Building a Nuclear Forensic Analysis Capability in South Africa

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Abstract

The threat of nuclear proliferation requires international co-operation and the development of improved measures for the prevention and detection of and response to any incidents of illicit trafficking of nuclear and/or radiological materials. No single country or nation-state can effectively address this critical 21st century problem in isolation, even on a local scale, without global engagement. To meet this need, the Confidence Building Measures (CBM) Program within NNSA's Office of Nonproliferation and International Security promotes international engagement efforts to assist partner countries develop and strengthen indigenous capabilities in nuclear forensics. Beginning in 2013, Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL) and the South African Nuclear Energy Corporation (Necsa) committed to a program of mutual cooperation and assistance to enhance nuclear forensic analysis capabilities in South Africa. This paper reviews the important steps, discusses the current status and points the way to future developments both in South Africa and with other partner countries.

Introduction and Initial Steps The threat of nuclear proliferation requires international co-operation and the development of improved measures for the prevention and detection of and response to any incidents of illicit trafficking of nuclear and/or radiological materials. No single country or nation-state can effectively address this critical 21st century problem in isolation, even on a local scale, without global engagement. To meet this need, the Confidence Building Measures (CBM) Program within NNSA's Office of Nonproliferation and International Security promotes international engagement efforts to assist partner countries develop and strengthen indigenous capabilities in nuclear forensics. Beginning in 2013, Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL) and the South African Nuclear Energy Corporation (Necsa) committed to a program of mutual cooperation and assistance to enhance nuclear forensic analysis capabilities in South Africa. This paper reviews the important steps, discusses the current status and points the way to future developments both in South Africa and with other partner countries.

The first important step occurred in April 2011 when Necsa hosted a meeting at Pelindaba, South Africa to discuss how the United States and South Africa could best cooperate to improve South Africa's nascent nuclear forensics capabilities and infrastructure. All parties

agreed on the need for a Memorandum of Understanding (MOU) discussing critical needs and important milestones and establishing a time frame for future activities. The MOU was drafted over the next four months and the final version signed in July 2011.

The MOU identifies activities to be conducted jointly between the United States and South Africa to enhance scientist-to- scientist engagement including:

1. Organize and conduct a training course in nuclear forensic analysis for Necsa staff to be given by LANL and LLNL;
2. Organize a visiting scholars program to allow senior staff from both countries to visit for an extended period and participate in daily nuclear forensic activities;
3. Assist South Africa improve their nuclear forensic analysis capabilities, specifically to construct and equip a clean room for trace element and isotope analysis of uranium-rich materials (primarily uranium ore concentrate; UOC);
4. Assist South Africa develop and maintain a nuclear forensic database containing information on U-rich materials produced or stored within South Africa;
5. Organize and execute a regular sample exchange and analysis program in which U-rich materials produced in the two countries are exchanged and analyzed independently as part of a round robin exercise program; and
6. Hold a meeting of nuclear forensic experts from Necsa, LANL and LLNL at least every two years to review the results of the round robin exercises, create a lessons learned list and review the current status of activities in both countries.

The initial step in this cooperative program was executed in January-February 2012 when LLNL and LANL held a two-week course at LLNL in nuclear forensic analysis focusing on trace element analysis of UOC; six staff scientists from Necsa attended the training course. The course provided an introduction to nuclear forensics followed by a series of lectures discussing techniques for receiving and sampling UOC in a clean room environment and the primary techniques used for UOC characterization – microscopy, x-ray diffraction, x-ray fluorescence and inductively-coupled plasma mass spectrometry (ICP-MS) for trace elements. The course also provided an introduction to geochemistry and trace element behavior and uranium ore bodies. Approximately two-thirds of the course was devoted to hands-on work in the nuclear forensic laboratories at LLNL. The course concluded with an introduction to data analysis, uncertainties and interpretation.

Staff from LANL and LLNL have worked with Necsa since late 2012 to design and construct a new clean room facility at Necsa to process U-rich samples. Information sharing developed through the collaboration allowed the U.S. team to provide Necsa with a state-of the-art design for a clean room facility and to assist with the procurement of air handling and clean room equipment as well as a new ICP-MS. Staff from LANL visited Necsa in Sept. 2012 to review progress on construction of the new cleanroom and discuss important next steps.

The second Experts Meeting was held at LLNL in July 2013. Both sides stated their commitment to the partnership and discussed plans for Kobus Hancke to visit LLNL as part

of the Visiting Scholars program and to hold the first joint exercise involving the analysis of UOC. Necsa also expressed a desire for advanced training in nuclear forensic databases.

In xx 2014 Necsa received a new ICP-MS, which is now installed in the new clean room facility. Staff from LLNL and LANL will travel to Necsa in Sept. 2014 to provide advanced training in ICP-MS analysis of trace elements in UOC, review the status of the clean room, provide training in nuclear forensic databases and search/geolocation algorithms and review the analysis of the UOC sample interdicted in Durban, South Africa in November 2013 (see companion paper by Borg et al.). Plans for the first round robin excise with UOC will also be discussed, as will the next steps in the Visiting Scholar program.

In summary, over the past 3 years the United States and South Africa have developed a very effective partnership in nuclear forensics. This partnership represents a significant advance in scientist-to-scientist engagement and international nuclear nonproliferation and we anticipate many ears of fruitful partnership. Both South Africa and the United States are very pleased with the substantial progress made by South Africa since the signing of the Memorandum of Understanding and appreciates the opportunity to work closely with Necsa to expand cooperation in nuclear forensics.

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