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LLNL-TR-408092

FY 2008 Next Generation Safeguards Initiative International Safeguards Education and Training Pilot Progerams Summary Report

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October 23, 2008

Disclaimer

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

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International Safeguards Education and Training Pilot Programs
Summary Report

Executive Summary

Key component of the Next Generation Safeguards Initiative (NGSI) launched by the National Nuclear Security Administration 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. Two pilot programs at university level, involving 44 students, were initiated and implemented in spring-summer 2008 and linked to hands-on internships at LANL or LLNL. During the internships, students worked on specific safeguards-related projects with a designated Laboratory Mentor to provide broader exposure to nuclear materials management and information analytical techniques.

The Safeguards and Nuclear Material Management pilot program was a collaboration between the Texas A&M University (TAMU), Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL). It included a 16-lecture course held during a summer internship program. The instructors for the course were from LANL together with TAMU faculty and LLNL experts. The LANL-based course was shared with the students spending their internship at LLNL via video conference. A week-long table-top (or hands-on) exercise on was also conducted at LANL. The student population was a mix of 28 students from a 12 universities participating in a variety of summer internship programs held at LANL and LLNL. A large portion of the students were TAMU students participating in the NGSI pilot.

The International Nuclear Safeguards Policy and Information Analysis pilot program was implemented at the Monterey Institute for International Studies (MIIS) in cooperation with LLNL. It included a two-week intensive course consisting of 20 lectures and two exercises. MIIS, LLNL, and speakers from 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. Other university/organizations represented: University of California in LA, Stanford University, and the IAEA. Four of the students that completed this intensive course participated in a 2-month internship at LLNL.

The conclusions of the two pilot courses and internships was a NGSI Summer Student Symposium, held at LLNL, where 20 students participated in LLNL facility tours and poster sessions. The Poster sessions were designed to provide a forum for sharing the results of their summer projects and providing experience in presenting their work to a varied audience of students, faculty and laboratory staff. The success of bringing together the students from the technical and policy pilots was notable and will factor into the planning for the continued refinement of their two pilot efforts 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 Iran and North Korea. At the same time that the mandate and workload of regime is expanding, the safeguards human capital base, both at the International Atomic Energy Agency (IAEA) and in the United States is declining rapidly. In October 2007, NNSA's Office of Nonproliferation and International Security issued a report entitled "International Safeguards: Challenges and Opportunities for the 21st Century." This report recommended the creation of a Next Generation Safeguards Initiative (NGSI) to include a component devoted to improving human capital and training for safeguards. 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.

As part of NGSI, the Office of Nonproliferation and International Security (NA-24) initiated two pilot graduate-level university collaborations that focused on international safeguards technology and safeguards policy/information assessments intended to lead to career positions in government, industry or at the IAEA. Associated with summer courses, internships directly linked to NGSI programmatic efforts were offered to students. In parallel, these projects developed some 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 the nuclear industry and across the federal government.

Texas A&M University (TAMU) developed a Summer Internship Program focusing on Safeguards and Nuclear Material Management in the context of Nonproliferation and International Security, in conjunction with Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL). The summer course was delivered as part of the internship program to TAMU and other summer interns at LANL. Monterey Institute for International Studies in cooperation LLNL developed a two-week course and summer internship program focusing on Implementation of the International Nonproliferation Regime: Safeguards Policies and Information Analysis.

The hands-on internships at LANL or LLNL worked on specific safeguards-related projects with a designated Laboratory Mentor to provide broader exposure to nuclear materials management and information analytical techniques. To bring together the 2008 interns, a two-day Summer Student Symposium was organized at LLNL to provide an opportunity for students to share highlights of their training experience and present the results of their internship projects with a series of posters. This included a student poster contest and tours/briefings at some safeguards facilities at LLNL.

This report will present details on each pilot project, the internships, NGSI Student Symposium and a summary of our close-out session to compare lessons learned and consider next steps. The appendices include: descriptions of some student projects and posters (Appendix 1); a summary of the results of student evaluations (Appendix 2); the initial draft reading list for the MIIS course (Appendix 3), and the accepted abstract on the pilot efforts, to be presented at the American Nuclear Society Meeting in the Fall of 2008 (Appendix 4).

An attached CD provides the lecture materials used in both courses, some of the student posters and other ancillary information.

A. 2008 Safeguards Technology Training and Summer Internships

William Charlton (TAMU)
James Doyle, Brian Boyer, Phil Hypes (LANL)
Mona Dreicer, Arden Dougan (LLNL)

I. Introduction

Collaboration between Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), and Texas A&M University (TAMU) resulted in a pilot phase of the project with a cohort of approximately 20 students completing 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. 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.

As follow-on to planning the summer courses, the pilot project team will evaluate and build upon those course materials to develop a curriculum for a graduate certificate in nuclear safeguards that could be taught in natural science departments around the country. We will also plan and propose complimentary activities with universities and faculty that strengthen human capital development
for International Safeguards.

II. Student Participation

Even thought the pilot human capital project teams were only able to being planning the summer program late in the academic year, a diverse and talented initial class for the summer of 2008 was recruited:

Student Name	Status	School	NA-243-funded
At LANL:			
Sandra De La Cruz	Post-BS	UNLV	√
Michael Fensin	Post-Doc	Univ. of Florida	
Analisa Sandoval	UGS	Notre Dame	√
Nathan Sandoval	Post-BS	UNLV	√
Scott Thompson	Ph.D	Idaho State	√
Charles Streeper	GRA	LANL (Monterey Institute)	
James Miller	Post-MS	TAMU	
Corey Freeman	GRA	TAMU	
Dan Strohmeyer	GRA	TAMU	√

continued Student Name	Status	School	NA-243-funded
Adrienne LaFleur	GRA	TAMU	
Eric Rauch	GRA	TAMU	
Karen Miller	GRA	TAMU	
Jessica Feener	GRA	TAMU	
Grant Spence	Post-BS	TAMU	
Akshayan Rajasingum	Post-BS	Xavier Univ.	
Brian Quiter	GRA	Berkeley	√
Eve Uribe	UGS	Yale Univ.	√
Marisa Sandoval	UGS	Washington State	
Blake Nolen	GRA	Univ. New Mexico	
Ashley Reid	UGS	Univ. of New Mexico	
Ann Dallman	UGS	Arizona State Univ.	
Drew Rasmussen	UGS	Univ. of New Mexico	
Elisa Bonner	Post-BS	Univ. of New Mexico	
Laura Musgrave	UGS	Univ. of Redlands	
Melissa Schear	GRA	Univ. of Illinois, Urbana	
At LLNL:			
David Garnetti	GRA	TAMU	
Mathew Sternat	GRA	TAMU	
David Sweeney	GRA	TAMU	

GRA – Graduate student
UGS – undergraduate student

The majority of students are graduate level or beyond and are pursuing 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.

III. Classroom Modules

To test the viability of distance learning, classroom modules were shared between LANL and LLNL every Tuesday and Thursday in June. At LLNL, the MIIS-LLNL interns attended as well occasional attendance by other LLNL summer interns not formally involved in the NGSI pilots.

	Lecture Title	Instructor	Schedule (Mountain Time)
1	The Framework of International Safeguards and Nonproliferation Efforts	Jim Tape	Tues. June 10, 2:00-3:15
2	The Nuclear Fuel Cycle - Nonproliferation Efforts	Bill Charlton	Tues. June 10, 3:15-4:30
3	Domestic and International Safeguards Systems	Rebecca Stevens, Ken Thomas	Thurs. June 12, 2:00-3:15

	continued **Lecture Title**	**Instructor**	**Schedule (Mountain Time)**
4	MC&A	Rebecca Stevens	Thurs. June 12, 3:15-4:30
5	Nondestructive Analysis Methods - Gamma	Steve Tobin, Howard Menlove,	Tues. June 17, 2:00-3:15
6	Nondestructive Analysis Methods - Neutron	Howard Menlove, Bill Charlton	Tues. June 17, 3:15-4:30
7	Destructive Analysis Methods	P. Hypes	Thurs. June 19, 2:00-3:15
8	Environmental Sampling/Signatures	Ross Williams	Thurs. June 19, 3:15-4:30
9	Statistics and Safeguards	Tom Burr, John Howell	Tues. June 24, 2:00-3:15
10	Design information Verification/ KMPs and MBAs - Use of Open Source Information Analysis	Brian Boyer, Arvid Lundy, Frank Pabian	Tues. June 24, 3:15-4:30
11	Containment and Surveillance	Mike Browne	Thurs. June 26, 2:00-3:15
12	Safeguards approaches for light water reactors	Brian Boyer	Thurs. June 26, 3:15-4:30
13	Safeguards Approach for Centrifuge Enrichment Facility	Brian Boyer, Dave Beddingfield	Tues. July 1, 2:00-3:15
14	Safeguards Approach for LEU/MOX Fuel Fabrication Facility	Johnna Marlow, Martyn Swinhoe	Tues. July 1, 3:15-4:30
15	Safeguards approaches for Reprocessing	Scott DeMuth.	Thurs. July 3, 2:00-3:15
16	Advanced Safeguards Approaches – New Approaches, GNEP Facilities	Mike Miller	Thurs. July 3, 3:15-4:30

Instructors for the pilot course include staff from LANL, LLNL and TAMU. A list of instructors and their specialties is included below:
Bill Charlton (TAMU)

- Brian Boyer, Michael Browne, Tom Burr, Scott Demuth, Phil Hypes, Arvid Lundy, Johnna Marlow, MikeMiller, Frank Pabian, Rebecca Stevens, Martyn Swinhoe. Ken Thomas, Steve Tobin (LANL)
- Jim Tape (consultant)
- John Howell (University of Glasgow)
- Ross Williams (LLNL)

For evaluation purposes, some of these lectures were videotaped and will be used to improve the lectures and possibly expand distance learning and outreach for technical safeguards instruction. The presentation materials are included on the attached CD.

IV. Week-long Technical Practicum

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 will gain hands-on technical

safeguards training using nuclear materials. The LLNL students traveled to LANL to participate. The schedule for was:

	AM	PM
Monday 7/7	Centrifuge Enrichment Plant Tabletop Exercise	Gamma Spectroscopy Basics
Tuesday 7/8	U Enrichment Exercises	U Enrichment Exercises
Wednesday 7/9	Reprocessing Plant Tabletop Exercise	Pu Gamma Exercise
Thursday 7/10	Passive Neutron Exercises	Active Neutron Exercises
Friday 7/11	Calorimetry/Microcalorimetry	Portal Monitors, Nanodetectors

B. 2008 International Nuclear Safeguards Policy and Information Analysis Course and Internships

Elena Sokova, Lawrence Scheinman, Fred Wehling (MIIS/CNS)
Jonathan Essner, Geroge Anzelon, Mona Dreicer (LLNL)

I. Introduction

The James Martin Center for Nonproliferation Studies (CNS) at the Monterey Institute of International Studies and Lawrence Livermore National Laboratory (LLNL) designed a pilot course on international nuclear safeguards policy issues offered on June 2-13, 2008 in Monterey. The course was developed and implemented as part of the Next Generation Safeguards Initiative to contribute to the development of viable international safeguards career paths and solid curricula for a wide range of professionals, who will be performing safeguards-related responsibilities in the U.S. nuclear industry and across the federal government, as well as at the International Atomic Energy Agency and other international organizations.

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. As a complement to the technically focused LANL-TAMU course, the LLNL-MIIS 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. In addition, 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:

- Concepts, objectives, and history of nuclear safeguards
- Negotiation of safeguards agreements
- Safeguards technology and techniques: concepts, approaches and practices
- Safeguards information and evaluation
- Effectiveness and limitations of safeguards
- Future development of safeguards.

A suggested reading list was provided to the students and 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 Los Angeles, one postdoctoral fellow from Stanford University, and a junior officer from the International Atomic Energy Agency. Students represented the following countries: Greece, Indonesia, Italy, Republic of Korea, Peru, Romania, Russian Federation, Spain, and the United States.

Four course participants were selected for 2-month internships at the Livermore National Laboratory (June 16th - August 15th). These students completed research papers and posters presenting a summary of their work at the Student Safeguards Symposium at LLNL on August 14, 2008.

II. Student Participation in the Course

Name	Nationality	School	Degree Status	Major	Other Nonproliferation Experience
Amlin, Kate	U.S.	MIIS	4th Semester	IPS/Nonproliferation	CNS GRA (9/07-present); peer reviewer for WMD articles for "Ethics & Int'l Affairs" journal; 5/06-8/06 Research Intern at Pugwash U.S.A.; 6/05-8/05 Research Intern at the Arms Control Association; 6/03-8/03 Intern at Wayne State Univ. Center for Peace & Conflict Studies
Bainter, Zachary	U.S.	UCLA	Upper Division Undergraduate	Political Science & History	Intern at Hudson Institute
Belousova, Ksenia	Russia	MIIS	3rd Semester	IPS/Nonproliferation	CNS GRA; 3/04-12/04 worked at IAEA, Dept. of Safeguard, Office of Nuclear Security & Dept. of Technical Cooperation

continued **Name**	**Nationality**	**School**	**Degree Status**	**Major**	**Other Nonproliferation Experience**
Feldman, Yana	U.S.	IAEA - JPO Program	PhD from UC San Diego; M.Sc. From London School Economics; B.S. from UC Berkeley (Chemistry)	Political Science / International Relations	Courses in Disarmament & Arms Control
Gouveia, Fernando	U.S.	MIIS	2nd Semester	IPS/Nonproliferation	CNS GRA
Hamedan, Hamdan	Indonesia	MIIS	3rd Semester	IPS/Terrorism Studies	Several nonproliferation courses
Horovitz, Liviu	Romania	MIIS	3rd Semester	IPS/Nonproliferation	IAEA Internship during fall 2007
Kim, Insook	South Korea	MIIS	4th Semester	IPS/Nonproliferation	IAEA Internship 8/06-7/07; CNS GRA
Moore, William	U.S.	MIIS	2nd Semester	IPS/Nonproliferation	Completed Masters Certificate Program in International Security at Stanford University in 2006
Oliver, Shari	U.S.	MIIS	4th Semester	IPS/Nonproliferation	GRA at CNS; Sub-Contractor at First Watch International duirng summer 2007;
Peranteau, David	U.S.	MIIS	3rd Semester	IPS/Nonproliferation	GRA at CNS; Nuclear Scholars Initiative Fellow with Project on Nuclear Issues at CSIS in Washington, DC (1/08 - present); Editor-in-chief of World Outlook (journal of undergraduate scholarship dealing with international security issues);

continued **Name**	**Nationality**	**School**	**Degree Status**	**Major**	**Other Nonproliferation Experience**
Quamme, Jacob	U.S.	MIIS	4th Semester	IPS/ Nonproliferation	GRA at CNS (2006-present); Internship at the Center for Defense Information during summer 2007;
Rengifo, Christhian	Peru	MIIS	Certificate Student; also holds degrees in Political Science from the University of Vienna	IPS/Nonproliferation	CNS GRA; IAEA employment; awarded scholarship to attend the "INMM-ANS 8th International Conference on Facility Operations-Safeguards Interface"
Rodriguez-Vieitez, Elena	Spain	UC Berkeley	PhD (December 2007)	Nuclear Engineering	Postdoctorial Fellow at CISAC (2007-2008); Internship at National Academy of Science, Board on Radioactive Waste Management (2000); Research Assistant at UC Berkeley Neutronics Lab (2001-2002) and Lawrence Berkeley National Laboraroty (2003-2007)
Savvidis, Vasileios	Greece	MIIS	2nd Semester	IPS/Nonproliferation	Took several courses in arms control and disarmament prior to enrolling at MIIS
Soderini, Giuliano	Australia	MIIS	Graduated December 2007	IPS/Nonproliferation	Internship at WMD branch of UNODA (Summer 2006); Internship with CTBTO in fall 2006; Research & Outreach Intern - Global Resource Action Center for the Environment (12/04 - 5/05); CNS GRA from 8/05-12/07; Consultant at UNODA 2/08 - 5/08

III. Course Curriculum and Instructors for International Nuclear Safeguards Policy Course (June 2-13, 2008) – Lecture materials provided on attached CD.

Date	**Part I** **9:00--10:30 am**	**Part II** **11:00 am--12:30 pm**	**Part III** (time noted for each activity)
June 2	Technical intro part 1 (Fred Wehling, MIIS)	Concept of international safeguards (Larry Scheinman, MIIS/CNS)	**1:30--2:30 pm** Reserved for extracurricular activities
June 3	Technical intro part 2 (FW)	Atoms for Peace safeguards/ Bilateral safeguards (LS)	**1:30--2:30 pm** Reserved for extracurricular activities
June 4	IAEA safeguards before NPT (LS)	Comprehensive Safeguards Agreements (153) (LS)	**1:30--2:30 pm** Reserved for extracurricular activities
June 5	Comprehensive Safeguards Agreements (153) (LS)	Regional Verification Mechanisms (Christhian Rengifo and LS, MIIS/CNS)	**1:30--2:30 pm** Reserved for extracurricular activities
June 6	Verifying Nuclear Weapons Free Zones (Jean De Preez, MIIS/CNS)	Working for the IAEA: JPO Experience, Yana Feldman, IAEA	
June 9	Safeguards Technology and Techniques: Concepts, Approaches and Practices (Rich Hooper, Wind River Consulting)	Safeguards Technologies and Techniques: Material accountancy, C&S, tags & seals etc. How does all of this work in the field (Brian Boyer, LANL)	**1:30--2:30 pm** Exercise 1 (preparation)
June 10	Iraq and 93+2 (LS and Bill Domke, LLNL)	Additional Protocol (RH)	**1:30--2:30 pm** Exercise 1 (presentation)
June 11	Safeguards Information and Evaluation: The Beginnings of State-Level Evaluation (George Anzelon, LLNL)	Safeguards Information and Evaluation: Open Source Information and its Evaluation in IAEA Safeguards (Jon Essner, LLNL)	**1:30--2:30 pm** Exercise 2 (preparation)
June 12	Safeguards Information and Evaluation: Other Non-Traditional Information Sources for Safeguards (GA)	Safeguards Information and Evaluation: Putting it all together: the State Evaluation Process (Rick Wallace, LANL)	**2:00--3:00 pm** Exercise 2 (presentation) **3:00 pm -** reception
June 13	Current trends & challenges (Michael Rosenthal, BNL)	Review for final assignment & course evaluations (all)	

Instructors:
Dr. Lawrence Scheinman, Dr. Fred Wehling, Dr. Jean DuPreez, Christhian Rengifo (MIIS)
Michael Rosenthal (BNL)
Richard Wallace, Brian Boyer (LANL)
Richard Hooper (consultant)
George Anzelon, Jonathan Essner, Bill Domke (LLNL)
Yana Feldman (IAEA)

V. Summer Internship

Four students participating in the International Nuclear Safeguards Policy course at MIIS were selected for an eight-week pilot internship program at LLNL. The interns in this program were paid a small stipend by MIIS, and LLNL provided office space at LLNL and mentorship. To keep things manageable for this first year's program which was stood up fairly quickly, we limited the program to four students. The mentors this year were Mona Dreicer, Jon Essner, and George Anzelon. In addition, Bill Domke and Neil Joeck spent time with the students and provided useful lectures for them in a small-group setting. The four interns were selected from a competitive field based on past academic performance, recommendations from faculty and other references, and demonstrated interest in international safeguards and nonproliferation.

Each for the four interns are new MIIS graduates or continuing MIIS students. Based on individual's backgrounds and interests, we matched them up with research topics that we had selected for their relevance to topics of relevance to the NGSI roadmap and anticipated NA-243 priorities. The output of each of the projects was a paper, as well as a poster presented at the NGSI Student Symposium. The four summer intern's projects are summarized below and their posters are included in Appendix 1.

--David Peranteau conducted an analysis of options for backup IAEA safeguards for states that withdraw from the NPT. David's paper is really well done and probably is publishable. (By the way, David starts a 6-month internship at the IAEA at the end of August, so we should keep track of his progress there.)

--Ferndando Gouveia conducted an analysis of the IAEA's use of its access authorities in investigating undeclared activities. He assessed the contributing causes to the IAEA's preference for "technical visits" over explicit special inspections, and he presents recommendations for ways to encourage greater use of special inspections, especially in non-AP states.

--Bill Moore assessed the ways in which the Nuclear Suppliers Group could contribute to restraint on the spread of new enrichment and reprocessing capabilities and to promotion of safeguards best practices, as well as areas where the NSG control lists may need to be updated.

--Jacob Quamme examined the question of whether, in the event that agreement were eventually to be reached on a FMCT that included verification provisions, the IAEA would be a likely choice to implement the verification provisions. He drew on case studies like the decision to establish a new CTBTO for CTBT verification rather than use the IAEA, and the development of information-barrier technologies under the trilateral initiative, and summarized pros and cons for an IAEA role in a FMCT.

C. NGSI Student Symposium and tours at LLNL

The final activity for the two NGSI summer pilot courses and internships was a symposium at LLNL during which students shared highlights of their training experience and described the results of their internship projects. The first Radiochemisty/Environmental Sampling Summer Course held at LLNL (funded by NA-241), joined the LANL-TAMU-LLNL and MIIS-LLNL students. The intention of this activity was to bring the different pilots together to facilitate cross-communication between the policy and technology tracts, in addition to exercising public presentation skills in a lower key poster environment. Three judges critically reviewed the poster content, presentation an short oral presentations and chose the three "Best Posters". The final agenda of the 2-day activity was as follows:

Wednesday, August 13

- Opening comments and Overview of LLNL and Global Security:

Michael Carter (LLNL, Deputy Principal Associate Director for Global Security Programs)

- Overview of the two days – Mona Dreicer (LLNL, Program Manager, Nonproliferation and International Security)
- Group Photo
- Tours
    - National Ignition Facility (NIF)
    - Center for Accelerator Mass Spectrometry (CAMS)
    - National Atmospheric Release Advisory Center (NARAC)
    - Ultraspec Lab
    - GEMini Lab
    - RFID Lab
    - Network of Analytical Laboratories (NWAL)- Environmental Sampling Laboratory
- Evening – Reception

Descriptions of the four safeguards-oriented tours are, as follows:

RFID Lab (PI: Faranak Nekoogar)

The concept of Radio Frequency Identification (RFID) and the technology and applications related to safeguard activities will be presented. Commercial RFID tags and readers will be demonstrated along with a discussion of their capabilities and limitations with respect to safeguard applications. The LLNL ultra-wideband (UWB) RFID technology will be discussed and shown in a 3-minute video of the LLNL UWB RFID technology.

Ultraspec Lab (PI: Stephan Friedrich)

At the UltraSpec Lab, we are developing superconducting Gamma-ray and fast-neutron detector operated at temperatures of ~0.1 K, close to absolute zero. These low operating temperatures enable detectors with extremely high energy resolution, more than an order of magnitude higher than conventional high-purity germanium detectors. This can improve the accuracy of non-destructive isotope analysis in complicated actinide mixtures for nuclear safeguards and forensics applications.

GeMini Lab (PI: Morgan Burks)

Our lab specializes in detector instrumentation for gamma-ray spectroscopy and gamma-ray imaging. In particular, we focus on high-resolution germanium-based systems and develop both the electrical and mechanical aspects. Current projects include a hand-held mechanically-cooled spectrometer, a segmented imaging system and a segmented coaxial detector used for both gamma and neutron detection.

Network of Analytical Laboratories (NWAL) Facilities (PI: Ross Williams)

The LLNL (Network Analytical Laboratory) NWAL is really a collection of analytical facilities rather than a single laboratory. These facilities include the gamma spectrometry/nuclear counting laboratory, an ordinary radiochemistry laboratory for handling the higher activity samples, and three laboratories within the clean-room complex for sample preparation chemistry and mass spectrometry. Information on the activity levels of the bulk environmental samples taken for safeguards is provided to the NWAL by the IAEA before shipping. The gamma spectrometry analyses are done first, without removing the samples from their plastic bags. The combined information from these first analyses will determine which laboratory is used to decompose the sample and do the chemical separations and purifications for the mass spectrometric measurements of uranium and plutonium.

Thursday – August 14, 2008

- Opening remarks
  - Joanna Sellen (NA-24)
  - David McCallen (LLNL, Director or Nonproliferation Programs)

- *Morning Poster Session (Detection Technology in Support of International Safeguards)*
  1. Field-Expedient Moderators for Neutron Source Evaluation (Bonner) ***(Awarded Best Poster)***
  2. FWHM Resolution and Testing of the GeMini Detector (Garnetti)
  3. Nuclear Characterization of Nano-composite Scintillators (Schear)
  4. Direction Sensitive Neutron Detector (Spence)
  5. Software development for Ultraspec- an ultra high resolution cyrogenic gamma and neutron detection system (Sternat)
  6. Measurements using AVIS (Strohmeyer)
  7. Using Safeguards Analytical Methods to Determine Legacy Contamination (Alsobrook, Dokic, Klug, Morris)

- Lunch & General Discussion of Lessons Learned/Feedback

- *Afternoon Poster Session: Safeguards Implementation (Technical application and Policy)*
  1. Measuring Gaseous Centrifuge Enrichment using Doubles and Singles counting at the Cold Trap (Freeman)
  2. NDA Calculations for the Characterization of Spent Fuel Assemblies (De La Cruz, Sandoval, Rajasingam,)
  3. Special Inspections, Technical Visits and the IAEA (Gouveia)
  4. Compatibility between the Nuclear Supplier Group and the Global Nuclear Energy Partnership (Moore)

5. Development of Isotopic Taggants for Uranium Fuel (Sweeney) ***(Awarded Best Poster)***
6. NPT Withdrawal and the Impact on IAEA Safeguards (Peranteau) ***(Awarded Best Poster)***
7. Feasibility of Expanding the IAEA's verification role (Quamme)

- Closing remarks
  - Announcement of Best Posters
    (Judges: Brain Boyer (LLNL), William Charleton (TAMU) Fred Wehling (MIIS))
  - Collection of Evaluation Forms (see Appendix

D. Lessons Learned and next steps

On August 15th, the organizers of the two 2008 NGSI Pilots met to take stock and review lessons learned. The meeting was attended by: Jon Essner, George Anzelon, Mona Dreicer, Arden Dougan (LLNL), Elena Sokova, Fred Wehling (MIIS), Jim Doyle, Brian Boyer (LANL) and Bill Charlton (TAMU). The discussion was organized to address:

1) Goals and Focus:
- Goals and objectives of each course (would we change anything?)
- Synergies we be/Can the two pilots be more inter-connected? (technical and social sciences integration)
  - Lectures
  - Practical exercises
  - Intern projects
- Course and internship linkages (assignments, difficulty)
- Inclusion of students not participating in courses.

2) Lessons learned:
- What should be done differently?
  - Recruiting (how wide, when to start)
  - Intern assignments (length, direction/mentoring, integration with course work)
  - Lectures (how did they go? What should we add/delete)
  - Practical exercises (length, difficulty, connection between subject areas)
  - Lecturers (should we cast a wider net for lecturers?)
- Funding

3) Leverage:
- Should we expand the courses or work to refine what we have?
- Can the lectures/courses be put on the road (given NA-24's desire to fund others)
  - Different audiences in U.S. – define better
  - International infrastructure development (NA-242) – what should be modified/expanded? This is needed.
- Links to NGSI and Laboratory projects
- TAMU and MIIS plans – how to connect?

A summary of some of the key points that were agreed upon:

- Further formal evaluation and documentation of the courses is needed for future development of the courses. This should include establishing behavior learning objectives, defining entry competence for courses compilation of course materials, ensuring less course material overlap, and greater leveraging/sharing between policy and technology courses. Further consideration is needed with regards to length of courses, amount of material to be included, and improvements to distance learning format.
- Clearly define the objectives for the internships – consider funding year-long work to continue while student is at school.
- We will be able to initiative planning and broader recruiting at an earlier stage, if the follow-on activities are approved for FY09.
- An area where we could make a great contribution would be to better develop and document hands-on exercises for courses/internships and consider creation of a joint Policy-Technology exercise to bring groups together (e.g. mock state assessment exercise using technical data/expertise, information analysis and policy expertise).
- We believe that the development of course material/modules would be the most efficient use of resources and would best target different student and/or mid-career target populations. This format would be the most useful in propagating the use of the materials developed for other universities and NGSI venues. The development of some modules may start in the second year of the project (particularly of some basic technical and policy introduction modules). Our initial discussions are outlined in the table.

Beginner Modules
What is safeguards and what is not. – should be addressed
• Fuel cycle basics (include weapons technology, or as a separate course or weekend workshop) – look to use Rick G's Nonproliferation course material, if available.
• Nuclear detector technology basics
• Safeguards Policy basics - International Safeguards in the context of the international regime
• Awareness of physical protection system should be included – maybe not standalone
Medium Expertise Modules
• Safeguards challenges- Case Studies. good cross-over course between technical and policy students. Involve NPG interns and NA-24 folks.
• Safeguards system course (NDA, statistics, why and wherefore, how you set up a safeguards approach for a facility systems analysis safeguards by design
• NDA instrumentation module – quantification of nuclear materials
• DA, environmental sampling MSpect,Hybrid K-edge,
Advanced Expertise Modules
• Technical satellite science, technology imagery analysis, emerging technologies, prospects and challenges of using it in a safeguards context.
• Advanced level NDA
• Advanced Containment and Surveillance technology
• Modeling and Simulation

• State evaluation, information analysis, how to think about analysis, resolving disparate information, logically and defensively analyze data to come to a conclusion. How to deal with those parts of the information stream not coming out of safeguards (or deterministic sources) 'open source". Setting safeguards priorities. Three modules:
o Collection finding a processing open source information – find collect evaluate a source – information input (research methods) commercial satellite technology evaluation
o Evaluation/analytical – country level safeguards approach
o State Analysis at the country level

Appendix 1: Examples of some of the Intern Project Descriptions and Posters

A. LANL Students

Eric Rauch
I have worked on two projects this summer, one which monitors the Uranyl Nitrate flow at a Uranium Conversion plant and the other is the High Enrichment Uranium Detector Array (HEUDA). For the Uranyl Nitrate system, I tuned the already built detector by adjusting the gain and finding the proper voltage for its test run at Oak Ridge. For HEUDA, I gathered testing data by placing a neutron source in varying locations to measure detector response. This work was mainly to characterize the detector system for further application and development.

Marisa Sandoval
This summer I have been working with mentors Brian Boyer and Rebecca Stevens, with the help of students Analisa Sandoval and Eva Uribe, on a project of the Additional Protocol implementation training for DOE laboratories. After conducting extensive open source research on Lawrence Livermore National Laboratory in relation to their IAEA Declaration Line Items, I compiled a list of questions for a mock inspection of the Lab. With these questions and relevant information, the AP implementation training could proceed at LLNL. Following this project, I assisted in open source research regarding research reactor technology in Iran for a proposed N-4 database. Currently, and for the rest of the summer, I will continue to aid my mentors in the AP training and continue with open source research. Lastly, I participated in the Pilot Safeguards Training Course managed by Jim Doyle at Los Alamos National Laboratory.

Corey Freeman
The majority of my time this summer was spent on one of Bill Geist projects determining the feasibility of detecting the output enrichment of a gaseous centrifuge plant by using a coincidence counter at the exit cold trap. After filling a product cylinder the small quantity of UF6 that remains in the piping is sent to the cold trap where it is collected. The benefit of taking measurements at the cold trap is that it does not require any entry into the cascade hall where proprietary equipment is kept. With a coincidence counter the ratio of doubles counts (from spontaneous fission of U-238) and singles counts (from alpha, n reactions instigated by U-234) is taken. With this measurement (along with other information from the plant) it is hopeful that some degree of assurance can be gained that the enrichment plant is not producing HEU.

Analisa Sandoval
In preparation for the US ratification of the Additional Protocol, Oak Ridge, Lawrence Livermore, and Idaho National Labs are participating in a training course on complimentary access. In order to ensure that all field element personnel are aware of the CA procedures the training course includes a mock inspection. As part of these mock inspections, we have been looking at each labs DLIs and completing extensive open source research on each declaration. This open source research investigates the level of granularity and any inconsistencies within the DLIs that could initiate a CA visit. Our search is intended to mirror the open source research that would be performed at the IAEA prior to a Complimentary Access visit to the National Labs

Eva Uribe
This summer the U.S. national laboratories are preparing for the implementation of the Additional Protocol, which includes the possibility of Complementary Access granted to IAEA inspectors. As the United States is defined as a nuclear weapons state under the NPT, implementation of the Additional Protocol in the United States is intended to encourage international cooperation with the nonproliferation regime. However, security is the top priority, and as IAEA inspectors are foreign nationals, their potential access to U.S. national labs must be carefully planned and restricted according to our security needs. A team from Los Alamos National Laboratory and Brookhaven National Laboratory including Brian Boyer, Rebecca Stevens, Jae Jo, and John Valente are assisting the labs' preparation for implementation of the AP. As part of this preparation, they will be conducting mock inspections so that the laboratories may test and practice their security measures. As a student under the mentorship of Brian Boyer, I have assisted him in collecting open source articles on the direct line items (DLIs) declared by Idaho National Laboratory for the implementation of the AP, primarily focusing upon INL's collaboration with the Korean Atomic Energy Research Institute (KAERI) in the area of pyroprocessing.

Akshayan Rajasingam
Goal for my project is to model X-ray fluorescence (XRF) measurements of spent fuel on MCNPX. To do this I need to evaluate how well MCNPX can model XRF measurements. For this I am constructing a simple geometry and running an XRF simulation, and comparing my MCNPX results to Andrew Hoover's GEANT4 simulation results of the same model.

B Student Posters on attached CD

<u>*LLNL Intern Posters*</u>

TAMU
David Garnetti
Mathew Sternat
David Sweeney (Best Poster)

MIIS
Fernando Gouviea
William Moore
Jacob Quamme
David Peranteau (Best Poster)

Environmental Analysis for the IAEA
Andrea Alsobrook, Denia Djokic, Chris Klug, Wesley Morris

<u>*LANL Intern Posters*</u>

Elisa Bonner (Best Poster)

Appendix 2: Results of evaluations/feedback

8. LANL/TAMU Practicum

The following questions were posed to the students participating in the hands-on exercise held at LANL from July 7 through 11, 2008.

- Please rate (on a scale of 1 to 10) the teaching skills of the instructors, quality of the handout, and quality of the equipment/facility.
- Are there any topics that you wish had been given more time in the schedule?
- Are there any topics that had too much time in the schedule?
- Are there any questions about or aspects of Nondestructive Assay that we did not answer during the course?
- Should the course be shorter? Longer?
- Was the ratio of lab time to lecture time appropriate? Should we include formal lectures?
- What is your level of education?
- What is your degree in?
- Please provide any other comments you would like is to consider:

The student input was very positive. Most of the suggested changes centered around addressing the differing levels of student expertise. It was suggested by quite a few students that there 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 time to "play" more with the equipment would be advantageous. Details of the results can be provided upon request.

9. MIIS/LLNL Safeguards Policy and Information Analysis Course

Students in the safeguards course at MIIS were given the opportunity to participate in an evaluation survey. Fourteen of the 16 students taking the course completed the 20-question survey (yielding a response rate of 87.5%), which asked for both quantitative ratings and qualitative comments on course content, organization, activities and assignments, readings, performance of the instructors, and other aspects of the course. Responses to the survey questions asking for general impressions of the course as a whole yielded the following results: the first pilot course on nuclear safeguards policy and information analysis at MIIS (June 2-13, 2008) was positively evaluated by student participants (over 4.0 out of 5.0 possible), including overall course contribution to their learning at 4.21; overall instructors performance at 4.28; and overall course organization at 4.14.

Many students expressed their appreciation for the offering of the course, 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 hands-on experience. Among the suggestions offered for the future courses were:

a. Even greater participation of experts from national laboratories and those with in the field experience;
b. More hands-on, interactive exercises
c. Less focus on history, more on contemporary issues
d. More technical material on the nuclear fuel cycle
e. More compact schedule (shorter but more intense).

Students also demonstrated high interest in practical exercises developed for the course and recommended expanding practical exercises to include a hands-on exercise on state evaluations based on either earlier cases (Iraq) or on mock data developed specifically for such exercise.

10. Over all Pilot Evaluation for all Safeguards related efforts – input collected at Student Symposium at LLNL

At the end of the 2008 NGSI Student Symposium, we asked that the student complete an Evaluation form that asked them to evaluate, on a scale from Poor to Excellent, the following questions:

- Organization of the internship was…
- Clarity and usefulness of presentation and materials for the LANL/TAMU/LLNL lectures was…
- Difficulty level of Lecture Material was…
- Overall Instructor Performance of lectures was… (how can we improve)
- Contribution of the LANL Lab/Tabletop Practical Experience to our understanding of the material was…
- Length of Internship was…
- Do you think the balance between time spent on lecture material vs research /hands on research was right?
- Guidance you received complete in your summer projects was… (did you get enough mentoring and support?)
- The course and internship contribution to your knowledge or skill related to nonproliferation and international safeguards has been…
- Overall, this experience was…
- What did you like most about this summer pilot program?
- What did you like least?
- Will this experience influence your future studies or career interests?
- Can you imagine working at a national laboratory after you graduate?
- Would you be interested in additional opportunities related to international safeguard training? If so, please provide some examples of what you would like to see.

The student population for this evaluation was a mix of three pilot programs that were conducted at LLNL and LANL, so the feedback was more diverse. Again, we heard about the need to target different levels of expertise related to policy and technical

capabilities but also the interest in more appropriate level of training in the area that was not the primary interest of the student (e.g. a policy student getting more appropriate level of exposure to technical issues). There was considerable interest in bringing together the three focused training groups at an earlier stage in the internship and providing opportunities to work together. This has been the core of the idea to design an student exercise that will require policy, technical and analytical capabilities to be utilized during the 2009 intern program.

Appendix 3: MIIS-CNS Course Reading Assignments

Concept of International Safeguards (June 2, Session 1)

Atomic Energy - Agreed Declaration by the President of the United States, the Prime Minister of the United Kingdom, and the Prime Minister of Canada (November 1945) Available at http://www.treaty-accord.gc.ca/ViewTreaty.asp?Treaty_ID=104149

"Establishment of a Commission to deal with the problems raised by the Discovery of Atomic Energy" (January 1946) Available at http://www.icanw.org/1946

The Acheson-Lilienthal Report. Report on the International Control of Atomic Energy (March 1946) Available at http://www.learnworld.com/ZNW/LWText.Acheson-Lilienthal.html#nuclear

Baruch Plan (June 1946) Available at http://www.atomicarchive.com/Docs/Deterrence/BaruchPlan.shtml

Technical Intro (June 2, Session 2 and June 3, Session 2)

Nuclear Safeguards and the International Atomic Energy Agency. U.S. Congress, Office of Technology Assessment, OTA-ISS-615 (Washington, DC: U.S. Government Printing Office, June 1995). Available at http://igcc.ucsd.edu/pdf/OTA-ISS-615.pdf

Ane Håkansson and Thomas Jonter. An Introduction to Nuclear Non-Proliferation and Safeguards. Published by the Swedish Regulatory Body-SKI (June 2007) Available at http://www.ski.se/dynamaster/file_archive/080328/4fee8e8398b71cca5bcb38ac2e3bcabd/SKI%202007-44%20web.pdf

Atoms for Peace / 1954 US Atomic Energy Act / Bilateral agreements and safeguards (June 3, Session 1)

Atoms for peace speech (December 1953) Available at http://www.iaea.org/About/history_speech.html

The United States Atomic Energy Act of 1954, chapter 11 "International Activities" Available at http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/ml022200075-vol1.pdf

IAEA Safeguards before NPT (June 4, Session 1)

Lawrence Scheinman. The International Atomic Energy Agency and World Nuclear Order. (Washington DC: John Hopkins University Press, 1987), chapter 4: "The Agency's safeguards system before the NPT" Available on e-Reserve.

Comprehensive Safeguards Agreements (June 4, Session 2 and June 5, Session 1)

David Fischer and Paul Szasz. Edited by Josef Goldblat. Safeguarding the Atom: A critical appraisal. (USA: Taylor & Francis, 1985), chapter 4: "The technical basis", pp. 23-33. Available on e-Reserve.

Lawrence Scheinman. The International Atomic Energy Agency and World Nuclear Order. (Washington DC: John Hopkins University Press, 1987), chapter 5: "NPT Safeguards". Available on e-Reserve.

Regional Verification Mechanisms (June 5, Session 2)

E. Palacios et al. "The Experience of ABACC after ten years applying Safeguards" 2001 IAEA Symposium in International Safeguards. Available at http://www-pub.iaea.org/MTCD/publications/PDF/ss-2001/PDF%20files/Session%2011/Paper%2011-03.pdf

Bharat Patel et al. "Fifty Years of Safeguards under the EURATOM Treaty – A Regulatory Review" ESARDA Bulletin No. 36 (2007) Available at http://esarda2.jrc.it/db_proceeding/mfile/B_2007_036_02.pdf

Verifying Nuclear Weapons Free-Zones (June 6, Session 1)

Hans Blix. "The IAEA full scope Safeguards Agreements and compliance with them by Parties to the Nuclear Weapon-Free Zones" (1997) Available at http://www.opanal.org/Articles/Aniv-30/blix.htm

Michael Crowley. "Steps towards a Middle East WMD Free Zone— examining verification and national implementation measures" (2006) Available at http://www.vertic.org/assets/MC%20-%20SOAS%20BrPugwash%20conference%20Middle%20East%20WMDFZ%207%20Nov%2006.pdf

Working for the IAEA: JPO Experience (June 6, Session 2)

Nuclear Safeguards Technology and Techniques (June 9, Sessions 1 and 2)

IAEA Safeguards Glossary (2001 edition) Available at http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdfn

IAEA Safeguards Techniques and Equipment (2003 edition) Available at http://www-pub.iaea.org/MTCD/publications/PDF/NVS1-2003_web.pdf

Iraq, 93+2 and Additional Protocol (June 10, Sessions 1 and 2)

Richard Hooper. "Strengthening IAEA safeguards in an Era of Nuclear Cooperation". Arms Control Today, November 1994, pp. 14-18. Available on e-Reserve.

Richard Hooper. "The IAEA's Additional Protocol" Disarmament Forum. (1999, no. 3), pp. 7-16. Available at http://www.unidir.org/pdf/articles/pdf-art209.pdf

Reinhard Loosch. "From "Programme 93+2" to Model Protocol INFCIRC/540: Negotiating for a Multilateral Agreement in the International Atomic Energy Agency", in Erwin Hackel and Gotthard Stein, editors. Tightening the Reins: Toward a strengthened International Nuclear Safeguards System (Germany: Springer, 2000), pp. 23-66. Available on e-Reserve.

Rudiger Gerstler et al. "Aspects of Integrating INFCIRC/153 and INFCIRC/540", in Erwin Hackel and Gotthard Stein, editors. Tightening the Reins: Toward a strengthened International Nuclear Safeguards System (Germany: Springer, 2000), pp. 77-88. Available on e-Reserve.

Bruno Pellaud. "The strengthened safeguards System: Objectives, Challenges and Expectations", in Erwin Hackel and Gotthard Stein, editors. Tightening the Reins: Toward a strengthened International Nuclear Safeguards System (Germany: Springer, 2000), pp. 89-98. Available on e-Reserve.

Laura Rockwood**,** "The IAEA's Strengthened Safeguards System" Journal of Conflict and Security Law (2002), Vol. 7No. 1, 123-136. Available on e-Reserve.

Richard Hooper. "The changing Nature of Safeguards" IAEA Bulletin 45/1 (June 2003), pp. 7-11. Available at http://www.iaea.org/Publications/Magazines/Bulletin/Bull451/article2.pdf

Jill Cooley. "Integrated nuclear safeguards: Genesis and evolution" Verification Yearbook 2003, pp. 29-44. Available at http://www.vertic.org/assets/YB03/VY03_Cooley.pdf

Theodore Hirsch, "The Additional Protocol: What It Is and Why It Matters," Nonproliferation Review, Fall-Winter 2004. Available at http://cns.miis.edu/pubs/npr/vol11/113/113hirsch.pdf

Jill Cooley "International Atomic Energy Agency Safeguards under the Treaty on the Non-Proliferation of Nuclear Weapons: Challenges and Implementation", in Rudolf Avenhaus et al., editors. Verifying Treaty Compliance: Limiting Weapons of Mass Destruction and Monitoring Kyoto Protocol Provisions (Germany: Springer, 2006), pp. 61-76. Available on e-Reserve.

Jaques Baute "A concrete experience: The Iraq case", in Rudolf Avenhaus et al., editors. Verifying Treaty Compliance: Limiting Weapons of Mass Destruction and Monitoring Kyoto Protocol Provisions (Germany: Springer, 2006), pp. 235-257. Available on e-Reserve.

Nuclear Safeguards Information and Evaluation (June 11 and 12)

A. Nilsson et al. "Information Analysis – A key Element in Integrated Safeguards: Progress and Advances" INMM 40th Annual Meeting, 1999. Available on e-Reserve.

K. Chitumbo. "Information Analysis in the Strengthened Safeguards System" 2001 IAEA Symposium in International Safeguards. Available at http://www-pub.iaea.org/MTCD/publications/PDF/SS-2001/PDF%20files/Session%2013/Paper%2013-01.pdf

John Lepingwell et al. **"**Processing of Additional Protocol Declarations" INMM 45th Annual Meeting, 2004. Available on e-Reserve.

John Lepingwell **"**Information Analysis for Additional Protocol Evaluation" INMM 45th Annual Meeting, 2004. Available on e-Reserve.
Michel Richard et al. "Information Collection and Analysis: The National Level" INMM 47th Annual Meeting, 2006. Available on e-Reserve.

Jaques Baute. " Information Management for Nuclear Verification: How to make it work in a sustainable manner" Journal of the Institute of Nuclear Materials Management. Summer 2007, Volume XXXV, No. 4, pp. 115-123. Available on e-Reserve.

Current trends and Challenges (June 13, Session 1)

Nuclear nonproliferation: IAEA Has Strengthened Its Safeguards and Nuclear Security Programs, but Weaknesses Need to Be Addressed. GAO Report (October 2005) http://www.gao.gov/new.items/d0693.pdf

Nuclear nonproliferation: IAEA Safeguards and Other Measures to Halt the Spread of Nuclear Weapons and Material. GAO Report (September 2006) Available at http://www.gao.gov/new.items/d061128t.pdf

Henry Sokolski. "Assessing the IAEA's ability to verify the NPT", in Henry Sokolski (Editor) Falling Behind: International Scrutiny of the Peaceful Atom (USA: Nonproliferation Education Center, 2008). Available at http://www.npec-web.org/Frameset.asp?PageType=Books&BookID=-1009596920

20/20 Visions for the Future. Background Report by the Director General for the Commission of Eminent Persons (February 2008) Available on e-Reserve.

Report of the Commission of Eminent Persons on the Future of the Agency. GOV/2008/22-GC(52)/INF/4 (May 2008) Available on e-Reserve

Complementary readings

General Arms Control

Alan Krass. Verification: How much is enough? (UK: Taylor and Francis, 1985), Introduction. Available at http://books.sipri.org/product_info?c_product_id=234

Jeffrey A. Larsen. "An introduction to Arms Control", in Jeffrey A. Larsen (Editor) Arms Control: Cooperative Security in a changing environment (London: Lynne Rienner Publishers, 2002), pp. 1-15. Available on e-Reserve.

General Nuclear Safeguards

David Fischer, "History of the International Atomic Energy Agency: The First Forty Years," (Vienna: IAEA, 1997), chapter 8: Nuclear Safeguards. Available at http://www-pub.iaea.org/MTCD/publications/PDF/Pub1032_web.pdf

"The Evolution of IAEA Safeguards", International Nuclear Verification Series No. 2, IAEA, Vienna, 1998. Available at http://www-pub.iaea.org/MTCD/publications/PDF/NVS2_web.pdf

Lawrence Scheinman. "Cooperative Oversight of Dangerous Technologies: Lessons from the International Atomic Energy Agency Safeguards System" (University of Maryland, January 2005) Available at http://www.cissm.umd.edu/papers/files/scheinman2005.pdf

Laura Rockwood. "Safeguards and Nonproliferation: The first half-century from a legal perspective" Journal of Nuclear Materials Management. Summer 2007, Vol. XXXV, Number 4, pp. 7-17. Available on e-Reserve.

Limits and effectiveness of nuclear safeguards

David Fischer and Paul Szasz. Edited by Josef Goldblat. Safeguarding the Atom: A critical appraisal. (USA: Taylor & Francis, 1985), chapter 5: "The risk of secret nuclear plans", pp. 35-40; chapter 6: "Limits to the present approach", pp. 41-45; chapter 7: "Problems with safeguards methods", pp. 47-58. Available on e-Reserve.

Lawrence Scheinman. The International Atomic Energy Agency and World Nuclear Order. (Washington DC: John Hopkins University Press, 1987), chapter 7: "Problems facing the IAEA". Available on e-Reserve.

NPT Article III negotiations

Mohamed I Shaker. The Nuclear Proliferation Treaty: Origin and Implementation, 1959-1979. Three Volumes (USA: Oceana Publications, INC, 1980), chapter 10: "International safeguards: Article III", pp. 651-775. Available on e-Reserve.

George Bunn. Arms Control by Committee: Managing Negotiations with the Russians (California: Stanford university Press, 1992), chapter five: "The NPT finally brings widespread international safeguards on reactors", pp. 83- 105. Available on e-Reserve.

Nuclear Safeguards and the point of view of the Industry

Rudolf Weh. "The point of View of German Facility Operators", in Erwin Hackel and Gotthard Stein, editors. Tightening the Reins: Toward a strengthened International Nuclear Safeguards System (Germany: Springer, 2000), pp. 99-106. Available on e-Reserve.

Peter Friend "URENCO's view on International Safeguards Inspection" Paper presented during the 8th International Conference on Facility Operations-Safeguards Interface, March 30-April 4, 2008. Portland, Oregon. Available on e-Reserve.

Appendix 4: To be presented at the American Nuclear Society Meeting in Reno, Nevada 2008

DOE, UNIVERSITY, NATIONAL LAB PROGRAM TO ENHANCE SAFEGUARDS EDUCATION FOR THE NEXT GENERATION OF FUTURE SAFEGUARDS PROFESSIONALS

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INTRODUCTION

The growth of nuclear power worldwide requires a strong community of professionals trained in a variety of disciplines, including nuclear and other engineering fields, nuclear physics, accounting, health physics, applied mathematics and statistics, chemistry, project management and international relations. The current lack of trained personnel in some of these fields, combined with the retirement of trained scientists and experts now and into the next decade, make the recruitment, training and retention of international safeguards professionals an urgent necessity.

As a major thrust of its Next Generation Safeguards Initiative (NGSI), DOE/NNSA's Office of International Regimes and Agreements (NA-24) aims to establish a human capital management system that provides qualified US candidates to staff international safeguards positions at US national laboratories and at the IAEA Department of Safeguards. NA-24 seeks qualified individuals for the international safeguards workforce and will establish a human capital management system that provides those individuals with career advancement, professional development, job security, education, training, and a competitive compensation system. With the growing significance of safeguards in the successful and peaceful

deployment of nuclear energy research and nuclear power, it has become apparent that technological advances in safeguards technology have lagged under reduced funding and attention over the last two decades and the safeguards workforce both in the U.S. and at the IAEA is aging, retiring, and shrinking. Hence, a concentrated effort in NGSI aims to build up the technology base and labor base in safeguards starting in the U.S. As one of the first steps in building the safeguards workforce of the future, NA-24 aimed to sponsor summer institutes of one-week duration or longer to introduce college students and professors to safeguards concepts and facilities. Hence, NA-24 working with DOE laboratory staff created two pilot courses in safeguards. This paper focuses on specific efforts to build the labor base through training of students in two summer short courses run by Lawrence Livermore National Laboratory (LLNL), Monterey Institute of International Studies (MIIS), Los Alamos National Laboratory (LANL) and Texas A&M University (TAMU).

LLNL/MIIS COURSE DESCRIPTION

MIIS and LLNL together conducted the MIIS-LLNL International Nuclear Safeguards Policy Course June 2-13, 2008 at Monterey Institute of International Studies (MIIS) within their James Martin Center for Nonproliferation Studies (CNS). This course focused on international nuclear safeguards policy and information analysis. During this two-week course, students gained an understanding of the relevance of nuclear safeguards and their contribution to facilitating civil nuclear cooperation and supporting nonproliferation, as well as their strengths and their limitations. It provided students with an overview of the interaction between different technical, legal and policy aspects of nuclear safeguards.

The International Nuclear Safeguards Policy Course contained the following lectures focusing on policy:

- 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

LANL/TAMU COURSE DESCRIPTION

LANL and TAMU together conducted the Technical Safeguards Training Course from June 3 to July 11, 2008 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
- Practicum Week – NDA Exercises
    - NDA at Enrichment Facilities
    - NDA at Reprocessing Facilities

In August, the LANL students had the opportunity to go to LLNL and interact with the MIIS-LLNL students to participate in a symposium during which the students shared highlights of their training experience, described the results of their internship projects, and received a tour of LLNL. The LANL, LLNL, TAMU and MIIS staff took time during this symposium to gather feedback from the students regarding their summer experiences to improve the pilot course for use in universities and for subsequent summer internships.

RESULTS

The result of these two courses was a chance to introduce the concepts of nuclear safeguards to promising undergraduate, graduate, and post-doctoral students who will be doing summer internships and holding other student positions at LLNL and LANL during the summer of 2008. It will now be used as a basis for future human resource initiatives by NA-24 intended to build and educate the workforce of the future in nuclear safeguards and to preserve and pass on the knowledge of the older generation of safeguards professionals before they retire.

LA-UR-08-03847