EEEL-Boulder Internal Investigative Report on the 6/9/08 Plutonium Incident in Laboratory 1-2124 at the NIST-Boulder Site

[redacted]
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This investigative team was selected by 817 Division Chief [redacted]. 817.03 Project Leader [redacted] was also an early member of the EEEL-Boulder investigative team and contributed to this report.

This report is based on written statements, in most cases given in the first day or two after the incident, from personnel involved in or affected by the incident, discussions with Group, Division, and EEEL management, informal discussions with NIST Safety Health and Environment Division (SHED) staff, informal discussions with the first NRC personnel on site after the incident, follow-up interviews with involved/affected personnel, discussions with other Division Safety Representatives (DSRs), and informal discussions with, or anecdotal information from, other site staff.

EEEL management, since the earliest hours after the incident, has stressed complete transparency and openness in dealing with this incident. This report has been written in that spirit.

Summary of Incident:

This summary is not intended to be comprehensive. There are various other formal investigations of this incident that presumably go into much more detail on the key aspects and timeline of the incident itself; we defer to those other investigations for definitive details of the incident, and we trust that there are no details in the summary below that are not already part of those other investigations.

On Monday, June 9th the plutonium source was removed from the locked cabinet in the lab in room 2124 to be used in an experiment. On a previous occasion three days earlier, the source had been removed from the canister that it was stored in and inspected to determine whether the source was a powder, liquid or other type of source. During subsequent use, to obtain a better count rate, the source was apparently taped close to the cryogenic dewar housing the gamma-ray detector array being tested using the source. Also at some earlier time (it is unknown exactly when) the heat-sealed plastic bag(s) the source was originally sent in had degraded and torn. The staff had decided to remove the source from the original bags and put it into two zip-lock bags for safer storage. On this day, June 9, apparently the source was gently removed from those zip-lock bags and manually held close to the dewar to achieve the correct signal. The source was placed back into the metal canister, apparently on top of the plastic bags,

and the measurements continued. The staff had started to record the pulses and had also moved some lead bricks close to the canister in an attempt to protect the nearby computer from the source. At some time after data collection was begun, the staff report that they noticed what they believed to be a crack in the vial of the source and immediately placed some tape over the top of the canister and reportedly placed it back in the locked cabinet and then went out of the lab to notify the lead researcher for the experiment.

The lead researcher came into the lab after a brief period of time and cut a small window into the tape on the top of the canister to look at the source. It was at this time that there was a small amount of brown powder that was noticed inside of the canister, possibly outside the bag(s). The lead researcher went to where the experiment was being carried out and reported that he saw additional powder on the floor around the granite table. The lab was evacuated, and the NIST Boulder Radiation Safety Officer (RSO) was called, as well as the Project Leader, who subsequently contacted EEEL and site management.

Unfortunately, the RSO was away on vacation, and a message was left for him. The call was returned in approximately 45 minutes, and the staff was told that he was on his way to the NIST site and that the hall should be shut down (the hall may not have actually been closed down until roughly when the RSO arrived). All of the known or suspected exposed personnel were gathered in front of the lab and asked to remove their shoes to avoid any additional spreading of the contamination. Apparently some had already been spread to the hallway and subsequently contaminated socks, bare feet, and secondary shoes. At some point, the lead researcher re-entered the lab, on instructions from NIST-Boulder Safety (SHED) personnel, and shut down air handling in the lab.

When the NIST Boulder RSO (who is also a SHED staff member) came, he and the NIST-Boulder Director located a “clean” spot to be able to scan everyone suspected to have possibly come into contact with the powder. Those people were scanned, as well as their shoes and, if necessary, shoes were cleaned with soap and water and re-scanned. Socks were scanned and, if contaminated, were confiscated and contained in a plastic bag.

Efforts through the night were made to clean and clear the hallway so that work could go on as usual the next day. The lab was sealed off, and the adjacent lab that was connected to it through a rear doorway was also closed and sealed off.

KEY FINDINGS, ISSUES, AND QUESTIONS:

Source Issues

We are somewhat perplexed that such sources ever were packaged, originally by NBS/NIST and apparently still by New Brunswick Lab (NBL), in this seemingly relatively easily compromised configuration of a glass vial with a screw-top lid. We were told that NBL has been notified about this incident, and we sincerely hope that there is contemplation of a safety recall and future packaging modifications of all such sources. We also wonder if the age of the source, roughly 20 years, could have led to degradation of the vial in any way. Several accounts from involved personnel indicate that the plastic containment bags were seriously degraded from 20 years of handling. We have not seen all documentation that accompanied the source; we wonder whether such documentation included procedures, instructions, best practices, etc., and we wonder whether all experimental staff had seen such documentation.

NIST-Boulder Radiation Expertise and Infrastructure

We wonder what considerations were made before Division 817 and NIST-Boulder as a whole undertook a project involving more significant radiological danger than dealt with in the past and for which there was little pre-existing safety infrastructure in place. This project was initially funded through the EEEL Director's Reserve, with clear knowledge that significant extramural funding potential existed. There was a fairly rapid ramp-up of the types and hazard levels of sources used. The extension to sources such as the Plutonium ones led to the need for an amended NRC license for the NIST-Boulder site and apparently was a significant factor in the SHED hiring of a dedicated RSO for the Boulder site. These were proper responses, but it seems like the expansion of radiological infrastructure was occurring nearly concurrently with the arrival of more substantial sources, rather than well in advance. We speculate whether the lure of extramural funding can lead NIST to take on work for which we are not properly "equipped" and whether collateral considerations such as safety are adequately considered in such cases. We believe that NIST management at all levels must reaffirm that safety and training must come first in such cases, regardless of the profile/funding-potential of the experiment.

NIST Hazard-Review Policies and Procedures

NIST policy and procedures for hazard review of experiments are spelled out in detail in the NIST Administrative Manual and the NIST Laboratory Safety Manual (NIST ionizing-radiation rules add extra requirements for radiological work). The NIST policies and procedures can be summarized as follows:

- Line management must be aware, as early in the process as possible (preferably before procurements, construction, etc.), of ALL new experiments and major modifications to existing experiments.
- The Division Chief, consulting as appropriate with the DSR, SHED personnel, and/or higher level management, determines the level and formality of the review.
- Many reviews can be done informally at the Division level. The DSR, experimental personnel, SHED staff, and possibly others take part in a review of all safety aspects relating to the experiment and determine need for policies, procedures, and documentation.
- Experiments with significant hazards (radiation-related experiments would typically qualify) may require a more formal review at the Operating Unit (OU) level, by a Hazard Review Committee (HRC). In this case the review team includes OU-level safety personnel and possibly outside experts, and a formal analysis and report is generated.

Based on the amending of the NRC license, RSO consultation and involvement, and RSO-provided training, it is clear that some aspects of hazard review were performed for this research. However, it is abundantly clear that all NIST hazard-review policies were not followed, as evidenced by the fact that the Plutonium sources arrived on site and were put into use without any formal knowledge of the DSR. Based on the lack of required Division Chief signature on procurement-related paperwork for the sources, it is also unclear whether the Division Chief was fully aware of the new hazards introduced into this research. There are various contributing factors to why hazard-review protocol may not have been followed—research personnel may have been unaware of requirements; intermediate line management may have been unaware of or forgotten requirements; higher level management may not have

adequately communicated requirements down the management chain; the RSO, being relatively new to NIST, may have also been unaware of the requirements.

With a combined 20+ years of DSR experience, including participation in numerous informal and formal hazard reviews in the past, the authors of this report are confident that a hazard review following existing NIST protocol, even if informal, would have identified the following issues with regard to this particular experimental setup:

- The need for written and posted Standard Operating Procedures (SOPs) covering the routine use and handling of the sources and covering what to do if an incident occurred.
- An evaluation of whether real-time sensing as well as alarms/notification-protocol were needed and/or possible.
- An evaluation of whether it was good practice to locate the source safe along a major entry/exit egress route (right next to the room entrance).
- An evaluation of whether this experiment should share laboratory space with other unrelated experiments, with staff from other projects or even other Divisions, etc.
- Consideration of whether all laboratory staff should be notified whenever a source was taken out of the locked cabinet.
- Determination that all laboratory staff should receive radiation training.

It is important to note that we strongly believe that existing hazard-review policies and procedures are adequate and sufficient; problems seem to be in communication, adherence, and enforcement. In our experience, some low- to moderate-hazard experiments may not have as detailed or formal of a review as seemingly intended by NIST policy, but significant hazards are generally reviewed thoroughly. We worry that the aftermath of this incident could lead to draconian reforms of the hazard-review process, when in fact we believe that the needed reforms are strict communication of, adherence to, and enforcement of the existing process.

Training

Training was provided by the NIST-Boulder RSO to those who worked on radiation experiments. This training was also offered optionally to others working in the same Project and apparently to some others from outside projects who worked in this particular laboratory. But, some who worked in the lab (but not on the radiation-related experiment) do not recall ever being offered such training. We did not have a chance to find out exactly how many were trained. In hindsight, we believe that the training should have been required for everyone who worked in the lab, and it should have been offered and recommended for everyone who worked in the general area.

The training apparently covered general radiation safety, handling of sources, and source hazards. Some who took the training remember it also giving some coverage of incident response. One trainee remembers learning to: stop; contain but don't disturb; contact the RSO. Others did not remember incident-response information being covered. It seems to us that incident response should have been a prominent part of the training and that, given the potential for spreading contamination in an incident, that an ongoing training regimen of drills or mock incidents should have also been put in place.

There was also apparently an ongoing evaluation of possible long-term exposure, in which radiation researchers had been asked to wear dosimetry badges and rings whenever working with the sources. It was unclear to what extent this was being practiced.

Evacuation Consideration

We wonder if there was at any time consideration of evacuating surrounding areas (nearby areas of main spine and surrounding wings/annexes? All of Building 1? Entire site?) We understand, from all discussions we've had, that the perceived level of actual potential hazard was (and continues to be) quite low, for all but those directly involved in the incident. But, if the actual hazard level was demonstrably relatively low, this should be an easy point to communicate. And in fact, the high level of hyperbole, media coverage, congressional inquiries, etc. seem to indicate that this point has not been convincingly communicated. This is clearly exacerbated by the reputation and notoriety of radioactivity in general and Plutonium specifically. There are technically knowledgeable people at the Boulder Labs site who expressed real fear and outrage at learning that Plutonium was being used on site without their knowledge.

We trust that if there were any doubts about the safety of site personnel, appropriate evacuation orders would have been given. We also hope that any such decisions would be premeditated based on incident-response and hazard-review procedures rather than being made "on the fly" during the incident.

Closure of Wing 1

Clearly one of the most major oversights in the incident response was the failure to "close" Wing 1 in a more timely fashion. Proper procedure would seem to have been for everyone in the Wing to stay in place until verified contamination-free and for no one else to be allowed into the Wing. This was significantly complicated by the fact that some time passed between the initial discovery of the damaged vial and the verification that there had been a compromise in containment.

Once the spill was verified, those who were known or remembered to have been in the lab were told not to leave the site. However many of them, as well as other staff in the area, continued to use the hallway, including passing through the now-contaminated area outside of the lab entrance. Many went back and forth between offices in Annex C or the cleanroom area and areas including restrooms at the spine-end of the Wing. Some went into the cleanroom or into offices or other areas in the main spine and even on other floors. Additionally, some staff from other parts of the building passed through Wing 1 to exit the building from Annex C. At some point, those who were suspected of having been potentially exposed were instructed to remove their shoes, to prevent further spreading of contamination, but since contamination had already spread to the hallway, this resulted in socks, bare feet, and spare shoes getting contaminated. One person from another Division was in the lab, apparently when the incident happened but left before it had been discovered/reported; he ended up taking slightly contaminated equipment to another building. He was also not identified as having been in the lab nor tested until he came forward after the first site-wide announcement of the incident. The vast majority of the spreading of contamination could have been prevented if the Wing had been promptly and definitively closed.

The RSO states that he advised by phone that the Wing be closed, about 45 minutes before his arrival on site, but accounts seem to indicate that the closure did not actually occur until about the time of his arrival. If these accounts are accurate, then this was crucial lost time.

We have a couple of unanswered questions regarding the Wing closure:

- Why was there, to the best of our knowledge, no SHED-personnel presence, with the possible exception of NIST-Boulder Director [redacted] acting on their behalf, until the arrival of the RSO?

- Why was Boulder-Labs Security (DOC Police) not consulted or coordinated with, to assist in the securing of Wing 1?

Initial Communications

We are concerned about the lack of communication in the immediate aftermath of the incident, when pertinent information needed to flow from those familiar with the details to other affected or potentially affected staff (particularly those who worked in or passed through Wing 1, but also really all staff on site). Such delays can create and help foster mistrust, but more importantly, staff needed to know that something was going on.

We understand that the release of information needs to be careful and guarded (medical privacy issues, concerns to not release inaccurate information, avoiding a panic situation, etc.), but when anecdotal information is freely flowing (around water coolers and break rooms, etc.), the lack of any "official" information can give the perception that the situation is worse than it really is.

It is our understanding that the release of official information was controlled from the beginning by the very top of the NIST chain of command. Again, we understand this, but we believe this caused significant delays. And while this information (a detailed description) does need to be double checked and verified for accuracy before release, this is not even the type of information we are really concerned with. The information that needed to go out immediately is the sort of information that might typically be broadcast over an emergency public-address system—that an incident has occurred, what actions should be taken, whether or not people are in any continuing danger, etc. That all details were not known at the time, should not have prevented an immediate communication of what was known.

It was also very important for a free flow of information between the various groups involved directly in the aftermath (cleanup, assessment, investigation). EEEL sources report that communication between Boulder SHED and relevant EEEL management was either poor or non-existent until well after the incident period. Clearly when various groups are working together to solve a situation, information must be shared among and between them, so that all views are presented and all concerns heard.

Post-Incident Medical Testing

We are aware of several reports of problems with accurate dissemination of proper methods of sample collection to those who were potentially exposed and were part of medical post-incident testing.

Priority of Cleanup

We continue to believe that cleanup of contaminated areas must be done at as soon as realistically possible. The longer areas remain contaminated and closed, the more chance of a perception that things must be worse than reported or that "NIST is hiding something." There is also potential for another incident in the affected area (fire, water leak, etc.) leading to the dispersal of contamination with corresponding property damage and risk to personnel. This potential was highlighted when a fire alarm in a nearby laboratory the week of June 23 resulted in acute concern on the part of first responders, until it was realized that the alarm had not originated in the affected areas.

In the initial days after the incident, when area staff were expected to be at work passing through areas where contaminated carpet, covered by tape and paper, was still present, we made

a plea for quick removal of affected carpet, tile, etc. This was done fairly quickly and helped foster a perception of things getting somewhat back to normal. We believe that there is also a sense of urgency for the "major" cleanup of the contaminated rooms. Of course we understand that such a cleanup cannot take place until all "forensic" evidence has been gathered (we believe evidence gathering is now complete) and until a thorough and workable plan for containment during cleanup has been developed and can be implemented; we also believe that the health of those potentially exposed should be the highest priority of all. In our opinions, the sooner the cleanup occurs, the more it looks like NIST is in control and "has a handle" on the situation.

Coordination Issues

There is an existing infrastructure within the radiation-safety community for dealing with, addressing, and resolving incidents like this one. There appears to have been a hesitance, or possibly lack of knowledge, by Boulder SHED and/or NIST management in soliciting outside assistance. The decision to bring in the DOE Radiological Assistance Program (RAP) to help assess and survey the affected area seemed to have been delayed by several days. All along, from the moment of the incident until now, three weeks later, it would seem that the Oak Ridge Radiation Emergency Assistance Center/Training Site (REAC/TS) could have provided substantial benefit, but we are not aware of any utilization of REAC/TS expertise.

It is also our perception that there is a possibly long-standing disconnect or even mistrust between Safety (SHED) and Security (DOC Police) at the NIST-Boulder site. If this perception is correct, then this situation must improve. In a major incident, it is very important for these two entities to provide a coordinated and coherent response.

While this incident was unfolding, apparently Security personnel were not notified. This is unfortunate in our opinion, because they could have provided much needed assistance and expertise in "securing" Wing 1. Furthermore, in the intervening days, Security could have been more effectively engaged, in providing surveillance tapes, pin-out records, etc., to help identify all staff that passed through the area on the day of the incident. This has now apparently occurred, but it could have happened much earlier.

***Broader Topic* – Priority of Safety, NIST Safety Operational System, and the Culture of Safety at NIST**

SHED is primarily funded through "overhead" at NIST, basically a "tax" based on the salaries of NIST laboratory staff, which funds most administrative and support functions across the institute. There has long been a prevalent philosophy of keeping the overhead as low as possible, of streamlining administrative and support services. As a result, it seems that overhead funding is hotly contested and competed for. In recent years the pool of NIST staff has been shrinking, and the purchasing power of the overhead pool has shrunk. The authors of this report have no real expertise on what the level of funding and staffing in SHED should be, but we do have an impression that both are too low for an institute the size and complexity of NIST. SHED must be provided with adequate resources to perform their crucially important roles.

The other major players in the safety operational system at NIST is the collection of individuals known as division safety representatives (DSRs). The DSR is delegated by the Division or Office Chief to carry out most safety operations for the Division or Office. DSR is a "collateral" duty, meaning most DSRs have primary duties as bench scientists, technicians, office managers, etc. We do not know how this compares to the rest of NIST, but in EEEL DSRs are generally expected to dedicate roughly 10% of their time to safety-related tasks. In our

experience, the vast majority of DSRs take their safety roles very seriously. However, when performance ratings are based 90% on other tasks (sometimes up to 40% on other single categories) and 10% on safety, there can be a tendency for safety to "take a back seat," unless all levels of management continually reaffirm that the safety role is a top priority. In fact, many DSRs also perform other collateral duties, and we know of cases where such individuals have been told, at different times and by different managers, that each of their roles is top priority. Hence, DSRs can be put into a position of walking a very delicate balance.

The overhead funding/staffing issues in SHED and the collateral-duty aspect of DSRs can, and in our opinion has, lead to a culture of safety by "triage." In such cases, the most pressing and urgent issues are dealt with, but lower priority items can be left unfinished. Such a practice accomplishes what absolutely has to be done, but it also it can also leave gaps and oversights and is clearly not the best method to achieve a broad, deep, and healthy safety infrastructure.

Several years ago there was a very visible effort across NIST to push safety to the forefront of issues. Much time and effort was spent in evaluating how NIST needed to improve and in stating the importance of safety. Unfortunately, the net result in our experience was a series of mostly unfunded mandates, which may have given an impression to some that safety is not really that important after all. In the meantime other issues have moved to the forefront of NIST consciousness (IT security, property issues, etc.), and safety has probably resultantly moved to the back burner in many minds.

In the aftermath of this incident, we believe that the following issues are important to improving the culture of safety at NIST:

- Everyone working in a given laboratory, in the surrounding area, or anywhere on site should be aware of the significant hazards that exist; incidents must be widely and promptly reported.
- The addressing of significant safety issues should never be put into the position of competing for scarce funding or manpower.
- All safety measures need to be taken into account and put in place, not as a suggested method, but as required practice.
- NIST's unique role as a research laboratory must continually be considered in development of safety policies, procedures, and requirements. In the safety changes sure to come as a result of this incident, we believe that any efforts to "force fit" procedures from other places (technical manufacturing industry, for example) would be a mistake. In a research-laboratory setting, safety issues are necessarily fluid and dynamic, and the safety system must be designed to also be dynamic. To achieve this, we believe that safety at NIST must continue to be done as a partnership between safety professionals and technical staff, but for this model to succeed, there must be complete "buy in" on both sides and unequivocal support from all levels of management.