Nuclear Security Education at Texas A&M University

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NSSPI Mission

• We employ science, engineering, and policy expertise to:
  – Conduct research & development to help detect, prevent, and reverse nuclear and radiological proliferation and guard against nuclear terrorism
  – Educate the next generation of nuclear security leaders
  – Analyze the relationship between policy and technology in the field of nuclear security
  – Serve as a public resource for knowledge and skills to reduce nuclear threats

• We seek multi-disciplinary technological solutions to problems associated with the malevolent use of nuclear and radiological materials; NSSPI strives to integrate these technological solutions within a policy framework
Nuclear Security Education

• TAMU has one of the most robust technical nuclear security education programs in the world

• Program includes:
  – Graduate and undergraduate courses
  – MS degree in Nuclear Engineering with a specialization in Nonproliferation
  – Certificate offerings
    • Nuclear security certificate
    • Interdisciplinary nuclear forensics certificate
    • Summer nuclear security certificate
  – Tabletop exercises involving political and technical aspects of global nuclear security
  – Field exercises at Disaster City Training Facility

• Other facts:
  – Approximately 35 students in the program
  – Supported 73 MS students and 31 Ph.D. students
  – 40 MS graduates specialized in nuclear nonproliferation
  – 16 Ph.D. graduates in nuclear engineering
Outline

• Overall Program Characteristics
  – Course Inventory
  – Program Educational Objectives
  – Program Elements
  – Online Asynchronous Learning Modules

• MS Degree Program

• Summer Certificate Program

• Other Certificates

• Conclusions

• Future Developments
OVERALL PROGRAM CHARACTERISTICS
Program Educational Objectives

• To produce leaders in the development of technological solutions to prevent, detect, and deter proliferation and combat nuclear terrorism. These graduates can:
  – apply engineering techniques to design 3S systems for nuclear facilities
  – understand the international security policy implications of technology
  – Critically evaluate technical data to aid proliferation detection
  – perform quantitative measurements of nuclear and radiological materials and detect sources of radiation outside of regulatory control
  – apply science and engineering as part of a comprehensive nuclear security program including nuclear forensics and consequence management
  – perform fundamental and applied research independently and in small multidisciplinary groups that can lead to the creation of new knowledge in the field of nuclear nonproliferation
Course Inventory

- **General Nonproliferation Courses**
  - NUEN 650 – Nuclear Nonproliferation and Arms Control
  - NUEN 605 – Radiation Detection and Nuclear Materials Measurement
  - INTA 620 – International Security
  - INTA 617 – Deterrence

- **Safeguards Courses**
  - NUEN 651 – Nuclear Fuel Cycles and Nuclear Material Safeguards

- **Security Courses**
  - NUEN 451 – Nuclear Security System Design
  - INTA 669 – Threat Assessment
  - INTA 657 – Terrorism in Today’s World
  - NUEN 689 Consequence Management

- **Forensics Courses**
  - NUEN 656/610 – Critical Analysis of Nuclear Security Data
  - CHEM 689 – Radiochemistry and Nuclear Forensics
  - MATH 644 – Inverse Problems in Nuclear Forensics
Online Learning Modules  
(http://nsspi.tamu.edu/NSSEP)

- Module characteristics
  - text, graphics, videos, wikis, quizzes
- Currently deployed:
  - Basic Radiation Detection
  - Nuclear and Atomic Physics
  - The Nuclear Fuel Cycle
  - Introduction to Statistics
  - Containment and Surveillance
  - Nuclear Material Accountancy
  - Physical Protection Systems
  - Nuclear Security Threats
  - Safeguards Terminology
  - Treaties and Legal Issues
  - Nuclear Security Culture
  - Insider Threat
- Shortly Coming up:
  - Uranium Enrichment Safeguards
  - Spent Fuel Storage Safeguards
Statistics

• From October 1, 2011 to October 1, 2015 over 69,000 unique users accessed NSSEP
  – This is a level of outreach that would have been impossible to produce with traditional learning methods

• In this period, the courses have seen traffic as follows:

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<tr>
<th>Course Title</th>
<th>Number of Page views</th>
<th>Date Released</th>
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<td>Basic Radiation Detection</td>
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<td>Basic Nuclear and Atomic Physics</td>
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<td>Introduction to Statistics</td>
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<td>The Nuclear Fuel Cycle</td>
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<td>Physical Protection Systems</td>
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<td>Nuclear Materials Accountancy</td>
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<td>Containment and Surveillance</td>
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<td>Nuclear Security Culture</td>
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<td>India</td>
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<td>Canada</td>
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<td>Malaysia</td>
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MS DEGREE PROGRAM
Topics Covered

• Fundamental Nuclear Engineering
  – Interactions of Radiation with Matter
  – Radiation Detection
  – Reactor Physics
  – Radiation Transport
  – Nuclear Fuel Cycles

• Nuclear Safety
  – Radiation Shielding
  – Radiation Protection
  – Reactor Engineering

• Nuclear Nonproliferation
  – History and Policy Impacts
  – Proliferation Detection
  – Export Controls

• Nuclear Safeguards
  – Nuclear Material Quantification and Accountancy
  – Safeguards System Design

• Nuclear Security
  – Threat Assessment
  – Physical Security
  – Border Security
  – Nuclear Forensics

10/6/2015
NSSPI-15-039
# Nonproliferation MS Degree Curriculum

<table>
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<tr>
<th>Course Designation and Title</th>
<th>Credit Hours</th>
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<tbody>
<tr>
<td><strong>Fall Year 1</strong></td>
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<tr>
<td>NUEN 650 Nuclear Nonproliferation and Arms Control</td>
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<tr>
<td>NUEN 604 Nuclear Radiation Shielding</td>
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<tr>
<td>NUEN 605 Rad Detection and Nuclear Materials Measurement</td>
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<td>NUEN 681 Seminar</td>
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<td><strong>Spring Year 1</strong></td>
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<td>NUEN 601 Nuclear Reactor Theory</td>
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<td>NUEN 606 Nuclear Reactor Analysis and Experimentation</td>
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<td>NUEN 651 Nuclear Fuel Cycles and Nuclear Material Safeguards</td>
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<td><strong>Fall Year 2</strong></td>
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<tr>
<td>NUEN 656/610 Critical Analysis of Nuclear Security Data</td>
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<td>NUEN 681 Seminar</td>
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<td>NUEN 691 Research</td>
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<td><strong>Spring Year 2</strong></td>
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<td>Elective</td>
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<tr>
<td>NUEN 691 Research</td>
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NSSPI’s Many Customers
**NSSPI Array of Activities**

**Students**
- Graduate and UG courses in safeguards, security, and safety
- Program emphasizes both science and policy concerns
- Founded first INMM student chapter

**Hands-on Safeguards Education**
- Short courses at National Laboratories
- Direct, practical experience with safeguards technology

**Workshops**
- Domestic and international
- Global nuclear security topics

**Research**
- Innovative research on all aspects of safeguards, security, and nonproliferation

**Faculty / Scientist Exchange**
- NSSPI faculty travel to the National Labs to teach courses
- National Lab researchers maintain joint faculty appointments

**International Collaborations**
- International programs and education support
- INMM and ESARDA conferences and workshops

**Informing the Public**
- NSSPI News Digest, daily summary of news and research on global nuclear issues
- Searchable database of articles on NSSPI website

**Distance Education**
- Lectures given to international students through video conferencing
- Nuclear Safeguards Education Portal (NSEP)
Strong Research Focus

- Safeguards Instrumentation Development
- Novel Detection Systems with Robotics Support
- Nuclear Forensics
  - Pre-detonation and post detonation
- Reactor Analysis for Proliferation Detection
- Nuclear Security and Deterrence Analysis using Game Theoretic & Bayesian Network Models
- Proliferation Resistance Analysis
- Consequence Management
SUMMER CERTIFICATE PROGRAM
Nuclear Security Certificate
8-Week Summer Program

• May, June and July

• Educational Outcomes:
  – Produce nuclear professionals who will lead efforts to reduce the nuclear and radiological security risks
  – Raise the awareness of nuclear security in nuclear professionals working in industry, research facilities, government, or in academia.

• Program Learning Objectives:
  – apply science and engineering as part of a comprehensive nuclear security program
  – apply engineering techniques to design security systems and infrastructure at the State and facility level
  – understand the international security policy implications of technology developments
  – generate an estimate of nuclear security threats
  – perform quantitative measurements of nuclear and radiological materials and detect sources of radiation outside of regulatory control
Nuclear Security Certificate Components

• Executive Seminars
• Self-Paced Learning Modules (using NSSEP)
• Tours
• Simulation and Tabletop Exercises
• Summer Session Courses:
  – NUEN 657 Global Nuclear Security
    • (2 credit hours)
  – NUEN 689 Nuclear Security Radiation Detection Fundamentals
    • (2 credit hours)
  – INTA 689 Nuclear Security Threat Assessment and Analysis
    • (1 credit hour)
• Optional Participation in the INMM Annual Meeting
International Engagement

NSSPI is heavily involved in international activities

– Observer status at the IAEA General Conference
– Research collaborations with Russia, France, India, and Japan
– Educational collaborations in UAE, Russia, India, UK, Japan, Malaysia, Indonesia, Jordan, Brazil
– Nuclear Facilities Experience for students in Japan, UK, France
OTHER CERTIFICATE PROGRAMS
## Nuclear Security Certificate

<table>
<thead>
<tr>
<th>Relevant Nuclear Security Area</th>
<th>Course Developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications of sensors/sources for radiation detection in nuclear security</td>
<td>NUEN 605 (Radiation Detection and Nuclear Materials Measurement)</td>
</tr>
<tr>
<td>Global nuclear security policies</td>
<td>NUEN 650 (Nuclear Nonproliferation and Arms Control)</td>
</tr>
<tr>
<td>Threat Analysis and Assessment</td>
<td>INTA 669 (Nuclear Security Threat Assessment)</td>
</tr>
<tr>
<td>Design and analysis of security systems for nuclear and radiological facilities</td>
<td>NUEN 451 (Nuclear Security System Design)</td>
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</table>

Students must complete 3 out of 4 courses to earn certificate
# Nuclear Forensics Certificate

<table>
<thead>
<tr>
<th>Relevant Nuclear Forensics Areas</th>
<th>Course Developed</th>
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<tbody>
<tr>
<td>Nuclear and radioactive material measurement methods and technology</td>
<td>NUEN 605 (Radiation Detection and Nuclear Materials Measurement)</td>
</tr>
<tr>
<td>Radiochemistry and separations processes</td>
<td>CHEM 689 (Radiochemistry and Nuclear Forensics)</td>
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<tr>
<td>Inverse analysis methods to evaluate measurements</td>
<td>MATH 664 (Inverse Problems in Nuclear Forensics)</td>
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<tr>
<td>Forensics evaluation and integrating sample collection and analysis to arrive at technical conclusions</td>
<td>NUEN 656/610 (Critical Analysis of Nuclear Security Data)</td>
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Students must complete all 4 courses to earn certificate
CONCLUSIONS
The Product of this Program

• Students produced from this program will have
  – a strong disciplinary background in traditional nuclear engineering
  – ability to apply engineering principles to nuclear security issues
  – an introduction to the policy aspects of nuclear security

• These students typically will seek employment at
  – US national laboratories
  – government
  – intelligence
  – nuclear industry
  – insurance industry
  – security consultants and vendors
  – etc.
FUTURE DEVELOPMENTS
Distance ME Degree

- We are also in the process of implementing a distance Masters of Engineering 3S degree
- Courses will be taught synchronously using web meeting software, online quizzes, and making use of asynchronous materials where appropriate
- Will include distance laboratory components
- We would benefit from having a distance component to the nuclear security certificate
NSSPI Campus Engagement

NSSPI engages with colleges and departments across TAMU
  - Engineering, Science, Geosciences, Liberal Arts, Bush School of Government and Public Service, Agriculture and Life Sciences
Backup Slides
Module Characteristics

• Modules are designed to employ asynchronous technology
  – asynchronous: text, graphics, wiki entries, videos, FAQ, email questions

• 1-5 hours of asynchronous course material per module

• Small self-assessments to assess learning outcomes

• Display textual and graphical content that describes basic material
  – highlighted text links to wiki

• Text is supplemented by short video clips (3-12 min) that describe the material in more detail
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<td><strong>Initiation</strong></td>
<td><strong>Introductory Seminars</strong></td>
<td><strong>Self-Paced Learning Modules (Fuel Cycles, Detection, Security)</strong></td>
<td><strong>Security Culture</strong></td>
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Executive Seminars

- History of Nuclear Development and Global Nuclear Outlook
- Uses of Nuclear and Radiological Materials
- Global Nuclear Security Regime
- Legal and Regulatory Issues
- Roles and responsibilities of people/organizations for nuclear security, safeguards, and safety
- Security Culture
- Nuclear Security Management
- Comprehensive Nuclear Security Approach