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Oak Ridge National Laboratory Next-Generation Safeguards Initiative: Human Capital Development

Kimberly V. Gilligan
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September 2014

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ORNL/TM-2014/331

Nuclear Security and Isotope Technology Division

OAK RIDGE NATIONAL LABORATORY NEXT-GENERATION SAFEGUARDS INITIATIVE: HUMAN CAPITAL DEVELOPMENT

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ACRONYMS

AWCC	active well coincidence counter
BNL	Brookhaven National Laboratory
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DIQ	design information questionnaire
DIV	design information verification
DOE	US Department of Energy
FY	fiscal year
GCEP	gas centrifuge enrichment plant
HBCU	Historically Black College or University
HCD	human capital development
HFIR	High Flux Isotope Reactor
IAEA	International Atomic Energy Agency
INMM	Institute of Nuclear Materials Management
INSEP	International Nuclear Safeguards Engagement Program
ISOCS	in situ object characterization
JPO	Junior Professional Officer
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NA-24	NNSA Office of Nonproliferation and International Security
NCSU	North Carolina State University
NDA	nondestructive analysis
NGSI	Next Generation Safeguards Initiative
NGSPN	Next Generation Safeguards Professional Network
NNIS	Nuclear Nonproliferation International Safeguards
NNSA	National Nuclear Security Administration
OLEM	on-line enrichment monitor
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
PSU	Pennsylvania State University
REDC	Radiochemical Engineering Development Center
SNL	Sandia National Laboratories
SNM	special nuclear material
SNS	Spallation Neutron Source
SRS	System Requirements Specification
SSAC	state system of accounting for and control of nuclear material
UF	University of Florida
UM	University of Michigan
UT	University of Tennessee
UTK	University of Tennessee, Knoxville
WNU	World Nuclear University

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The university NGSI nonproliferation workshops held at ORNL are successful because of the willingness of staff members to mentor the students. While this effort takes many dedicated people, special thanks are extended to the Safeguards Laboratory staff, George Flanagan, Michael Whitaker, Porter Bailey, and the High Flux Isotope Reactor staff. The summer internship program is made possible by the efforts of Amy Hunt and Diana Tucker.

The continued success of the education outreach is also dependent on the following individuals, who serve on the 2014 Nuclear Science and Engineering Directorate Education Outreach Committee. These individuals have donated hours of work to ensure the success of the program, particularly Julie Ezold, Denise Lee, Adam Aaron, and Barb Snow.

1. INTRODUCTION

In 2007, the US Department of Energy National Nuclear Security Administration (DOE NNSA) Office of Nonproliferation and International Security (NA-24) completed a comprehensive review of the current and potential future challenges facing the international safeguards system. The review examined

- trends and events that have an effect on the mission of international safeguards,
- the implications of expanding and evolving mission requirements of the legal authorities and institutions that serve as the foundation of the international safeguards system, and
- the technological, financial, and human resources required for effective safeguards implementation

The review's findings and recommendations were summarized in the report *International Safeguards: Challenges and Opportunities for the 21st Century* (NNSA, 2007). The executive summary of this report is available at http://nnsa.energy.gov/sites/default/files/nnsa/inlinefiles/NGSI_Report.pdf.

One of the report's key recommendations was for DOE NNSA to launch a major new program to revitalize the international safeguards technology and human resource base. In 2007, at the International Atomic Energy Agency (IAEA) General Conference, then Secretary of Energy Samuel W. Bodman announced the newly created Next Generation Safeguards Initiative (NGSI). NGSI consists of five program elements:

- policy development and outreach,
- concepts and approaches,
- technology and analytical methodologies,
- human capital development (HCD), and
- infrastructure development.

This report addresses the HCD component of NGSI. The goal of the HCD component as defined in the *NNSA Program Plan* is "to revitalize and expand the international safeguards human capital base by attracting and training a new generation of talent." The major objectives listed in the HCD goal include education and training, outreach to universities and professional societies, postdoctoral appointments, and summer internships at national laboratories.

Oak Ridge National Laboratory (ORNL) is a participant in the NGSI program, together with several other DOE laboratories, such as Pacific Northwest National Laboratory (PNNL), Lawrence Livermore National Laboratory (LLNL), Brookhaven National Laboratory (BNL), and Los Alamos National Laboratory (LANL). ORNL's participation specifically encompasses student internships, postdoctoral appointments, collaboration with universities in safeguards curriculum development, workshops, and outreach to professional societies through career fairs.

2. ORNL NEXT GENERATION SAFEGUARDS INITIATIVE INTERNS

ORNL hosted four NGSI interns in FY 2014, mostly during the summertime. Many ORNL interns come under the Nuclear Engineering Science Laboratory Synthesis (NESLS) internship program, which is geared toward students in scientific disciplines who have an interest in nuclear science and engineering. Two students were supported through the Higher Education Research Experience (HERE) program, which is designed to encourage careers in science and technology.

Students from the University of Tennessee, Knoxville (UTK) and Pennsylvania State University (PSU) participated in the FY 2014 internship program.

The student breakdown included

- one PhD candidate in political science (UTK),
- one master's degree level nuclear engineer (UTK),
- one undergrad nuclear engineering student (UTK), and
- one undergrad computer science student (PSU).

2.1 ORNL SUMMER INTERN PROJECTS

ORNL did an internal call for intern project proposals and submitted the consolidated list to NA-24 for review. ORNL staff submitted requests for 14 nonproliferation projects that could benefit from intern support. Of these projects, the following four were selected to be supported with NGSI funds for FY 2014.

- Human Capital Development Roadmap (one intern in the fall of 2013 and one in the summer of 2014) – **Alex Okowita** helped developed the SHULA database, which records all of the students who have received NGSI assistance and training. He also worked on developing a specific definition of a "safeguards expert" and how to train these individuals. **Rachel Gaudet**, a junior nuclear engineering major at the University of Tennessee, wrote a paper assessing the core competencies in nuclear safeguards. She identified core competencies that may be necessary for nuclear safeguards and matched them to subject matter experts in those fields.

- Modified SQP – **Allyn Milojevich**, a Ph.D. candidate at the University of Tennessee in political science, created new learning material for an IAEA-sponsored workshop on safeguards implementation for Small Quantity Protocol States. She assessed current documentation and created new, interactive exercises for an upcoming IAEA workshop.

- System Requirements Specification (SRS) for a state system of accounting for and control of nuclear material (SSAC) information systems – **Dennis Samuel**, a junior computer science major at Penn State, worked on a document summarizing different requirements a state might consider when selecting an information system for their SSAC.

- Cloud-based Training Delivery for Safeguards – **Rachel Gaudet** worked on this project as well as the Roadmap project. Gaudet worked with mentor Jim Younkin to gather all previously recorded lectures and videos in a centralized repository that will eventually be available to a much broader audience to gain access to safeguards knowledge. A storyboard was created to use as the framework for a short yet informative introduction video that will be included with the videos to promote NGSI and its missions for these projects. In the future, work will shift towards researching and creating new videos to be included in this repository.

Summer interns are required to participate in the annual lab-wide end-of-summer poster competition. Below are two NGSI summer interns at the competition (Figs. 1 and 2).

Fig. 1. NGSI summer intern Allyn Milojevich presenting her work.

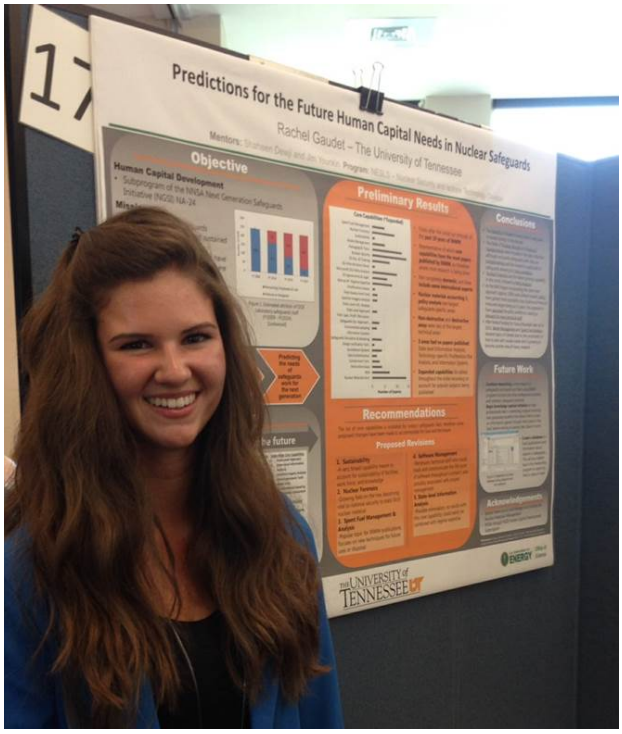

Fig. 2. Rachel Gaudet discusses her human capital development project.

2.2 INTERN PROGRAM

ORNL offered the following tours for the interns during the summer of 2014:

- Spallation Neutron Source (SNS),
- Consortium for Advanced Simulation of Light Water Reactors (CASL),
- High Flux Isotope Reactor (HFIR) and Radiochemical Engineering Development Center (REDC),
- High-Temperature Materials Laboratory,
- Aquatics Laboratory,
- Center for Nanophase Materials Sciences,
- Carbon Fiber Technology Facility,
- Graphite Reactor,
- Stable Isotopes laboratory, and
- Robotics and Remote Systems laboratory.

Interns also attended the following NGSI Summer Seminar Series via Webinar.

July 7	Zoe Gastelum, PNNL, "Information Technology for IAEA Safeguards"
July 9	Deborah Dale, LANL, "Safeguards for Reprocessing Facilities"
July 14	Brian Boyer, LANL, "The Life of an IAEA Inspector"
July 16	Michael Whitaker, ORNL, "Safeguards for Uranium Enrichment Facilities"
July 21	Sarah Frazer, PNNL, "Safeguards Infrastructure Development"
July 23	Deborah Dale, LANL, "State-Level Approaches for States with a Full Nuclear Fuel Cycle"
July 28	John Schweighardt, PNNL, "The IAEA Junior Professional Officer (JPO) Experience"
July 30	Kory Budlong-Sylvester, LANL, "Acquisition Path Analysis for Safeguards"
August 4	Helly Diaz-Marcano, SRS, "Safeguarding CANDU Reactors"
August 6	Ray Diaz and Tanya Collins, BNL/ISPO, "The International Safeguards Project Office and Careers in Safeguards at the IAEA"
August 11	Risa Haddal, SNL, "Safeguards Approaches for Spent Fuel Repositories"
August 13	George Anzelon, LLNL, "Pursuing Noncompliance: IAEA Legal Authorities and their Use in Practice"

2.3 INTERN RECRUITMENT

Career fairs are an important complementary effort to the NGSI HCD program at ORNL. ORNL staff participated in several career fairs. NGSI funds were not used to support their participation, but the NGSI internships and fellowships are emphasized at these events.

3. ORNL NGSI SUPPORTED POSTGRADUATE APPOINTMENTS

In FY 2014, NGSI postgraduate fellowship funds contributed to supporting six postgraduate positions at ORNL. The following section summarizes each fellow's contribution to nonproliferation and safeguards during his or her time at ORNL.

3.1 BRET VAN DEN AKKER

Dr. Bret van den Akker was a postdoctoral fellow with the Nuclear Security Modeling Group within the Reactor and Nuclear Systems Division. His research focus was nuclear forensics, and during his first year he worked on a variety of projects, including the feasibility of using noble gases to discriminate among six fission types (fast fission and high-energy fission for ^{235}U, ^{238}U, and ^{239}Pu), with the goal of making such a discrimination within the first 72 hr in the event of an improvised nuclear device detonation in the United States. He also conducted a sensitivity study of the particle size distribution function within the DELFIC (Defense Land Fallout Interpretative Code) computer code and investigated the development of a physical model to quantify the subsurface transport via geological formations of radioactive gases released in underground nuclear explosions. Van den Akker has since transitioned to a staff position in the Reactor and Nuclear Systems Division.

3.2 KATY SNOW

During her appointment in the ORNL Post-Master's Research Participation Program, Katy Snow worked in the International Safeguards Group of the Nuclear Security and Isotope Technology Division under the supervision of Michael Whitaker. In FY 2014, she supported a range of safeguards workshops and events (Fig. 3).

Fig. 3. Katy Snow presenting a case study she developed on Syria.

In December of 2013, she worked as a coordinator for the IAEA Workshop on Effective Management of Safety, Security and Nonproliferation Issues at Operating Nuclear Facilities. Her role was to work with ORNL colleagues and the staff at Watts Bar Nuclear Power Plant and the NRC Technical Training Center to coordinate the visit of 15 high-level government and industry representatives from around the world.

In addition to her work with the international guests, Snow assisted Whitaker with his duties as chairman of the International Safeguards Division of the Institute of Nuclear Materials Management (INMM). This included traveling to the 2014 annual meeting to assist with organizing over 600 abstract submissions and attend numerous meetings. She is an active member of the INMM Chapter Relations Committee and will continue to serve in this role at the conclusion of her Oak Ridge Associated Universities (ORAU) appointment.

The last 6 months of Snow's post-master's research associate position was conducted from Salt Lake City thanks to the ORNL NGSI HCD partnership with the University of Utah. She has now completed her

research associateship and established herself as an independent contractor for national laboratories based on the reputation she built while with ORNL.

3.3 SCOTT STEWART

Scott Stewart is an ORAU post-master's research associate supporting Jim Garner and Michael Whitaker in the International Safeguards Group of the Nuclear Security and Isotope Technology Division (Fig. 4). He works with Jim Garner on the Unattended Cylinder Verification Station (UCVS) project, and as part of that effort is working on camera surveillance image encryption and verification. Stewart also supports Garner's work with the General Advanced Review Software, or GARS product, from Canberra for surveillance imagery review, as well as other work with the Genetec software package, which is essentially commercial off-the-shelf security software. Stewart began his post-master's position June 30, 2014.

Fig. 4. Scott Stewart works on calibrating new equipment.

3.4 PHILIP MAKAREWICZ

Philip Makarewicz joined the International Safeguards group of the Nuclear Security and Isotope Technology Division as a post-master's research associate in August 2014, having worked most recently as a NNSA Graduate Program Fellow within the NNSA Production Office in Amarillo, Texas. Makarewicz is mentored by Jim Garner and since joining the team has primarily focused on safeguards efforts at gas centrifuge enrichment plants (GCEPs). Makarewicz's work to date has included current safeguards techniques at GCEPs and the political environment surrounding development of new supplemental techniques for safeguards. His work has included a literature review of the methodology for counting GCEP feed cylinder throughput from load cell data and the use of commercial products in an experimental surrogate flow loop located at ORNL to test these methodologies.

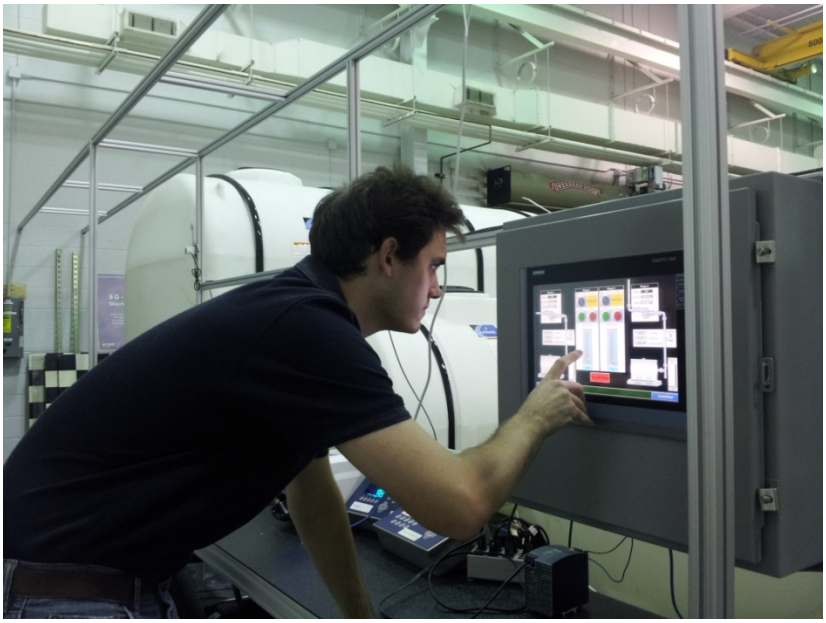

Fig. 5. Philip Makarewicz is collaborating with ORNL staff to strengthen safeguards at GCEPs.

3.5 MARIANNE GILLOGLY

Mari Gillogly transitioned to ORNL as a research associate after a year at the NNSA as a Nonproliferation Graduate Fellow. In DC, she coordinated, facilitated, and supported foreign partner workshops, trainings, and meetings through NA-241's International Nuclear Safeguards Engagement Program (INSEP). She also collaborated on export control and export licensing projects with NA-242 programs. Since August 2013, as a follow-on to her work at headquarters, she splits her time between two programs at ORNL: International Safeguards and Nuclear Security/Export Controls.

With the International Safeguards Group, Gillogly works closely with the Regional Lead for Sub-Saharan Africa engagement. This work supports a new regional mission for INSEP, and she is focused on developing workshops and training covering a myriad of nuclear safeguards activities in Africa. She is also coordinating upcoming events and workshops for INSEP-related projects in Europe, the Middle East, and Southeast Asia, and separately for the International Safeguards Division of INMM. With the Nuclear Security/Export Control team, Gillogly participates in licensing reviews for NNSA to provide to the United States government interagency for approval/denial of export control licenses. She works on two teams—one for developing curriculum for university- and professional-level export control trainings and the other on developing an analysis tool for license reviews.

3.6 ROSS SNOW

In March 2014, Ross Snow left ORNL for employment with Energy Metrics in Salt Lake City. Snow was investigating new safeguards measures involving unattended process monitoring to more effectively implement IAEA safeguards at GCEPs. Snow split his time between two projects aimed at improving safeguards at GCEPs: load cell monitoring development and the On-Line Enrichment Monitor (OLEM). Snow was an ORAU research associate for a little over 2 years, and during that time he developed 3D animations to visualize real time data from a mock feed and withdrawal test bed in the Containment and Surveillance Laboratory. Over the past year, Ross has taken on the mechanical design of the OLEM development project. Snow was instrumental in establishing the new Platform Scale Testing Center, which is used to further test load cell monitoring technologies and better simulate data generated at an operating GCEP feed or withdrawal station (Fig. 6).

Fig. 6. Research Associate Fellow Ross Snow.

3.7 ANN PEDERSON

Ann Pederson works part-time as an ORAU research associate in the International Safeguards Group (Fig. 7). She has assisted in research and writing on NGSI-related topics, including process monitoring, international inspections, and the verification of disassembled warhead components. She has also been instrumental in safeguards-by-design research at ORNL. Pederson works less than part-time as her workload at UTK law school increased. She also received a prestigious summer clerkship.

Fig. 7. Research Associate Ann Pederson.

3.8 KAARA PATTON

Kaara Patton is working as an ORAU research associate for the Process Engineering Research group of the Nuclear Security and Isotope Technology Division. She has worked hands-on with a variety of fuel-cycle-related processes, including many uranium processes such as solvent extraction, uranium hexafluoride reduction, uranium tetrafluoride reduction, and uranium metal production. She has also helped to make uranium microspheres for possible use as fuel for NASA spacecraft, which require a compact, long-lasting, stand-alone source of power. When not in the laboratory, Patton compiles and reports the results of these studies. Recently, NGSI funds made it possible for Patton to present some of her ongoing research at the 33rd International Nuclear Air Cleaning Conference, held June 22–24 in St. Louis, Missouri (Fig. 8).

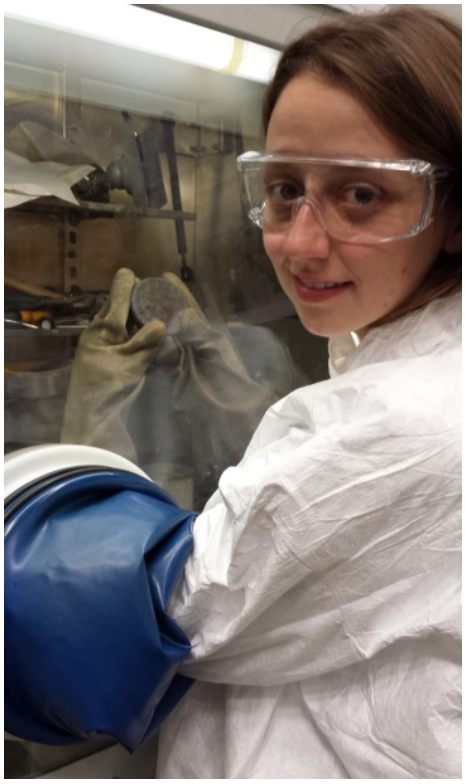

Fig. 8. Research Associate Kaara Patton.

4. NGSI HCD PROGRAM SUPPORT

4.1 NGSI HCD PROGRAM REVIEW

The first NGSI HCD program review was held on October 29–30, 2013, at ORNL. Federal Program Manager Melissa Scholz led the program review, with nine national laboratories participating (Fig. 9). Although this was the first program review, a couple of NGSI HCD workshops had been previously held.

The participants of the program review included NGSI HCD points of contact and HCD representatives:

- J'Tia Taylor, Argonne National Laboratory (ANL)
- Susan Pepper and Sara Poe, Brookhaven National Laboratory (BNL)
- Sean Morrell, Idaho National Laboratory (INL)
- Carolynn Scherer, Los Alamos National Laboratory (LANL)
- William Moore, Lawrence Livermore National Laboratory (LLNL)
- Kimberly Gilligan, Dawn Eipeldauer, Bernie Kirk, Shaheen Dewji, and Sam Hinson, ORNL
- Roberta Burbank, Pacific Northwest National Laboratory (PNNL)
- Risa Haddal, Sandia National Laboratories (SNL)
- Rick Poland, Savannah River National Laboratory (SRNL)
- Melissa Scholz and Gisele Irola, Department of Energy (DOE) National Nuclear Safety Administration (NNSA)

Fig. 9. Group photo from the first NGSI HCD program review held at ORNL in October 2013.

There were several objectives of the meeting. The first was to review the status of NGSI programs currently in place at the national laboratories. Second, the group discussed implementation challenges and how to address them. The third objective of the group was to focus on discussing current methods of collection and sharing of NGSI education and training materials and program implementation practices. The final objective was to discuss right-sizing of the NGSI program (expected human capital needs,

future program expectations) and how best to transition interns, students, and postdocs into permanent safeguards or nonproliferation assignments at the laboratories.

ORNL worked with Melissa Scholz to organize the event, including the agenda, participants, and objectives. An internal report was drafted on the meeting discussions and delivered to headquarters.

4.2 NUCLEAR NONPROLIFERATION INTERNATIONAL SAFEGUARDS EVALUATION AND SUPPORT

Kim Gilligan and Michael Whitaker reviewed applications for the 2014 Nuclear Nonproliferation International Safeguards (NNIS) Graduate Fellowship Program. ORNL NGSI HCD partner universities were well represented in the applicant pool. The top 10 ranked applications included six students from partner universities.

NNIS Fellow and UTK PhD student Ben Dabbs worked with the International Safeguards Group for 8 months. Dabbs worked closely with ORNL staff to evaluate how the advanced features of modern commercial off-the-shelf video management software could be leveraged for international safeguards surveillance review. He also contributed to the cylinder monitoring project. Dabbs is currently on a hiatus from his studies and research at ORNL to be a JPO in the Department of Safeguards at the IAEA. Dabbs presented at the 2014 INMM Annual Meeting (Fig. 10).

Fig. 10. NNIS Fellow and ORNL researcher Ben Dabbs presenting at the Annual INMM Meeting in July 2014.

5. UNIVERSITY ENGAGEMENT

In addition to the NGSI nonproliferation workshops (Sect. 6), ORNL works with universities to enhance their programs and worked with several universities in FY 2014 to introduce safeguards concepts into their curricula. The following sections summarize the safeguards university engagement with the North Carolina State University (NCSU), University of Florida (UF), the University of Michigan (UM), and Georgia Institute of Technology (Ga Tech).

5.1 UNIVERSITY OF FLORIDA

University of Florida (UF) worked to improve the "Introduction to Safeguards" course content and execution, based on student feedback and instructor and key ORNL personnel observations.

In addition to the changes to refine the course, work has been done to incorporate the course into the nuclear engineering curriculum (it is currently offered as a special topic of study). The course will now be offered as a technical elective. Much of this work on revising the course has been completed, and the program is awaiting approval from the university and assignment of a permanent course number.

A new textbook has been chosen for the course, instead of the instructor notes and scattered resources that were previously used. The textbook, *Deterring Nuclear Proliferation: The Importance of IAEA Safeguards*, was developed at BNL and funded by NGSI. It was used in the spring 2014 offering of the course with good results.

This course consists of lectures divided into four general areas:

- Policy and Fundamentals,
- Detection,
- Prediction (computer simulations), and
- Practical exercises.

The first course offering provided important results and suggested improvements that have since been incorporated in the expanded course. The policy and fundamentals section of the class addresses treaties related to nuclear safeguards and how these treaties are implemented and monitored. This section was expanded in this offering to require the students to develop nuclear dossiers on different countries. These nuclear dossiers covered not only the current known and suspected nuclear capabilities of the country but also examined the internal and external conflicts the country would need to guard against. Students then presented their findings to the class. The dossiers were used in a simulation exercise performed later in the course.

The detection segment of the class examines and compares the different devices used for nuclear safeguards. Students performed this section prior to attending the training at ORNL in the middle of the semester so they would be more familiar with the detection systems used. This section of the course was also expanded to include more information of the various types of detectors and how they work. The prediction exercises of the course focus on what safeguards analysts would be looking for with computer models and how accurately they can predict inventories. The exercise the students performed was revised to have them examine an actual assembly and compare their results when they vary selected parameters.

The practical exercises consist of two hands-on training sessions. The first is a week-long trip to ORNL to attend courses and work in the laboratory. The week at ORNL includes lectures given by NGSI-supported Dr. Brandon Prins at UTK's Political Science Department. These lectures included both international affairs students and nuclear engineering students. Collaboration between the two groups proved highly beneficial. Students also attended lectures on North Korea and Project Sapphire from ORNL staff with hands-on experience. Both lectures were very well received. Taking the nuclear engineering students out the laboratory and exposing them to the relevant international affairs issues was most beneficial and will be included in future offerings.

A nonproliferation simulation exercise developed by Samantha Hinson was added to the ORNL workshop. This exercise had students represent countries with competing nuclear objectives. Using the nuclear dossiers they had previously prepared, the students tried to reach their objectives, while being monitored by the IAEA. This exercise showed the students that while at a global level countries want to meet the goals of the IAEA, in actual practice, a country's own objectives usually conflict and win. This exercise was very well received by the students and was very informative.

The remainder of the time at ORNL was spent in the Safeguards laboratory and with export control staff. The hands-on nature of the exercises and the real-world examples used by the export control staff made a big impact on the students.

The class size of this course, due to schedule conflicts, did not allow all the slots made available by NGSI funding to be filled. The nuclear engineering program at UF therefore filled these empty slots with students from the program on a first-come first-serve basis. This allowed students who would not otherwise have attended the training to benefit from the program. One example is a PhD student who was recently added to the UF program and is working in the field of nuclear safeguards.

Upon returning to UF, the students prepared reports summarizing their experiences and lessons learned. The final exercises were directed by ORNL's Gilligan and Hinson, when they visited UF April 22–23, 2014. During their visit, Gilligan conducted a mock Complementary Access of the UF subcritical assembly facility. Prior to the inspection, the students had prepared the required mock design information questionnaire (DIQ) paperwork to provide their inspector (Gilligan). While playing the part of an IAEA inspector, she instructed the students on what an inspector looks for and takes with him or her in the field. The students played the role of site and government representatives during the exercise.

Due to the popularity of the nonproliferation simulation at ORNL, Hinson was invited by a student group, Women in Nuclear, to run the exercise at one of the group's meetings. Both Gilligan and Hinson met with students before the simulation to have an "Ask Me Anything" session (Fig. 12). Students then performed the simulation exercise that evening (Figs. 13 and 14). The event was very well received and gave the students who had been unable to attend the ORNL workshop exposure to some of the difficulties associated with nuclear safeguards.

Fig. 11. Students in the University of Florida's "Introduction to Safeguards" class participating in a mock Complementary Access.

Fig. 12. Gilligan and Hinson attend an "Ask Me Anything" session with UF students.

Fig. 13. Students actively engage in a nonproliferation-themed simulation.

Fig. 14. Hinson works with a group of UF students during the nonproliferation simulation.

Gilligan and Hinson met with professors throughout the nuclear engineering department and were able to tour the labs and the research reactor. They were also able to meet with the director of the newly created Florida Institute for National Security (FINS) to discuss future collaborations. Finally, they received briefings from students on their capstone projects.

Fig. 15. Gilligan and Hinson toured a new laboratory being developed by UF professor Dr. A. Enqvist, who specializes in nuclear safeguards.

5.2 GEORGIA TECH

In November 2013, students enrolled in the Georgia Tech mechanical engineering course, Elements of Nuclear Safeguards, Nonproliferation, and Security, took a field trip to visit the offices of the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO) and the IAEA, including a visit to the Safeguards Analytical Laboratory in Seibersdorf, Austria (Fig. 16). The trip started with a lecture by Mr. William Fuhr on the creation of the IAEA, the evolution of safeguards, and the impact of environmental sampling on enhancing safeguards. They learned about the United Nations system and were able to tour the buildings to gain an appreciation for the complexities of UN operations.

The IAEA provided lectures on topics as varied as nuclear material balance evaluations, environmental sampling methods and techniques, and evaluation and reporting of results (Fig. 17). Visiting the Environmental Sample Laboratory and Nuclear Materials Laboratory at the Safeguards Analytical Laboratory in Seibersdorf, Austria, was an especially rewarding experience for students (Fig. 18). They also attended a day of lectures at the CTBTO, including an unexpected introductory talk by the Executive Secretary to the CTBTO, Dr. Lassina Zerbo. While at the CTBTO they visited the International Data Center, the particulate monitoring state, and the noble gas monitoring project.

Overall, the students were very impressed with the planning and coordination of the trip. They indicated that they were more inclined to pursue further studies or career paths in safeguards as a result of the field trip. Most indicated that the highlight of the trip was the visit to the IAEA Safeguards Analytical Laboratory. The professor indicated that the trip was a valuable experience for all of the students involved, and their interest in safeguards continued over the duration of the course. A full report has been submitted by Georgia Tech to HQ separately.

Fig. 16. Group photo of the Georgia Tech students in front of the Vienna International Center (VIC).

Fig. 17. IAEA representatives provided lectures on IAEA long-term strategic planning and bulk and particle analysis methods.

Fig. 18. Georgia Tech students attend laboratory briefings at IAEA Safeguards Analytical Laboratory.

5.3 NORTH CAROLINA STATE UNIVERSITY

Previously, ORNL NGSI HCD created a series of taped lectures of safeguards and nonproliferation experts that are still used in university courses. In NCSU's "Nuclear Nonproliferation and Safeguards Technology and Policy" course, students watch the lectures and then develop questions for the subject matter experts (Fig. 19). Professor John Mattingly collects these questions and submits them to the subject matter experts at ORNL. The students are then able to have a live video teleconference with these experts at their next class session (Fig. 20). This year, NCSU also requested a new fuel cycle lecture by Andy Worrall, which was done via video teleconference. Because of the impact of this course, one student has now selected a nonproliferation topic for his dissertation and another student is actively pursuing opportunities at the IAEA. Several other students have included aspects of nonproliferation into their research.

A list of NGSI taped lectures and teleconferences with ORNL subject matter experts is provided as follows. One lecture on the fuel cycle by ORNL staff member Andy Worrall was done live via VTC.

NGSI Taped Lectures of ORNL Subject Matter Experts

- Nuclear Fuel Cycle – Back End
- International Safeguards
- Physical Security – Part I
- Physical Security – Part II
- Spent Fuel Safeguards
- Environmental Sampling

- IAEA Safeguards
- Safeguards for Uranium Enrichment
- Containment and Surveillance Technologies for Safeguards
- Second Line of Defense
- Nuclear Export Controls

Live Q&A via VTC with ORNL SME

- Nuclear Fuel Cycle (Front and Back End)
- Physical Security – Part I
- Physical Security – Part II
- Spent Fuel Safeguards
- Environmental Sampling
- IAEA Safeguards
- Safeguards for Uranium Enrichment
- Containment and Surveillance Technologies for Safeguards
- Second Line of Defense
- Nuclear Export Controls

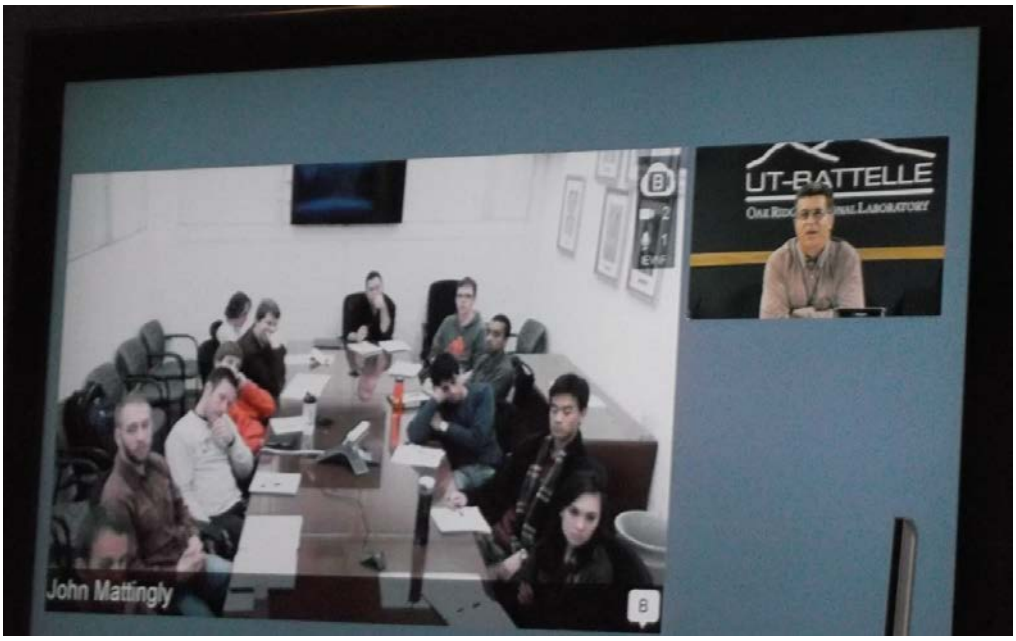

Fig. 19. NCSU class during a VTC with Chris Pickett at ORNL.

Fig. 20. ORNL staff member Chris Pickett works with students at NCSU through a video teleconference.

NGSI also partially funded a 1 day visit to NCSU by ORNL staff Andy Worrall and Louise Worrall that included a meeting with the local INMM chapter. Louise presented a lecture entitled "Nuclear Material Signatures and Safeguards Radiation Measurements," in which she discussed the role of nuclear material signatures in material control and accountancy. Both Andy and Louise gave a presentation, followed by an extensive question-and-answer session on career perspectives from an early and mid-career professional.

5.4 THE UNIVERSITY OF TENNESSEE, KNOXVILLE

5.4.1 Arms Control, Nonproliferation, and Nuclear Safeguards and Security Course

This year ORNL NGSI HCD worked with UTK political science professor Brandon Prins to support the "Arms Control, Non-Proliferation, and Nuclear Safeguards & Security" course. Undergraduate and graduate political science and nuclear engineering students take this course. ORNL and Dr. Prins arranged for guest subject matter experts from ORNL to lecture on a variety of topics as part of the course. The subject matter experts discussed a wide range of topics, including safeguards, the IAEA, the nuclear black market, nuclear weapons, nuclear power in the Middle East and North Korea. This gave the students a unique opportunity to interact with researchers and practitioners involved in the topics they were learning about in the course.

- January 5: Mari Gillogly and Kim Gilligan, "Nonproliferation and IAEA Safeguards"
- January 12: Krystee Ervin and Len Philips, "Export Control"
- February 19: Pat Lynch, "Nonproliferation and the Middle East"
- March 5: Lisa Loden and John Begovich, "Experience in DPRK" (Fig. 21)
- March 5: Ambassador Cameron Munter, "Experience in Pakistan" (not NGSI funded)
- April 2: Bill Toth, "Nuclear Nonproliferation Programs Overview"

Note: The University of Florida was able to attend the March 5 talks as part of their NGSI Nonproliferation Workshop at Oak Ridge.

Fig. 21. ORNL staff John Begovich and Lisa Loden speak with the University of Tennessee and University of Florida about North Korea and working with Pyongyang.

5.4.2 Export Control and Nonproliferation Course

During the fall of 2013, the ORNL NGSI HCD program supported ORNL staff members in developing and delivering a new class for students earning a master's degree in nuclear engineering at the UTK. The class, NE536 "Export Control and Nonproliferation," focused on the principles and regulatory framework for controlling sensitive nuclear commodities and technology. Various case studies were discussed relevant to export control violations and nuclear proliferation issues. This class featured a number of guest speakers who covered a wide variety of proliferation-related topics, including export enforcement, the IAEA, the nuclear fuel cycle, and various types of reactor designs. The detailed infrastructure of the US export control system was studied, along with impending changes resulting from President Obama's Export Reform Effort. Hands-on exercises challenged students to examine proliferation-sensitive equipment and determine the associated export controls. Students were assigned a topic and required to give a 15 minute presentation on the export control and nuclear nonproliferation aspects of their topic. The class was well received, students were engaged and attentive, and the goal of understanding the importance of nonproliferation efforts was accomplished.

Class Topics Covered via Lecture and Exercises:

- International Regimes and US Controls
- WMD Processes Control List
- Export Control Basics
- Enforcement
- Nuclear Island
- Reese Roth Case
- Trigger List
- Dual-Use List
- A.Q. Khan
- Fuel Cycle
- End-Use/End-User
- Export Controlled Information
- Small Modular Reactors
- Publically Available Information

6. NGSI NONPROLIFERATION WORKSHOPS

6.1 NGSI UNIVERSITY WORKSHOPS

ORNL is pleased to host several NGSI nonproliferation/safeguards workshops throughout the year, the focus of which can vary depending on the group. Attendance in FY 2014 was 91 students and 16 faculty (and staff) from nine universities. The students were evenly divided between undergraduate and graduate degree programs and were predominantly nuclear engineers. In FY 2014, ORNL started to reach beyond nuclear engineers to those policy students interested in the science of nonproliferation as well.

6.1.1 The University of Tennessee

Staff from the ORNL's Safeguards and Security Technology Group conducted four laboratory hands-on classes for the spring semester UTK nuclear engineering course "Radiation Measurements Laboratory" (NE550). The class had four nuclear engineering students, one teaching assistant, and a professor. The activities in the lab included in situ object characterization (ISOCS), basic nondestructive analysis (NDA), and holdup measurements. The application for safeguards was discussed in conjunction with the hands-on activities. Safeguards instrumentation and software provided the students with a practical understanding of a number of NDA techniques used for analyzing special nuclear material (SNM). The exercise culminated in the analysis of an unknown nuclear sample, which forced the students to assimilate all the information they garnered in the previous sessions. The professor for the class is Dr. Steve Skutnik, a former Nuclear Nonproliferation International Safeguards Fellow.

6.1.2 Morehouse College

In February, Morehouse College sent 10 undergraduate students (predominantly physics majors) and two physics professors to ORNL for a 2 day workshop on nonproliferation NDA training. The students were given lectures on nuclear nonproliferation and the role that the IAEA plays in ensuring nonproliferation. They participated in several exercises in the Safeguards Laboratory, that included the use of a handheld detectors and a radiation portal monitor. They also participated in tours of the High Flux Isotope Reactor (HFIR) and the REDC and a design information verification (DIV) exercise with the Surveillance and Containment Laboratory. This and future workshops with historically black college or universities will encourage minority students to pursue nonproliferation- and safeguards-related careers (Fig. 22).

Fig. 22. Morehouse students taking an NDA measurement.

The students who participated in the NGSI nonproliferation workshop each have independent research projects with a central theme on energy or nuclear science. Some of the research projects include measuring the effects of radiation on the environment, minimizing radiation absorption, and redesigning the Geiger-Muller counter for more efficient measurements. Safeguards Laboratory staff were able to support two of these projects by assisting the students in taking relevant measurements while at ORNL (Fig. 23).

Fig. 23. Dr. Louise Worrall from ORNL instructs students on enrichment measurements.

6.1.3 The University of Florida

Staff from the International Safeguards Group organized a week-long NGSI Nonproliferation Workshop (March 3–7, 2014) for the UF "Introduction to Safeguards" course. The class of 12 upper-level nuclear engineering students and two professors attended. The 5 day class consisted of lectures, tours, and valuable hands-on experience with safeguards instrumentation and software that provided the students with an introduction to a number of NDA techniques used for analyzing SNM. There was also a DIQ/DIV exercise and tour (Figs. 24 and 25).

In order to accommodate the UF's request that policy be added to the agenda, 1 day of the workshop was held at the University of Tennessee's Howard H. Baker Jr. Center for Public Policy. The day included lectures by University of Tennessee professor Dr. Brandon Prins, Ambassador Cameron Munter, and ORNL researchers John Begovich, Lisa Loden, and Kim Gilligan.

Fig. 24. UF student taking a holdup measurement.

Fig. 25. University of Florida group photo with ORNL Safeguards Laboratory staff.

6.1.4 North Carolina State University

Staff from the Safeguards and Security Technology Group and the International Safeguards Group conducted a week-long course (March 10–13, 2014) entitled "Nonproliferation NDA Training Workshop" for a group of 12 nuclear engineering students and one professor from NCSU. The 5 day class consisted of both lectures and valuable hands-on experience with safeguards instrumentation and software that provided the students with an introduction to numerous NDA techniques used for analyzing nuclear material (Fig. 26–29).

Topics covered during the class included the following:

- nuclear nonproliferation and the IAEA
- uranium enrichment measurements using an HM5 with NaIGEM, WINU235, and uranium/plutonium detection system
- uranium holdup measurements
- neutron coincidence counting using an active well coincidence counter (AWCC)
- ISOCS measurements
- radiation portal monitors
- portable NDA instrumentation operation, including
  - the FLIR Interceptor and HM5 (Identifinder)
  - the Canberra InSpector 1000
  - the Ortec Detective

In addition, as part of the class, students attended several technical tours including the SNS, ORTEC, the HFIR, and the X-10 Graphite Reactor.

Fig. 24. NCSU class photo outside the ORNL Spallation Neutron Source.

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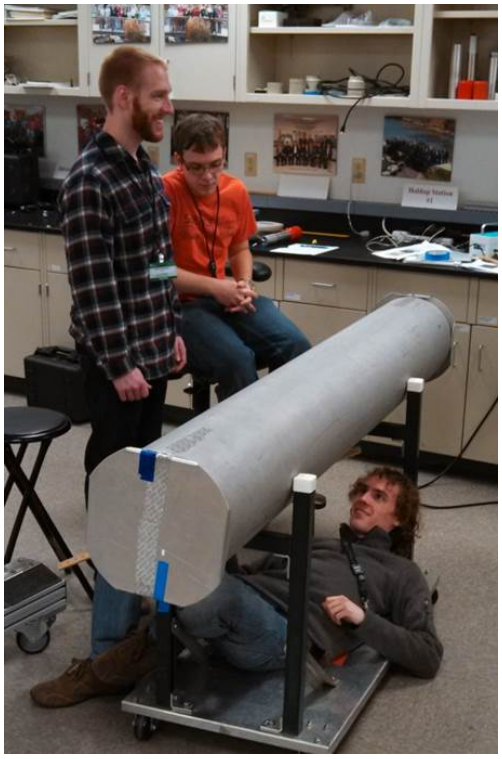

Fig. 25. NCSU students perform holdup measurements in Safeguards Laboratory.

Fig. 26. Students work with ORNL researchers to analyze data they previously recorded.

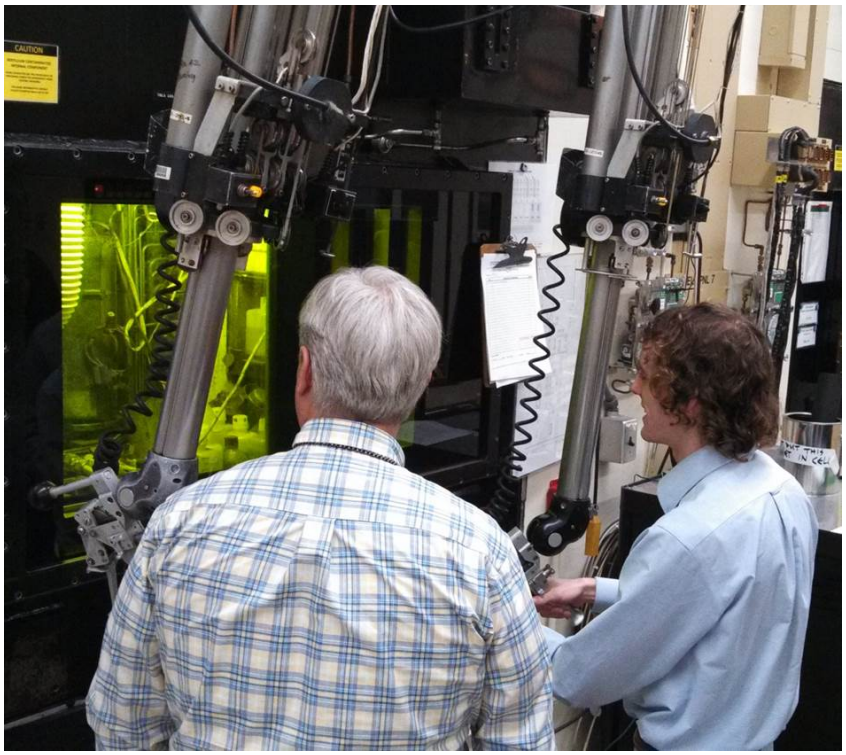

Fig. 27. NCSU student manipulates arms inside of a hot cell at REDC.

6.1.5 Clemson University

Staff from the Safeguards and Security Technology Group and the International Safeguards Group hosted a Clemson University workshop (March 25–27, 2014) entitled "Nonproliferation NDA Training Workshop" for a group of 12 nuclear engineering graduate students and two professors (Fig. 30). The 3 day class consisted of both lectures and valuable hands-on experience with safeguards instrumentation and software that provided the students with an introduction to numerous NDA techniques used for analyzing SNM.

Topics covered during the class included the following.

- uranium enrichment measurements using an HM5 with NaIGEM, WINU235, and uranium/plutonium detection system
- uranium holdup measurements
- neutron coincidence counting using an AWCC
- ISOCS measurements
- radiation portal monitors
- portable NDA instrumentation operation, including
  - the FLIR Interceptor and HM5 (Identifinder)
  - the Canberra InSpector 1000
  - the Ortec Detective

In addition, as a part of the class, the students attended several technical tours including Y-12, HFIR, REDC, and the X-10 Graphite Reactor.

Fig. 28. Clemson University group photo with Safeguards Laboratory staff.

6.1.6 The University of Georgia and Mercyhurst University

ORNL NGSI HCD worked with two new universities this year that have interests in nonproliferation but no nuclear engineering programs—the University of Georgia and Mercyhurst University. ORNL hosted a joint workshop (March 18–21, 2014) for students from these schools entitled "Next Generation Safeguards Initiative (NGSI) Nonproliferation Workshop." In attendance were 15 students, two professors, and an international policy staff member from the University of Georgia and four students and two faculty members from Mercyhurst University. The workshop opened with a daylong meeting of the Central Chapter of the INMM. The students were active participants in a meeting held at UTK's Howard H. Baker Jr. Center for Public Policy entitled "75 Years of Securing Nuclear Material: Reflections on the Past, Lessons from the Nuclear Experts, and the INMM Future." The students particularly enjoyed hearing some of the retirees' lessons learned.

The workshop portion at ORNL began with a discussion of nuclear nonproliferation and the important role played by IAEA in attaining nonproliferation goals. The students had a full first day, which included discussions of DIQ/DIV, environmental sampling, and nuclear material accounting and control (Figs. 31–33). They were then able to learn the basics of NDA and use detectors to search for undeclared nuclear materials. They also learned how these NDA techniques could be applied to SNM.

While at ORNL, the students participated in tours of the HFIR, REDC, Y-12, and the Graphite Reactor.

Fig. 29. University of Georgia student working toward a master's degree in international politics learning to use a manipulator during a tour of REDC.

Fig. 30. ORNL staff member Nathan Rowe guides Mercyhurst University intelligence students through the process of taking an enrichment measurement.

Fig. 31. ORNL staff member Tyler Guzzardo guides the students through a uranium enrichment measurement exercise.

6.1.7 The University of Utah

Ten students and one professor from the University of Utah attended the NGSI workshop "Nuclear Forensics for Nonproliferation" at ORNL (May 12–13, 2014). The workshop not only provided an overview of nuclear nonproliferation but also informed students of the role nuclear forensics can play in the nonproliferation regime. They studied the inverse analysis of spent fuel, post-detonation nuclear forensics, and environmental sampling with subject matter experts from across ORNL. Students attended tours of the Ultra-Trace Forensics Science Center, the X-10 Graphite Reactor, Y-12, K-25, HFIR, REDC, SNS, and the Center for Nanophase Materials Sciences (Figs. 34 and 35).

Fig. 32. University of Utah nuclear engineering students visit HFIR.

Fig. 33. University of Utah students with ORNL staff at the historical graphite reactor.

6.1.8 The University of Michigan

Staff from both ORNL's Safeguards Laboratory and the International Safeguards group conducted a week-long course titled "Introduction to NDA Techniques for Nuclear Safeguards" for 12 students from the University of Michigan (November 4–8, 2014). The course focused on hands-on exercises with safeguards instrumentation and software that provided the students with an introduction to numerous NDA techniques used for analyzing SNM (Figs. 36–39).

Topics covered included nuclear nonproliferation and the IAEA, uranium enrichment measurements, uranium holdup measurements, neutron coincidence system, neutron coincidence counting using an AWCC, ISOCS measurements, radiation portal monitors, and portable NDA instrumentation operation including the FLIR MicroRaider and HM5 (IdentiFinder), Canberra's InSpector 1000, and ORTEC's Detective. In addition, as a part of the class, students attended several technical tours, including Canberra's and ORTEC's Germanium Crystal Growing Facility, the X-10 Graphite Reactor, ORNL's supercomputer, and the SNS.

As a part of an ongoing effort to improve the workshops, two new activities were included in this course. Optional lunchtime discussions were offered to the students so they could talk with ORNL staff in an informal setting and learn more about the work conducted at ORNL. The four lunchtime topics included ORNL Career Opportunities by Channa Palmer, Working at ORNL by Tyler Guzzardo, NDA Spent Fuel Measurements by Adam Shephard, and NDA Q/A by Stephen Croft. Also, a new presentation was developed on uranium enrichment measurement techniques to help the students gain a better understanding of enrichment measurements conducted during the workshop.

Fig. 34. Participating students from the University of Michigan.

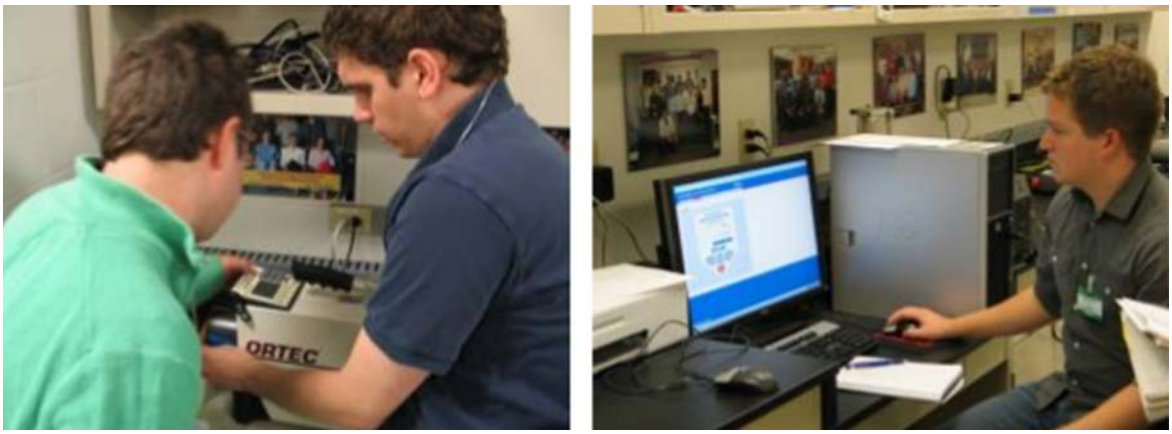

Fig. 35. Students collaborate to perform measurements on nuclear material.

Fig. 36. ORNL staff works with students performing measurements in the Safeguards Laboratory.

Fig. 37. Students were able to gain practical hands-on experience with the same equipment that is used in the field.

6.2 INTERNATIONAL SAFEGUARDS AND NONPROLIFERATION WORKSHOP

This fiscal year, ORNL has decided not to hold the annual International Safeguards and Nonproliferation Workshop. The workshop will now be offered in December 2014 and will focus on modeling and simulation for safeguards. The workshop will capitalize on the work being done by ORNL and its NGSI university partners, making the topics significantly different from the NGSI workshops offered across the complex each summer. This workshop is intended for interns, university students, professors, and mid-career staff members, but ORNL will also invite international partners.

6.3 NGSI INTERNATIONAL NONPROLIFERATION AND NUCLEAR SECURITY WORKSHOP

In the last month of the fiscal year, ORNL NGSI HCD will be partially funding a workshop in Erie, Pennsylvania, for the Tom Ridge School of Intelligence Studies and Information Science at Mercyhurst University. This workshop will include nonproliferation and fuel cycle discussions as well as a safeguards legal framework and IAEA presentations. There will also be an NDA exercise and a safeguards noncompliance case study. ORNL's Global Security Directorate will be leading the nuclear security portion of the agenda but with an emphasis on the synergy between safeguards and security.

7. PROFESSIONAL DEVELOPMENT

7.1 NEXT GENERATION SAFEGUARDS PROFESSIONAL NETWORK ACTIVITIES

7.1.1 NGSPN Workshop

In March 2013, Denise Lee and Brent Beatty attended the Next Generation Safeguards Professional Network (NGSPN) workshop held jointly at Sandia and Los Alamos national laboratories in New Mexico. During their week in New Mexico, the participants attended a variety of safeguards presentations given by subject matter experts. They were also able to interact with their peers and become more familiar with the wide breadth of cutting-edge research being performed at these facilities. The agenda included tours of the plutonium facility at Los Alamos and the Physical Security Facility at Sandia, both of which are unique in their capabilities. This workshop also provided excellent network opportunities, including development of several FY 2015 multi-laboratory proposals as a direct result of this event (Figs. 40–42).

Fig. 38. Participants in the NGSPN workshop from across the United States.

Fig. 39. Brent Beatty participating in a physical security simulation.

Fig. 40. Various safeguards technology participants were presented.

7.1.2 NGSPN Website

ORNL NGSI HCD continues to update and maintain the Next Generation Safeguards Professional Network website. It currently has more than 70 members (Fig. 43).

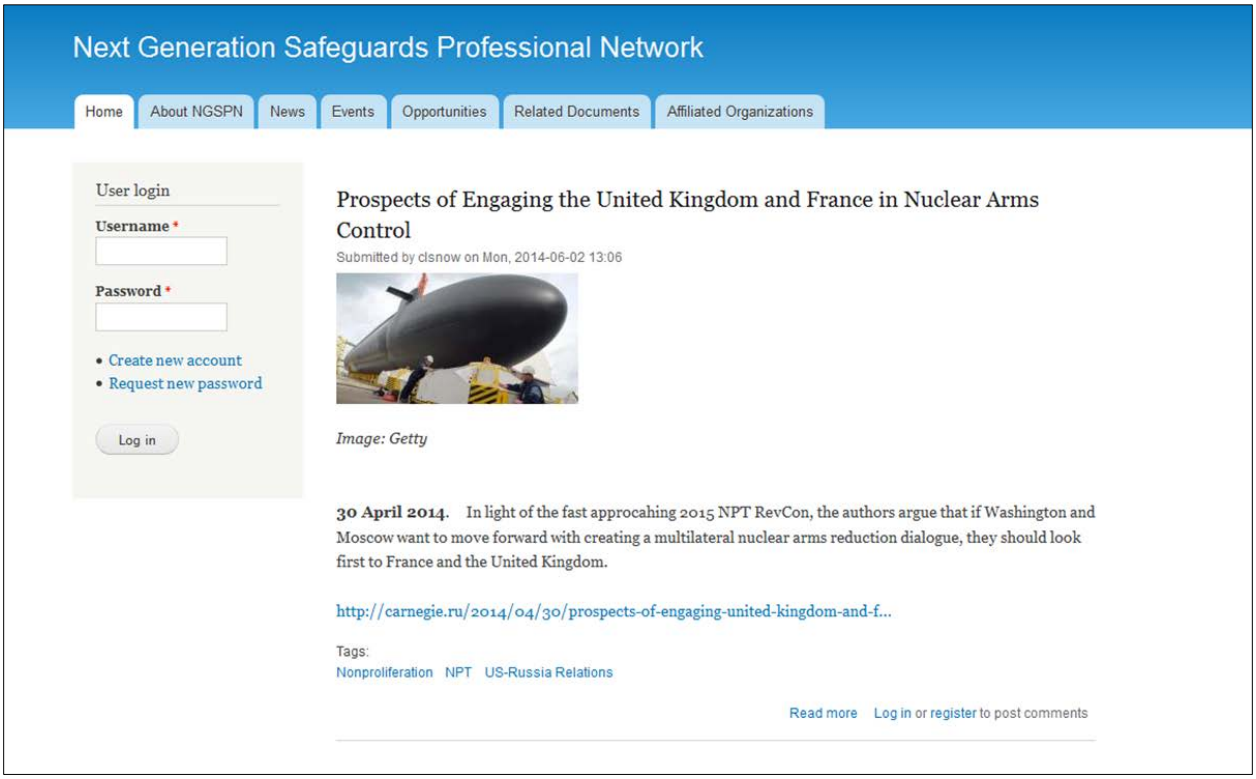

Fig. 41. Screenshot of the NGSPN.org website.

7.2 WORLD NUCLEAR UNIVERSITY

ORNL NGSI HCD continued to play an active role in the World Nuclear University (WNU) thanks to the support of NA-241's NGSI HCD program. ORNL was able to send a next generation staff member to the WNU Summer Institute. In April 2014, ORNL had the privilege of hosting the 2nd WNU Alumni Assembly of the WNU Summer Institute.

7.2.1 World Nuclear University Alumni Assembly

The 2nd WNU Alumni Assembly was held at ORNL from March 31–April 4, 2014. The event offered three separate areas of opportunities for the participating alumni: professional development, leadership, and peer-to-peer engagement. The professional development area consisted of training activities, while the leadership area involved discussions with invited leaders, including members of the international commercial sector and the US government. The peer-to-peer engagement not only gave past fellows a chance to reconnect with each other but also provided them the opportunity for further engagement with the speakers, as well as with fellows from other classes. The 2nd WNU Alumni Assembly was expanded to 5 days (the first was a 2 day event) to accommodate additional alumni presentations and to provide tailored training opportunities in the middle of the week, leadership seminars, and tours of ORNL facilities on the final day.

The 2nd WNU Alumni Assembly had 52 attendees, with no attendees from 2005, 8% from 2006, 2% from 2007, 12% from 2008, 10% from 2009, 21% from 2010, 19% from 2011, 13% from 2012, and 15% from 2013. The geographical metrics were as follows: 21% from Europe, 57% from North America, 6% from Asia, 10% from Africa, and 6% from South America. Figure 44 presents the metrics of the 2012 attendees, as a percentage, by alumni class and by home continent.

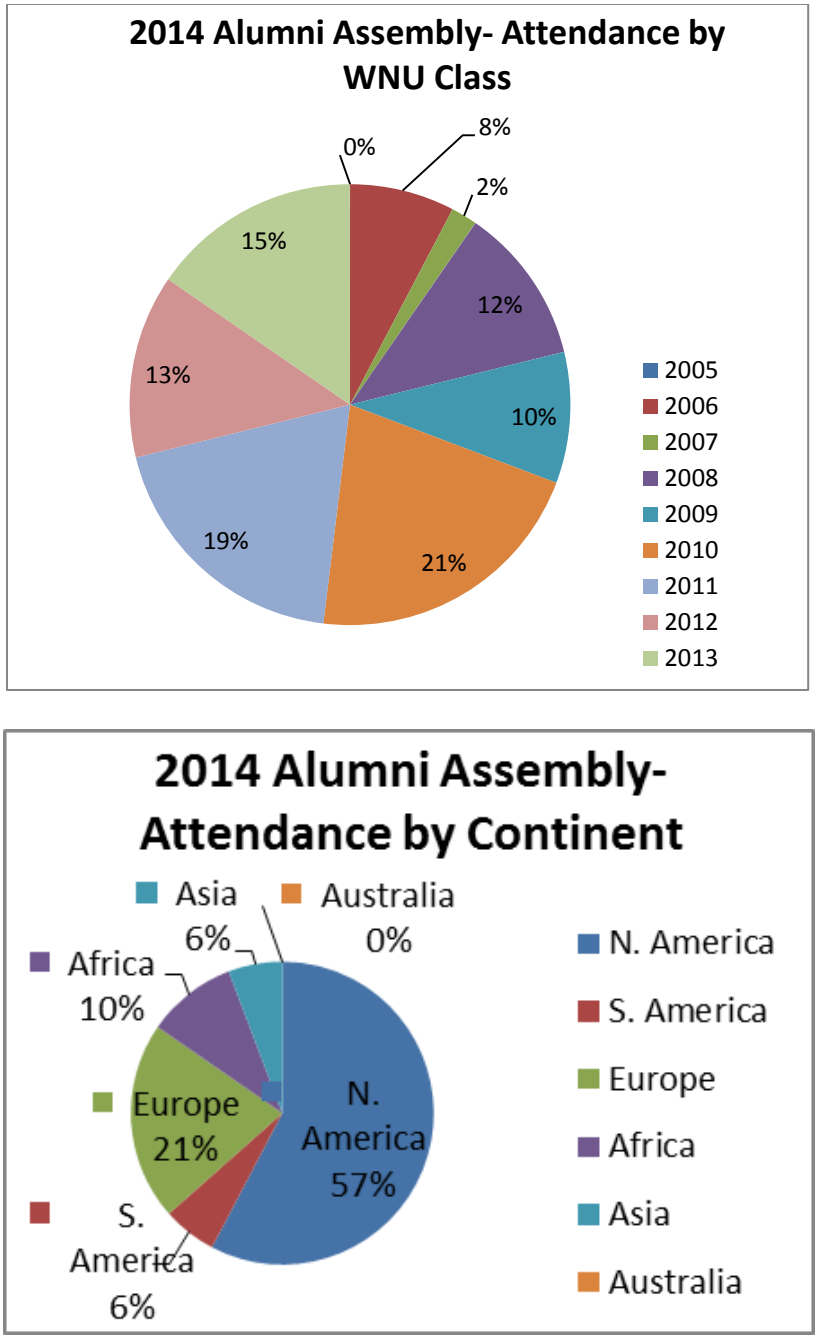

Fig. 42. Metrics of the 2014 attendees as a percentage by WNU class (top) and by home continent (bottom).

The alumni had four different training topics to choose from: Nuclear Safeguards/Inspector Training, Research Reactor and Isotope Production, Nuclear Security and the Technical Community, and Nuclear Safety Culture.

NGSI supported the Nuclear Safeguards/Inspector training and ORNL safeguards staff participation in the assembly. The Nuclear Safeguards/Inspector training gave participants an opportunity to spend a day in the life of an IAEA inspector performing NDA measurements on nuclear material, inspecting tamper-indicating devices (TIDs), and considering international safeguards policy implications of their actions. The course provided an introduction to international safeguards policy as well as a variety of safeguards instrumentation. Throughout the training, the overarching theme of how to collect information on an undeclared drum of nuclear material was discussed through demonstrations and hands-on exercises. Participants searched for and identified hidden radioactive sources with handheld radiation detectors, measured cans of uranium ranging in enrichment from 0.31% to 93% ^{235}U, as well as quantified the mass of nuclear material stored in a variety of containers. The resulting experience left participants with a new understanding of nuclear safeguards and gave them an excellent introduction to the challenges of working as an IAEA inspector.

Most of the safeguards training session was taught by three WNU alumni: Tyler Guzzardo, ORNL (2012 fellow), Nathan Rowe, ORNL (2010 fellow), and Karen Miller, LANL (2008 fellow). Apart from the initial lecture given by an ORNL manager, the rest of the course was taught by WNU alumni and/or early career professionals (Figs. 45–47).

Fig. 43. Group photo of the WNU Alumni Assembly.

A great group of World Nuclear University fellows in the safeguards training session at the alumni assembly! — with Aninda Dutta Ray and 6 others at Oak Ridge National Laboratory.

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Ramsundar Solaimalai, Jessica White-Horton and 33 others like this.

Darren Klassen Thanks again Tyler and everyone in the safeguards lab for putting on an excellent training session! We had a great time and learned a ton!
April 5 at 6:58pm · Like · 1

Shehab G. Mustafa This was a amazing session and great group of people! But where is Inspector 1000?
April 5 at 7:23pm · Like

Shehab G. Mustafa Thanks again to Tyler Guzzardo and Co. At ORNL!
April 5 at 7:25pm · Like

Yann Magnon Thanks. It was just awesome !
April 5 at 7:48pm · Like · 1

Aninda Dutta Ray Thanks again to the Oak Ridge Safeguards lab team. A great opportunity to learn from the best.
April 6 at 8:39am · Like · 1

Rashid Harib AlFalahi Looking great !!

Fig. 44. Photo and feedback on the safeguards training portion of the WNU Alumni Assembly.

Fig. 45. Jessica White-Horton (left) presented on the WNU Alumni Assembly at ORNL (preparation of the paper was partially funded by NGSI).

7.2.2 World Nuclear University Summer Institute

With the support of NGSI, ORNL was able to send postdoc Roger Kapsimalis to the World Nuclear University Summer Institute at Christ Church, Oxford University from July 4 through August 15. This year's program consisted of 67 fellows from nearly 30 countries. This year's fellows brought expertise from many sectors of the commercial nuclear industry, as well as regulatory bodies and nuclear research scientists (Fig. 48).

Throughout the summer institute, the fellows learn from a broad range of international experts. Invited speakers give presentations on nearly all economical, technical, and personal aspects of the nuclear fuel cycle. Corporations, regulators, and representatives from numerous international agencies discuss current and future issues related to the expansion of the nuclear industry.

Peer breakout groups to further discuss issues presented during the day augment expert lectures. These breakout groups of no more than 10 people promote lively discussions and provide an opportunity for fellows to share their own unique experiences. These discussions cover not only technical topics but also social responsibilities associated with the nuclear industry as a whole.

As the institute concludes, the fellows prepare and present their capstone project, the Forum Interest Group. Kapsimalis and his group focused on the many issues surrounding the expansion of nuclear technologies to countries currently without nuclear programs. Other topics included the disposal of nuclear waste, nuclear economics, and the importance of safety throughout the nuclear industry.

Fellows travel outside of Oxford on several occasions to nuclear installations throughout the United Kingdom.

Fig. 46. WNU Summer Institute Fellows, including ORNL's Roger Kapsimalis.

7.3 OTHER PROFESSIONAL DEVELOPMENT OPPORTUNITIES

7.3.1 Symposium on Radiation Measurements and Applications

Tyler Guzzardo attended the Symposium on Radiation Measurements and Applications (SORMA) conference that was held at the University of Michigan on June 9–12 (Fig. 49). He presented "Stability of Working Reference Standards for Hybrid K-Edge Densitometer Quality Control," a research paper which will be published in a special issue of *Nuclear Instruments and Methods in Physics Research A*. He said that attending this conference allowed him to discuss his research in a public forum, learn about new radiation measurement methodologies applicable to safeguards, and foster new collaborations through networking.

Fig. 47. The University of Michigan, which hosted the symposium.

7.3.2 IAEA Pre-Inspector Course (at INL)

ORNL's participant had to drop the IAEA Pre-inspector course this year because he was offered a JPO position with the IAEA.

7.3.3 International School of Nuclear Law

Jessica White-Horton will be attending the International School of Nuclear Law (ISNL), at the University of Montpellier 1. The program this year will take place August 25–September 5, 2014. The program is organized by the Organisation for Economic Co-

operation and Development (OECD) Nuclear Energy Agency annually. Nuclear law directly impacts White-Horton's current work supporting implementation of IAEA safeguards in the United States. She expects that learning more about nuclear law will strengthen her contributions to ongoing NNSA projects.

In FY 2013, NGSI partially supported Kim Gilligan's participation at ISNL. In FY 2014, she completed additional requirements to earn a University Diploma in International Nuclear Law from the University of Montpellier. This did not use NGSI funds but was an extension of the original investment by NGSI.

8. KNOWLEDGE RETENTION

8.1 HCD ROADMAP

Since the 2013 kickoff, ORNL has continued to work closely with BNL on the development of an NGSI HCD Roadmap. The objective is to conduct a roadmap study, based on recruitment/retention metrics, to assess if the human capital pipeline is meeting current and future demand and to create a knowledge capture database to catalogue, evaluate, and disseminate NGSI HCD-developed education resources.

This year the subject matter expert/core competency database was greatly expanded. The objective of this project was to create a database that is able to match core competencies in the safeguards field with subject matter experts and publications. Also this year a paper entitled "Assessment of Core Competencies in Nuclear Safeguards" was published, and a brochure describing the HCD program and the importance of the HCD Roadmap was completed. Survey data from HCD-sponsored short course and university course participants are currently being compiled and will be analyzed throughout the FY 2015. As part of this effort, possible migration of SHULA to a central server using a MySQL database is currently being investigated.

Shaheen Dewji attended the IAEA School of Nuclear Knowledge Management course August 25–29 in Vienna. The purpose of her trip was to investigate knowledge management paradigms and to present the HCD Roadmap project for feedback from IAEA knowledge management professionals. The deliverable for attending this course is an HCD Roadmap Knowledge Management Strategic Plan. More information is available in the HCD Roadmap annual report to be delivered to NA-241.

8.2 CLOUD-BASED DELIVERY OF NGSI TRAINING

The Cloud-Based Delivery Project has completed its evaluation of an efficient means for generating content quickly and cost-effectively. Themes have been reviewed, and content has been developed for a common introduction to several proposed series of video-based presentations. Subject matter experts have been approached regarding a variety of new offerings that would complement the existing lectures. The method for delivering this content is still being assessed.

After reviewing many hardware and software tools, the Mediasite recorder was selected to serve as a reliable mechanism for generating content. Using the Mediasite recorder does not preclude any other content generation methods but does provide a quick and easy way that can be relied on for content generation. A purchase order was issued to obtain a Mediasite recorder demonstration machine to create content for several series.

Rosemary Walker of ORNL's Creative Media will create the common introduction that will be supplied for cloud delivery. Two themes have been selected, and the introduction will include the breadth of the NGSI Pillars and pictures of NGSI activities.

The initial content will be the NCSU lectures and will be introduced as the "NGSI Lecture Series." These will be re-mastered with the common introduction, and adjustments will be made to the audio quality. A pilot of the "Refresher Series," brief reviews of instrumentation used in the field, a pilot of the "Working at the IAEA Series," and brief reviews of peoples' experiences working at the IAEA will follow. Angela Lousteau will develop the material and conduct a refresher for the IAEA's HM5 tool based on the Identifinder. Other refreshers being considered for inclusion are the active well counter and the Falcon

HPGe detector. Jim Garner has been asked to prepare and present his perspective on working at the IAEA in safeguards. Others who have worked in other IAEA organizations will be included.

Determining how to officially offer this content has been a slow process. ORNL has a YouTube channel that will probably be used as the initial delivery method. Approvals must be obtained to clear the content for posting. At this time, having the Lecture Series, the HM5 refresher, and the IAEA Safeguards work content available by the end of the fiscal year appears to be possible. An NGSI playlist will be created on the ORNL channel. ORNL does not currently have a iTunes University site, but the University of Tennessee does. The idea here is to work through UT's Nuclear Security Institute to use the iTunes University site. Another possibility is to have NGSI itself standup a YouTube channel and enter into an agreement for an iTunes University site.

9. STATEMENTS BY THOSE BENEFITING FROM NGSI

Below is a sample of the feedback ORNL NGSI HCD receives throughout the year attesting to the value and benefits of the NGSI HCD program.

NGSI Postgrad Experience by Katy Snow

Overall I have been extremely pleased with my time spent at ORNL. I developed a strong set of skills which will benefit me throughout my career, and I also feel as though I was able to make a positive impact on my group's work. I will take up employment as an independent contractor in international relations and nuclear safeguards. I already have one contract pending with Idaho National Lab and am exploring the possibility of opening others with Pacific Northwest National Lab as well as ORNL. I look forward to the exciting times ahead and thank NGSI for the wonderful opportunity which has prepared me so well.

Fig. 48. NGSI postgrad Katy Snow.

NGSI-Funded Course Experience by Professor John Mattingly (NCSU)

One of my students applied for an IAEA internship as a direct result of the NE591: Nuclear Nonproliferation Technology and Policy class supported by NA-24's Human Capital Development program. I know the competition is stiff, but I'm encouraged that she applied. Also, one of our first-year graduate students has decided to pursue research (in my group) directly supporting nonproliferation for his Ph.D. as a result of the class, and several other graduate students are going to cite applications of their research to nonproliferation.

NGSI-Funded Course Experience by Student Holly Ray (UTK)

The class was great and I wish I could continue with similar classes that further my knowledge in the field of Export Control and Nonproliferation. Taking this class has also affected the way I am looking at my future. I want to be involved in the nuclear security field through policy as well as technology, so I wish to pursue a graduate degree in nuclear security, but I plan on finding a job in the field first and then progressing into school.

NGSI Funded Field Trip Experience by Professor Glenn Sjoden (Georgia Tech)

I profoundly appreciate the opportunity this trip offered for the students, and for the generous funding of it by NNSA/NGSI, without which it would not have been possible. This particular use of funds from NNSA for this field trip seems, in my view, to be exactly in line with the spirit and intent of the NGSI vision to revitalize the international safeguards technology and human resource base. The students were keenly interested in what they heard and saw and asked numerous questions at every juncture. I have reviewed the results of a student evaluation of the field trip, and I can assure you it reflects a universal appreciation for the unique opportunity the students had to dialogue with the professional staff members from IAEA and CTBTO about the technical challenges and opportunities in effective and verifiable international safeguards. Moreover, this field trip enabled the students to see firsthand how and what professional staff trained in safeguards related disciplines contribute to the international community. In fact, the students' enthusiasm and interest in international safeguards was reflected in their responses to several salient questions on their student evaluations.

NGSI Intern Experience by Student Allyn Milojevich

Before my time at Oak Ridge National Laboratory, I had studied safeguards and nonproliferation in both the classroom at the University of Tennessee as well as at an NGSI-sponsored three week workshop at Brookhaven National Laboratory. However, my summer interning at ORNL allowed me to experience what nonproliferation specialists do on a day to day basis to prevent proliferation. I have learned how to read reports, research nonproliferation topics, and engage with our partners. I am starting the final year of my Ph.D. at the University of Tennessee and plan to pursue a safeguards and nonproliferation-related career.

NGSI Nonproliferation Workshop Experience by Student Caitlin McKibben (UGa)

On behalf of the master's in International Policy students at the University of Georgia, I would like to thank you for a wonderful week at Oak Ridge. Many of our students had little exposure to the hands-on applications of the policies we study every day in the classroom before we travelled to Tennessee. The trip was a great introduction to the IAEA for those who had not previously studied the agency, and it was great opportunity for those with some preexisting knowledge to learn more. It was a positive experience for all, and we appreciate you taking the time to plan our visit.

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