuation System Setpoint	06/11/97	All holders of OLs or CPs for nuclear power reactors
95-36, Supp. 1	Potential Problems with Post-Fire Emergency Lighting	06/10/97	All holders of OLs or CPs for nuclear power reactors
97-32	Defective Worm Shaft Clutch Gears in Limitorque Motor-Operated Valve Actuators	06/10/97	All holders of OLs or CPs for nuclear power reactors
97-31	Failures of Reactor Coolant Pump Thermal Barriers and Check Valves in Foreign Plants	06/03/97	All holders of OLs or CPs for pressurized-water reactor plants

OL = Operating License
CP = Construction Permit

the fire to spread to that room and could have resulted in the loss of the A switchgear as well.

The Pilgrim licensee enhanced the fire protection design in the turbine building by installing containment curbs at the fire doors leading to the A essential switchgear room and the stairway leading to the radwaste holding tanks, and modified the iso-phase bus duct by installing an 8-inch diameter downcomer drain line on each of the three phases. Each drain line is routed to drain into the oil leak retention pit, and will be equipped with a rupture disc designed to open under 2 psig of static oil pressure in the drain line down-comer.

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OFC	TECH CONTACTS	C:SPLB	C:PECB	D:(A)DRPM
NAME	DSkeen* PMadden*	LMarsh*	AChaffee*	MSlosson SHW
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The Pilgrim licensee enhanced the fire protection design in the turbine building by installing containment curbs at the fire doors leading to the A essential switchgear room and the stairway leading to the radwaste holding tanks, and modified the iso-phase bus duct by installing an 8-inch diameter downcomer drain line on each of the three phases. Each drain line is routed to drain into the oil leak retention pit, and will be equipped with a rupture disc designed to open under 2 psig of static oil pressure in the drain line down-comer.

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