June 30, 2008

Memorandum For: Dr. James E. Turner
Director, National Institute of Standards and Technology

From: J. Michael Rowe

Subject: Pu Contamination Incident at Boulder

The following information is derived from a visit to the Boulder laboratories of NIST in response to your request to investigate the Pu spill that occurred on June 9, 2008. It also draws on the written information provided to me by NIST. I went to Boulder on Monday, June 23, and interviewed many of the staff there most directly involved in this incident. Dr. Kenneth Rogers, Dr. Paul Hoover, Les Slaback, and Dr. Richard Toohey, the other radiation experts that you had asked to investigate, also participated in all of the interviews. On the first evening we were given an overview of the incident by Dr. Thomas O'Brien (Director of the Boulder laboratory), who was incident response coordinator and [redacted] (head of Health Physics, NIST Gaithersburg), who was Chief Safety Official for the incident response.

On the following day, we interviewed in order, the following people:
[redacted] Chief Safety Officer for the incident
[redacted], Radiation Safety Officer for Boulder laboratory
[redacted] Principal Investigator and NRC limited use license holder
[redacted], foreign guest researcher and researcher on the experiment
[redacted] supervisor for [redacted]
David Wollman, Division Chief and supervisor of [redacted]
William Anderson, Director of EEEL and supervisor of David Wollman
Patrick Gallagher, Chair, Ionizing Radiation Safety Committee

I want to thank all of the NIST employees involved for their openness during our interviews, for their cooperation, and for their clear acknowledgement of their failures and responsibility. Without this, we could not have made any progress in our investigation.

Based upon these interviews, and other written information provided by NIST, I offer the following ***preliminary*** observations and findings on this incident.

1) There is no evidence of deliberate malfeasance or misfeasance by any NIST employee in this incident, and in my opinion, there was no such behavior.

2) This incident was the culmination of multiple failures of the NIST safety procedures and policies and their application, which could have prevented or mitigated the incident.

i) The guest researcher most directly involved, [redacted] received no training before being allowed to use the source by himself, without direct supervision.

This is in direct contradiction of the terms of NRC License 05-03166-05, which is the materials license for NIST Boulder, as amended, February 15, 2007, Item 8, Training.

ii) The principle investigator, [redacted] was not properly instructed on his responsibilities as NRC license holder (which included ensuring that all source users were properly trained prior to source use).

The 2005 application for renewal of License 05-03166-05 specifies that there will be "Additional training specific to the assigned duties and utilization of the sources shall be provided by the immediate supervisors with the support of the RSO". This provision was not stated explicitly in the 2007 amendment, but is assumed to be in force. If not, then the policy for training is inadequate.

iii) [redacted] was not adequately trained on the policy for source acquisition, in particular the use of form 364, "Proposal to Acquire a Radioactive Source".

Form 364 is designed to assure an assessment of hazards by the Principal Investigator, by the RSO, and by line management (Division Chief or designee). In the case of the Pu sources, the safety assessment was inadequate for powdered sources (e.g. no definition of encapsulated, no consideration of spills), the handling requirements were inadequate (e.g. lack of labeling on sealed bags around source as required secondary containment), and the required management review was not obtained. It is clear from email traffic related to source acquisition that the RSO realized that the proposed sources were different, and that the PI and his collaborators were not adequately trained for use of such sources (email from [redacted] to [redacted] 08/21/07). However, this did not translate into appropriate training and procedures.

iv) Division management did not adequately analyze the drastically changed experimental hazards when the decision to use Pu sources was made.

According to the Division Chief, David Wollman, a thorough Safety and Cost/Benefit analysis was conducted prior to initiation of the program to use the cryogenic detectors with nuclear materials, and this is an admirable management action. However, that analysis did not foresee the use of powdered Pu sources, and the analysis was not revisited when the decision to acquire the sources was made. It is possible that the need for such a reanalysis would have been more evident had the proposal to acquire the source been reviewed by management, but even without this trigger, a reanalysis was required when the decision to extend the work to include Pu sources was taken.

v) The Ionizing Radiation Safety Committee did not probe sufficiently deeply into the nature of the sources to be used when the license amendment was discussed.

Although the Ionizing Radiation Safety Committee was not required to approve the license amendment prior to submission, the amendment was discussed, and some concerns were raised. However, it appears that the common assumption was that the sources would be the equivalent of the sealed sources used previously. The new program proposed was far outside past experience at Boulder, which should have triggered a more intense review.

3) The proximate cause of the incident was apparently the result of the glass vial hitting a lead brick during an attempt by [redacted] to optimize the intensity in the radiation detector.

There is much confusion concerning the role of [redacted] – this may be partially the result of communication problems, faulty memory, or other issues. However, during his interview with the group, he stated that the bottle containing the source was out of the bags, and hit a lead brick during an attempt to optimize source placement. The optimization process itself was not appropriate for such an experiment, and reflected inadequate experimental planning (the process involved watching a ratemeter while manipulating the source held in a hand without watching where the source was at any given time).

4) The researchers were not adequately trained in the appropriate response to contamination, and this led to spreading of the contamination.

It is apparent that no one seriously considered the possibility of a spill, and no response to such an event was planned. This is consistent with the fact that all prior source work at Boulder involved "Sealed Sources", where the possibility of a spill was indeed effectively zero. This again points up the inadequate analysis of the source acquisition process as implemented.

5) The infrastructure at Boulder was not adequate to support the use of non-sealed sources, and this led to problems during the experiments and in the immediate response.

See comment above. Boulder Health Physics did not have adequate equipment in place to cope with the aftermath of a Pu spill.

6) The response to the incident was slow to mobilize appropriate resources, but the responders did the best that they could in extraordinarily difficult circumstances, and worked diligently to contain the incident.

At the beginning of this incident, it appears that the response team did not adequately understand the seriousness of the incident, and the need for rapid and decisive action. Resources were mobilized too slowly, and outside help should have been requested earlier. However, the individuals involved worked diligently at great cost to their personal health to mitigate the problem.

7) The laboratory used for these experiments was entirely unsuitable for the work, and access was not limited to those directly involved in the experiment.

   Best practice for the use of such sources (as for example given in the MSDS provided by the source supplier) requires the use of a dedicated space for experiments using potentially spillable radioactive materials. Guidelines for such experimentation are available, but were not followed.

8) The researchers directly involved at the time of the incident did not have an adequate experimental plan that would allow the experiment to be conducted safely.

   See item 3 above for a specific example of the problems that this caused. Especially when working with unsealed sources, careful experimental planning is an absolute requirement. In this regard I also note that the lead bricks were placed to shield the computer from radiation which was postulated as a source of computer failures, reflecting an inadequate knowledge of the source characteristics and radiation interactions with matter. This is an example of the need for better supervision of the researchers.

9) The general safety culture at NIST was described by one interviewee in response to a direct question as "dysfunctional".

   The concerns leading to this statement included lack of real management commitment (one manager was quoted as stating that safety must not be allowed to stifle innovation), lack of adequate resources (computer training courses are readily available, but funding could not be obtained), and other issues. It was stated that safety policies were subject to negotiation between OUs and required consensus that was elusive, and that best practices were not readily extended throughout the institution, with a strong flavor of NIH (not invented here).

10) The safety infrastructure (in general, not only for radiation safety) is inadequate in resources and personnel.

    This was a common complaint, and it is self-evident that there were not adequate resources to support the program involving the Pu powder sources. It is also clear that training requirements were not adequately supported by resources to track and enforce policy. Staffing is minimal for a laboratory of the size of NIST (everything stated here refers equally to Gaithersburg in the opinion of the safety staff).

Preliminary Recommendations

It is perhaps premature to offer detailed recommendations at this point. However, it is critical that NIST use this unfortunate and serious incident to focus on the improvement of the overall safety culture at both Gaithersburg and Boulder. We all hope that the recently discovered internal contamination of some Boulder personnel is minor, with minimal health effects. However, even if there had been no such contamination, that would have been the result of luck, not good safety practice. NIST can and must do better to protect the staff and the general public.

Notwithstanding the above caveats and the early stage of investigation, I offer some general ***preliminary*** recommendations below.

1. Commit the necessary resources to quickly and completely finish the preliminary containment of this incident. When this is complete, contract for outside contractors to decontaminate the affected areas, subject to NRC approval.

   It is critical for the credibility of the NIST commitment to the staff and the general public that this incident be handled with very high priority. The cleanup will not be cheap, either in dollars or impact on Laboratory programs. The resources needed to do the job right must be found.

2. Terminate all work with all radioactive material but sealed sources at the Boulder campus.

   Interest from the public and from Congress has been high, and will only increase with the latest developments. NIST should immediately commit to a policy of no use of radioactive material at Boulder unless it is in sealed sources for the foreseeable future. If this policy is ever reconsidered, NIST should convene an expert external committee to audit the Radiation Safety program to ensure that adequate infrastructure exists to support such work, including personnel, equipment, policies and procedures, emergency supplies and an emergency plan.

3. Initiate a detailed root cause analysis of this incident.

   In order to prevent future incidents, it is essential that NIST have a formal Root Cause analysis done for this incident. Given the urgency of this issue, it would seem appropriate to look for expert outside assistance, either at other Government laboratories or in the private sector.

4. Conduct a detailed audit of safety practices at NIST, with special emphasis on ensuring that workers are adequately trained for all activities relevant to their work.

   This is a longer term (but perhaps not too long) issue to determine whether this incident reflects systemic failures in NIST operations with respect to safety. This recommendation applies to all work done at NIST, not only radiation work, at both Boulder and Gaithersburg.

5. Ensure that all levels of management are truly committed to a safety culture, by holding all managers responsible for safety in their organizations, with real consequences for failure.

   From personal experience, I am aware that NIST includes safety in all employees' performance agreements. However, it is necessary to then use this to develop a sense of actual responsibility for safety at all levels. Safety must be part of all work, and must be fostered by a top down commitment that can be summed up as "if it wasn't done safely, it was a failure, whatever other good results may have been obtained". That level of commitment requires actual priority setting in which safety is a requirement, not something desirable.