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June 18, 2009

INMM 50th Annual Meeting
Tucson, AZ, United States
July 12, 2009 through July 16, 2009

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International Safeguards Technology and Policy Education and Training Pilot Programs

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Abstract: A major focus of the National Nuclear Security Administration-led Next Generation Safeguards Initiative (NGSI) is the development of human capital to meet present and future challenges to the safeguards regime. An effective university-level education in safeguards and related disciplines is an essential element in a layered strategy to rebuild the safeguards human resource capacity. NNSA launched two pilot programs in 2008 to develop university level courses and internships in association with James, Martin Center for Nonproliferation Studies (CNS) at the Monterey Institute of International Studies (MIIS) and Texas A&M University (TAMU). These pilot efforts involved 44 students in total and were closely linked to hands-on internships at Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL). The Safeguards and Nuclear Material Management pilot program was a collaboration between TAMU, LANL, and LLNL. The LANL-based coursework was shared with the students undertaking internships at LLNL via video teleconferencing. A weeklong hands-on exercise was also conducted at LANL. A second pilot effort, the International Nuclear Safeguards Policy and Information Analysis pilot program was implemented at MIIS in cooperation with LLNL. Speakers from MIIS, LLNL, and other U.S. national laboratories (LANL, BNL) delivered lectures for the audience of 16 students. The majority of students were senior classmen or new master's degree graduates from MIIS specializing in nonproliferation policy studies. The two pilots programs concluded with an NGSI Summer Student Symposium, held at LLNL, where 20 students participated in LLNL facility tours and poster sessions. The value of bringing together the students from the technical and policy pilots was notable and will factor into the planning for the continued refinement of the two programs in the coming years.

Introduction

The international safeguards regime is coming under increasing strain as a result of growing nuclear energy demand, existing concerns over the diffusion of sensitive nuclear technologies, and the challenges posed by clandestine nuclear programs. At the same time that the mandate and workload of regime are expanding, the safeguards human capital base, both at the International Atomic Energy Agency (IAEA) and in the United States, is declining rapidly due to the aging of safeguards experts and the lack of trained specialists to replace them. In 2008, NNSA's Office of Nonproliferation and International Security initiated the Next Generation Safeguards Initiative (NGSI) to address these challenges. An effective university-level education in safeguards and related disciplines is an essential element in a layered strategy to rebuild the safeguards human resource capacity.

During the summer of 2008, NGSI initiated two university-level pilot programs with Texas A&M University (TAMU) and the James Martin Center for Nonproliferation Studies (CNS) at the Monterey Institute of International Studies (MIIS) linked to hands-on internships at Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL) in nuclear safeguards technology and international safeguards policy and information analysis. The pilot courses and internships are

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

intended to lead to career positions related to safeguards in government agencies, nuclear laboratories, industry or the IAEA. These projects developed a number of materials that can be used as part of existing curricula to institutionalize a foundation of safeguards understanding in a wide range of professionals performing their responsibilities in nuclear industry and across the federal government.

Texas A&M University developed a Summer Internships and Safeguards Technology Training Program focusing on technical safeguards and nuclear material management in conjunction with LANL and LLNL. The summer course was delivered as part of the 3-month internship program to TAMU and other summer interns at LANL and video transmitted to interns at LLNL. CNS, in cooperation with LLNL, developed a two-week course entitled “International Nuclear Safeguards Policy and Information Analysis” and a related summer internship program at LLNL.

The hands-on internships at LANL and LLNL engaged interns in specific safeguards-related projects with a designated Laboratory Mentor and provided broader exposure to nuclear materials management and information analysis techniques. The final 2008 activity was a student symposium held at LLNL in August. This activity brought together the LANL-TAMU-LLNL and MIIS-LLNL students for the first NGS Radiochemistry-Environmental Sampling Summer Course to facilitate cross-communication between the policy and technology tracts, tour LLNL facilities and exercise public presentation skills during a poster session.

The 2009 summer courses and internships at MIIS/LLNL and LANL/TAMU have been built on the successes and key lessons-learned during the 2008 pilot programs. Several components of the 2009 programs are still underway and are even more encouraging than the 2008 pilots. Details on each pilot project and 2009 developments are provided below.

Texas A&M University, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory Program

Summer 2008

The 2008 collaboration between Texas A&M University (TAMU), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL), resulted in a cohort of 26 students taking part in summer safeguards internships at LANL, completing 56 hours of technical safeguards training and working full-time at the lab for approximately 3 months. This included eight classroom modules and one intensive week of safeguards laboratory exercises at LANL. In addition, safeguards interns at the Lawrence Livermore National Laboratory were incorporated into the program and participated in the lecture series and other training activities. The students attended the annual meeting of the Institute of Nuclear Materials Management (INMM) and participated in special activities of the Institute’s student chapter. As a final summer activity the students traveled to LLNL to highlight some of their projects and tour the laboratories facilities and interact with the Monterey Institute of International/Center for Nonproliferation Studies – LLNL Summer Safeguards Policy and Information Analysis interns.

Even though the pilot TAMU/LANL/LLNL human capital project planning started late in the academic year, the team was able to attract a diverse and talented class for the program. Twenty six interns completed the program at LANL and three interns at LLNL. Most of the student participants were graduate-level students or advanced undergraduates pursuing degrees in natural science fields such as nuclear engineering, physics, and chemistry. Eleven of the students are affiliated with Texas A&M University, a participant in the pilot project team and the home of the Nuclear Security Science and Policy Institute. One Texas A&M student concurrently participated in a DHS Forensics summer internship at LLNL.

LANL and TAMU conducted the Technical Safeguards Training Course from June 3 to July 11, 2009 at LANL on a twice weekly basis, topped-off by a practicum week of experience in the LANL nondestructive assay (NDA) laboratories. The LANL course was made available to LLNL students live through a videoconference connection from LANL to LLNL.

The Technical Safeguards Training contained the following lectures focusing on technical aspects of safeguards:

- The Framework of International Safeguards and Nonproliferation Efforts
- The Nuclear Fuel Cycle - Nonproliferation Efforts
- Domestic and International Safeguards Systems
- Material Control and Accountancy
- Nondestructive Assay (NDA) Methods – Gamma and Neutron Measurements
- Destructive Assay (DA) Methods
- Environmental Sampling/Signatures
- Statistics and Safeguards
- Design Information Verification, Key Measurement Points and Material Balance Areas/ Use of Open Source Information Analysis
- Containment and Surveillance
- Safeguards Approaches: Light Water Reactors
- Safeguards Approach: Centrifuge Enrichment Facility
- Safeguards Approach: LEU/MOX Fuel Fabrication Facility
- Safeguards Approach: Reprocessing Facilities
- Advanced Safeguards Approaches: New Approaches for GNEP Facilities

The classroom portion of the pilot course was supplemented, from July 7-11, 2008, by an intensive week-long safeguards practicum in which the students gained hands-on technical safeguards training using nuclear materials. The LLNL students traveled to LANL to participate. The practicum included the following exercises and hands-on activities:

- Centrifuge Enrichment Plant Tabletop Exercise
- Gamma Spectroscopy Basics
- Uranium Enrichment Exercises
- Reprocessing Plant Tabletop Exercise

- Plutonium Gamma Exercise
- Passive Neutron Exercises
- Active Neutron Exercises
- Calorimetry/Microcalorimetry
- Portal Monitors and Nanodetectors

The student evaluation of the program was very positive. Most of the suggested changes centered on addressing the differing levels of student expertise. It was proposed by quite a few students that it might be useful to introduce beginner and advanced sections that will allow for more targeted training. In addition, it was suggested that planning for smaller groups that would allow for greater access to Lab experts and equipment would be advantageous.

The results of the course were evaluated and the materials of the course assessed for the use in a curriculum for a graduate certificate in nuclear safeguards that could be taught in natural science departments around the country. Several additional activities were planned to complement activities with universities and faculty that would strengthen human capital development for International Safeguards.

International Safeguards Policy and Information Analysis Course and Internships

Summer 2008

A two-week intensive course was facilitated by senior CNS and Monterey Institute faculty and staff with presentations by technical experts from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Brookhaven National Laboratory, and other leading nonproliferation specialists offered on June 2-13, 2008 in Monterey. As a complement to the technically focused LANL-TAMU course, the MIIS-LLNL course was designed to give students a grounding in the legal and policy foundations of safeguards, an overview of how safeguards are implemented and how they have evolved in response to challenges, and an understanding of contemporary and prospective policy issues in safeguards. The course complements the facility-centric content of the LANL-TAMU course by emphasizing information analysis and the state evaluation process. Lectures, briefings, and in-class exercises were focused on the following topics:

- Introduction of Key Technical Concepts
- Concept of International Safeguards
- Atoms for Peace Safeguards/ Bilateral Safeguards
- IAEA Safeguards Before NPT
- Comprehensive Safeguards Agreements (INFCIRC/153)
- Regional Verification Mechanisms
- Verifying Nuclear Weapons Free Zones
- Working for the IAEA: JPO Experience
- Safeguards Concepts, Approaches and Practices
- Practical Issues in the Implementation of IAEA Safeguards
- Iraq and 93+2

- The Additional Protocol
- Safeguards Information Evaluation and Analysis
- Current Trends and Challenges

A suggested reading list was provided to the students and two exercises related to the course material were conducted in the afternoons.

Sixteen course participants were selected on a highly competitive basis. They included 13 MIIS students and recent graduates, one student from the University of California in Los Angeles, one postdoctoral fellow from Stanford University, and a junior officer from the International Atomic Energy Agency.

Many students noted that such a course was long overdue and should be offered on an annual basis. All participants indicated that the course stimulated their interest in the subject and in the prospect of careers in the field. They emphasized the value to them of both the lectures and the opportunity to interact with technical experts from the U.S. national laboratories and other invited guest speakers with practical experience. Other suggestions called for more hands-on, interactive exercises and greater focus on contemporary issues. Students also recommended expanding practical exercises to include an exercise on state evaluations process.

After the completion of the International Nuclear Safeguards Policy course, four of the participating students continued their training in an eight-week pilot Safeguards Policy Internship Program at LLNL. Based on the individual's backgrounds and interests of the interns, they were matched with research topics relevant to the NGSi roadmap and priorities. The output of each of the projects was a paper, as well as a poster presented at the NGSi Student Symposium.

Summer 2009

Course development continued as a partnership between CNS and LLNL, with experts from CNS, LANL, LLNL, Pacific Northwest National Laboratory (PNNL), the IAEA, and other well-known safeguards specialists providing lectures. The key recommendations and lessons learned from the 2008 pilot were implemented in the MIIS/LLNL course offered on May 18-22, 2009. The course was designed to be more intense, focusing the material on more recent cases, introduction of an exercise on state evaluation reports, development of an introductory module on the nonproliferation regime and nuclear safeguards, and integration of students with policy and technical backgrounds in the classroom. It provided a comprehensive overview of the origins and fundamentals of international safeguards and the evolution of the legal, political, and technical elements of and approaches to their implementation. Case studies on nuclear programs in Iraq, North Korea, and Iran were reviewed in detail to demonstrate their influence on the development of safeguards approaches and technologies, as well as to highlight the challenges they continue to pose. A special session was devoted to open-source information analysis.

Focusing on IAEA state evaluation is considered to be especially relevant in meeting the challenges of a more information-driven state assessment process and a need for integrated analysis of various types of information as more and more states implement the Additional Protocol. A new week-long exercise on the state evaluation report process was developed by LLNL experts with input from CNS and LANL. Guest speakers, in addition to their contributions to the lectures, served as consultants to students during the exercise and shared their first-hand knowledge and practical experience in the field.

The success of the 2008 pilot course at MIIS and internship program at LLNL appear to have generated a large pool of strong and promising candidates with some prior exposure to nonproliferation and safeguards issues in 2009. The thirty participants selected, out of the 50 applications received, represented a mix of students with policy and technical knowledge. The majority of participants were graduate students pursuing a Master's or Doctorate degree; the institutions represented included a number of major U.S. universities, such as Georgia Institute of Technology, Harvard University, Monterey Institute of International Studies, Missouri University of Science and Technology, Old Dominion University, Syracuse University, and Texas A&M University. In addition, several professionals from U.S. national laboratories, government and international agencies, and researchers from think tanks and nongovernmental organizations (NGOs) took part in the course. This highly diverse and well-prepared group demonstrated a keen interest in the subject, actively participated in class discussions and challenged speakers with thorough questions and comments. The course culminated in students presenting the results of an exercise simulating the preparation of a state evaluation report for a particular state.

To help all course participants acquire the minimum tools and knowledge necessary to comprehend the more advanced and complex issues that were covered in course, CNS designed an Online Introductory Module comprised of four sections: nuclear technology, the basics of the nonproliferation regime, the International Atomic Energy Agency and its safeguards system, and a few of the most important proliferation cases of recent years (Iraq and North Korea).

This year the number of summer safeguards policy internships at LLNL was increased to seven. The selected interns are affiliated with MIIS, TAMU, and Harvard University. A joint LANL and LLNL intern exercise is planned on the margins of the INMM meeting for both policy and science students.

MIIS/LLNL team viewed the increased interest to the course and summer internships as a testimony to the timeliness of the this NGS effort, success of the 2008 pilots, better advertisement strategy in 2009, and good employment prospects for students pursuing their studies further. For example, three of the four 2008 MIIS/LLNL interns continue their careers working on safeguards issues. Two interns received Graduate Nonproliferation Program Fellowships and are on a year-long assignment at the NNSA headquarters working on safeguards and related issues; another student is doing a year-long safeguards internship at the Idaho National Laboratory. The fourth MIIS/LLNL intern is working on Cooperative Threat Reduction programs at DTRA.

Conclusion

The 2008 TAMU/LANL/LLNL and MIIS/LLNL pilot programs jump-started the development of a focused curriculum that introduces concepts of nuclear safeguards to students and young professionals with prospects to become future safeguards workforce. Coupled with targeted internships at the labs, these projects contribute to the nurturing and professional growth of the next generation of safeguards specialists.

The enhancement and expansion of the pilots in 2009, along with new programs at other universities and laboratories, moves the process further and has a potential to increase many-fold the number of qualified technical and policy safeguards specialists in the coming years.

Several additional key accomplishments and underlining concepts of these NGSIS-sponsored efforts are particularly worth mentioning:

- Establishment of university-laboratories partnership;
- Increased synergy between policy and science expertise; and
- Linkage of educational and training programs with practical work and research experience at the labs.

The results of the 2008 and 2009 university-labs programs as well as the future direction of these programs will be evaluated at an August 2009 workshop at Los Alamos for university faculty. This workshop will also assess the prospects of using curricula and materials developed under the university-lab program by other universities and other countries. The workshop will review safeguards and nonproliferation educational approaches and course design, integration of safeguards issues into nuclear engineering and political science programs, as well as interdisciplinary approaches.

Some of the preliminary recommendations for moving forward include: continued support of the programs established in 2008-2009, their refinement and adjustment; introduction of the material and courses developed in the past two years into regular degree programs at participating universities and other institutions; modularization of the content and its differentiation for various learning levels (from introductory to advanced); exploring the possibility of offering similar programs to young professionals at relevant government agencies and laboratories; and the establishment of cooperative projects with other countries and programs with a focus on education and training in safeguards and security issues (such as ESARDA network in Europe, nuclear security and nonproliferation programs at a number of universities in Russia, China, Japan, and other countries).