NIST 30-Day Report on Radiation Incident at NIST Boulder

Report Pursuant To 10 C.F.R. 50.30(c)(2) And Paragraph 4 of the July 2, 2008 Confirmatory Action Letter

This report describes an incident in which a vial containing approximately 0.25 grams of plutonium was broken at a NIST facility in Boulder, Colorado. The description below represents NIST's best preliminary understanding of the facts at this time, based on the testimony of those with first hand knowledge, a review of security camera recordings, a review of detector data collection files, and direct measurements of contamination patterns in the laboratories and in the corridors and offices outside the spill area. NIST continues to investigate the incident.

Reporting Requirements

This report is submitted pursuant to 10 CFR 30.50(c)(2), as specified in paragraph 4 of NRC's Confirmatory Action Letter of July 2, 2008.

Source Material Involved

A glass vial of Certified Reference Material (CRM) 138 (approximately 0.25 grams of Pu in the form of $Pu(SO_4)\cdot 4H_20$; isotopic distribution certified at Pu-238 Atom Percent 0.010, Pu-239 Atom Percent 91.805, Pu-240 Atom Percent 7.925, Pu-241 Atom Percent 0.227, Pu-242 Atom Percent 0.033).

Exact Location

NIST Boulder Laboratories, 325 Broadway, Boulder, Colorado, 80305, Building 1, Room 2124.

Date and Time

June 9, 2008, at an indeterminate time, likely in the afternoon.

Description of Event

On the afternoon of June 9, 2008, two researchers (Individual #1 and Individual #3)[1] using the glass vial of CRM 138 began setting up an experiment on a micro-calorimetry spectroscopy system ("detector") in Building 1, Room 2124 of the NIST Boulder facility. Individual #3, a post-doctoral associate from the University of Colorado, was primarily responsible for computer set-up; Individual #1, a foreign NIST guest researcher, handled the vial. Our best evidence suggests that, at some time during the experiment, the bottom

[1] To protect the identities of individuals involved, this report designates them using the numeric designations already assigned to the same individuals for the purpose of bioassay testing.

of the vial was broken as a result of contact with either the detector or nearby lead shielding while the source was being manipulated to optimize detector response.

Although the evidence regarding the timing of events is inconclusive and may contain inconsistencies at this time, we have been able to assemble the following information, which we continue to investigate and seek to clarify.

> A review of detector data collection records indicates that data acquisition started at 3:02 p.m. Between 3:43 and 3:52 p.m., there was a drop in count rate on the detector. At 3:52 p.m., the count rate resumed at a rate slightly diminished from the earlier reading, and continued until 4:24 p.m.
>
> Individual #1 testified that, following his suspicion that the vial had cracked, he placed tape over the can that contained the vial and placed it in the source locking file cabinet. Surveys performed by investigators on Saturday, June 14, 2008, however, showed no indication of significant contamination in the locking file cabinet.
>
> Through testimony, it is believed that sometime after 3:43 p.m., Individual #1 took a notebook, later confirmed to be contaminated, and began to exit the laboratory. Again through testimony, Individual #1 is believed to have, prior to exiting the laboratory, placed the contaminated notebook on the edge of the bonder table and washed his hands in the sink at the front of the laboratory. Contamination likely amounting to an unmonitored and unauthorized release of radioactive material into the sanitary sewer system was later detected in this sink. Likewise, contamination was later confirmed on the bonder table.
>
> Through testimony, it is believed that after leaving the laboratory with the notebook, Individual #1 reported a potentially cracked vial to the Principal Investigator (Individual #2) who was at that time in laboratory #3 (Room 2118). Testimony further indicates that, following this report, Individual #2 proceeded to Room 2124 to investigate the crack in the vial, entering the room between 4:00 and 4:13 p.m. Individual #2 reportedly was initially unable to observe a problem with the vial, which he removed from the locking file cabinet.[2]
>
> According to testimony, upon being unable to confirm damage to the vial, Individual #2 telephoned Individual #1 to return to the laboratory to discuss his observations. Surveillance tapes showed Individuals #1 and #3 returning to Wing 1 (where Room 2124 is located) at 4:13 p.m.

Based on testimony, between two and five additional researchers were in Room 2124 when Individual #2 removed the tape from the top of the can holding the broken vial,

[2] Individual #2's difficulty in locating the damage to the vial may have been due to looking at the wrong vial. Reportedly, at some earlier time, an identical, undamaged source vial had been placed in the container labeled for the damaged vial.

which he had by that time located.[3] Reportedly, Individual #2, observing the vial was broken, ordered everyone but himself and Individual #1 to leave the room. One of the observing researchers indicated that Individual #2 was wearing gloves, but Individual #2 testified that he put on gloves only after initially handling the source vial. Based on the contamination later found on the hands of Individuals #1 and #2, it appears that some unprotected handling of the source likely occurred. Individuals #1 and #2 testified that, after the others had left the room, they inspected the detector table area and found a significantly elevated response using a radiation survey instrument.

According to testimony, at approximately 4:40 p.m., Individual #2 began to notify his supervisors, the Boulder Radiation Safety Officer (RSO), the Office of Safety Health and the Environment (OSHE) and others, using the telephone in Room 2124. Initially, a message was left on the Boulder RSO's cell phone. OSHE received notification at 4:43 p.m. At the recommendation of OSHE staff, in consultation with Engineering, Maintenance, and Support Services staff, Individual #2 shut off the power to the room's Fan Coil Units.

Room 2124 is a multi-use laboratory. Based on testimony, thirteen individuals had at various times throughout the afternoon entered the laboratory, either to acquire tools, use the wire bonder station, or work with the spectroscopy systems. In addition, several individuals, including some who had been in Room 2124, were observed on surveillance cameras at the intersection of Wing 1 and the adjoining central hallway known as the "Spine" between 4:35 p.m. and 6 p.m. Based on a review of video evidence and interviews, these individuals likely walked around Wing 1 to various laboratories, offices, restrooms, and into Annex C.

At the recommendation of the Boulder RSO (via cell phone while en route) and OSHE staff, all individuals who had been in Room 2124 during the day were requested to stay in the corridor outside of Room 2124, and await for the RSO to arrive with contamination survey and decontamination equipment. During this interval, an unidentified person suggested that the waiting individuals' shoes may have been contaminated. Those persons removed their shoes and remained in the corridor in socks or bare feet. Because several individuals had already contaminated the floor in the corridor by walking through this area with contaminated shoes, this removal of shoes by the waiting individuals resulted in contamination on socks and/or feet.

The RSO arrived at 6 p.m. and personnel contamination surveys, decontamination, and clearance operations were initiated. Subsequent to the RSO's arrival, a student volunteered to help and was tasked by an as yet unidentified individual to operate survey instrumentation and decontamination equipment.[*] This volunteer had no prior training in survey procedures.

Personnel decontamination and clearance procedures were completed for all individuals except Individuals #1 and #2 by 7:30 p.m. With the exception of Individuals #1 and #2,

[3] Testimony is conflicting as to the exact number of individuals in the laboratory at the time. We continue to attempt to clarify that information.

* This sentence corrected, July 11

measured contamination was identified only on shoes, socks or bare feet. Individuals #1 and #2 had residual contamination on their hands. This contamination was removed slowly by multiple, frequent and gentle washings throughout the night of June 9-10, 2008. Individual #1 continued to wash his hands in this manner until Thursday, June 12, 2008. Both Individuals #1 and #2 wore gloves between washings to prevent the spread of contamination. Some contamination was found on the pants of Individuals #1 and #2, near their pockets. No contamination was found on their faces.

Probable Cause

Investigations conducted to date suggest that the probable cause of the incident was the breakage of the vial against a solid object during set-up or operation of the experiment. The primary probable cause of the spread of contamination inside and outside the laboratory was the failure of Individual #1 to recognize and report the event in a timely, appropriate, and accurate manner to his supervisor and safety professionals, and to limit his movements accordingly. An additional probable cause of the spread of contamination was the lack of an emergency response plan, which left safety personnel unprepared and unequipped to respond to the incident. Multiple organizational failures contributed to Individual #1's lack of preparedness to handle the source material and to respond to its spilling, including failure to follow procedures for acquiring source material and failure to provide individuals handling source material with the proper training or the necessary information to evaluate and understand the risks involved.

Preliminary Root Cause Analysis

Preliminary root cause analysis indicates that multiple organizational failures contributed to the incident. Specifically, proper procedures were not followed for acquiring a radiation source and line management was not aware of the inappropriate handling of the source material. As a result, a proper risk assessment was not conducted.

There were no procedures in place for source handling and utilization nor was there an incident response plan or an audit program for radiation safety at NIST Boulder. Our investigation has revealed at this point that the scope of the hazardous materials programs expanded without reevaluation of the risks involved and without a commensurate strengthening of the radiation safety program. As a result, there was inadequate infrastructure to support the use of encapsulated sources.

Available training was inadequate and insufficient with respect to the number of individuals trained. Existing training requirements were ignored by researchers and not enforced by safety personnel. Specifically, Individuals #1, #2 and #3 all received inadequate or no training.

Use of the posted radiation laboratory as a multi-use laboratory accessed by untrained and uninformed individuals contributed to risk, which was exacerbated by the lack of an accurate hazard posting on laboratory door.

In general, there was weak engagement by line management in overseeing personnel, programs, and safety-related activities. Similarly, safety personnel failed to identify and/or address obvious safety issues.

Results of Internal Investigation

While NIST's multiple internal investigations are still ongoing,[4] they have at this point revealed that the probable cause of the incident was handler error. Source material was removed from its secondary containment, and its vial broke after contact with a hard surface. Overall organizational failures contributed to this handler error. Specifically, procedures for acquiring source material were not followed as line management was not always aware of source material acquisition. Individuals (both those handling source material and those working in the vicinity) were not provided proper training or the necessary information to allow them to evaluate and understand the risks involved. Moreover, available training was inadequate for the circumstances. Lack of an emergency response plan contributed to the potential spread of contamination beyond the spill zone, as employees were neither prepared nor equipped to respond to the situation, and safety personnel were forced to respond as events unfolded, rather than from established protocols.

NIST's organizational structure contributed to an environment in which line supervisors failed to take adequate responsibility for safety issues, and safety personnel failed to assert a sufficient level of authority to ensure compliance with existing procedures and policies. In sum, a culture has developed with respect to safety issues that NIST understands must be addressed broadly, beyond this specific event.

Preliminary Corrective Actions Taken

NIST Boulder has issued a stop work order for all radioactive materials in use, and NIST management has made a preliminary decision to limit the use of radioactive materials in Boulder in the future to sealed sources.

Individuals possibly exposed have been identified, interviewed, and where appropriate referred for bioassays. In addition, the NIST Safety, Health, and Environment Division ("SHED") requested assistance in the form of personnel, equipment, and medical advice and test-result interpretation from the Department of Energy Radiological Assistance Program ("DOE RAP") and Radiological Emergency Assistance Center and Training Site ("REAC/TS") teams. NIST SHED coordinated lung, bone, and liver scans with the Colorado Department of Public Health and Environment for affected individuals as advised by physicians and radiation safety experts. The DOE RAP team is helping NIST SHED assess the extent of the laboratory contamination.

NIST took actions to stabilize the contaminated lab from the outside, which included ensuring that the roof was in good repair, bolting plywood over all of the windows, and

[4] As noted elsewhere in this report, multiple investigations have been conducted, are underway, or are to be conducted at NIST.

implementing measures to maintain negative pressure by connecting the laboratory fan to backup power. In addition, one door to the laboratory was bolted shut and the other door's locks were re-keyed, air handling units were secured, and filtration and monitoring was provided for the chemical fume hood emissions. Areas outside of the spill zone have been or are being surveyed and contaminated areas have been cleaned. Also, NIST is coordinating with the City of Boulder Water Quality and Environmental Services to estimate the amount of plutonium potentially discharged into the sanitary sewer from the washing of hands in the laboratory sink.

An Incident Response Plan has been developed and is being implemented. At the same time, multiple investigations of the incident have been completed, are underway, or are to be conducted at NIST. These investigations include, but are not limited to: (1) the NIST SHED investigation; (2) the NIST Ionizing Radiation Safety Committee ("IRSC") investigation; (3) the five preliminary individual experts' investigations ordered by the NIST Deputy Director; (4) the Department of Commerce Inspector General investigation; (5) the Nuclear Regulatory Commission ("NRC") inspection; and (6) the Blue Ribbon Panel investigation currently being convened by the Commerce Deputy Secretary.

Organizationally, the individual who is presently carrying out the duties and responsibilities of the Deputy Director was appointed as the Incident Response Director, and NIST SHED now reports directly to him.

Corrective Actions Planned

NIST intends to further stabilize the contaminated lab by securing the powered equipment and developing a decontamination plan based on the use of an NRC-licensed contractor. These plans will be submitted to NRC for approval prior to action being taken.

As part of its internal assessment of this event, NIST plans to consider recommendations and findings produced by each of the investigations conducted at NIST; assess the management response to the incident to identify lessons learned; contract for a formal root cause analysis; audit and improve safety, security, and training at NIST; evaluate and improve NIST's approach to risk management and emergency response; and re-evaluate NIST's organizational structure and culture from a safety perspective.

Review of Adequacy of Training

Although radiation safety training was offered, there was no mechanism in place to ensure that individuals in fact received required training. For instance, Individual #1 did not register or attend the radiation safety training nor did he attend the scheduled New Employees Orientation training. Similarly, Individual #3 was registered for radiation safety training but did not attend. As a result of these systemic failures, Individual #2 allowed untrained and unsupervised personnel, including Individuals #1 and #3, to handle the material.

NIST Form 1197 for Individuals #1, #2, and #3 had not been received by the Office of Safety Health and the Environment at the time of the incident. This indicates that hazards, including radiation hazards and the accompanying need for radiation safety training, were not communicated to the individuals so that their training needs could be addressed.

Reviews of Adequacy of Procedures that May Have Contributed to the Event

Our internal investigation at this point has revealed that there were no written procedures for the handling of the CRM 138,* and there had been no hazard review and therefore no emergency response procedures developed. Moreover, basic procedures, such as those for the acquisition of source material, and the provision of training were not consistently followed or observed.

Assessment of the Release of Plutonium into the Sanitary Sewage

Per agreement with the NRC, NIST will provide its assessment of any release of plutonium into the sanitary sewage by July 11, 2008.

* CRM number corrected July 11