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# University Engagement at INL

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Amanda Rynes
Sean Morrell

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# University Engagement at INL

Amanda Rynes, Sean Morrell

Idaho National Laboratory

P.O. Box 1625, Idaho Falls, ID 83415

There are currently over 900 facilities in over 170 countries which fall under International Atomic Energy Agency (IAEA) safeguards. As additional nations look to purse civilian nuclear programs or to expand infrastructure already in place, the number of reactors and accompanying facilities as well as the quantity of material has greatly increased. Due to the breadth of the threat and the burden placed on the IAEA as nuclear applications expand, it has become increasingly important that safeguards professionals have a strong understanding of both the technical and political aspects of nonproliferation starting early in their career. To begin overcoming this challenge, Idaho National Laboratory, has partnered with local universities to deliver a graduate level nuclear engineering course that covers both aspects of the field with a focus on safeguards applications. To date over 60 students across multiple disciplines have participated in this course with many deciding to transition into a nonproliferation area of focus in both their academic and professional careers.

## Objectives

The objective of this program is to educate students about the global nonproliferation regime with a strong focus on safeguards applications of the field while addressing the critical issues of knowledge retention and workforce demographic challenges.[1] The primary objectives for this course are as follows;

1. Introduce safeguards and nonproliferation concepts into the engineering curriculum.
2. Develop skills to communicate technical issues to policymakers and the broader community.
3. Apply basic nuclear engineering principles to relevant safeguards and nonproliferation issues.
4. Understand the relationship between policy and technology.
5. Identify potential career opportunities in the field.

## Evolution of Course Structure

The initial offering of the course "Nonproliferation of Nuclear Weapons and International Safeguards" was set up as an INL-taught guest lecture series in collaboration with Idaho State University in 2011. The course was split between history lectures contributed by

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[1]. L. Blair, D. Johnson, "Nuclear Nonproliferation International Safeguards Scientist and Engineer Workforce at U.S. Department of Energy National Laboratories", Nuclear *Security Education: The Intersection of Policy, Science, and Technology Workshop,* Knoxville, Tennessee, 2010.

ISU and a technical curriculum given by INL subject matter experts. Completed, the lecture series was comprised of 12 (1.25 hour) lectures covering a broad range of safeguards and nonproliferation topics from the heavily technical aspects of detection and measurements to the treaty and organizational structure of the global regime. The curriculum was designed to build upon the information in the previous presentation, leading students to employ their new knowledge base in each subsequent lecture. The course also included laboratory exercises to allow hands on experience with fielded safeguards equipment.

While the course was considered a success it was apparent that adjustments to enrollment and content needed to be made in future iterations. Due to the heavily technical nature of the material it was difficult to find a level of detail that was accessible to the enrolled history students while remaining elevated enough for graduate level nuclear engineers. The challenges with designing a course taught by twelve different experts also posed scheduling issues as well as difficulties with creating a coherent and (build upon) curriculum.

Taking into account the lessons learned following the first offering, subsequent iterations of the course included registration prerequisites as well as a streamlined scheduling and lecture process as course material was already designed and could be integrated into a cohesive semester long course. In the fall 2012 offering, the course was focused on nuclear engineering students and was taught as a traditional engineering course with regular homework and testing. The course focused primarily on safeguards instrumentation and radiation detection and was very successful.

A shift to primarily INL-driven course content decisions has allowed for a significantly more integrated material while avoiding redundant content. The lectures can now be designed to build upon one another, creating a strong foundational knowledge before building into additional areas of study (ex. An introduction to the scientific background needed to understand the later lectures covering radiation detection). The success of the course has created the opportunity to expand to other universities as well, with lectures having been given as Colorado School of Mines and Oregon State University as well as University of Utah, who participated in full in the spring 2014 offering of the course.

## Spring 2014 Course Offering

The spring 2014 offering was comprised of 12 (3 hour) lectures which took place once a week as well as three exercises and a capstone presentation. Classes were attended at both ISU campuses (Pocatello and Idaho Falls) as well as University of Utah through distance learning capabilities at both universities. Building on the technical backbone of the course, which includes the fuel cycle, diversion pathways, and the scientific basis of special nuclear material detection, the course also includes lessons discussing the history of nuclear weapons, relevant treaties and organizations, and the political implications of implementation. As previously mentioned the spring 2014 offing illustrated a shift to a less traditional engineering curriculum with greater focus on readings and in-class interactions. Policy content was expanded and a capstone project was integrated to the course to act as a benchmark for student progress. A second university champion became involved in the course, allowing for even greater student to professor interactions. Students were expected to come to class prepared to discuss the week's readings as well

as their responses for each of the three exercises (discussed below). This pushed the students to interact and consider the policy framework within which their technical advancements would have to take place. This was successfully accomplished as students from all three campuses routinely participated in discussions

The three larger exercises were designed to expand the student's working knowledge of state and policy specific areas of nonproliferation. The first required the students to review the NPT and establish, given their retrospective perspective, what they would change about the Treaty. The second, a safeguards simulation, required students to become familiar with the limitations placed on the IAEA by each type of safeguards agreement as they carried out simulated inspections while partnered with a proliferent state. The final exercise was comprised of presentations covering the proliferation history of non-nuclear weapons states which had pursued a program in the past.

The final graded portion of the course was a capstone project which is discussed in the 2014 lessons learned section below.

**Spring 2014 Lecture Structure**

| Week | Date | Time | Topic | Presenter |
|---|---|---|---|---|
| 1 | 01/17/2014 | 9:00 - 11:50 | Course Into | Sean Morrell |
| 2 | 01/27/2014 | 9:00 - 11:50 | Evolution of Global Security Environment | Amanda Rynes |
| 3 | 01/31/2014 | 9:00 - 11:50 | Nonproliferation Treaty (NPT) | Amanda Rynes |
| 4 | 02/07/2014 | 9:00-11:50 | Effects of Nuclear Weapons/Criticality | Dr. Kunze |
| 5 | 02/14/2014 | 9:00 - 11:50 | IAEA and International Safeguards | Mark Schanfein |
| 6 | 02/21/2014 | 9:00 - 11:50 | Nonproliferation Regime | Amanda Rynes |
| 7 | 02/28/2014 | 9:00 - 11:50 | Case Study Exercise | Amanda Rynes |
| 8 | 03/07/2014 | 9:00 - 11:50 | IAEA Exercise | Amanda Rynes |
| 9 | 03/14/2014 | 9:00 - 11:50 | Utah: Spring Break<br>ISU: Safeguards Instrumentation Lecture | Jeff Sanders |
| 10 | 03/21/2014 | 9:00 - 11:50 | Diversion Pathways | Sean Morrell |
| 11 | 03/28/2014 | 9:00 - 11:50 | Utah: Safeguards Instrumentation<br>ISU: Spring Break | |
| 12 | 04/04/2014 | 9:00 - 11:50 | Material Control & Accountability | Jeff Sanders |
| 13 | 04/11/2014 | 9:00 - 11:50 | Security | Dr. Harris |
| 14 | 04/18/2014 | 9:00 - 11:50 | Utah: Spring Break<br>ISU: Safeguards Instrumentation | Sean Morrell |
| 15 | 04/21/2014<br>04/25/2014 | 8:00-11:50<br>9:00 - 11:50 | Utah: Student Presentations<br>ISU: Student Presentations | (Students)<br>(Students) |

## Lessons Learned – 2014

As the course continues to evolve new challenges will continue to become apparent. For the 2014 offering the difficulty of integrating an additional university as well as how differing backgrounds and levels of professor engagement resulted in unforeseen hurdles.

First, the students' educational background drastically varied between universities. The ISU class was comprised of entirely nuclear engineering and health physics students whereas the students at Utah were primarily materials engineering students. The nuclear background allowed the ISU students to grasp the related concepts at a faster rate than Utah students, creating a delta in the level of knowledge at the end of the course. It can also be assumed that the ISU students were more resolute understanding the material because it was relevant to their career and the others may have had a less focused intent.

Second, the Utah students did not have the benefit of having the lecturer present. The distance learning technology created challenges for the students in Utah. They experienced a delay in the audio, which could have discouraged some students from engaging the teacher because they were conscious of the delay. Utah students were also not afforded the luxury of having the speakers available during the breaks and after class to pursue lingering questions or misunderstandings.

Lastly, the university professors who hold the responsibility for the course have a dramatic impact on the tone of the class. Professors each have their own style, reputation, and passions. The ISU professor has a sincere interest and background in nonproliferation above and beyond the course and it translated to the students. The Utah professor has other interests and limited experience in the field and material, this inhibited his ability to engage the students on the material and direct and misguided students. All three factors should be considered upon engaging in a distant learning course again.

New to the course in 2014 was the inclusion of a capstone project which required students to establish a technical solution to a political problem. While guidance on the project was given, students were required to come up with their own topics, which ranged from Small Modular Reactors (SMRs) to bolstering the IAEA's capabilities. While most of the students grasped the goal of the assignment the freedom given in establishing topics resulted in some students bypassing portions of the assignment, remaining either completely political or approaching a technical problem without the inclusion of policy implications. Variance in student backgrounds and guidance across campuses also resulted in wide-ranging performances by the students. In the future greater guidance, as well as consistently checking back with the student progress will be needed to garner the full potential from the project.

## Future and Sustainability

Due to the importance of expanding the reach of a strong teaching curriculum and the possibility for greater multi-institution cooperation, INL has creating a university engagement program that thrives in multiple areas of nonproliferation and safeguards education. By continuing to build on previously developed material designed to leverage

facilities and expertise, INL is creating a formal, flexible, and transferable curriculum that participating universities can adjust to fit their academic requirements..

The transferable nature of the product, which will allow the university staff to eventually deliver the material without the INL subject matter expert present, is critical to the future expansion and sustainability of this program. Beyond transferability, continued advancement of this program requires an active chairperson at the university, student demand, and a university that desires to provide this curriculum. It is paramount to the success of the course that a university champion is present who can drive the course at their institution, allowing INL to ultimately fill a supporting role in the future. The goal of the university and NGSI can be met by leveraging current infrastructure and safeguards technology development expertise to lead hands-on, focused research projects which can help to generate funding and future programs.

Long-term goals for increased participation and sustainability create the opportunity for greater multi-laboratory and multi-university collaboration; allowing for increased breadth and depth of experience and research and subsequently an increased project outlook well beyond FY-14. Constant interest from universities that are already participating illustrates a continuing demand for this type and format of course.

The new university engagement model at INL will jumpstart the future sustainability of nonproliferation and safeguards education through a standardized yet flexible curriculum, increased collaborative small research programs and the subsequent broader applicability of newly learned skill sets. The collaborative model allows for INL and Next Generation Safeguards Initiative (NGSI) to direct university led research while engaging both students and professors in an effort to further develop safeguards human capital.

## Conclusions

INL is in the unique position to provide students with expertise from professors and professionals currently working in the field along with state of the art facilities and instrumentation. By creating and presenting courses that takes advantage of the ability to fully integrate a major university with a national laboratory, INL, ISU and the University of Utah will place local students in a prime position for employment within various arms of the U.S. Government, industry, and international organizations. INL has the opportunity to expand on the courses and lessons learned from the incredibly successful experience as ISU and Utah to expand this curriculum to other universities and national laboratories, offering this unique learning experience to an even broader audience.