The Tenuous Future of Radiological Laboratories

Addressing the Declining Operational Readiness for Mission Critical Activities of Radiological Laboratories

Version 1.0

October 5, 2018

Executive Summary

The nation's radiological laboratories face serious challenges in the near future that threaten to compromise their ability to support functions that are vital to the missions of their respective agencies and to adequately respond to a radiological or nuclear terrorist attack or a major nuclear accident. The most critical challenges include:

- A crippling loss of expertise in radiochemistry due to personnel retirements coupled with a shrinking number of qualified replacements;
- Aging and difficult-to-maintain radioanalytical instrumentation and equipment;
- Deteriorating radiological laboratory facilities that jeopardize the generation of essential data.

It is imperative that plans are developed and actions taken in the near term to begin to address the above issues in order to avoid disastrous consequences to governmental agencies due to significant losses of radiological laboratory capability and capacity. These losses will result in gaps and critical delays in the generation of radiological data to support vital mission areas including:

- National security – counterterrorism safeguards and nuclear forensics;
- Nuclear energy and power generation;
- Chemical, environmental, food/agricultural monitoring and surveillance;
- Environmental characterization and cleanup of contaminated sites;
- Nuclear medicine;
- Consequence management.

Delays in data generated for consequence management activities and support for decision-making authorities in governmental agencies following a radiological or nuclear terrorist attack or major nuclear accident will result in a number of negative consequences, including:

- Reduction in the ability to protect the public's health;
- Delays in incident response, decontamination and recovery;
- Greater and longer term negative economic impacts;
- Public loss of confidence in responding federal and state agencies.

This document focuses on these three most critical challenges facing radiological laboratories and provides recommendations to address the challenges.

1. **Human Capital Challenges/Loss of Expertise in the Field**

The pool of trained radiochemists is shrinking and these losses will lead to a reduced ability to perform and meet critical mission functions (e.g. surveillance, monitoring, site cleanup, nuclear power generation, nuclear medicine, etc.) and the ability to respond to radiological or nuclear incidents (i.e., emergency response and recovery). Due to the aging of the workforce and the resulting increased personnel retirements, in conjunction with fewer academic programs producing fewer qualified replacements, there will be a significant reduction in the number of experienced radiochemists in the next five to ten years. In the cases where qualified scientists can be identified, they will normally be much less experienced than the personnel they are replacing, often leading to significant loss of cumulative historical knowledge.

Since the end of the 1980s, growth and funding of all segments of the nuclear industry, including nuclear weapons development and production and nuclear power research, has stagnated. Slowed growth in these areas that traditionally provided long-term careers has fueled a perception among individuals now entering or considering entering the workforce that the field of radiochemistry no longer provides the challenging opportunities and employment security that it once did 30-40 years ago. The National Academy of Sciences (NAS) report, *Assuring a Future U.S.-Based Nuclear and Radiochemistry Expertise,* points out that a "factor influencing the number of trained nuclear and radiochemists available to fill these government supported jobs is the attrition in the current workforce that is likely to occur over the next 10-20 years."[1] Based on NAS estimates (2012), 44% of the national laboratory career nuclear and radiochemistry workforce is 50 years of age or older and will therefore be eligible to retire in the next 15 years. Of these, 42% hold advanced degrees.[2] The demand for nuclear chemists and radiochemists will outpace supply of those working toward advanced degrees over the coming years. Dr. Howard L. Hall[3] corroborated that a critical aspect of this attrition of radiochemistry personnel is the loss of decades of hands-on experience accumulated by those who are retiring. There needs to be a sufficient period of overlap between the new hire and the retiree so the cumulative historical knowledge gained by decades of experience can be passed on.

The loss of expertise in radiochemistry will result in gaps and critical delays in the generation of radiological data to support vital missions including:

- National Security – Counterterrorism Safeguards, Nuclear Forensics, etc.;
- Nuclear Energy and Power Generation;
- Clinical, Environmental, Food/Agricultural Monitoring and Surveillance;
- Environmental Characterization and Cleanup of Contaminated Sites;
- Nuclear Medicine;
- Consequence Management.

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[1] NAS report page 109
[2] Data drawn from Figure 2-5 in NAS report.
[3] Radiobioassay and Radiochemical Measurements Conference, 2014

The impending gap of experienced radiochemists will have dire consequences in the event of a potential future radiological or nuclear terrorist attack (i.e. Radiological Dispersion Device (RDD) or Improvised Nuclear Device (IND) or a major nuclear accident). The loss of expertise in radiochemistry will result in delays in the generation of critical radiological data to support timely consequence management activities and for decision-making authorities in a number of federal and state agencies, resulting in the following negative consequences:

- Reduction in the ability to protect the public's health (health risk assessment and medical management);
- Probable increase in morbidity and mortality;
- Delays in the Incident Response, Decontamination and Recovery;
- Greater and longer term negative economic impacts to the nation;
- Public loss of confidence in responding federal and state agencies.

A number of actions must be taken in a timely manner in order to ensure an adequate, well-trained workforce of radiochemists in the future (see recommendations).

2. Laboratory Instrumentation

A major issue facing radiological laboratories over the next several years involves aging analytical instrumentation and equipment. As instrument manufacturers are no longer able to support the legacy equipment and replacement parts become unavailable, the laboratories will lose critical capacity and capability to perform mission essential functions and to respond to radiological or nuclear incidents. In addition, there are computer software challenges with aging equipment, e.g., compatibility with newer computers and operating systems, that can negatively impact the ability to rapidly output analytical results electronically to support critical public health decisions. Therefore, it is imperative that laboratories be able to replace aging, less sensitive, and less capable instrumentation with updated versions that will rapidly produce accurate data to enable decision-makers to have the most relevant and timely information possible. Otherwise, a delay in producing data will impede the making of timely informed public health decisions and other mission critical activities.

3. Facilities

Many radiological laboratories are deteriorating (e.g., buildings, chemical fume hoods, HVAC, electrical systems, etc.), a circumstance which will only continue to worsen. Many of these facilities were built up to six decades ago during the height of the nuclear power industry and U.S. nuclear weapons development and testing. The continuing decline in the condition of these facilities makes radiological measurements challenging. Ever changing environmental conditions (e.g. HVAC systems), and electrical components, unstable power, lack of emergency backup power, leaking roofs, etc., results in frequent and sustained interruptions in the ability to produce essential analytical data. These conditions, should they worsen sufficiently, could cause the laboratory to be shut down, resulting in the loss of critical laboratory operational capacity and capability. These issues with deteriorating facilities can limit the ability of even the newest instrumentation to produce high quality data in a timely manner.

Recommendations:

Personnel Issue recommendations

- Establish an organizational framework among the appropriate federal agencies to establish and coordinate the following actions:
  - Promote and develop educational materials on radiation science, including radiochemistry, for college-level academic programs;
  - Develop and provide internet-based and outreach training courses on a variety of topics in radiochemistry;
  - Capture historical knowledge of retiring radiochemists through webinars, publications of practical laboratory experience, etc.;
  - Develop and implement staffing strategies which includes overlap to allow mentoring, to ensure each facility maintains personnel and expertise levels above critical minimums (as more senior staff move towards retirement.);
  - Provide financial assistance, paid internships and "hands-on" training for students pursuing studies in radiochemistry.

Instrumentation Issue recommendations

- Establish a plan to upgrade older instrumentation, computers and equipment as part of the sustainment of the radiation laboratory infrastructure. Review and revise the plan at least every five years;
- Identify critical instrumentation gaps and place them higher on the priority purchase list;
- Initiate the purchasing of replacement instruments and equipment using the priority purchase list and the equipment replacement plan.

Facility Issue recommendations

- Develop, review and revise the facility improvement plan periodically, by identifying the highest priority areas within facilities that need to be upgraded (power/energy/HVAC/structural/safety priorities);
- Develop a plan and a funding path to upgrade or build new laboratory facilities to replace aging laboratory facilities.