The Office of Environment, Safety and Health and its Office of Nuclear and Facility Safety (NFS) publishes the Operating Experience Weekly Summary to promote safety throughout the Department of Energy (DOE) complex by encouraging feedback of operating experience and encouraging the exchange of information among DOE nuclear facilities.

The Weekly Summary should be processed as an external source of lessons-learned information as described in DOE-STD-7501-96, *Development of DOE Lessons Learned Programs*.

To issue the Weekly Summary in a timely manner, the Office of Operating Experience Analysis and Feedback (OEAF) relies on preliminary information such as daily operations reports, notification reports, and, time permitting, conversations with cognizant facility or DOE field office staff. If you have additional pertinent information or identify inaccurate statements in the summary, please bring this to the attention of Jim Snell, 301-903-4094, or Internet address jim.snell@hq.doe.gov, so we may issue a correction.

Readers are cautioned that review of the Weekly Summary should not be a substitute for a thorough review of the interim and final occurrence reports.

Operating Experience Weekly Summary 97-27

June 27 through July 3, 1997

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EVENTS

1. PROCEDURE ISSUES RESULT IN WASTE TRANSFER ABOVE RECEIPT LIMITS

On June 24, 1997, at the Savannah River Site, an operator at the Receiving Basin for Offsite Fuel (RBOF) transferred liquid waste to an evaporator waste tank at H-Canyon that exceeded the dose rate limits for receipt. On June 27, H-Canyon operators contacted RBOF operators after they observed high radiation levels at the evaporator. The RBOF operators confirmed that the liquid waste transfer was above procedural limits. The RBOF operator's inattention to detail regarding limits in the procedure and the inconsistencies between RBOF and H-Canyon transfer procedures resulted in the event. The transfer of solutions with radioactivity in excess of limits can increase contamination levels in systems, generate more waste to process, and expose personnel to increased radiation dose rates. (ORPS Report SR--WSRC-RBOF-1997-0005)

The RBOF operator, following a waste handling procedure, contacted the H-Canyon operator before the transfer. She told the H-Canyon operator that the gamma dose result was 2.7 mrem/hr at 5 cm. The H-Canyon operator stated that he needed the results in dpm and said their limit was 400,000 dpm. A radiological control technician converted the gamma dose to dpm, and the RBOF operator told the H-Canyon operator the sample read 350,000 dpm. She then transferred the waste, which exceeded the 1 mrem/hr at 5 cm limit specified in the waste-handling procedure.

The facility manager conducted a critique on June 30. At the critique, the RBOF operator stated the sample read 2.7 mrem/hr at 5 cm and 0.2 mrem/hr at 30 cm. She saw a procedure note re-iterating the 1 mrem/hr at 5 cm limit, but missed the "5 cm" value because she was still thinking of a 30 cm requirement from a previous procedure step. Critique members identified and discussed the following inconsistencies between the H-Canyon and the RBOF waste-handling procedures.

- The H-Canyon procedure requests the amount of transfer in pounds; the RBOF procedure lists gallons.
- The H-Canyon procedure lists the transfer limit as 40,000 cpm or 400,000 dpm; the RBOF procedure lists the limit as 1 mrem/hr at 5 cm.
- The H-Canyon procedure measurements are based on readings from the RBOF tank; the RBOF procedure is based on readings from a sample bottle.

Critique members determined that H-Canyon personnel did not review the RBOF waste handling procedure before it was approved. They also determined RBOF personnel did not review the H-Canyon waste transfer procedure before it was approved. H-Canyon personnel stated that, based on the indicated radiation levels from the transfer, even the 1 mrem/hr limit would have exceeded their limit for receiving waste. They pointed out that gamma dose measurements on the sample bottle would not have provided an accurate measurement of the liquid waste in the tank. Critique members also determined that the RBOF relief supervisor did not hold a pre-job brief before continuing the transfer. Also, the relieving operator did not read the precautions and limitations that contained the 1 mrem/hr dose limit before continuing the procedure.

The facility manager suspended all transfers between RBOF and H-Canyon until the RBOF waste-handling procedure and the H-Canyon waste transfer procedure are changed to reflect consistent transfer limits. The facility manager identified the following corrective actions.

- Change the RBOF waste-handling procedure to include a step requiring the operator to contact the supervisor if sample results exceed the value for transfer to H-Canyon.

- Identify RBOF procedures that require interfacing with other facilities and identify appropriate staff at those facilities to review RBOF procedures.

- Require RBOF personnel to review RBOF procedures to ensure that appropriate precautions/limitations are addressed as steps in the body of the procedure and that no action steps are included in notes.

NFS has reported events involving procedure issues and inadequacies in several Weekly Summaries. The following are examples of these issues and inadequacies.

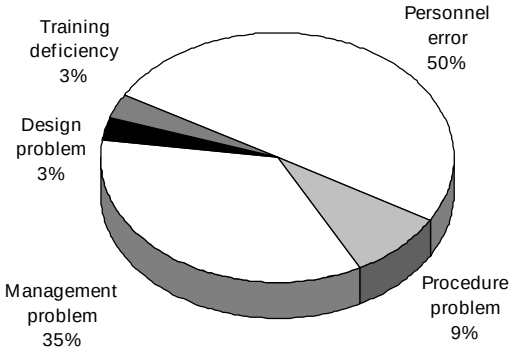
- An operating procedure was not revised to reflect system modifications, making it ineffective.

- Inadequate validation of a surveillance procedure resulted in the omission of important inspection points.

- A revised surveillance procedure was used before its implementation date and contained changed limits.

- An operating procedure did not have correct settings and did not reference the work package that had them.

Operating Experience Analysis and Feedback (OEAF) engineers reviewed the Occurrence Reporting and Processing System (ORPS) database for reports involving procedure violations or inadequate procedures and found 630 occurrences. Figure 1-1 shows the distribution of root causes reported by facility managers for these events. Personnel error represented 50 percent of the root causes and management problems, 35 percent. Procedure not used or used incorrectly accounted for 45 percent of the personnel errors and inadequate administrative control and policy not adequately defined or enforced each accounted for 34 percent of the management problems.



Personnel Error	Percent
Procedure not used or used incorrectly	45
Inattention to detail	41
Communication problem	7
Other human error	7

Management Problem	Percent
Policy not adequately defined or enforced	34
Inadequate administrative control	34
Work organization/planning deficiency	17
Other management problem	9
Inadequate supervision	4
Improper resource allocation	2

Figure 1-1. Distribution of Root Causes for Violation/Inadequate Procedures[1]

This event is significant because procedures used to control an evolution between two facilities were not consistent. Using different limits that require conversion for transfers between facilities provides the opportunity for error. Also, naming conventions used for equipment identifiers and tags on interfacing systems, should be consistent to eliminate confusion. There should also be a mechanism that provides for cross reviews of procedures when facilities interface with each other. These reviews would eliminate confusion and provide consistency. DOE 5480.19, *Conduct Of Operations Requirements for DOE Facilities*, chapter XVI, "Operations Procedures," states that consistency in procedure format, content, and wording is essential to achieve a uniformly high standard of operator performance.

DOE-STD 1029-92, *Writers Guide For Technical Procedures*, provides guidance to assist procedure writers in producing accurate, complete, and usable procedures that promote safe and efficient operations. Section 2.3, "Facility Configuration," requires desk-top reviews to ensure technical accuracy and adequacy of procedures. Section 4.10, "Action Steps with Warnings, Cautions, and Notes," states that notes call attention to important supplemental information. Notes should be used to present information to assist the user in making decisions or improving task performance. Action steps should not be included in notes. Embedded actions should be removed from the note. Both new and revised procedures should be reviewed before issuance to ensure that the information, instructions, and cautions are technically accurate and that human-factor considerations have been included.

KEYWORDS: procedure, radiation, dose, waste, transfer

FUNCTIONAL AREAS: Procedures, Operations, Radiation Protection

2. FAILURE TO REACTIVATE ALARMS RESULTS IN VIOLATION

On June 16, 1997, at Rocky Flats Environmental Technology Site, stationary operating engineers failed to reactivate data-logger alarm points after a monthly emergency generator load test, resulting in an operational safety requirement violation. Investigators determined there were no logs, policies, or procedures for deactivating the alarms. Facility managers failed to recognize that the alarm points were deactivated, even though alarm status is printed and available for review three times a day. Failure to reactivate alarm systems or data-loggers can result in operational safety requirement violations, affect facility operations, and delay operator response and reporting of abnormal or emergency situations. (RFO--KHLL-SOLIDWST-1997-0027)

Investigators determined that a stationary operating engineer reprogrammed a data-logger to deactivate nuisance alarms during a monthly emergency generator load test. On June 25, 1997, an operator reviewing the alarm status printout, noticed that the data-logger alarm points were deactivated. The facility manager terminated nuclear operations in the affected areas. A stationary operating engineer reprogrammed the data-logger to return the alarms to service. Operators performed an in-depth review of all other data-logger printouts to ensure no other alarm points were deactivated or in an out-of-tolerance condition.

Facility managers continue to investigate. However, as an immediate corrective action, they established a log for recording the deactivation and reactivation of alarms. Although alarm status

[1] OEAF engineers searched the ORPS database for reports during the period 01/01/96 through 07/02/97 with nature of occurrence code 01F, "violation/inadequate procedures," and found 630 occurrence reports.

was available and operations personnel were required to review it three times a day, the error was not identified for 9 days.

NFS reported similar events involving deactivation of alarms in Weekly Summaries 93-07, 92-25, and 92-16.

- On July 29, 1992, at the Idaho Chemical Processing Plant, operators disabled low-flow alarms without authorization. Disabling the alarms had no adverse consequences because the alarms had no required protective functions. Managers determined the root cause was management failure to provide policy and guidance on methods for disabling alarms. (ORPS Report ID--WINC-ICPP-1992-0052)

- On August 18, 1992, at Savannah River, personnel disabled fire alarms during welding operations. They entered the appropriate limiting condition for operation and documented the bypassed alarm in a log book. Several days after the work was completed, a shift supervisor discovered that the limiting condition for operation had been exited and the ionization heads for the fire detectors were still disabled. (ORPS Report SR--WSRC-HBLINE-1992-0015)

- On August 5, 1992, at Savannah River, personnel discovered that a low lubrication level alarm for a pump was inoperable because someone had removed the alarm circuit card from the alarm panel. Facility personnel suspected the card was removed during undocumented troubleshooting activities sometime after July 1991. (ORPS Report SR--WSRC-ETF-1992-0010)

Operating Experience Analysis and Feedback (OEAF) engineers reviewed the Occurrence Reporting and Processing System (ORPS) database for reports involving deactivated or disabled alarms that were not caused by an equipment or material problem and found 300 occurrences. Figure 2-1 shows the distribution of direct causes reported by facility managers DOE-wide for these events. Personnel error represented 51 percent of the direct causes. Inattention to detail accounted for 44 percent of the personnel errors, and procedure not used or used incorrectly accounted for an additional 29 percent of the personnel errors.

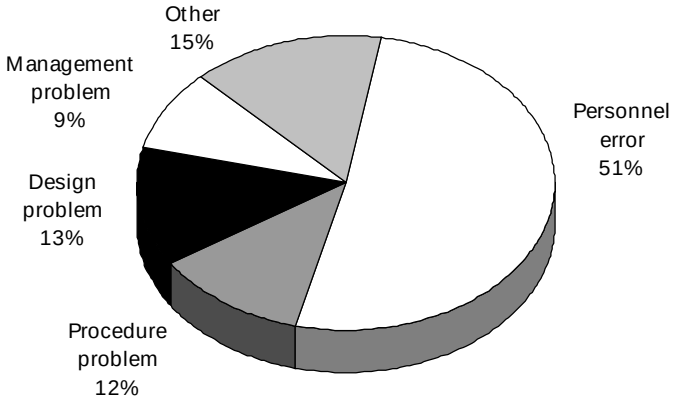


Figure 2-1. Distribution of Direct Causes for Disabled Alarms[1]

[1] OEAF engineers searched the complete ORPS database using narrative “alarm AND disabl@ OR deactiv@” AND NOT direct cause code “1” (equipment/material problem) and found 300 occurrences in 298 reports.

These events illustrate why facility managers must administratively control disabling of alarms with written policy or procedures to ensure that all disabling of alarms is authorized and that alarms are reactivated when work is completed. Defeating nuisance alarms without authorization can lead to a variety of problems, including reduced operator response time and delayed notification of site personnel in emergency situations. Appropriate authority, responsibility, documentation, and tagging should be included in operational procedures. Training of facility personnel must emphasize the importance of properly documenting disabled alarms.

Additional administrative controls, such as log books, may not be sufficient to prevent recurrence. Incorporating alarm deactivation and activation directly into procedure steps and requiring signatures upon completion will provide a high degree of reliability and reduce the risk of human error.

DOE-STD-1039-93, *Guide to Good Practices for Control of Equipment and System Status*, criteria 7, states that for equipment important to safety, all activities that affect operations or change control indications or alarms should be properly analyzed, documented, and authorized. DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities,* chapter VIII, "Control of Equipment and System Status," states that DOE facilities are required to establish administrative control programs to handle configuration changes resulting from maintenance, modifications, and testing such that the physical configuration can be restored to its proper state upon return to service. DOE-STD-1073-93, *Guide for Operational Configuration Management Program*, provides guidance to ensure overall program effectiveness by improving compliance and safety, reducing errors, and increasing efficiency. Effective implementation of this standard provides information and tools to ensure that work is done correctly and safely the first time.

The *Hazard and Barrier Analysis Guide*, developed by OEAF, discusses barriers that provide controls over hazards associated with a job. Barriers may be physical barriers, procedural or administrative barriers, or human action. The reliability of barriers is important in preventing undesirable events such as failing to reactivate alarms or equipment. The reliability of a barrier is determined by its ability to resist failure. Barriers can be imposed in parallel to provide defense-in-depth and to increase the margin of safety. The *Hazard and Barrier Analysis Guide* provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the *Hazard and Barrier Analysis Guide* is available from Jim Snell, (301) 903-4094, or by contacting the Info Center, (301) 903-0449, ESHIC, U.S. Department of Energy, EH-72/Suite 100, CXXI/3, Germantown, MD 20874. Managers and supervisors should review the guide and incorporate hazard and barrier analyses to work and operation processes.

KEYWORDS: alarm, operational safety requirement, work planning

FUNCTIONAL AREAS: Licensing/Compliance, Operations, Management

3. INADVERTENT RELEASE OF RADON GAS

On June 16, 1997, at the Hanford Shielded Materials Facility, personnel reported that an inadvertent release of radon gas from the facility main stack occurred on June 13. The release occurred when facility personnel repackaged a canister containing an actinium source. A radiological control technician discovered the release during a routine surveillance of the stack monitor chart. Calculations performed by facility engineers indicate that a relatively small amount of radon was released. They conservatively estimate the potential effective dose equivalent to be 0.013 mrem at 680 meters from the stack. Investigators believe that inadequate design of the canister contributed to the release. (ORPS Report RL--PHMC-324FDP-1997-0007)

Investigators determined that facility personnel considered the actinium to be a sealed source because it was sealed in the canister, vented, and filtered. The canister had been transferred to the Shielded Materials Facility from another building for repackaging into a large cask. Engineers did not develop effluent monitoring plans for the work because the actinium was considered a sealed source. On June 13, approximately 5 hours after personnel repackaged the source, a continuous air monitor alarmed. A radiological control technician counted the filter for the air monitor. The results indicated the presence of radon of a magnitude that indicated that it was not naturally occurring. This led the radiological control technician to believe the source seal broke during handling. The technician notified a supervisor, who directed removing the source from the cask for inspection. The supervisor discovered the canister lid was loose and tightened it.

On June 16, 1997, a radiological control technician conducted a routine review of strip charts for the ventilation stack and discovered two small increases in the readings. The discovery of the two increases caused personnel to initiate an investigation. Investigators believe the lid was inadvertently loosened during handling. The canister is designed with an eye-bolt attached to the lid for lifting and handling. Investigators stated that a better design would have incorporated lifting fixtures on a non-removable part. The source contained actinium, thorium, radon, and associated daughter radionuclides. Radon-226 was the only gaseous daughter present. Because radon is a gas, it passed through the high efficiency particulate air filters and out the main ventilation stack.

NFS reported events involving releases in Weekly Summaries 94-28, 94-19, 93-19, and 93-06.

- Weekly Summary 94-28 reported that in August 1993, at the Pantex site, workers identified deficiencies in a shipment from Savannah River. During an investigation, Pantex personnel found that 12 of 52 bolts securing the shipping containers were stripped or galled. (ORPS Reports ALO-LA-LANL-MATWAREHS-1993-0023 AND ALO--TSD-TSS-1993-0004)

- Weekly Summary 94-19 reported that on May 5, 1994, at Savannah River, facility managers notified DOE of an Unreviewed Safety Question regarding the analysis of airborne releases of radioactive material to the environment from cooling towers. The Savannah River F-Canyon and H-Canyon safety analysis reports addressed a liquid radioactive release for the circulated water cooling towers but did not address an airborne radioactive release. (ORPS Report SR--WSRC-SEPGEN-1994-0007)

- Weekly Summary 93-19 reported that on April 20, 1993, at Pinellas, approximately 10 curies of radioactive krypton-85 gas were released through the main exhaust stack while facility personnel attempted to transfer the gas to a storage chamber after a tracer flow system failed to operate correctly. (ORPS Report ALO-PI-MMSC-PINELLAS-1993-0007)

- Weekly Summary 93-06 reported that on April 2, 1992, at the Idaho Chemical Processing Plant, a operational health physics supervisor reported a radioactive release from the main stack. Facility personnel determined the root cause of the event was deficiencies in risk assessment policies. Specific deficiencies identified included inadequate evaluation of stack surface changes, failure to integrate operating experience from other DOE facilities, and insufficient evaluation of the impact of individual processes on stack operation. (ORPS Report ID--WINC-ICPP-1992-0035)

Operating Experience Analysis and Feedback (OEAF) engineers reviewed the Occurrence Reporting and Processing System (ORPS) database and found 432 occurrences involving radionuclide releases. Further review identified 260 occurrences that involved radionuclide releases during handling of containers, casks, boxes or drums. Of those, 141 involved gaseous

releases and 81 involved gaseous and airborne releases. A search for radionuclide releases through a cooling tower or a ventilation stack resulted in 54 occurrences. Figure 3-1 shows the distribution of root causes reported by facility managers DOE-wide for these events. Design problems accounted for 17 percent of the root causes.

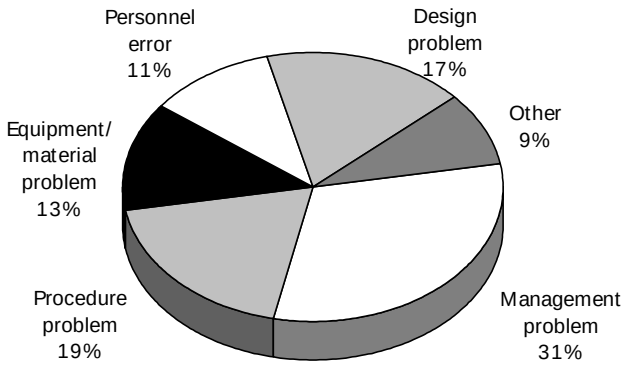


Figure 3-1. Root Causes for Radionuclide Releases DOE-Wide[1]

This event underscores the importance of establishing detailed administrative controls to ensure sealed source integrity remains intact. For the June 13 event, facility personnel considered the source sealed because of the configuration of the canister. However, inadequate design led to an inadvertent release. By performing a thorough review of established administrative controls before unique evolutions, personnel can identify potential weaknesses and evaluate the hazards. Also, identifying and analyzing all potential release points for the possibility of an uncontrolled or unmonitored release is essential. Personnel at DOE facilities using cooling towers should review their safety analysis reports to determine if the potential for an airborne release is addressed. Facility management should review policies, procedures, and work packages for inclusion of information before unique or infrequent evolutions are performed.

DOE O 5480.21, *Unreviewed Safety Questions*, paragraph 6a, states: “For the purposes of properly implementing the USQ [Unreviewed Safety Question] Order, the term accident analyses refers to those bounding analyses selected for inclusion in the SAR [Safety Analysis Report]. These analyses refer to design basis accidents only.” DOE O 5480.19, *Conduct of Operations Requirements for DOE Facilities*, states: “Procedures should be developed for all anticipated operations, tests, and abnormal or emergency situations.” Chapter 13, of the Order contains guidance for unique processes.

KEYWORDS: airborne radioactivity, safety analysis, radon

FUNCTIONAL AREAS: Materials Handling/Storage, Licensing/Compliance, Hazards Analysis

[1] OEAF engineers searched the ORPS database for the period 1990 to June 30, 1997, and found 432 occurrences. Further review of these reports yielded 54 events. The search criteria was for nature of occurrence code “2A” (radionuclide release) AND narratives containing tower OR stack.

4. INADEQUATE WORK CONTROL RESULTS IN UPTAKE OF TRANSURANIC RADIOACTIVE MATERIALS

On June 20, 1997, the Nuclear Regulatory Commission (NRC) issued Information Notice 97-36, "Unplanned Intakes by Worker[s] of Transuranic Airborne Radioactive Materials and External Exposure due to Inadequate Control of Work." The NRC issued the notice to alert licensees to inadequate radiological work controls in highly contaminated areas with the potential for personnel radiation exposures in excess of NRC limits. On November 2, 1996, two workers performing a cleanliness inspection of a fuel transfer canal at a commercial nuclear facility, scraped up debris and placed it in a plastic bag. Health physics technicians surveyed the bag of debris, and recorded 60 rem/hr on contact and 4 rem/hr at 30 centimeters. Nasal smears of the workers indicated 200,000 dpm beta/gamma. Health physicists determined that none of the workers' doses exceeded limits; maximum assigned doses are 473 mrem deep dose and shallow dose equivalent, 1,164 mrem extremity, and 397 mrem eye lens dose equivalent. Air samples indicated airborne radioactivity concentrations of 3.5 DAC beta and 108 DAC alpha. Based on analysis of fecal samples, the maximum committed effective dose equivalent was 913 mrem, with a total organ dose equivalent to the bone surface of 5,873 mrem. Poor radiological work controls contributed to these unplanned exposures. (NRC Information Notice 97-36)

NRC inspectors determined that the pre-work briefing was inadequate because there was no common understanding between the workers and the health physics technicians as to what work was to be done. They also identified the following deficiencies.

- The work procedure provided no work scope detail.
- The technicians did not know that the workers would hand-collect paint chips; metal rust; and dried, dirt-like materials from the floors and walls.
- The workers did not know the actual radiological conditions in the canal.
- Health physics technicians led the workers to believe the canal was generally clean following decontamination in August 1996.

The NRC inspectors also determined the technicians did not perform pre-work contamination or radiation surveys to support the job. Surveys performed by technicians after the work was completed indicated up to 80 millirad/hr beta/gamma and 30,000 dpm/100 cm^2 alpha removable contamination in the canal. A local hot spot on the canal floor indicated 25 rem/hr on contact and 8 rem/hr at waist level. NRC inspectors also determined the workers were allowed to begin work with an invalid radiation work permit instead of one specifically written for the fuel transfer canal work. The technicians decided not to require the use of respiratory protection based on air sample results from the August 1996 decontamination. These results were not representative of the extensive debris cleanup.

A backup air sample of the reactor cavity was started well away (not representative) from the fuel transfer canal. A health physics technician checked the air sample filters with a hand-held survey instrument. However, because the instrument was inoperable, it erroneously indicated no airborne radioactivity. Because the technicians incorrectly believed there was no airborne radioactivity, they authorized two other workers to enter the reactor cavity. The workers unknowingly spent 15 minutes in an area with elevated airborne levels. An NRC inspector later

determined that the licensee failed to implement an effective program to adequately check the operability of the survey instrument.

The licensee initiated the following corrective actions based on a root cause analysis and the findings of an independent review team.

- The licensee suspended all work in radiological areas of high risk until they instituted a work-approval program that required the plant radiation manager and work services director to review and approve all radiation work permits.

- The licensee implemented a radiation work permit procedure that required clear descriptions of authorized work controls, improved procedures for high-risk evolutions, and representative pre-work surveys.

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

- The licensee required workers to use respirators for work in high-alpha-intake risk areas until air sampling justified working without them.

NFS reported events involving uptakes of radioactive material in Weekly Summaries 97-25, 96-48, 96-40, 96-30, 95-47, and 95-19. The following two events are similar in that workers were not prepared for existing radiological conditions and entry requirements were based on old survey results.

- On January 29, 1997, at Hanford, a decontamination and decommissioning worker received an uptake of plutonium while characterizing sediment in a fuel basin storage pit. The worker was exposed to dust containing radioactive material while removing plywood that covered the pit. Investigators determined the cause of the event was a lack of engineered radiological controls (ventilation, water spray, and respiratory protection) for removing the plywood pit cover. A corrective action required taking air samples to quantify the airborne hazard during various aspects of the performance of the work. The worker's committed effective dose equivalent was 120 mrem. (ORPS Report RL--BHI-DND-1997-0009)

- On September 4, 1996, at Hanford, four workers received uptakes while performing periodic inspection and surveillance in canyon cells. Two workers received an internal exposure of 16.75 mrem; the other two received 22 mrem. The radiation work permit used for entry was based on a 6-month-old survey that required no respiratory protection. (Weekly Summary 96-40 and ORPS Report RL--BHI-DND-1996-0021)

These events illustrate the importance of radiological controls personnel performing adequate and up-to-date pre-work contamination and radiation surveys. They should also anticipate changing radiological conditions that can occur as a result of the work activity. Events involving uptakes at nuclear power plants are infrequent and generally occur during maintenance and refueling outages at reactors that have experienced fuel defects. However, protection from internal exposure to transuranic materials is particularly important for personnel at DOE facilities. Some facilities still work with, process, or store transuranic materials and wastes. Decontamination and decommissioning of the facilities can result in the release of alpha-emitting airborne radioactive material.

DOE/EH-0256T, *U.S. Department of Energy Radiological Control Manual*, article 322, "Use of Radiological Work Permits," states that job-specific radiological work permits shall be used to control non-routine operations or work in areas with changing radiological conditions. Radiological

surveys shall be routinely reviewed to evaluate adequacy of the permit requirements and shall be updated if radiological conditions change to the extent that protective requirements need modification. Article 323, “Radiological Work Permit Preparation,” states that the permit should be based on current radiological surveys and anticipated radiological conditions. Article 324, “Pre-Job Briefing,” states that pre-job briefings should include radiological conditions of the work place, special radiological control requirements, and radiological limiting conditions.

Copies of NRC information notices may be obtained from the NRC Public Document Room, 2120 L Street, NW, Washington, DC 20555, (202) 634-3273. NRC information notices, bulletins, and generic letters are also available on the NTIS FedWorld Bulletin Board System, which can be accessed with a modem by dialing 1-800-303-9672.

KEYWORDS: radiation protection, contamination, internal exposure, work control

FUNCTIONAL AREAS: Radiation Protection, Work Planning