LA-UR-14-28250

Approved for public release; distribution is unlimited.

Title: Next Generation Safeguards Initiative Efforts at Los Alamos National Laboratory: Developing Our Human Capital FY2014

Author(s): Boyer, Brian David
Scherer,Carolynn P.

Intended for: Report

Issued: 2014-10-22

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Next Generation Safeguards Initiative Efforts at Los Alamos National Laboratory: Developing Our Human Capital FY2014

Executive Summary

Since its inception in 2008, the Human Capital Development (HCD) subprogram of National Nuclear Security Administration's (NNSA's) Next Generation Safeguards Initiative (NGSI) has made significant progress in cultivating sustainable academic and technical programs that support the recruitment, education, training, and retention of the next generation of international safeguards professionals. The undertaking of this program is to develop additional safeguards and nonproliferation experts to meet the needs of the United States and the International Atomic Energy Agency (IAEA).¹ Through partnerships with nine national laboratories within the NNSA complex, the HCD subprogram has supported hundreds of summer student internships, longer-term graduate and postdoctoral fellowships, and the development and delivery of in-house summer courses in safeguards-related topical areas for student interns, fellows, and mid-career professionals. Additionally, the program has funded the development of graduate-level international safeguards and nonproliferation curricula and the delivery of guest lectures at U.S. universities.²

At the Los Alamos National Laboratory (LANL), professionals from line organizations and program offices working within the Global Security Directorate were instrumental in fulfilling the mission of the HCD subprogram for the past four years. This report documents the accomplishments of the Safeguards HCD Fiscal Year 2014 (FY14) Project Work Plan, highlighting our work as well as the accomplishments of our NGSI-sponsored students, graduate and postdoctoral fellows, and mid-career professionals during this past year. LANL again delivered a graduate-level course, *Nuclear Nonproliferation Primer with Emphasis on Safety, Safeguards and Security* to students at the Pennsylvania State University, fall 2013 semester online via the Pennsylvania State University World Campus. LANL also participated in NGSI sponsored events such as the Public Policy & Nuclear Threats Boot Camp 2014 at UCSD and the *Nuclear Nonproliferation, Safeguards, and Security in the 21st Century* at Brookhaven National Laboratory.

The HCD subprogram confirmed budget at LANL for FY14 was 25% less than FY13, due to the continuing resolution and sequestration implemented by Congress at the beginning of the fiscal year. With the budget uncertainties, LANL was late in offering positions to prospective summer students, even though we initiated discussions with the students early in the school year. Several students—including former NGSI-sponsored students—took guaranteed positions instead of waiting for offers from LANL. Additionally, with the smaller budget and fewer students, we were unable to offer our Nuclear Safeguards Policy and Technology Workshop and Advanced Gamma-Ray Measurements Course during the summer of 2014.

CONTENT

<u>24.1.1.3.1.1 UNIVERSITY ENGAGEMENT</u>	<u>6</u>
1. DEVELOPMENT OF UNIVERSITY COURSES:	6
2. DEVELOPING AND SHARING COURSE MATERIAL	8
THE PENNSYLVANIA STATE UNIVERSITY–UNIVERSITY PARK, PA	8
THE UNIVERSITY OF FLORIDA–GAINESVILLE, FL	8
THE UNITED STATES MILITARY ACADEMY, WEST POINT, NY	8
3. GUEST LECTURES AT UNIVERSITIES	9
THE OHIO STATE UNIVERSITY–COLUMBUS, OH	10
THE UNIVERSITY OF FLORIDA–GAINESVILLE, FL	10
4. PROMOTING AND ENGAGING STUDENTS IN SAFEGUARDS AND NONPROLIFERATION	10
ANS STUDENT CONFERENCE – AT PENN STATE, APRIL 3, 2014	10
INMM SOUTHWEST CHAPTER (SWC) TAOS TECHNICAL MEETING – MAY 17, 2014	11
INMM ANNUAL MEETING – ATLANTA GA – JULY 2014	12
SUPPORT TO SOUTH CAROLINA UNIVERSITIES RESEARCH AND EDUCATION FOUNDATION	13
<u>24.1.1.3.1.4 / 24.1.1.3.1.6 STUDENT SUPPORT TASKS</u>	<u>13</u>
ALICIA G. DOMINGUEZ – NGSi INTERN	13
JULIA EIGENBRODT- NGSi PH.D. CANDIDATE	14
ALEXIS KAPLAN – NUCLEAR FORENSICS GRADUATE FELLOW	15
ALEX KHRIZMAN - NGSi SUMMER INTERN	16
CHANTELL MURPHY – NGSi PH.D. CANDIDATE	16
JOSHUA RICHARD - NNIS GRADUATE FELLOW	17
ROBERT WEINMANN-SMITH - NGSi INTERN	17
ROBERT ZEDRIC –NNIS GRADUATE FELLOW	18
UPPSALA UNIVERSITY (SWEDEN) JOINT LANL –UPPSALA EFFORT ON SPENT FUEL VERIFICATION	18
NGSi EARLY/MID-CAREER UPDATE – DR. KAREN A. MILLER –INMM AWARD WINNER	19
<u>24.1.1.3.1.5 LABORATORY SAFEGUARDS COURSES</u>	<u>19</u>
BROOKHAVEN NATIONAL LABORATORY	19
NGSi SUMMER LECTURE SERIES – ORGANIZED BY LLNL	20
NUCLEAR LUNCH	21
THE UNIVERSITY OF CALIFORNIA SAN DIEGO, PPNT, LA JOLLA, CA	21
<u>24.1.1.3.1.8 MID-CAREER TRANSITION</u>	<u>21</u>
VLADIMIR HENZL	21
<u>24.1.1.3.1.9 PROFESSIONAL DEVELOPMENT</u>	<u>23</u>
NEXT GENERATION SAFEGUARDS PROFESSIONAL NETWORK WORKSHOP	23
RETURNING IAEA LANL STAFF	24
HEATHER NORDQUIST	25
DEBBIE DALE	25
REFERENCES	26

APPENDICES	28
APPENDIX A: THE PENNSYLVANIA STATE UNIVERSITY	28
APPENDIX B: UNITED STATES MILITARY ACADEMY-BNL-LANL MEETING NOTES (C. BATHKE)	31
APPENDIX C: UNIVERSITY OF FLORIDA	32
APPENDIX D: FY14 NGSi-SPONSORED GUEST LECTURES	35
APPENDIX E: FY14 NGSi SUPPORTED PH.D. CANDIDATES AND INTERNS	36
APPENDIX F: FY14 LANL PROJECT COST BREAKDOWNS	37
FY14 NGSi COSTS AND LABOR, UNIVERSITY OUTREACH (24.1.1.3.1.1)	37
FY14 NGSi COSTS AND LABOR FOR LANL SUMMER INTERNS (24.1.1.3.1.4)	37
FY14 NGSi COSTS AND LABOR FOR LANL INTERN AND POST DOCS (24.1.1.3.1.6)	38
FY14 NGSi COSTS AND LABOR, LAB SAFEGUARDS COURSES (24.1.1.3.1.5)	38
FY14 NGSi COSTS AND LABOR FOR MID-CAREER (24.1.1.3.1.8)	39
FY14 NGSi COSTS AND LABOR FOR PROFESSIONAL DEVELOPMENT (24.1.1.3.1.9)	39
APPENDIX G: NUCLEAR LUNCH SERIES	40
APPENDIX H: STUDENT POSTER SESSION – LANL AUGUST 5, 2014	43
NGSi STUDENT PRESENTATION AT THE 14 TH ANNUAL STUDENT SYMPOSIUM	43
APPENDIX I: NGSPN LANL-SNL WORKSHOP AGENDA	44

24.1.1.3.1.1 University Engagement

With support from the HCD subprogram, LANL professionals strengthened existing university partnerships and forged new ones during FY14. This subprogram includes efforts in (1) developing new undergraduate and graduate-level courses on international safeguards and nonproliferation at U.S. universities, (2) developing and sharing course material, (3) giving guest lectures at universities, and (4) promoting and engaging universities in safeguards and non-proliferation education, including building certificate level programs. Highlights of our efforts to engage faculty and students at U.S. and international universities are given below.

1. Development of University Courses:

Figure 1. Sample screenshot from Nuc E 597G videos

Brian Boyer strengthened his existing collaborations with faculty in the Mechanical and Nuclear Engineering Department at The Pennsylvania State University (PSU)—University Park. Boyer presented the third offering of his popular graduate-level course, *Nuclear Fuel Cycle Primer with Emphasis on Safety, Safeguards, and Security (3S)* [NUC E 597G], during the fall 2013 semester. The course consists of 30 LANL produced lectures via NGSI-HCD funding. The course attracted 18 full-time students and working professionals and delivery is through PSU's World Campus Distance Learning Program. Previous HCD subprogram FY11–12 budgets supported the development of the curriculum for this course. In August and September 2013 Boyer retaped 30 lectures. His team helped to revise 10 homework assignments and 2 projects for relevance and to incorporate lessons learned from three previous offerings of this course (two times at Penn State and one time at the New Mexico Institute of Mining and Technology).

This *Nuclear Fuel Cycle Primer with Emphasis on 3S* course surveys the historical events leading to the creation of the IAEA; presents the legal framework for IAEA operations; explores the safety, safeguards, and security issues associated with nuclear fuel cycle facilities and operations; and reviews proliferation pathways, indicators, and case studies. Appendix A contains a copy of the course syllabus and reading list. To bring the course content alive for the students are two graded projects using interactive, 3-D immersive virtual reality simulations. One of these simulations is a gas centrifuge enrichment plant that students “inspect” for compliance with IAEA safeguards requirements. This simulation and its associated model generated interest from URENCO for training its staff on enrichment safeguards. In addition, the IAEA has interest in using it to supplement its inspector training course for performing Low Frequency Unannounced Access Inspections. Also, Dr. Olli Heinonen contacted Boyer about a training initiative with U.S. Dept. of State leveraging the courses developed through NGSF funding.

LANL is proud that one of the Fall 2013 Nuc E 597G students, Luis A. Ocampo-Giraldo (Figure 2), a Penn State graduate student won second prize in the INMM 55th Annual Conference J. D. Williams Student Paper Award Competition. He interned the last two summers at Brookhaven National Laboratory (BNL) under Susan Pepper and has observed the IAEA/BNL Additional Protocol Exercise course and been part of BNL’s annual *Nuclear Nonproliferation, Safeguards, and Security in the 21st Century* course. LANL believes that his participation in our offerings to his education provided a keystone to his prize-winning paper entitled “Status of the Implementation of Safeguards by Design in the International Safeguards Regime” in Atlanta.

Figure 2. Luis Ocampo-Giraldo of The Pennsylvania State University receives his prize from INMM President Ken Sorenson and Vice President Larry Satkowiak

2. Developing and Sharing Course Material

The Pennsylvania State University–University Park, PA

Partially through Boyer's ongoing engagement with PSU in nuclear safeguards and nonproliferation, the University has built a graduate program in nuclear and radiological security.

Penn State in conjunction with the National Nuclear Security Administration, the Massachusetts Institute of Technology, and Texas A&M University started a graduate-level program to educate the next generation of nuclear and radiological security experts. Students in the program take courses in threat analysis and assessment, detector and source technologies, application of detectors/sensors/sources for radiation detection and measurement, global nuclear security policies, and design and analysis of security systems for nuclear and radiological facilities.³

Through LANL's coursework at PSU, we are part of the Penn State World Campus or "Penn State Online" launched in 1998i. U.S. military personnel stationed around the globe, young nuclear professionals, and on-campus students are students in our *Nuclear Fuel Cycle Primer with Emphasis on Safety, Safeguards, and Security* (NUC E 597G) course.⁴

The University of Florida–Gainesville, FL

Brian Boyer supported Professor Joseph Mack of the Nuclear Engineering Department at the University of Florida, Gainesville, FL in the second offering of *Perspectives on Nuclear Energy and Nonproliferation* in the fall semester 2013. Appendix B contains the syllabus for this course. Boyer presented two lectures for the course, "Nonproliferation and Safeguards Issues: Focus on Nuclear Reactors"⁵ and "Nonproliferation and Safeguards Issues: Focus on Enrichment Plants"⁶ on November 4 and 6, 2013. These lectures focused on international safeguards technology and policy. Boyer also had several working meetings with faculty, discussing research focus and possible LANL collaborations. Boyer gave a talk entitled "The IAEA and the Role of the International Safeguards System in the Nuclear Field" to the Nuclear Engineering Department on November 5, 2013. He also met with U. of Florida faculty and was able to get Robert Weinmann-Smith to apply to LANL for a summer internship. Fall 2014 Florida will be rolling out the new Florida Institute for National Security⁵. This can be a vital center for NA-20 to participate with Florida in nonproliferation and safeguards issues.

The United States Military Academy, West Point, NY

Boyer met COL Sones [United States Military Academy (USMA) at West Point, NY] at Penn State during the ANS Student Conference in April 2014. There were more than a dozen of Sones' nuclear engineering students in attendance, and their enthusiasm impressed Boyer. During a follow-on meeting at BNL, Brian Boyer and Chuck Bathke met with COL Bryndol Sones and LTC Lou Florence. Along with Robert Bari and Lap-Yan Cheng (both of BNL). Appendix B contains an overview of the meeting. Boyer worked with Bari building a LANL/BNL FY15 proposal to work with USMA to strengthen USMA's nuclear engineering and nonproliferation program with lectures, provide access to BNL, and further support students by placing some

cadets in independent research efforts for either the fall or spring semesters of 2014/2015 and/or placing some two-cadet teams against a capstone design project for the year. COL Sones requested some ideas for cadet topics to start the fall semester and Boyer sent him the following topics:

CAPSTONE Plutonium Production (Team Project)

The students will research the nuclear fuel cycle around the world, specifically looking at civilian plutonium production. The students will estimate yearly Pu production for the current year based on the operational data for global civilian power reactors. Additionally the students will examine worldwide research reactor operations and estimate their plutonium production. There are several models, such as the Binford Correlation, to predict Pu production from light water reactors. The student will use these models to get a reasonable estimate of Pu production.

The key analysis will provide:

- 1) Projections of nuclear power growth and how this will affect Pu stocks in 25 to 50 years.
- 2) Growth of civilian Pu and impacts on
 - a. Repository
 - b. Reprocessing
 - c. Long to mid-term storage in casks
 - d. Estimate how these solutions will address increased Pu production
- 3) Proliferation and security impacts
 - a. Where will the Pu be?
 - b. Will new states getting nuclear power shift proliferation and security impacts?

CAPSTONE Gas Centrifuge Enrichment

Over the last decade a key topic of security and proliferation interest is uranium enrichment at gas centrifuge facilities. The students in this project will analyze the scale of centrifuge projects around the world, examining proliferation paths, analysis of plants size and scale for UF₆ enrichment. They will use this data to analyze proliferation threats. The students will use models created at LANL for analysis of enrichment and build scenarios of declared and undeclared facilities and work up timelines for attaining enough material for weapons production.

The students will evaluate application of safeguards to provide the “tripwire” of detection of “wayward” nuclear programs, to support the IAEA and other inspectors.

TERM PROJECT Fuel Cycle Analysis

For a fictional State with a nuclear fuel cycle, the student will describe nuclear material balances and throughputs, and evaluate safeguards applications to address the nuclear fuel cycle safeguards issues of that State.

3. Guest Lectures at Universities

Several LANL staff members were guest lecturers at universities during FY14. Appendix D is a detailed list of the lectures and associated information.

The Ohio State University–Columbus, OH

Chuck Bathke gave a lecture on “Material Attractiveness and Why It Is Important”⁹ on February 19, 2014 to the OSU Department of Mechanical and Aerospace Engineering.

The University of Florida–Gainesville, FL

Brian Boyer supported Professor Joseph Mack of the Nuclear Engineering (NE) Department at the University of Florida, Gainesville, FL in the second offering of *Perspectives on Nuclear Energy and Nonproliferation*, fall semester 2013. Appendix C contains the syllabus for this course. Boyer presented two lectures for the course, “Nonproliferation and Safeguards Issues: Focus on Nuclear Reactors” and “Nonproliferation and Safeguards Issues: Focus on Enrichment Plants” on November 4th and 6th, respectively. Boyer also gave a seminar, “The IAEA and the Role of the International Safeguards System in the Nuclear Field” for the NE Department Seminar Series on November 5th.

4. Promoting and Engaging Students in Safeguards and Nonproliferation

ANS Winter Meeting- Washington DC – November 2013

Brian Boyer participated in the Tools for Nuclear Nonproliferation–Panel Sponsored by the ANS Nuclear Nonproliferation Technical Group (NNTG) at the ANS Winter Meeting in Washington DC with Session Organizer: Matthew J. Gidden (Univ. of Wisconsin, Madison). According to the program⁶, the panel attempted to define:

“The complex challenges inherent to safeguarding the nuclear fuel cycle reflect its diverse nature, spanning a wide range of activities from initial mining to enrichment, irradiation, storage, reprocessing, and disposal, each requiring unique tools for verification. This panel session brings together experts from a broad range of expertise to discuss the development and use of modern tools for nuclear nonproliferation, including technology, inspections, and intelligence, and in particular their combined application to advance global nonproliferation goals.”

PANELISTS:

- Brian Boyer (LANL)
- Jeff Chapman (ORNL)
- David Chichester (INL)
- Melonie Richey (Mercyhurst)
- Kris Wheaton (Mercyhurst)
- Jessica White-Horton (ORNL)

ANS Student Conference – at Penn State, April 3, 2014

During the 2014 ANS Student Conference held at The Pennsylvania State University, (University Park, PA) the Penn State Student INMM Chapter helped host an Institute of Nuclear Materials Management Workshop. The conference program⁷ stated that:

“This workshop will teach participants the basic principles behind physical security at nuclear power plants and how the International Atomic Energy Agency (IAEA) safeguards enriched uranium and plutonium to ensure it is not diverted for clandestine weapon development. Participants will be divided into teams and play the role of adversaries or security/safeguards personnel. The teams will work with experts in the field to determine how to protect or attack a mock facility. Finally, the teams will see how their efforts might work (or fail) in a tabletop exercise. This workshop is sponsored by the Institute of Nuclear Materials Management.”

During this workshop, Steve Ward (U. of Michigan) gave short lectures on INMM, safeguards by B. Boyer (LANL), and security by Joe Rivers (US-NRC). They introduced attack and defend style events for an exercise. Ward designed this exercise to give students an opportunity to think like safeguards and security personnel while promoting INMM and especially the Penn State Student Chapter. The experts in the field, Ward, Boyer, and Rivers, critiqued students groups on their response plans. This interaction gave the students a taste for how safeguards and security can be applied to various realistic events and situations.⁸.

INMM Southwest Chapter (SWC) Taos Technical Meeting – May 17, 2014

On Saturday, May 17 2014, at the INMM Southwest Chapter (SWC) held their annual Taos Technical Meeting. The INMM SWC subsidizes student participation. The following is a list of student presentations and Figure 3 is a picture of the student participants. Student participation was strong because TAMU brought a van of students to New Mexico to tour Urenco USA, SNL, and LANL and was able to finish the week at Taos.

1. **Jeremy M. Osborn and Taylor M. Coles** (TAMU), “Trace Fission Product Ratios for Nuclear Forensics Attribution of Weapons-Grade Plutonium Separated from Fuel Irradiated in Thermal and Fast Reactor Types,” co-authors Sunil S. Chirayath and William S. Charlton.
2. **Robert Zedric** (TAMU, NNIS Fellow at LANL), “Monte Carlo Modeling of the Californium-Interrogation with Prompt Neutron (CIPN) Device for Spent Nuclear Fuel Measurements.”
3. **Stephen Gerlt** (TAMU), “Towards Safeguarding the Fast Breeder Reactor Fuel Cycle.”
4. **Phil Lafreniere** (UNM) “Determination of Pyroprocessing Cathode Processor Failure Modes and Integration Into a Signature-Based Safeguards (SBS) Framework” with co-authors Robert Hoover and Edward Blandford.

Figure 3. TAMU and UNM students at the INMM SW Chapter Taos Meeting, May 2014

INMM Annual Meeting – Atlanta GA – July 2014

Dr. Karen Miller was recognized by INMM with an Early Career Award. She is a LANL staff member recently converted from a postdoctoral position. Her PhD is from TAMU, and she received support from NGSI, in 2010 she was the recipient of the J. D. Williams Student Paper Award in 2010, for the showing she has continued to build her skills in the areas of neutron detection of uranium and in being a key trainer in LANL's premier NDA courses.

Alexis Kaplan (LANL NEN-1, University of Michigan Ph.D. candidate), a LANL student received the J. D. Williams Student Paper Award in the Materials Control and Accountability Division for "Total Plutonium Content Determination with the Differential Die-Away Self-Interrogation Instrument." Her co-authors are LANL mentors Vladimir Henzl, Anthony P. Belian, Martyn T. Swinhoe, and Howard O. Menlove, and her University of Michigan faculty and staff represented by Marek Flaska and Sara A. Pozzi. Kaplan also won the Robert J. Sorenson Scholarship of \$1,000 for a Domestic (U.S.) Student.

Luis A. Ocampo-Giraldo, (Penn State graduate student) as previously noted, one of the Penn State Nuc E 597G students from fall 2013 class, won second prize in the J. D. Williams Student Paper Competition, INMM 55th Annual Conference.

Chantell Murphy (LANL Graduate Research Assistant in NEN-1, NGSI sponsored Ph.D. candidate at University of New Mexico), presented "Success Through Safety, Security, and

Safeguards by Design (3 SBD)”,⁸ with her attendance funded by UNM.

Support to South Carolina Universities Research and Education Foundation

Over the past year Brian Boyer supported South Carolina Universities Research and Education Foundation (SCUREF). He reviewed university applications to participate in the Nuclear Nonproliferation International Safeguards (NNIS) Graduate Fellowship program. He is also a participant of the team that yearly reviews applications for the NNIS Graduate Fellowship program. LANL supported three SCUREF sponsored fellows [Zedric, (TAMU), Kaplan (U. of Mich.), and Richard (MIT)] at the laboratory doing their mandatory stint at a national laboratory as part of the NNIS and Nuclear Forensics Graduate Fellowship obligation.

24.1.1.3.1.4 / 24.1.1.3.1.6 Student Support Tasks

The three NGSi-sponsored student interns represent different universities; highlights of their work and accomplishments are given below. Appendix E lists the three interns supported by 24.1.1.3.1.4 and the two Ph.D. students supported by 24.1.1.3.1.6 and their affiliated universities, degree programs, and research projects; note that the NA-241 Office of Technology Development sponsored several NGSi interns who are not included in this list but are noted below. All five of the interns supported by 24.1.1.3.1.4 and 24.1.1.3.1.6 were American citizens.

During FY13, LANL received a confirmed budget of \$33K from the HCD subprogram to fund student internships (down from \$195k in FY12). This budget supported two student interns, with minimal support to their mentors; a third intern was supported through partial funding from LANL’s National Security Office (NSO) and from Postdoctoral Fellowships (24.1.3.1.6). Appendix F provides a detailed breakdown of costs associated with the LANL summer internships budget, and Appendix G gives a cost breakdown for the full-year intern and postdoctoral fellow. Many of these students participated in the laboratory student poster competition (Appendix H)

Alicia G. Dominguez – NGSi Intern

Alicia Dominguez, a University of New Mexico sophomore was 50% funded on NGSi funding with mentor Carolyn Scherer, and 50% on other another project with mentor Crystal Dale. Ms. Dominguez spent her summer supporting the development of a model for a distributed nuclear security framework. She did research supporting the changing mobility in the nuclear workforce, showing that the millennial workers are not as dedicated to a company, and are more mobile with 401K retirement plans than the older workforce with pensions. She also researched changes in technological advancement, showing electronics are becoming smaller with higher storage capacities and more capability; an example is Google Glasses, which could be worn into a secure area, and transmit pictures real time from the facility. The third avenue she investigated was greater employee independence with less management

oversight. She showed that these three things combined made nuclear security more challenging, and that the current security models need updating for these new challenges. Alicia presented “Distributed Security Framework for Modern Workforce” at the LANL Student Symposium on August 5, 2014. Additionally this work supported two papers and presentations given this summer by LANL technical staff. One presentation and paper was at the Institute of Nuclear Material Management in Atlanta, GA, July 2014, titled: A Model for a Distributed Security Framework and the other paper and presentation was at the Pacifica Basin Nuclear Conference 2014 in Vancouver, British Columbia, Canada, August 2014, titled: Distributed Security Framework for Modern Workforce.

Julia Eigenbrodt- NGSi Ph.D. Candidate

NGSI HCD supported Julia Eigenbrodt at TAMU and during her stays at LANL to work on her experimental thesis work. She performed Passive Neutron Albedo Reactivity (PNAR) technique measurements on spent nuclear fuel at the Fugen reactor in Japan in June 2013, which demonstrated that the PNAR signal trends with multiplication. She is analyzing this data and comparing it to simulations of the same spent fuel. Eigenbrodt presented some of this research at INMM this summer. She also prepared some series of fresh fuel PNAR measurements at LANL (see Figure 4). She completed these measurements during Aug 4-12, 2014. These measurements provided a more controlled and well-known environment than when measuring spent fuel in a spent fuel pond. The fresh fuel measurements investigated the effects of: effective enrichment, water gap between the fuel assembly and the detector, position of the assembly within the detector, sensitivity to the center of the assembly, and presence of Gd-laced pins (to simulate fission product neutron absorbers). Eigenbrodt has the data set she needs to benchmark MCNP calculations for her thesis. She expects to defend her Ph.D. thesis in May 2015.

Figure 4. Eigenbrodt's PNAR Apparatus at LANL / handling fuel rods for measurements

Alexis Kaplan – Nuclear Forensics Graduate Fellow

Alexis Kaplan is a Nuclear Nonproliferation International Safeguards (NNIS) Graduate Fellow. NNGSI spent fuel verification program partially supported Alexis Kaplan, a Ph.D. Nuclear Engineering candidate at the University of Michigan and Nuclear Forensics Graduate Fellow. She is working on developing a theory and is preparing for experiment with the Differential Die-Away Self-Interrogation (DDSI) instrument. She used MCNP to simulate the DDSI signal with Rossi-alpha distributions in order to characterize the measured spent fuel assembly. Kaplan obtained two primary findings through this work: determination of assembly multiplication and total elemental plutonium mass. The journal *Nuclear Instruments and Methods A* accepted 3 articles by Kaplan on this work. She is preparing the detectors and data acquisition system for benchmarking experiments, which will take place this fall (2014). She simulated DDSI measurements with four different spent fuel libraries and made pulse train and list mode simulation with MCNP and MNCPU-PoliMi, deconstruction and analysis of Rossi-alpha distributions, and simulated DDSI with simplified, homogenized assemblies for theory development. She presented DDSI research at three conferences over the past year: ANS Winter Meeting 2013⁹, ANS Student Conference 2014¹⁰, and INMM Annual Meeting 2014¹¹. The papers and presentations won her the best student paper or poster awards at each conference. Hence, Kaplan published a prodigious amount of conference¹² and journal^{13,14,15} publications over the past year on new and valuable insights and discoveries in the field of measurements for nuclear material verification, thus advancing the state-of-the art. She is a tireless volunteer in the ANS student chapter at Michigan and in the NNTG professional division.

Alex Khrizman - NGSi Summer Intern

Alex Khrizman, an Ohio State University graduate student worked this summer with his mentor Charles Bathke. Khrizman modeled using MCNP6 the CAREM-25 small modular reactor developed by INVAP and currently being deployed in Argentina by the National Atomic Energy Commission (CNEA). He researched sources and used this information to construct the reactor's geometry following design parameters and schematics from these sources. He modified a Java software code developed by Bathke for generating the geometry of an unrelated reactor to quickly generate an MCNP input deck with the ability to change certain design parameters and axial resolution. The model will simulate spent fuel burn-up using MonteBurns, a fully automated tool that links the Monte Carlo transport code MCNP with the radioactive decay and burnup code ORIGEN2. This calculation will determine Pu content for the purpose of identifying CAREM-25 spent fuel's material attractiveness.

Chantell Murphy – NGSi Ph.D. Candidate

Chantell Murphy passed her comprehensive exams in Jan 2014, and is now a Ph.D. candidate in Nuclear Engineering at University of New Mexico, and a fourth-year NGSi *Graduate Research Assistant (GRA)* at LANL. She continues her research in prioritizing acquisition paths for the state-level concept (SLC), which the IAEA is very interested in. Brian Boyer and Kory Budlong-Sylvester jointly mentor her. This year Murphy worked half time in LANL's National Security Office (NSO) researching international challenges to the state-level concept, and other national security and nonproliferation issues. In addition to her

research, Murphy is actively involved with organizing the National Security Education Lecture Series at LANL co-hosted by the National Security Office and the National Security Education Center. These well-attended lectures are geared towards students and young professionals featuring prominent scientists and political leaders in the field of national security. In the fall 2013, Murphy participated in a 3-month exchange program at Forschungszentrum Juelich (FZJ), Germany. Murphy worked on acquisition path analysis using directed graphs, explored strategic assessment methodologies, further developing the SLC. Since working at FZJ, Murphy is increasingly more involved with ESARDA's Verification

Technologies and Methodologies (VTM)

working group and they invited her to co-author a chapter in their upcoming book “Risk and Information Driven Verification”. Additionally she is working with the same group to put together a workshop on how SLC methods, such as pathway analysis, could be applied and adapted to future non-proliferation and arms control initiatives, scheduled for November 2014. Murphy is actively involved in professional organizations and education programs in both the U.S. and Europe. She was recently elected Member at Large for the INMM Southwest Chapter. She represented LANL and NNSA ably at the ESARDA VTM WG Meeting in Ispra, Italy November 2013, the 36th ESARDA Annual Meeting¹⁶ in Luxembourg in May 2014 (see Figure 5), UCSD’s 2014 PPNT Summer "Boot Camp" July 2014, and the 55th Annual INMM Meeting^{17,18,19,20} in Atlanta, GA, July 2014. She is assembling a Ph.D. committee, and aims to defend her thesis proposal in early 2015.

Figure 5. Murphy in Luxembourg at the 36th ESARDA Annual Meeting

Joshua Richard - NNIS Graduate Fellow

Joshua Richard elected to spend his summer as an NNIS Fellow at LANL developing a MCNP-TH or thermal code working with LANL staff member mentor Michael Fensin. He also worked with Holly Trelle and Jack Galloway for collaboration on reactor physics and thermal-hydraulics issues on the development of MCNP-TH. This Monte Carlo code is a framework (using the python development environment) for linking full core MCNP calculations to a nodal drift flux solver in order to perform in-

line coupled neutronic linked thermal hydraulic simulations for Boiling Water Reactors. The methodology significantly improves the localized flux solutions, by providing better estimates of fluid density and temperature, which enhances the accuracy of the time dependent burnup simulation. The enhanced burnup simulation technology will significantly improve spent fuel source terms used by the non-proliferation radiation detection modeling community especially for boiling water reactor (BWR) fuel. These simulations are a priority for analysis of Sweden’s spent fuel. In Sweden 70% of the reactors are BWRs. He presented “MCNP-TH: External Coupling of MCNP to a Multi-Channel Thermal-Hydraulic Solver” at the LANL Student Symposium on August 5, 2014 with LANL co-authors Galloway, Trelle, and Fensin.

Robert Weinmann-Smith - NGSI Intern

Robert Weinmann-Smith, a summer undergraduate student from the University of Florida, spent his time working with Martyn Swinhoe. His work with Swinhoe was in using the new cosmic ray capability of MCNP6 to calculate the expected coincidence rates from cosmic rays for different materials (empty, lead, and uranium) in the detector chamber. He also compared his modeling results with experimental measurements he made. He found that MCNP and experimental values differ by an average of about 30%, which is reasonable considering all of the sources of error in the simulations (the building/floor materials,

the detector and sample modeling, high energy physics models, etc.). In the future this information will be used to advance the limit of detection.

Weinmann-Smith stated that he learned more about MCNP at LANL in a summer than he had in a year at school; and he'll share that knowledge with his classmates when he returns to Florida for the fall semester. He stated that he became experienced in running a project, which forced him to stay organized and focused, thus building valuable professional skills and habits. He enjoyed being at LANL, and would love to return to continue working in nuclear safeguards. He presented "Measurement and Simulation of Cosmic Ray Effects on Neutron Multiplicity Counting" at the LANL Student Symposium on August 5, 2014. He will be submitting a paper, "Measurement and Simulation of Cosmic Rays Effects on Neutron Multiplicity Counting" as the lead author with Martyn Swinhoe and John Hendricks to the journal *Nuclear Instruments and Methods in Physics Research A*.

Robert Zedric –NNIS Graduate Fellow

NGSI spent fuel verification program partially supported Robert Zedric, a Ph.D. Nuclear Engineering candidate at the University of Michigan and Nuclear Nonproliferation International Safeguards Graduate Fellow. Under mentor Holly Trelue, Robert Zedric worked on simulations for the 252Cf Interrogation with Prompt Neutron (CIPN) instrument using spent fuel libraries 2a and 4. He helped produce a database of information on CIPN performance and uncertainties associated with calculations. He presented "Monte Carlo Modeling of the Californium-Interrogation with Prompt Neutron (CIPN) Device for Spent Nuclear Fuel Measurements"²¹ as lead author with Charlton of TAMU and Henzlova, Tobin, Trelue, Hendricks, and Burr of LANL at the 55th Annual INMM Meeting in Atlanta, GA, July 2014.

Uppsala University (Sweden) Joint LANL –Uppsala Effort on Spent Fuel Verification

In Cooperation with NNSA and Uppsala University, LANL hosted Tomas Martinik in NEN-1 beginning this past April (2014). Martinik is working on the Differential Die Away (DDA) detector design for a specific use at the Swedish central interim storage facility for spent nuclear fuel (CLAB - Centralt mellanlager för använt kärnbränsle) at the nuclear power plant in Oskarshamn, Sweden. NNGSI is supporting him while he is at LANL working on his thesis-related research. Henrik Liljenfeldt from Uppsala University will be joining NEN-1 in September 2014 to work calorimetry assessment for the Swedish spent fuel. The NGSI spent fuel effort in NA-241 supports both these collaborations with Uppsala University.

NGSI Early/Mid-Career Update – Dr. Karen A. Miller –INMM Award Winner

Dr. Karen Miller converted from post doc to LANL staff member in 2010. In 2007 she came to the Laboratory as an NGSi sponsored graduate student in the Nuclear Nonproliferation (N) Division predecessor to the current Nuclear Engineering and Nonproliferation (NEN) Division.²² She received her PhD in Nuclear Engineering from Texas A&M University, and while at TAMU was instrumental in forming the INMM Student Chapter. As a student, she won the JD Williams Student Paper Award for her work on “The Uranium Cylinder Assay System for Enrichment Plant Safeguards” in 2010, Baltimore, MD²³. She followed her student success in Atlanta this past summer by receiving the INMM’s Early Career Award. INMM recognized her with the Early Career Award for her accomplishments as a young professional in the field of nuclear materials management and for her leadership and contributions to the Institute. Miller is instrumental in developing advanced detection systems for measurement of enrichment in uranium hexafluoride (UF₆) cylinders. At LANL, she is also a member of the Postdoctoral Review Committee, mentors students in various fields of study, teaches in the Laboratory safeguards training courses for IAEA inspectors, and organizes and participates in numerous workshops and meetings. Over the course of her career Miller has to her credit 40 publications and 11 invited presentations. NGSi can be proud to have assisted her developing Miller and furthering her career.

24.1.1.3.1.5 Laboratory Safeguards Courses

During FY13 LANL supported Brookhaven National Laboratory’s (BNL’s) three-week *Nuclear Nonproliferation, Safeguards, and Security in the 21st Century Course*, and LLNL/Monterey Institute of International Studies (MIIS) one week *International Safeguards Policy and Information Analysis*. LANL also had staff presentations and students participate in LLNL’s summer safeguards video teleconference lecture series. Appendix F is the detailed explanation of the funding spent for this subprogram.

Brookhaven National Laboratory

Brian Boyer served as a guest lecturer for BNL’s annual *Nuclear Nonproliferation, Safeguards, and Security in the 21st Century* course, June 10–28, 2013. This summer course is designed to give graduate students a sound understanding of the foundations of the nuclear nonproliferation regime and U.S. programs and policies developed to meet the emerging nuclear proliferation threats to our security. The course attendees are graduate students or recent graduates.

Boyer gave a presentation on “IAEA Verification at a Uranium Enrichment Plant,”¹⁷ on Wednesday, June 19. In addition, Kory Budlong-Sylvester, (U.S. Standing Advisory Group on Safeguards Implementation (SAGSI) representative,) presented “State Level Concept – Status 2014; Looking Ahead” and “Current Safeguards Issues” on June 20th.

NGSI Summer Lecture Series – organized by LLNL

LANL supported the NGS Summer Lecture series organized by LLNL with four video lectures using recently returned IAEA safeguards inspector Debbie Dale to give her perspective on safeguards issues along with former IAEA inspector Brian Boyer and U.S. SAGSI representative Kory Budlong-Sylvester. See Table 1.

Table 1
LANL Given Video Lectures for LLNL Summer Safeguards Video Series

Date	Topic	Speaker
July 9 (Wed)	Safeguards for Reprocessing Facilities	Deborah Dale, LANL
July 16 (Wed)	The Life of an IAEA Inspector	Brian Boyer, LANL
July 23 (Wed)	State-Level Approach for States for Large Nuclear Fuel Cycle States	Deborah Dale, LANL
July 30 (Wed)	Acquisition Path Analysis for Safeguards	Kory Budlong Sylvester, LANL

Nuclear Lunch

LANL created a program for summer students titled “Nuclear Lunch,” (details in Appendix H). Christy Ruggiero of Nuclear Engineering and Nonproliferation Division (NEN) along with Julianna Fessenden-Rahn of Environmental and Engineering Sciences (EES) were key sponsors of these lunches. They endeavored to link students from around the lab to see what goes on in the nuclear field at LANL and around the world. NGSi students had the opportunity to participate. LANL hopes to be able to use NGSi HCD funds to build up this program next year. This forum also gives mid-career staff a chance to see opportunities available in the nuclear field at the lab.

The mailing list for the lunch lectures reached 50+ people. Most student participants expressed an interest in seeing the lecture series continue. The casual format (eat, talk, listen, learn) and diversity of topics (particularly the science-policy interface) were strongly appreciated. We feel that some minimal HCD funds could be used in FY15 to expand the program and provide credit to NA24 HCD subprogram for sponsorship.

The University of California San Diego, PPNT, La Jolla, CA

Dr. Bethany Goldblum, Program Director of the University of California’s Institute of Global Conflict and Cooperation, Public Policy and Nuclear Threat (PPNT) summer boot camp, invited Brian Boyer and Chantell Murphy to be guest lecturers. The summer camp bridges science and public policy and aims to give participants the knowledge and analytic tools to contribute to the debate on future U. S. nuclear policy. The event took place from July 6–19, 2014,¹¹ with Boyer and Murphy attending on July 9-11, 2014 lecturing and participating in the course amongst several internationally-renowned guest lecturers.

24.1.1.3.1.8 Mid-Career Transition

Vladimir Henzl

During FY14, the HCD subprogram supported educational and networking opportunities for one mid-career professional, Vladimir Henzl of the Nuclear Engineering and Nonproliferation Division’s Safeguards Science and Technology (NEN-1). Henzl attended the prestigious six-week *World Nuclear University* in Christ Church College, Oxford, UK from July 7-August 8, 2014.

NGSI and LANL laboratory funds supported Henzl in this effort. The *Nuclear Engineering International*²⁴ (NEI) magazine's expert panel of judges named the World Nuclear University's (WNU) Summer Institute as the training course of the year (duration <1 year) in the NEI Nuclear Training Awards for 2013. Hence, LANL believes that getting our excellent young to mid-career professionals to the WNU is a key piece of career development. This course introduced the IAEA and possible professional career opportunities. Henzl's career goals expanded to seek employment at the IAEA within the next decade where we believe he can contribute to international safeguards and later bring excellent experience and knowledge back from the IAEA.

Figure 6. WNU Summer Institute 2014 at Harwell
(Photograph – courtesy of WNU - <https://www.facebook.com/worldnuclearuniversity/photos>)

Figure 7. WNU Summer Institute 2014 at Capenhurst URENCO Enrichment Facility
(Photograph – courtesy of WNU - <https://www.facebook.com/worldnuclearuniversity/photos>)

24.1.1.3.1.9 Professional Development

Next Generation Safeguards Professional Network Workshop

LANL along with Sandia National Laboratories (SNL) put on the young professionals *Next Generation Safeguards Professional Network (NGSPN)* workshop at SNL on March 10-11, 2014 and at LANL on March 12-13, 2014. James Doyle along with Heather Erpenbeck, Brian Boyer, and Carolyn Scherer planned the LANL portion of the meeting. Because of the continuing resolution and resulting budget cuts, NA-241 postponed this meeting from September 2012 to October 2013 and then again to the final dates of March 10-13, 2014.

Seventeen research associates, post-docs and early career staff from across the U.S. DOE nuclear complex attended the latest NGSPN workshop, held March 10-13, 2014 at Sandia and Los Alamos National Laboratories. They received presentations and technology demonstrations from subject matter experts in safeguards instrumentation, treaty verification, cryptography, remote monitoring, geospatial information analysis and chemical and biological threat reduction. They also visited key laboratory facilities and a commercial manufacturer of instruments for the detection, identification and measurement of nuclear materials in a variety of locations and configurations.

LANL provided lectures, tours and demonstrations on safeguards and nonproliferation and key activities in nuclear forensics. A highlight of the days at LANL was tours of the Plutonium Facility and Dual-Axis Radiographic Hydrodynamic Test (DARHT) test facility. The tours immersed everyone in activities in the nuclear weapons complex that will benefit American nonproliferation practitioners in understanding nuances and complexities of weaponization. We received kudos from the NGSPN group on the content of these tours as the best tours they ever attended. Additionally these tours have spawned ideas for many proposals.

Participants had ample opportunities for social and professional networking during the working lunches and informal evening activities. One activity was a dinner lecture on the history of the nuclear weapons complex and international nuclear safeguards²⁵²⁶. The agenda for the workshop is in Appendix K. See Figure 6 for a photo of the workshop participants.

Figure 6. Next Generation Safeguards Professionals Network Workshop

The following 17 professionals participated in the workshop:

1. Brent Beatty – ORNL – Nuclear Engineering
2. Jennifer Dahnke – NNSA HQ (NA-241), Physics, Russian, International Relations
3. Michael Fensin – LANL – Nuclear Engineering (*Supported through 24.1.1.3.1.6 funds*)
4. Ernest (Travis) Gitau - PNNL – Nuclear Engineering, Nonproliferation
5. Jose Gomera – BNL – Nuclear Engineering
6. Denise Lee – ORNL – Nuclear Engineering
7. Valerie Lewis– PNNL – Nuclear Nonproliferation and Terrorism Studies
8. Michael McDaniel – SNL – Information Science, Computational Models
9. Sean Morrell – INL – Nuclear Engineering
10. Sarah Marie Poe – BNL - Nuclear Nonproliferation and Terrorism Studies
11. Christopher Ryan – LLNL – Nuclear Engineering
12. Amanda Rynes – INL – International Relations
13. Jennifer Steeb – ANL – Analytical Chemistry
14. Alison Tamasi – LANL – Analytical Chemistry
15. J'Tia Taylor – ANL – Nuclear Engineering
16. Maikael Thomas – SNL – Electrical Engineering
17. Jason Wilson– SRS – Physics, Nuclear Engineering

Returning IAEA LANL Staff

It has long been a concern that staff returning from the IAEA did not have proper support when returning back to the laboratory. NGSF supplied \$50K of funding for each of two returning LANL staff members, Heather Nordquist and Debbie Dale.

Heather Nordquist

After returning from the IAEA, Nordquist used the HCD funding to get up to speed on a number of projects she took over from Joe Longo who transitioned to the IAEA in August 2014. They used some of that time to complete a knowledge transfer, assure continuity of these projects and do some future planning for these projects.

Debbie Dale

Dale used the HCD funds for getting caught up on all the training requirements and other administrative things necessary to function in an office with a computer and phone at LANL. She also provided several informal briefs on her experience as an inspector. Two briefs were formally scheduled and announced. The first one was to LANL summer students and the other one was to LANL's nuclear nonproliferation and security program and project managers. Dale used a good deal of time to find and organize open source (non-IAEA sensitive) documents related to safeguards so she could better respond to new project work requests. Additionally, she provided lectures for the NGSi summer lecture series.

References

- ¹ Scholz, M.; Dewji, S.; Poe, S.; Finklea, L., “2013 Snapshot of NGS Human Capital Development and Future Roadmap,” *54th Annual Meeting of the Institute of Nuclear Materials Management*, Palm Desert, CA, July 2013.
- ² Lockwood, D.; Scholz, M., “Next Generation Safeguards Initiative (NGSI): Human Capital Development Program, Promoting Lab–University Partnerships,” *Nuclear Security Education: The Intersection of Policy, Science, and Technology*, Knoxville, TN, 2010.
- ³ “Features: Nuclear Security,” *Engineering/Penn State*, Spring/Summer 2013, Vol. 29, No. 1, The Pennsylvania State University College of Engineering, University Park, PA, p. 15.
- ⁴ Spinelle, Jenna, “Bringing Penn State to the World,” Aug 27, 2013, available at <http://www.statecollege.com/news/print.php?article=1375037>, accessed Sept. 10, 2013.
- ⁵ “Smith to Lead new Florida Institute for National Security,” Oct. 15, 2012, available at <http://www.ise.ufl.edu/blog/2012/10/smith-to-lead-new-florida-institute-for-national-security/>, accessed Aug. 7, 2014.
- ⁶ American Nuclear Society, *2013 ANS Winter Meeting Preliminary Program*, ANS, Chicago, IL, 2013, p.36.
- ⁷ American Nuclear Society, *American Nuclear Society Student Conference 2014*, ANS, Chicago, IL, 2014, p.12.
- ⁸ INMM, *2014 Annual Report to the Membership*, INMM, Deerfield, IL, 2014.
- ⁹ Kaplan, A. C., “Spent Fuel Characterization with the Differential Die-Away Self-Interrogation Instrument,” *Proceedings of the American Nuclear Society Winter Meeting*, Washington, D.C., Nov. 10-14, 2014.
- ¹⁰ Kaplan, A. C.; V. Henzl, H. O. Menlove, M. T. Swinhoe, A. P. Belian, M. Flaska, S. A. Pozzi, “Partial Defect Scenario Detection with the Differential Die-Away Self-Interrogation Instrument,” *American Nuclear Society Student Conference*, State College, PA Apr. 3-5, 2014.
- ¹¹ Kaplan, A. C.; V. Henzl, H. O. Menlove, M. T. Swinhoe, A. P. Belian, M. Flaska, S. A. Pozzi, “Total Plutonium Content Determination with the Differential Die-Away Self-Interrogation Instrument,” *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ¹² Kaplan, A. C.; V. Henzl, H. O. Menlove, M. T. Swinhoe, A. P. Belian, M. Flaska, S. A. Pozzi, “Utilizing Simulated Rossi-Alpha Distributions to Develop New Methods of Characterizing Spent Nuclear Fuel,” *PHYSOR Conference Proceedings*, Kyoto, Japan Sep. 29 - Oct. 3, 2014.
- ¹³ Kaplan, A. C.; V. Henzl, H. O. Menlove, M. T. Swinhoe, A. P. Belian, M. Flaska, S. A. Pozzi, “Determination of Total Elemental Plutonium Mass with the Differential Die-Away Self-Interrogation Instrument,” Accepted for publication in *Nuclear Instruments and Methods A*, June 2014.
- ¹⁴ Kaplan, A. C.; V. Henzl, H. O. Menlove, M. T. Swinhoe, A. P. Belian, M. Flaska, S. A. Pozzi, “Determination of Spent Nuclear Fuel Assembly Multiplication with the Differential Die-Away Self-Interrogation Instrument,” *Nuclear Instruments and Methods A*, Volume 757, No. 1, pp. 20-27. (2014).

-
- ¹⁵ Kaplan, A. C.; M. Flaska, A. Enqvist, J. L. Dolan, S. A. Pozzi, "EJ-309 Pulse Shape Discrimination Performance with a High Gamma-Ray-to-Neutron Ratio and Low Threshold," *Nuclear Instruments and Methods A*, Volume 729, pp. 463-468, (2013).
- ¹⁶ Murphy, C.L.; B. Boyer, and K. Budlong Sylvester, "Random Path Selection in Acquisition Path Analysis," *Proceedings of the 36th Annual ESARDA Meeting*, Luxembourg, May 2014.
- ¹⁷ Listner, C.; C.L. Murphy, M.J. Canty, G. Stein, A. Reznicek, and I. Niemeyer, "Evolution of Safeguards – What Can Formal Acquisition Path Contribute," *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ¹⁸ Murphy, C.L.; C. Listner, and K. Budlong Sylvester, "Evolution of Safeguards – An Expert-driven Approach to Acquisition Path Analysis," *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ¹⁹ Budlong-Sylvester, Kory; Joseph F. Pilat, George Anzelon, Chantell L. Murphy, Celia Reynolds, and Brian D. Boyer, "Use of Performance Targets in the State Level Concept," *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ²⁰ Boyer, Brian D.; Kory Budlong-Sylvester, Chantell L. Murphy, and James E. Doyle, "Developing a State-level Approach for a Hypothetical State with Advanced Fuel Cycle Capabilities," *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ²¹ Zedric, Robert Michael; William S. Charlton, Daniela Henzlova, Stephen Joseph Tobin, John S. Hendricks, and Thomas Lee Burr, "Monte Carlo Modeling of the Californium-Interrogation with Prompt Neutron (CIPN) Device for Spent Nuclear Fuel Measurements," *Proceedings of the 55th Annual Institute of Nuclear Materials Management Meeting*, Atlanta, GA, July 20-24, 2014.
- ²² Boyer, Brian David and Marisa N. Sandoval, "Next generation safeguards initiatives at Los Alamos National Laboratory Strengthening human capital for international safeguards," LA-UR-09-04378, 2009.
- ²³ Miller, Karen A.; Martyn T. Swinhoe, Johnna B. Marlow, Howard O. Menlove, Carlos D. Rael, Tomonori Iwamoto, Takayuki Tamura, and Syun Aiuchi, "The Uranium Cylinder Assay System for Enrichment Plant Safeguards," *Proceedings of the 51st Annual Institute of Nuclear Materials Management Meeting*, Baltimore, MD, July 11-15, 2010.
- ²⁴ "The WNU Summer Institute -Training the nuclear industry's best," <http://www.neimagazine.com/features/featurenei-nuclear-training-awards-2013-wnu-summer-institute-4155091/>, *Nuclear Engineering International Magazine*, 8 January 2014, accessed Oct. 7, 2014.
- ²⁵ Doyle, James E., and Risa Haddal, *Strengthening Human Capital for Nuclear Safeguards: Expanding the Next Generation Safeguards Professional Network*, LA-UR-14-23252, May 2014.
- ²⁶ Haddal, Risa, and James Doyle, *Report on the March 2014 Meeting of the Next Generation Safeguards Professional Network (NGSPN)*, LA-UR-14-22893, April 16, 2014.

APPENDICES

Appendix A: The Pennsylvania State University

Nuclear Fuel Cycle Primer with Emphasis on Safety, Safeguards, & Security (3S)

NUCE 597g – 3 credit hours - Online

Syllabus Fall Semester 2013

Instructor:

Brian Boyer, Ph.D.,

Nuclear Engineering and Nonproliferation Division, Los Alamos National Laboratory,

Email: bdboyer@lanl.gov

Course Objectives:

The course will cover the various technical components of the nuclear fuel cycle, in conjunction with relevant nonproliferation and safeguards considerations as well as the safety and security aspects. The students will see the nuclear fuel cycle from the “womb to the tomb” and also study the policy aspects of the nuclear fuel cycle including “Atoms for Peace”, the Nuclear Nonproliferation Treaty, the evolution of IAEA safeguards, the ramification of the weaponization of the fuel cycle, and case studies of proliferation events.

About the Instructor:

Dr. Boyer is the Nonproliferation Analysis Team Leader and the Project Leader for International Safeguards at Los Alamos. For 14 years he worked in the nonproliferation field at the IAEA, Brookhaven National Laboratory, and the last 4.5 years at Los Alamos. While at the IAEA from 1997 to 2002 he was a nuclear safeguards inspector who traveled around Europe to various types of nuclear facilities. After returning to the USA, he continued to work in safeguards doing system analysis of various nuclear facilities including the Chernobyl 4 Shelter, gas centrifuge enrichment plants, uranium conversion facilities, and advanced reactors. Dr. Boyer brings an understanding of the nonproliferation issues of the day from his own field experience and analytical work.

Attendance:

Students are expected to watch the recorded lecture videos posted on Angel in their entirety and regularly.

Grading:

- 10 Homework assignments – 100 points each
- 2 Projects – 500 points each

2000 points total -- A = 1800-2000; B = 1600-1799; C = 1400-1599, D= 1200-1399 F < 1200

There is a lot of work in this course, but a lot of work was put into its creation and running in the pilot in Spring 2011, ~2000 staff hours. This course was refined in Fall 2011 at PSU and at New Mexico Tech Fall 2012.

Lecture Outline:

1. Intro to the fuel cycle: What are the key areas? Key Fuels U, Pu, Th: A brief history of nuclear power
2. From Discovery of Fission to Atoms for Peace: The Fuel Cycle Technical and Political Background
3. An intro to Safeguards & Security: The IAEA Safeguards System- INFCIRC/66 - NPT – Legal basis – INFCIRC/153 – definitions – CSA – Para 28 - SQ - Timeliness
4. Material Accountancy – what it is for safeguards – security Domestic **HW#1**
5. International SGs Accountancy
6. Sampling statistics – how to do accountancy in the light of uncertainties of measurement and inability to measure all items to same accuracy **HW#2**
7. Safeguards tools – overview of techniques / Non Destructive Assay (NDA) gammas and neutrons / Destructive Assay and undeclared sites techniques / Containment and surveillance – philosophy and techniques
8. Mining and Milling – Locations - Yellow Cake **HW#3**
9. Conversion I and II
10. Enrichment – The History of Uranium Enrichment – Separation Theory
11. Enrichment – The History of Uranium Enrichment – Cascade Theory and Design **HW#4**
12. Enrichment – The History of Uranium Enrichment – Technology, Design and Application **HW#5**
13. Enrichment Safeguards
14. Enrichment Safeguards Project – VR Model and Information Task for GCEPs
PROJECT #1 Gas Centrifuge Virtual Inspection and Information Analysis
15. Fuel Fabrication – LEU, NU, MOX
16. Nuclear Reactors: Research Reactors and Critical Assemblies
17. Nuclear Reactors: LWR – Fuel Cycle and Safeguards Relevance **HW#6**
18. Nuclear Reactors: ON LOAD - CANDU and RBMK – Future Reactors PBMR - Fast Reactors - Fuel Cycle and Safeguards Relevance
19. **PROJECT #2** LWR Virtual Inspection and Information Management Task
20. Reprocessing I
21. Reprocessing II
22. Reprocessing SGs and issues **HW#7**
23. Waste Storage – waste and fuel long-term storage
24. The Fuel Cycle and Proliferation Indicators
25. A Case Study in Proliferation: “A Very British Bomb” – circa 1997 British TV Documentary (available on PSU web site and You Tube) **HW#8**
26. Accidents in the Fuel Cycle - Windscale, TMI, Chernobyl and beyond - the impact on the industry of failures – yesterday and today
27. Safeguards in Depth – from NPT Full Scope SGs to the Additional Protocol The AP and how it came about and where it leads - The art of the State Level Approach and open source analysis **HW#9**
28. Proliferation historical cases – the P-5, India, Pakistan / The truly hard cases in NPT safeguards – violations and breakouts – Iraq, Iran, DPRK
29. Current Multilateral Arms Control Agreements and the Future of Safeguards **HW#10**
30. Current events topics in the fuel cycle and how they relate to the 3S – synopsis of course

TENTATIVE READING LIST FALL 2013

Required:

1. Report on the International Control of Atomic Energy. Prepared for the Secretary of State's Committee on Atomic Energy. U. S. Government Printing Office, Washington, D. C., March 16, 1946. Department of State Publication 2498, 1946.
2. IAEA Safeguards Glossary, 2001 edition, IAEA, Vienna, Austria, 2002.
3. Safeguards Techniques and Equipment, 2003 Edition, International Nuclear Verification Series No. 1 (Revised), IAEA, Vienna, Austria, 2003.
4. H. Aigner, et al., International Target Values 2000 for Measurement Uncertainties in Safeguarding Nuclear Materials, IAEA Report STR-327, Vienna, Austria, April 2001.
5. Zhao, K., et al., International Target Values 2010 for Measurement Uncertainties in Safeguarding Nuclear Materials, STR-368, IAEA, Vienna, November 2010.

Recommended:

6. Brian Boyer and Mark Schanfein, "International Safeguards Inspection: An Inside Look," James E. Doyle, ed., Nuclear Safeguards, Security, and Nonproliferation: Achieving Security with Technology and Policy, Burlington, MA, Butterworth-Heinemann, 2008, pp 97-112.
7. The Nuclear Engineer, Journal of the Institution of Nuclear Engineers, the Institution of Nuclear Engineers, London, UK, Volume 28, No. 6, November/December 1987.
8. Allan S. Krass, Peter Boskma, Boelie Elzen and Wim A. Smit, Uranium Enrichment and Nuclear Weapon Proliferation, Stockholm International Peace Research Institute, Stockholm, Sweden, 1983.
9. W. Allen, "Nuclear Reactors for Generating Electricity: U.S. Development from 1946 to 1963," R-2116-NSF, Rand Corporation, Santa Monica, CA, 1977.
10. Design Measures to Facilitate Implementation of Safeguards at Future Water Cooled Nuclear Power Plants, Technical Reports Series No. 392, IAEA, Vienna, Austria, 1998.
11. J. R. Lamarsh, "Dedicated Facilities for the Production of Nuclear Weapons in Small and/or Developing Nations," Section VI-A of Appendix Volume II, Part Two, Nuclear Proliferation and Safeguards, June 1977, Congress of the United States, Office of Technology Assessment, NTIS order #PB-275843, 1977.

Documentaries:

Required – Lecture 25

(Proliferation Test Case) Equinox. A Very British Bomb (46 min)

UK Channel 4 documentary about the development of weapons grade materials in post war Britain and the scientist William Penney who was in charge of Britain's Bomb Programme. Also shows the first test in the Monte Bello Islands in Australia prior to the subsequent testing and contamination of Emu fields and Maralinga.

Recommended – Lecture 26

(Anatomy of a Nuclear Accident) --- Windscale: A nuclear disaster (88 min)

Fifty years ago, on the night of 10 October 1957, Britain was on the brink of an unprecedented nuclear tragedy. A fire ripped through the radioactive materials in the core of Windscale, Britain's first nuclear reactor. Tom Tuohy, the Deputy General Manager at the site, led the team faced with dealing with a nightmare no one had thought possible.

Appendix B:

United States Military Academy-BNL-LANL Meeting Notes (C. Bathke)

Brian Boyer and I arrived at BNL at 9:00 AM on Friday, June 20. We met with Bob Bari and Lap-Yan Cheng (BNL) prior to the arrival of COL Bryndol Sones and LTC Lou Florence from the USMA at 9:45 AM. Sones is the USMA Head of Nuclear Engineering and Florence is a professor in USMA Physics Department, whose research interest is photonics.

David Diamond, BNL, gave the first presentation describing the BNL capabilities related to Nuclear Engineering. The BNL capabilities included the National Nuclear Data Center (<http://www.nndc.bnl.gov/>), which has a broad spectrum of useful information (e.g., nuclear wallet cards, chart of the nuclides, ENDF, etc.). The latest feature of NNDC is a compilation of covariances of neutron reactions. Diamond also indicated that BNL has worked with Japan since Fukushima. He indicated BNL has a strong interest in the Thorium fuel cycle. Time did not permit Bathke to share his assessment of the materials attractiveness of the Thorium fuel cycle with BNL.

Col. Sones was the second speaker. He described USMA interests. He said he has worked with Tim Goorley, who is an MCNP6 co-author. He showed the curriculum of a cadet majoring in Nuclear Engineering. Two features of the curriculum stood out: (1) a policy course on nuclear weapons and (2) a Capstone project. The latter is two consecutive courses in which the cadets do a design project in their senior year. The cadets use the texts of Glasstone (*Nuclear Reactor Engineering*) and Lamarsh (*Nuclear Reactor Theory*) and *Swords of Armageddon* by Hansen. Col. Sones discussed the Army's nuclear and counter proliferation officers, which are designated as Functional Area 52. There are approximately 322 FA-52 officers. LTC Florence described three externally funded research centers at West Point: Photonics, Nuclear Engineering and Science Research, and Space and Missile Defense Command Research and Analysis.

Bob Bari was the third speaker. He described BNL's Nuclear Technology Programs. Brian Boyer followed with a historical review of IAEA Safeguards. Chuck Bathke then gave a review of material attractiveness. After Bathke's presentation, Col. Sones surprisingly asked Bathke how to calculate bare critical mass using MCNP.

After the presentations we ate lunch together, and then toured the Relativistic Heavy Ion Collider (RHIC), the Center for Functional Nanomaterials (CFN), and the National Synchrotron Light Source II (NSLS-II). Following the tour, we reconvened for discussions of how to help the USMA. The USMA expressed interest in war games dealing with nuclear security. They asked if there were computer programs that dealt with nuclear security. Bathke mentioned that at the INMM Risk Informed Security Workshop, February 11-12, 2014 at Stone Mountain, Georgia, a few presenters talked about computer code capabilities dealing with nuclear security. They also indicated that they needed reviewers and instructors of the Capstone projects (anything from a single lecture to longer). They also would like to be able take students on day trips to relevant facilities close to West Point (e.g., BNL). They indicated that career officers (i.e., FA-52) were in need of further education on safeguards and nonproliferation issues. We also discussed how to make a cadet's five-week stay at LANL or LLNL more of an educational experience.

**Appendix C:
University of Florida**

Perspectives On Nuclear Energy and (Non) Proliferation-Fall 2013

Standardized Syllabus for ENU6937, ENU 4930:

Perspectives On Nuclear Energy and Proliferation

1. Catalog Description (3 Credits) –Historic and modern perspectives on nuclear (non) proliferation are studied with particular attention given to the interrelationships among nuclear explosives, fission concepts, and fusion concepts. The relevant underlying physics of each will be addressed.

ENU 6937/Section 11G3; ENU 4930/Section 11G0

2. Pre-requisites and Co-requisites –Nuclear engineering physics and upper level mathematics background at the graduate or advanced undergraduate level or by instructor permission.
3. Course Objectives: Following successful completion of this course, the student will have developed an integrated understanding of the genesis and technical bases from which global (non) proliferation challenges are evolving. Nuclear explosive technology and fission/fusion energy development will be interrelated to nuclear safeguards, 4th generation nuclear systems, (non) proliferation, and national security.
4. Contribution of course to meeting the professional component:
This course provides 3 credits towards Engineering Sciences and nuclear energy development, and national security.

5. Relationship of course to program outcomes:

[This course integrates basic knowledge of mathematics, nuclear engineering science, and policy to identify present and future nuclear (non) proliferation challenges as they relate to the development of global nuclear energy and national security.]

- a. ABET Program Educational Objectives/Professional Components
 1. Graduates will have successful careers in Nuclear Engineering and related disciplines.
 2. Graduates will pursue advanced degrees or continuing education.
- b. ABET Program Outcomes Supported
 - i. Outcome a: Ability to apply knowledge of mathematics, science, and engineering to nuclear energy concepts.
 - ii. Outcome d: Ability to function on multi-disciplinary teams; term project.
 - iii. Outcome f: Understanding of professional and ethical responsibility; nonproliferation will continue to be a global responsibility.
 - iv. Outcome g: Ability to communicate effectively in both oral and written form; term project presentation and oral final.
 - v. Outcome h: Understanding of the global, societal, and environmental impact of engineering solutions; fuel cycles, spent fuel solutions, and materials safeguards.
 - vi. Outcome j: Knowledge of contemporary issues; definitely a major contemporary and evolving issue.

Perspectives On Nuclear Energy and (Non) Proliferation-Fall 2013

See the following website for the current list of MSE outcomes:

<http://nuceng.ufl.edu/students/objectives-a-outcomes> Perspectives On Nuclear Energy and (Non) Proliferation-Fall 2013

6. Instructor: Joseph M. Mack, Ph.D.
 - a. NSC 235
 - b. 352-846-1376
 - c. jmack@mse.ufl.edu
 - d. Office hours: M, W PM
 - e. Walk-in or appointments by email or phone
 - f. Meeting Times: Three times, every week
 - g. MWF 5th Period (11:45 AM – 12:35 PM)
 - h. Meeting Location: NSC 225
7. Material and Supply Fees: None
8. Textbooks and Software Required: None
Selected course notes will be provided, as warranted.
9. Recommended Reading:

Nuclear Explosives Technology

The Los Alamos Primer, Robert Serber: ISBN 0-520-07576-5

The Effects of Nuclear Weapons, Glasstone, S., Knowledge Publications (November 1, 2006), ISBN-13: 978-1603220163.

Fission Physics

The Physical Theory of Neutron Chain Reactors, [Alvin M. Weinberg](#) and [Eugene P. Wigner](#), ISBN-13: 978-0226885179, University of Chicago Press; 1st Edition (1958)

Fusion Physics

The physics of Fully Ionized Gases, Lyman Spitzer, Jr.: ISBN 0-470-81723-2.

Francis F. Chen, **Introduction to Plasma Physics and Controlled Fusion**, 2nd Edition, ISBN: 0-306-41332-9, 1984, Plenum (Springer) Press, New York, NY.

Inertial Confinement Fusion: The Quest for Ignition and Energy Gain Using Indirect Drive, John Lindl: ISBN 156396662X.

Nuclear (Non) proliferation

Nuclear Safeguards, Security, and Nonproliferation, James E. Doyle: ISBN 978-07506-8673-0.

Hitler's Uranium Club: The Secret Recordings At Farm Hall, J. Bernstein, D. Cassidy, 2nd Edition, Copernicus Books, (2001), ISBN 0-387-95089-3.

Nuclear Proliferation: Opposing Viewpoints, David L. Bender, Bruno Leone, Opposing Viewpoints Series, Greenhaven Press, Inc., 1992, ISBN 1-56510-005-0. Perspectives On Nuclear Energy and (Non) Proliferation-Fall 2013

Perspectives On Nuclear Energy and (Non) Proliferation-Fall 2013 - continued

10. Course Outline:

Overview:

1. Course Introduction
2. Basic definitions and concepts

Fission, Fusion, and Nuclear Explosives:

3. Conceptual chronology

Historical genesis

Agnew lecture

4. Fission explosives
5. Thermonuclear explosives

Fission Energy:

6. Fission for power; fission for “other”
7. Selected advanced concepts
8. Nonproliferation issues

Fusion Energy:

9. Why fusion?
10. Fusion for power; fusion for “other”
11. Paths to controlled ignition
12. Selected advanced concepts
13. Nonproliferation considerations
14. Diagnostics of thermonuclear burn

Modern Nuclear (Non) proliferation Challenges:

15. Policy

Attempts at international governance

Important treaties

16. Safeguards
17. Fourth-generation nuclear weapons
18. Guest speaker (TBD)

Note: Adjustments in lecture topical coverage may be necessary to accommodate presentations, quizzes, exams, and guest speaker

Appendix D:
FY14 NGSi-Sponsored Guest Lectures

University Name	Center, Department, Laboratory, or Institute	Sponsor/Contact	Guest Lecturer	Lecture Title	Date
University of Florida (UF)	Nuclear Engineering Program within the Department of Material Sciences & Engineering	Prof. Joseph Mack	Brian D. Boyer	Nonproliferation and Safeguards Issues: Focus on Nuclear Reactors ⁵	Nov 4, 2013
University of Florida (UF)	Nuclear Engineering Program within the Department of Material Sciences & Engineering	Prof. Joseph Mack	Brian D. Boyer	Nonproliferation and Safeguards Issues: Focus on Enrichment Plants ⁶	Nov 6, 2013
University of Florida (UF)	Nuclear Engineering Program within the Department of Material Sciences & Engineering	Prof. Joseph Mack	Brian D. Boyer	The IAEA and the Role of the International Safeguards System ⁹ in the Nuclear Field	Nov 5, 2013
Ohio State University (OSU)	Mechanical and Aerospace Engineering Department	Prof. Xiaodong Sun	Charles G. Bathke	Material Attractiveness and Why It Is Important	Feb 19, 2014

Appendix E:
FY14 NGSi Supported Ph.D. Candidates and Interns

Name/ Program	Affiliated University	Level of Education and Major	Project Title	Mentor's Name	Attended INMM?	Next Steps
1. Julia Eigenbrodt (24.1.1.3.1.6)	Texas A&M University	Graduate Nuclear Engineering	Development of Computational Tools for Analyzing IR-40 Reactors	Holly Trellue	Yes (Funded by TAMU)	Complete Ph.D.
2. Murphy, Chantell* (24.1.1.3.1.6)	University of New Mexico	Graduate Nuclear Engineering	Prioritizing Acquisition Pathways in the State Level Concept	Brian Boyer, Kory Budlong- Sylvester	Yes (funded by LANL (NSO))	Complete Ph.D.
3. Robert Weinmann- Smith (24.1.1.3.1.4)	University of Florida	Under-graduate Environmental Science	Measurement and Simulation of Cosmic Ray Effects on Neutron Multiplicity Counting	Martyn Swinhoe	No	Complete B.S.
4. Alex Khrizman (24.1.1.3.1.4)	Ohio State University	Graduate Environmental Science	Development and Testing of Bent Crystal E-X-ray Spectrometer	Charles Bathke	No	Complete M.S.
5. Alicia Dominguez (24.1.1.3.1.4)	University of New Mexico	Under-graduate Environmental Science	Development and Testing of Bent Crystal E-X-ray Spectrometer	Carolynn Scherer	No	Complete B.S.

*Partially funded by LANL's National Security Office (NSO)

**Appendix F:
FY14 LANL Project Cost Breakdowns**

FY14 NGSi Costs and Labor, University Outreach (24.1.1.3.1.1)

Category	Total Cost LANL (\$)	LANL Labor (hr.)	Travel Costs (\$)
Total LANL Labor	\$41,237		
Travel	\$0		
Total Costs (\$)	\$41,237		
Total LANL Labor (hr.)		111.0 hr.	
Travel			\$0
Total Travel Costs (\$)			\$0

FY14 NGSi Costs and Labor for LANL Summer Interns (24.1.1.3.1.4)

Category	Total Cost (\$)	LANL Labor (\$)	LANL Labor (hr.)	Travel Costs (\$)
Total LANL Labor	\$60,099			
Travel Costs	\$2,935			
Total Costs (\$)	\$63,034			
Students			1198.0	
Mentor & Support Staff			60.5	
Total LANL Labor (\$ and hrs.)		\$60,099	1258.5 hr.	
Student Relocation Costs				\$2,935
Total Travel Costs (\$)				\$2,935

FY14 NGSi Costs and Labor for LANL Intern and Post Docs (24.1.1.3.1.6)

Category	Total Cost (\$)	LANL Labor (\$)	LANL Labor (hr.)	Travel Costs (\$)
LANL Labor/Service Contract	\$189,009			
Travel	\$26,939			
Total Costs (\$)	\$215,948			
Service Contract to TAMU		\$69,737		
Early Staff - NGSPN			36.0	
Grad Students			1,155.0	
Mentor & Support Staff			94.5	
Total LANL Labor/Service Contract (\$ and hrs.)		\$189,009	1,285.5hr.	
Travel				\$26,939
Total Travel Costs (\$)				\$26,939

FY14 NGSi Costs and Labor, Lab Safeguards Courses (24.1.1.3.1.5)

Category	Total Cost LANL (\$)	LANL Labor (hr.)	Travel Costs (\$)
Total LANL Labor	\$123,253		
Travel / Material Costs	\$6,504		
Total Costs (\$)	\$129,757		
Total LANL Labor (hr.)		419.5 hr.	
Travel			\$6,504
Total Travel Costs (\$)			\$6,504

FY14 NGSi Costs and Labor for Mid-Career (24.1.1.3.1.8)

Category	Total Cost (\$)	LANL Labor (\$)	LANL Labor (hr.)	Travel Costs (\$)
LANL Labor/Service Contract	\$24,962			
Travel	\$26,645			
Total Costs (\$)	\$51,607			
Vladimir Henzl - WNU			80.0	
Mentor & Support Staff			8.0	
Total LANL Labor/Service Contract (\$ and hrs.)		\$24,962	88.0 hr.	
Travel				\$26,645
Total Travel Costs (\$)				\$26,645

FY14 NGSi Costs and Labor for Professional Development (24.1.1.3.1.9)

Category	Total Cost (\$)	LANL Labor (\$)	LANL Labor (hr.)	Travel Costs (\$)
LANL Labor/Service Contract	\$160,817			
Travel	\$0			
Total Costs (\$)	\$160,817			
Returning IAEA Staff		\$87,442	369.0	
NGSPN Staff Labor		\$73,375	262.0	
Total LANL Labor/Service Contract (\$ & hrs.)		\$160,817	631.0	
Travel				\$0
Total Travel Costs (\$)				\$0

Appendix G: Nuclear Lunch Series

Julianna Fessenden-Rahn, Christy Ruggiero and Heather Erpenbeck created and hosted a nuclear lunch series for the summer for graduate and undergraduate students and postdocs at LANL. This lab activity augmented NGSI activities during the summer of 2014.

A graphic for the Nuclear Lunch Series. At the top, the words "NUCLEAR LUNCH" are written in large, bold, red letters with a yellow outline and a 3D effect. Below this, the text "Wednesdays, 12-1" and "Starting June 11th" is in red. Then "Otowi Cafeteria Side Room C" is in red, followed by "(Occasionally will move to room A/B)" in black. A list of disciplines is centered: "Students, Postdocs, and other Summer LANL visitors in Nuclear Non-proliferation & safeguards, Nuclear energy, Nuclear forensics, Nuclear or Arms policy, Nuclear weapons, Actinide sciences, or any related discipline:". Below this is a paragraph about the lunch meeting. Then a list of speakers: "Tentative Topics/Speakers: Julianna Fessenden: DHS-DNDO-NTNFC Program Manager, Dave Clark: National Security Education Center Director & Pu Science Strategy, Albert Migliori: Seaborg Director, Bryan Fearey: LANL NSO Director, Charlie Nakhleh: XTD-DO, Olga Martin: NA-24 & safeguards efforts at LANL". At the bottom, it says "Co Hosted by: NSEC (National Security Education Office); NSO (National Security Office); DHS-DNDO-NTNFC Program office & their GMAP and UMAP supported staff; NA-24 Program Office and their HCD supported staff; and the Seaborg Institute."/>

NUCLEAR LUNCH

Wednesdays, 12-1
Starting June 11th
Otowi Cafeteria Side Room C
(Occasionally will move to room A/B)

Students, Postdocs, and other Summer LANL visitors in
Nuclear Non-proliferation & safeguards,
Nuclear energy, Nuclear forensics,
Nuclear or Arms policy,
Nuclear weapons,
Actinide sciences,
or any related discipline:

Please join us for a weekly lunch meeting that will help you learn more about other disciplines and efforts that support LANL missions and will encourage cross-discipline networking. Each week, a LANL scientist or manager 'lunch speaker' will give a description of what they do and how they got there, and will answer questions from students (No .ppts, just talk!). Students & Postdocs will have the opportunity to do the same—talk casually about your work (at an unclassified level, of course) to a group of people outside your field. Buy a lunch at Otowi, or bring one from home, and meet other students & postdocs.

Tentative Topics/Speakers:
Julianna Fessenden: DHS-DNDO-NTNFC Program Manager
Dave Clark: National Security Education Center Director & Pu Science Strategy
Albert Migliori: Seaborg Director
Bryan Fearey: LANL NSO Director
Charlie Nakhleh: XTD-DO
Olga Martin: NA-24 & safeguards efforts at LANL

Co Hosted by: NSEC (National Security Education Office); NSO (National Security Office); DHS-DNDO-NTNFC Program office & their GMAP and UMAP supported staff; NA-24 Program Office and their HCD supported staff; and the Seaborg Institute.

To be added to mailing list:
email Susan Ramsey (ramsay@lanl.gov), Christy Ruggiero (ruggiero@lanl.gov),
Or go to <http://register.lanl.gov> → Mailing Lists → Subscribe → nuclearlunch

The intent was to get students to reach out across their 'home' discipline in order to begin to understand all the ways that their skills could be used at the national labs, particularly in areas that are non-exclusively technical/laboratory research based. The attending students came from multiple technical organizations at LANL: Chemistry, Non-proliferation and nuclear energy, Computational physics, Theoretical science, Material physics and applications, National security, Intelligence Analysis and Technology, Material Science and Technology. Attendance was typically 10-20 students and interested staff, occasionally reaching more than 25.

The speaker list is copied below:

June 11th Julianna Fessenden (DHS-DNDO-NTNFC)
June 18th Debbie Dale-Returned IAEA
June 25th Doug Berning –Post Det Emergency Response
July 2nd Will Kinman & Mindy Zimmer (Mass Spec/ IAEA analysis)
July 9th Holly Trellue (Nuclear reactors and Reactor Science)
July 16th Kevin John & Eva Birnbaum (Isotopes Extravaganza!—or all the other cool things with isotopes and hot cells at LANL.)
July 23rd Olga Martin (NA24/Safeguards)
July 30th John Szymanski (Global Security program office, and former White House Science Policy Analyst)
Aug 6th No Meeting - Student Symposium Occurring! (NTNFC annual Review in Chicago)
Aug 13rd George Brooks (Post Det nuclear forensics)
Aug 20th Alison Pugmire (Chemistry/material science postdoc to LANL staff at TA55—how to make transition)

The organizers asked the speakers to present their work, how they got there, or any other interesting stories of their career that covered anything broadly ‘nuclear,’ with a minimum of technical detail, and very few, if any, PowerPoint slides. The intent was to have established staff and students talk, and for the students to ask questions, particularly questions outside their technical area of expertise. We wanted to engage students with other students outside their organization, see the large variety of work related to nuclear sciences that occurs at LANL, and learn about new areas of work to pursue. The presentation by Doug Berning on nuclear post detonation emergency response activities at LANL (along with stories from being out in the field conducting exercises) was perhaps the most engaging. Doug was overwhelmed afterword with students wanting to get involved. Doug could be a powerful student recruiter on his own. Students were also keenly interested in opportunities for fellowships or internships from outside their discipline—for example, IAEA fellowships or Department of State opportunities that were presented as great ways for students to get involved in different ways.

The mailing has reached 50+ people (copied below), and most students expressed an interest in it continuing this series beyond this summer. The casual format (eat, talk, listen, learn) and diversity of topics (particularly the science-policy interface) seemed to be strongly appreciated.

PARTICIPANTS

(Alicia L Swift) alicia.swift@lanl.gov
(Audrey Rae Roman) aroman@lanl.gov
(Alison Louise Tamasi) atamasi@lanl.gov
(Rian Mustafa Bahran) bahran@lanl.gov
(Brian David Boyer) bboyer@lanl.gov
(Bryan Leo Fearey) bfearey@lanl.gov
(Benjamin Thomas Manard) bmanard@lanl.gov
(Benjamin Byerly) byerly@lanl.gov
(Chloe Elizabeth Bonamici) chloebee@lanl.gov
(Chantell Lynne-Marie Murphy) cmurphy@lanl.gov
(Charles W Nakhleh) cnakhleh@lanl.gov

(Charles Wilhelm Herrmann) cwherr@lanl.gov
(Danil Smiles) danil@lanl.gov
(Deborah J Dale) djdale@lanl.gov
(David Lewis Clark) dlclark@lanl.gov
(Jacquelyn Marie Dorhout) dorhoutj@lanl.gov
(Jamie Doyle) doyle@lanl.gov
(Donivan R Porterfield) dporterfield@lanl.gov
(Elise Noel Pusateri) elisep@lanl.gov
(Emily C Saunders) emily_c@lanl.gov
(Andrew James Fallgren) fallgren@lanl.gov
(Julianna Eileen Fessenden-Rahn) fessende@lanl.gov
(George Henry Brooks Jr) gbrooks@lanl.gov
(Heather Hawkins Erpenbeck) hawk14@lanl.gov
(Jaimie Kay Daum) jdaum@lanl.gov
(Jeremy Michael Osborn) josborn@lanl.gov
(Jung Ho Rim) jrim@lanl.gov
(Juanita Debbie Martinez) juanita@lanl.gov
(Kyle C Hartig) khartig@lanl.gov
(Leigh Jackson Cash) lcash@lanl.gov
(Lisa Meyers) lmeyers@lanl.gov
(Miriam Marina Barnum) mbarnum@lanl.gov
(Matthew Baruzzini) mbaruzzini@lanl.gov
(Mindy Marie Zimmer) mzimmer@lanl.gov
(Olga Martin) olga@lanl.gov
(Patrick John Jaffke) pjjaaffe@lanl.gov
(Anthony Douglas Pollington) pollington@lanl.gov
(Pablo Andres Vaquer) pvaquer@lanl.gov
(Susan M Ramsay) ramsay@lanl.gov
(Royal A Elmore) relmore@lanl.gov
(Ariana Navarro Rowberry) rowberry@lanl.gov
(Rebecca Kristien Springs) rsprings@lanl.gov
(Christy E Ruggiero) ruggiero@lanl.gov
(Robert Allen Weldon, Jr.) rweldon@lanl.gov
(Robert Michael Zedric) rzedric@lanl.gov
(Stosh Anthony Kozimor) stosh@lanl.gov
(John James Szymanski) szymanski@lanl.gov
(Holly Renee Trellue) trellue@lanl.gov
(Teresa M Sparks) tsparks@lanl.gov
(William Scott Kinman) wkinman@lanl.gov
(Nicholas Wozniak) wozniakn@lanl.gov

Appendix H: Student Poster Session – LANL August 5, 2014

Robert Weinmann-Smith exhibits his summer research “Measurement and Simulation of Cosmic Rays Effects on Neutron Multiplicity Counting.” He and mentors Martyn Swinhoe and John Hendricks drafted a paper of the same title “Measurement and Simulation of Cosmic Rays Effects on Neutron Multiplicity Counting” intended for the journal *Nuclear Instruments and Methods in Physics Research A*. The table below gives a synopsis of NGSI and NNIS students in the 2014 Student Symposium.

NGSI Student Presentation at the 14th Annual Student Symposium

Student Name	Title of Research	Topic Area	Mentor
Alicia Dominguez	Distributed Security Framework for Modern Workforce	Mathematics	Carolynn Scherer
Joshua Richard	MCNP-TH: External Coupling of MCNP to a Multi-Channel Thermal-Hydraulic Solver	Engineering	Michael Fensin
Robert Weinmann-Smith	Measurement and Simulation of Cosmic Ray Effects on Neutron Multiplicity Counting	Engineering	Martyn Swinhoe

**Appendix I:
NGSPN LANL-SNL Workshop Agenda**

NEXT GENERATION SAFEGUARDS PROFESSIONAL NETWORK (NGSPN)

**Sandia National Laboratories (SNL)
Los Alamos National Laboratory (LANL)
March 10-14, 2014
Agenda**

Monday, March 10

SNL

8:15	Participants Arrive at IPOC Building for badging
8:50	Participant Introductions and Networking (IPOC Rm. 1248)
9:00	SNL Welcome – Rodney Wilson
9:05	NGSPN Overview and Instructions – Risa Haddal
9:10	Participant Introductions and Networking Cont. (Icebreaker game)
9:45	SNL History and Background in Nuclear Safeguards – Risa Haddal
10:00	<i>Coffee Break/Networking</i>
10:15	Information Assurance/Security & RMSA– George Baldwin
10:45	C/S & Remote Monitoring; seals demo – Sue Caskey
11:15	Cryptography/Authentication & Safeguards – Maikael Thomas
11:45	<i>Lunch (no host)</i>
13:15	Geospatial Information Tools & Nuclear Safeguards - Karl Horak
13:45	Intrusion/Detection Expertise & Application – Dave Furgal
14:15	<i>Coffee Break/Networking</i>
14:25	Depart IPOC for Tour: Tech Area V – Integrated Security Facility (ISF)
14:45	Brief overview of tour facility - Integrated Security Facility (ISF)
15:00	Tour
16:30	Return to IPOC, hotel
18:00	<i>Dinner in Old Town (no host) – Church St. Cafe</i>

Tuesday, March 11

SNL

9:00	Welcome remarks from Diana Blair, Global Security Programs
9:10	SNL's Diverse Nonproliferation Portfolio – Risa Haddal
9:30	Middle East Engagement on Nuclear Safeguards – Amir Mohagheghi
10:00	<i>Coffee Break</i>
10:15	Physical Protection – Ryan Whalen
10:45	Biological Threat Reduction – Connie Stewart
11:00	Chemical Threat Reduction – Linda Stiles
11:30	<i>Lunch (no host)</i>
13:00	Tour: TTD (IPB) – Karl Horak
14:00	Depart for Aquila Technologies
15:30	Participants depart for LANL

Dinner (no-host)
The Cowgirl, Santa Fe

Wednesday, March 12
LANL

8:00	Participants Arrive at LANL Badge Office
8:30	Shuttle to RLOUB TA-55
9:00	LANL Welcome and Introduction to Safeguards – Mike Baker
9:20	Brian Boyer – Safeguards by Design
10:15	<i>Break</i>
10:30	Jim Tape – SAGSI Interactions
11:00	Julianna Fessenden-Rahn – Nuclear Forensics
12:00	Lunch –Integrated Plutonium Science and Research Strategy- Franz Freibert
13:00	LANL Plutonium Facility Tour
16:30	Shuttle back to Otowi - Participants Stay in Los Alamos

Dinner (no-host)
Los Alamos Pajarito Brew Pub

Thursday, March 13
LANL

8:00	Participants arrive at Otowi Building
8:15	Shuttle to TA-35
8:30	Application of Safeguards Technology – Howard Menlove
9:00	Chantell Murphy – State Level Approach to Safeguards
<u>TA-35 Rotation Schedule 9:30 - 12:00</u>	
9:30 – 10:00	Group A Micro-Calorimetry (Gamma Technique) – Ryan Winkler Group B Neutrons – Karen Miller Group C Advanced Enrichment Monitor – Kiril Ianakiev
10:00 – 10:30	Group A Treaty Verification – Duncan MacArthur Group B Advanced Enrichment Monitor Group C Advanced Enrichment Monitor
10:30 – 10:45	<i>break – Conference room</i>
10:45 – 11:15	Group A Advanced Enrichment Monitor Group B Treaty Verification Group C Neutrons
11:15 – 11:45	Group A Neutrons Group B Micro-Calorimetry (Gamma Technique) Group C Treaty Verification – Duncan MacArthur

11:45 Lunch – Discussion of Demos and VISIBLE Team’s DARHT Simulation - Kelly Michel,
Phil Hypes

1:00 Shuttle to DARHT

1:30 Intro to DARHT

2:00 Tour DARHT

3:45 Shuttle back to Otowi

4:00 Participants drive to ABQ

Thursday, March 13

Dinner

Bravo Cucina

2220 Louisiana Blvd, NE
Albuquerque, NM 87110

18:00 Dinner at Bravo Cucina (no host)

18:00 – 18:30 Cocktails (cash bar)

18:30 – 19:30 Dinner (no-host)

19:30 – 20:00 Talk – Chuck Loeber (TBD)

20:00 – 21:00 Questions, Social/networking time

21:15 Return to hotels

Friday, March 14

Participants depart Albuquerque.