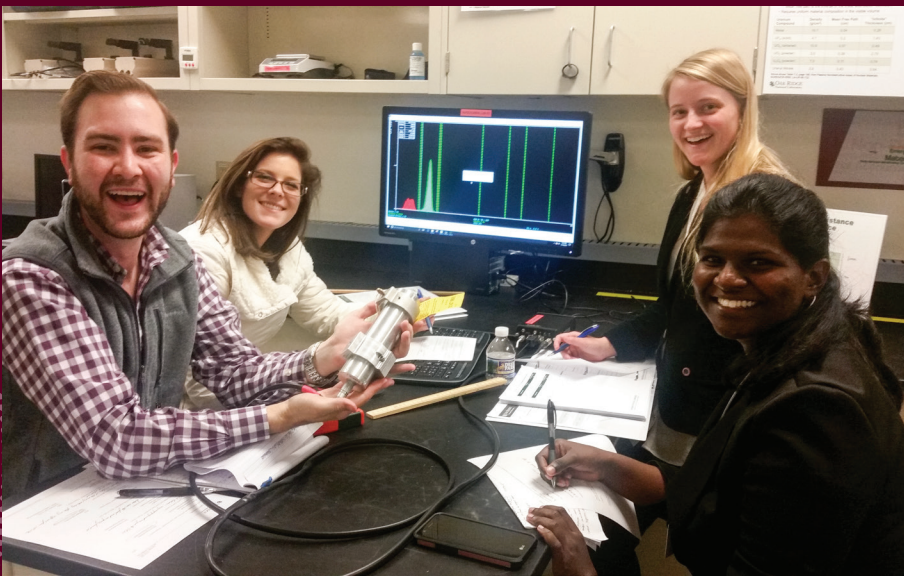


# NSSPI

**CENTER FOR NUCLEAR SECURITY  
SCIENCE & POLICY INITIATIVES**



**Supporting Human Capacity Development  
in Nuclear Security and Safeguards**

**• Training • Online Courses & Certificates • Workshops • Graduate Programs • Research •**



## What is NSSPI?

The Center for Nuclear Security Science and Policy Initiatives (NSSPI) is a multidisciplinary organization at Texas A&M University and the first U.S. academic institution focused on technical graduate education, research, and service related to the safeguarding of nuclear materials and the reduction of nuclear threats. In March of 2006, NSSPI was formed as a joint center between Texas A&M University and the Texas A&M Engineering Experiment Station (TEES), the engineering research agency of the Texas A&M University System. We work in collaboration with U.S. national laboratories and governmental agencies, the International Atomic Energy Agency (IAEA), and other partners to address the problems associated with the malicious use of nuclear materials and to study policy issues related to nuclear security.

NSSPI combines the talent of internationally recognized researchers from the U.S.'s largest nuclear engineering department with renowned policy expertise from Texas A&M's Bush School of Government and Public Service. This team brings unique capabilities to bear on complex nuclear threats and proliferation challenges involving both policy and technology.

### **NSSPI employs science, engineering, and policy expertise to:**

- Conduct research and development to help prevent, detect, and respond to 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

NSSPI holds observer status with the IAEA and is actively engaged in providing training and educational support to the agency. Through the TEES Office for National Laboratories Management, NSSPI is able to pursue research initiative in collaboration with U.S. national laboratories.



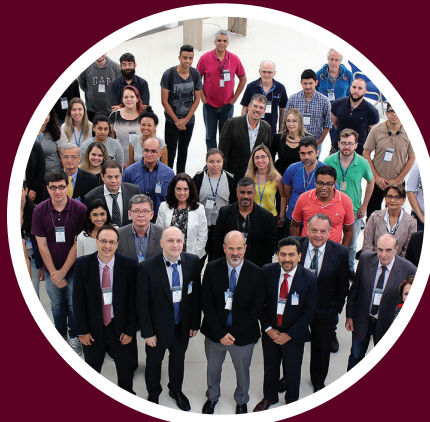
# Security and Safeguards Activities

## Supporting Prevention, Detection, and Response



### Education

Through the classroom and one-on-one interaction with NSSPI faculty, both graduate and undergraduate students gain science and policy education in safeguards, security, and nonproliferation.



### Human Capacity Building

NSSPI engages in activities designed to build human capacity in nuclear safeguards and security and enhance global nuclear security culture.



### Research

In collaboration with U.S. national laboratories, NSSPI faculty and students conduct innovative research on all aspects of safeguards, security, and nonproliferation.



### International Collaborations

NSSPI maintains close ties with international universities and institutions to share information and promote joint research and education efforts.



### Workshops & Training

NSSPI hosts and organizes domestic and international workshops on global nuclear security and safeguards topics. These workshops combine both lectures and hands-on exercises.



### Online Professional Development

NSSPI offers online courses and professional certificates in the fundamentals of nuclear security and safeguards. NSSPI can also deliver specialized distance education courses and programs.

## Preparing the Next Generation

NSSPI was the first academic organization in the U.S. to address a growing need for graduate-level technical education focused on nuclear safeguards and nuclear nonproliferation. This problem has long been identified in the nuclear community as one of the critical challenges facing the world today. In response, NSSPI faculty and staff have developed one of the most robust technical nonproliferation and safeguards education programs in the U.S.

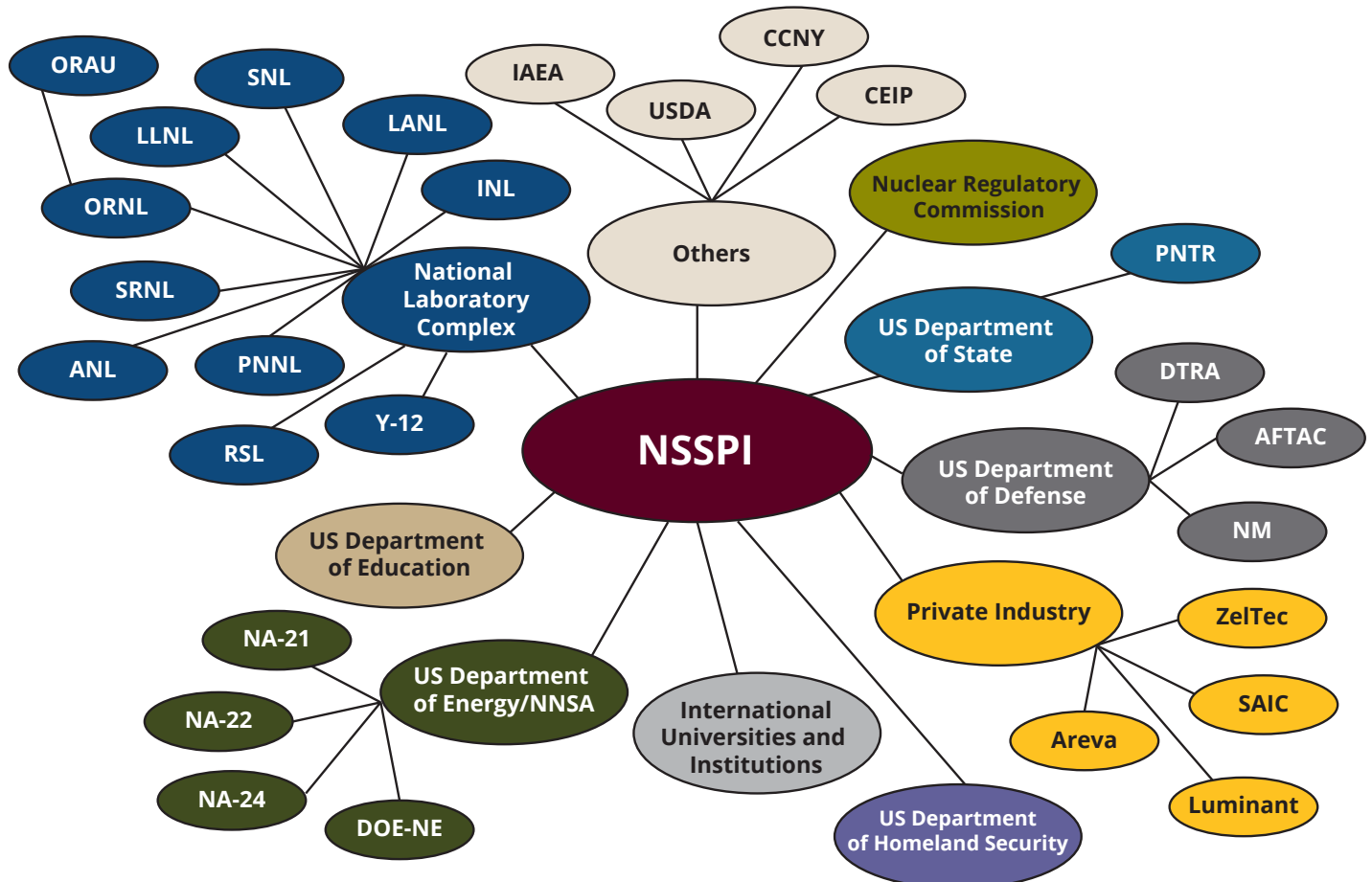
In addition to providing conventional classroom lectures, NSSPI programs involve students in practical educational experiences and NSSPI faculty advise students on valuable research projects that have contributed substantially to the overall

nuclear nonproliferation, safeguards and security arenas. NSSPI is engaged with several similar academic and research institutes around the world in activities and research for the benefit of Texas A&M students, and has also helped institutions worldwide in developing their own programs in nuclear security and nonproliferation.

## A Multidisciplinary Approach

Effective solutions to complex nuclear proliferation problems are often multidisciplinary. NSSPI's organizational structure enables us to seamlessly matrix in the expertise and research talent we need from across the Texas A&M campus (see list on facing page).

# NSSPI Partners and Customers





# NSSPI Expertise

## Nuclear Security

- Nuclear Security Systems
- Event Security
- Nuclear Security Risk Analysis
- Nuclear Security Human Resource Development
- Human Reliability Programs
- Knowledge Management for Nuclear Security
- Instrumentation Development
- Nuclear Security Culture

## Nuclear Safeguards

- Safeguards Instrumentation Development
- Safeguards Systems Risk Analysis
- Safeguards Approach Development for Nuclear Fuel Cycle Facilities
- Nuclear Fuel Cycle

## Nuclear Terrorism Prevention and Management

- Radiation Detection
- Detector Development
- Testing Detector Systems in Varying Environments
- Emergency Response
- Consequence Management

## Nonproliferation

- 21st Century Deterrence
- Modeling and Simulation

## Nuclear Forensics

- Radiochemistry
- Nuclear Reactor Modeling and Simulation



# Cross-Campus Expertise

- Nuclear Science
- Materials Science
- Computer Science
- Industrial and Systems Engineering
- Electrical Engineering
- Chemical Engineering
- Life Sciences
- Veterinary Medicine
- Cybersecurity
- Physical Sciences & Mathematics
- International Affairs
- National Security
- Political Science and Public Policy
- Emergency Preparedness and Response

# Research

Research and development is a key component in the fight against proliferation and nuclear terrorism. NSSPI conducts collaborative research with partners across the Texas A&M campus, throughout the U.S., and internationally. Collaborators include key federal agencies, national laboratories, the IAEA, other universities, and non-governmental organizations.

NSSPI has a strong focus on multi-disciplinary research. We organize carefully-sized research teams with students and faculty from across campus to develop targeted solutions for a wide variety of nuclear security problems.

NSSPI students are paired with or sponsored by project leads at various U.S. national laboratories to work in a myriad of areas including nondestructive assay (NDA), containment and surveillance technologies, proliferation resistance analysis, physical security science, border security

## NSSPI Research Areas:

- Arms Control
- Combating Nuclear Terrorism
- Ensuring the Peaceful Use of Nuclear Energy
- Nuclear Forensics & Attribution
- Nuclear Security & Proliferation Risk Analysis
- Safeguards Systems Analysis and Instrument Development

technologies, proliferation detection and latency analysis, attribution analysis and forensics, and other related topics. The students work in small groups that often include other students from disciplines outside of nuclear engineering—including international affairs students—as well as full-time members of the NSSPI research staff. Commonly, the projects include conducting research using the unique facilities at the sponsoring national laboratories.





# Research Accomplishments

- Became the first university research team to mount and record radiation data from a crane used in port operations.
- Designed the Self-Interrogation Neutron Resonance Densitometry (SINRD) detector for nuclear safeguards measurements with Los Alamos National Laboratory for testing by the IAEA.
- Developed the SHIELD framework to interdict HEU at borders.
- Made the first quantitative measurement of Pu in used nuclear fuel with Oak Ridge National Laboratory.
- Developed capability for bench-scale PUREX reprocessing of plutonium for nuclear forensics applications.
- Developed the PRAETOR tool and a latency method for proliferation risk analysis.
- Performed nuclear forensics analysis on weapons-grade plutonium samples employing PUREX combined with ICPMS and gamma spectrometry.
- Devised a safeguards system concept for pebble-fueled high temperature gas-cooled reactors.
- Developed a new technique for analyzing Pu K x-rays for nuclear forensics applications using a bent-crystal spectrometer.
- Performed proliferation resistance / safeguards analysis of the Fast Breeder Reactor fuel cycle.
- Developed a portable gamma radiation portal monitor specifically designed for the scanning of livestock.
- Devised a methodology for determining which states will go nuclear.
- Performed innovative N-terrorism pathways analysis to boost the efficacy of defense.
- Developed dynamic agent-based modeling using the Bayesian framework for addressing intelligent adaptive nuclear nonproliferation analysis.
- Produced a significant number of graduate students with M.S., M.E., and Ph.D. degrees in NSSPI-centered research, with many other graduate students supported in other areas and disciplines.

**65**

**M.S. DEGREES**

**8**

**M.E. DEGREES**

**25**

**Ph.D. DEGREES**

**TOTAL GRADUATES: 90\***

*\*as of August 2019*

**List of Theses and Dissertations: [nsspi.tamu.edu/education/our-students/](https://nsspi.tamu.edu/education/our-students/)**

# Education

NSSPI is committed to educating the next generation of safeguards and security experts through the programs it has implemented at Texas A&M.

Our successful academic programs are enhanced by a heavy practical component, which includes hands-on laboratory experience through short courses at national laboratories, visits to nuclear installations in the U.S. and other countries to discuss applied safeguards, summer internships at various national laboratories, and tabletop exercises involving both the political and technical aspects of global nuclear security.

## Graduate Certificate in Nuclear Security

The Graduate Certificate in Nuclear Security is a Texas A&M University certificate program that focuses on providing students a solid understanding of the policy and technical aspects behind nuclear security, safeguards and nonproliferation. This multidisciplinary program has courses both in the Department of Nuclear Engineering and at the Bush School of Government and Public Service. Upon completion of this program, students are uniquely qualified for positions in the federal government, national laboratories, and at the International Atomic Energy Agency (IAEA). This certificate can be completed at Texas A&M University or online.

## Summer Internships

Students in the Master of Science degree in nuclear engineering with specialization in nuclear nonproliferation (MS-NNP) program are encouraged to participate in summer internships at the national laboratories, where they can continue their research under the direct guidance of their national laboratory sponsors/mentors and other subject matter experts.

## The State of the Art in Nuclear Security Education

NSSPI's academic programs include:

- An accredited Master of Science degree in nuclear engineering with specialization in nuclear nonproliferation (MS-NNP);
- The nation's first technical academic certificate in nuclear forensics; and
- A graduate-level nuclear security certificate program.

## Laboratory Short Courses

NSSPI joins with staff at Oak Ridge and Los Alamos National Laboratories to provide the opportunity for graduate students within the MS-NNP program to complete practical courses using the labs' safeguards laboratories. This activity helps the students understand and appreciate basic material control and accounting technologies focused specifically on detecting and measuring special nuclear material using NDA techniques.

## Nuclear Facilities Experience

The Nuclear Facilities Experience (NFE) is sponsored by the NNSA as a unique opportunity for university students and early career professionals at the national laboratories to visit nuclear fuel cycle facilities and discuss applied safeguards and security measures with actual practitioners and facility operators.

The NFE is conducted both domestically and internationally. The domestic NFE takes Texas A&M students on an organized series of visits to nuclear facilities in and around the state of Texas. The international NFE gives students from Texas A&M and other U.S. universities the opportunity to visit advanced nuclear fuel cycle facilities, such as reprocessing plants, enrichment plants, and waste facilities, in countries like Japan, the United Kingdom, Switzerland, Germany, Austria, the Netherlands, and France.



# MS-NNP Specialization Courses Offered at Texas A&M

## Nuclear Engineering Fundamentals for Safeguards & Security

- **NUEN 605** – Radiation Detection and Nuclear Materials Measurement
- **NUEN 606** – Reactor Analysis and Experimentation
- **NUEN 610** – Nuclear Reactor Design & Critical Analysis
- **NUEN 630** – Monte Carlo Methods for Particle Transport

## Nuclear Safeguards

- **NUEN 650** – Nuclear Nonproliferation and Arms Control
- **NUEN 651** – Nuclear Fuel Cycles and Nuclear Material Safeguards

## Nuclear Security

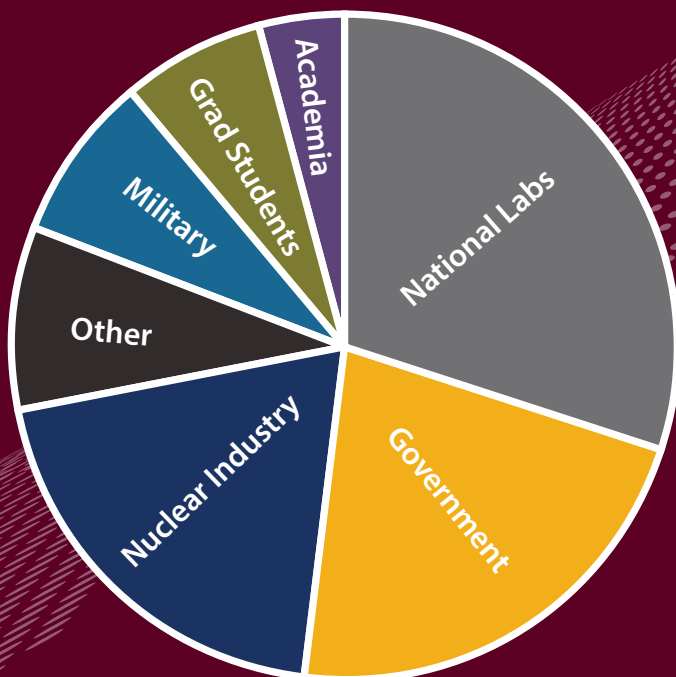
- **INTA 669** – Nuclear Terrorism Threat Assessment & Analysis
- **NUEN 657** – Emergency Response Dose Assessment
- **NUEN 451** – Nuclear Security Systems Design

## Nuclear Forensics

- **CHEM 681** – Radiochemistry and Nuclear Forensics

## Policy

- **INTA 617** – Deterrence and Coercion
- **INTA 620** – International Security
- **INTA 652** – The Role of Intelligence in Security Affairs



## Employment sectors for NSSPI students after graduation

- National Laboratory Complex: 30%
- Government: 22%
- Industry: 20%
- Military: 8%
- Graduate Students: 7%
- Academia: 4%
- Other: 9%

# Continuing Education

While traditional academic programs are the backbone of NSSPI's educational efforts, we also pursue educational projects designed to reach non-traditional students outside of Texas A&M.

## Nuclear Security and Safeguards Education Portal (NSSEP)

The Nuclear Security and Safeguards Education Portal (NSSEP) was launched in May 2009 and is aimed at providing education and outreach to those with an interest in enhancing security of nuclear materials and facilities. Initial funding for NSSEP was provided by the Office of Nonproliferation and International Security (NA-24) of the U.S. National Nuclear Security Administration (NNSA). Additional courses have been developed under the sponsorship of the NNSA and the US Department of State's Partnership for Nuclear Threat Reduction (PNTR). See facing page for details.

The course modules are intended to take from 1-3 hours for a student to complete. They consist of reading materials, videos, links to additional resources, and self-assessments. The student can complete the modules at their own pace.

## Professional Certificates

NSSPI offers two certificate programs to professionals and students who want to participate in formal training in nuclear security and safeguards. The certificate programs draw from the online modules in NSSEP and carry with them the option to earn three continuing education units (CEUs) and a professional certificate certified by NSSPI and the Texas A&M Engineering Experiment Station (TEES), the engineering research and training agency of the Texas A&M University System. See facing page for more details.

The NSSEP Professional Certificate in Nuclear Security Fundamentals covers fundamental

## Educational Support beyond Texas A&M University

- Online professional certificates in the fundamentals of nuclear security and safeguards.
- Asynchronous, self-paced online courses, accessible via the Nuclear Security & Safeguards Education Portal (NSSEP).
- Semester-long distance education courses.

concepts related to nuclear security, including a basic understanding of the properties of nuclear materials, the elements of the nuclear fuel cycle, the basics of radiation detection, nuclear security threat assessment, the design of nuclear security systems, as well as nuclear security culture and human reliability programs.

The NSSEP Professional Certificate in Nuclear Safeguards Fundamentals covers fundamental concepts related to nuclear safeguards, including an overview of the elements of the nuclear fuel cycle, basic and applied statistics for safeguards, nuclear material accountancy, containment and surveillance, spent nuclear fuel safeguards, and uranium enrichment safeguards.

## Distance Education

NSSPI faculty are proud to offer distance education opportunities for students and professionals who wish to learn more about nuclear security, nonproliferation and safeguards.

One program is available to active Texas A&M students and non-degree seeking students. Students will receive college credit, which can be applied to a degree at Texas A&M University or another university (if accepted by that university). Classes can be viewed in their entirety from a recording accessible through the Texas A&M University's distance education website.

NSSPI can also deliver specialized distance education courses and programs.



# Nuclear Security and Safeguards Education Portal (NSSEP)



## Basic Nuclear Science Modules:

- Basic Nuclear and Atomic Physics
- The Nuclear Fuel Cycle
- Basic Radiation Detection
- Introduction to Statistics

## Nuclear Security Modules:

- Introduction to Nuclear Safeguards and Security
- Threats to Nuclear Security
- Physical Protection Systems
- Insider Threats
- Nuclear Security Culture

## Nuclear Safeguards Modules:

- Introduction to Nuclear Safeguards and Security
- Containment & Surveillance
- Nuclear Material Accountancy
- Spent Nuclear Fuel Safeguards
- Uranium Enrichment Safeguards
- Applied Statistics for Safeguards

<http://nsspi.tamu.edu/nssep/>

**For Information on our professional online certificate programs:**

<https://nsspi.tamu.edu/education/professional-certificates/>

# International Training Programs

As part of its mission to serve as a public resource for knowledge and skills to reduce nuclear threats, NSSPI partners with countries and organizations around the world to help develop safeguards capabilities and enhance the global nuclear security culture. NSSPI faculty frequently present lecture series and workshops at universities and institutions in other countries. They also offer curriculum development help to professionals from other universities who want to incorporate nuclear security topics in their courses.

These activities allow NSSPI to respond powerfully to the call for the global issue of human resource development in nuclear security science.

## Participation in the International Nuclear Security Education Network

NSSPI is one of the founding members of the International Nuclear Security Education Network (INSEN). Through this network, we have helped develop textbooks and curricula and have supplied lecturers for professional development courses. Additionally, NSSPI participated in the drafting of the IAEA's Nuclear Security Series No. 12. These interactions have aided other countries in creating educational programs in nuclear security.

**NSSPI has provided educational support to universities in the following countries:**

*Brazil, China, Czech Republic, India, Indonesia, Japan, Jordan, Kenya, Malaysia, Nigeria, Russia, South Africa, South Korea, Thailand, United Arab Emirates (UAE), the United Kingdom (UK), and Viet Nam*

## Training Programs

Under sponsorship from the Department of State and NNSA, NSSPI has conducted a number of nuclear security & safeguards training programs at Texas A&M and abroad for international students and professionals. These dynamic programs use Texas A&M resources to offer education and training through: courses, seminars, technical tours, experiments, hands-on activities, group projects, and cultural experiences. In the past, NSSPI has provided training to groups from Japan, Brazil, Indonesia, Jordan, United Arab Emirates, Romania, China, Nigeria, South Africa, and India, as well as several multi-national groups.

## Curriculum Development Support

Due to the maturity and success of its educational program, NSSPI is responding to ever-increasing requests to participate in the development of academic programs in nuclear security and safeguards worldwide. The first of these requests grew out of interactions with the Moscow Engineering Physics Institute and the Obninsk State Technical University as part of the Russian Academic Program in Nonproliferation and International Security funded through the NNSA. NSSPI has since developed a close partnership with organizations like the U.S. Department of State's Partnership for Nuclear Threat Reduction and the IAEA in this area. NSSPI has hosted groups of professors from Nigeria, India, Jordan, Indonesia, and Brazil for workshops on adding nuclear security curricula to their current traditional nuclear engineering undergraduate degree plans.





# Past Courses/Lectures

## Nuclear Security

- Introduction to Nuclear Security Threats and Consequences
- Nuclear Terrorism Threat Assessment and Analysis
- Nuclear Security Case Studies
- **Physical Protection Systems**
  - Comprehensive Nuclear Security System Approach
  - Design Evaluation Process Overview (DEPO)
    - Design Basis Threat and Threat Assessment
    - Security Systems Objectives: Facility Characterization and Target Identification
    - Design Characteristics of Security Systems: Detection
    - Design Characteristics of Security Systems: Delay
    - Design Characteristics of Security Systems: Response
    - Security System Analysis: Adversary Sequence Diagrams
    - Security System Analysis: Scenario Analysis
    - Security System Analysis: Case Studies
  - Security System Analysis Tabletop
- **Human Element in Nuclear Security**
  - Insider Threat and Mitigation
  - Human Reliability Programs in Nuclear Security
  - Nuclear Security Culture
  - Insider Threat Tabletop
- **Radiation Detection**
  - Intrusion Detection Sensors
  - Radiation Isotope Identification Device-RIID
  - Counting Statistics and Error Propagation
  - Gas-Filled Detectors
  - Neutron Detection
  - Deployable Radiation Detection Technologies in Nuclear Security
- Nuclear and Radiological Event Consequence Management
- Transportation Security
- Detection, Interdiction, and Response to

Material Outside of Regulatory Control

- Best Practices of Nuclear Security in Nuclear Engineering Education
- Nuclear Security Human Resource and Capacity Development

## Nonproliferation

- History of Nuclear Nonproliferation
- Arms Control
- Export Control
- Proliferation Resistance Analysis
- Nuclear Nonproliferation Regime

## Nuclear Materials Measurements

- Nuclear Materials Measurement Techniques and Equipment
- Bulk Measurements
- Irradiated Fuel Measurements
- Destructive Analysis: Chemical Assay
- Destructive Analysis: Mass Spectrometry, Calorimetry, Alpha Spectrometry
- Non-Destructive Analysis: Gamma Measurements
- Non-Destructive Assay: Neutron

## Nuclear Safeguards

- Safeguards Treaties and Legal Issues
- IAEA Nuclear Material Safeguards
- Fuel Cycle and Applied Safeguards
- Containment and Surveillance
- Introduction to Nuclear Material Control & Accountancy (NMC&A)
- NMC&A Applications for Nuclear Power Reactors
- Environmental Sampling
- Remote / Unattended Monitoring Systems
- Uranium Enrichment Safeguards
- Spent Fuel Safeguards

## 3S - Nuclear Safety, Security, & Safeguards

- Interrelationship and Integration of Safety, Security, and Safeguards
- Roles and responsibilities of people/ organizations for nuclear security, safeguards, and safety
- Peaceful uses of nuclear energy

# NSSPI Facilities

## Radiation Detection and Measurements Laboratory

- NIM-bins to operate Geiger-Mueller tubes, gas-flow proportional counters, alpha-spectrometers, gamma detectors, and neutron detectors
- Digital electronic-based systems to study gamma spectroscopy, coincident radiation, neutron detection, and neutron multiplicity
- HPGe workstations, hand-held radiation identification systems, and He-3 and BF-3 tubes for neutron detection
- Mechanically and liquid nitrogen cooled HPGe detection systems;
- Lead vaults for low background measurements
- Portable systems calibrated for In-Situ Counting Systems
- High resolution LaBr scintillation detectors
- Portal monitors
- Surveillance and monitoring systems
- Environmental chamber to test radiation detector performance

## Nuclear Security and Emergency Response Laboratory

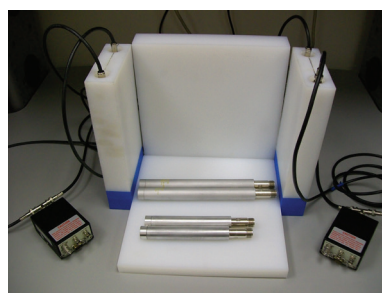
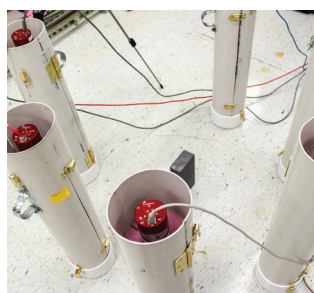
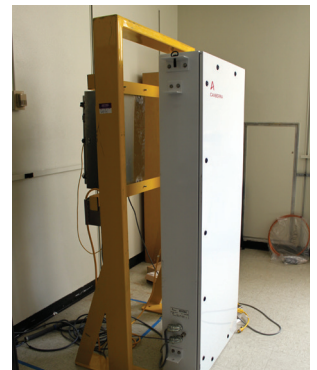
- Mechanically-cooled HPGe
- Radiation isotope identification devices
- Emergency response radiation detection equipment
- Neutron coincidence detection capability

NSSPI maintains forensics and detection laboratories for both teaching and research. In addition, NSSPI is able to draw from the vast resources of a first-class research university and the largest nuclear engineering department in the U.S.

- Vehicle-mountable scalable gamma detection array
- Comprehensive surveillance system apparatus (camera, IR, motion)
- HPGe system for determining U and Pu sample enrichment

## Nuclear Forensics and Radiochemistry Laboratory

- Glove box and fume hood for handling nuclear and other radioactive materials
- NaI and HPGe detectors for gamma-radiation spectrometry
- PIPS detectors for alpha-radiation spectrometry
- Electrochemical setup for radioactive material sample preparation
- Centrifuges to separate organic and aqueous phases
- Vortex mixer to mix different chemical phases
- Heating mantle for chemical dissolution of uranium dioxide
- Bench-scale setup for PUREX chemical process





## Texas A&M University



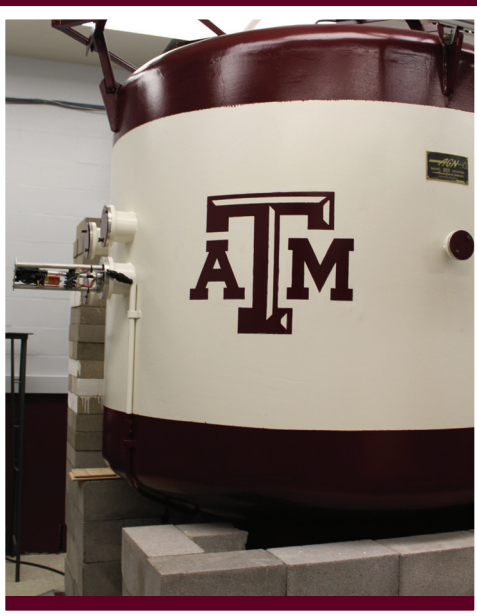
NSSPI supports graduate education at Texas A&M University by mentoring students and providing them with relevant research experience in the nuclear security sciences.

Texas A&M, established in 1876 as the first public university in Texas, is one of the nation's largest universities with more than 66,000 students and more than 440,000 living alumni residing in over 150 countries around the world. A tier-one university, Texas A&M holds the rare triple land-, sea- and space-grant designation. Research conducted at Texas A&M represented annual expenditures of more than \$905.4 million in fiscal year 2017. Texas A&M's research creates new knowledge that provides basic, fundamental and applied contributions resulting, in many cases, in economic benefits to the state, nation and world.

Furthermore, Texas A&M boasts the nation's largest nuclear engineering department with knowledgeable faculty members spanning a large spectrum of expertise.

## Texas A&M System Facilities

- Nuclear Science Center (1 MW Triga Reactor)
- The Cyclotron Institute
- Disaster City Search and Rescue Training Facility
- Parallel Computing Resources



## Department of Nuclear Engineering Facilities

- Accelerator Laboratory
- AGN-201M Nuclear Reactor Laboratory
- Fuel Cycle and Materials Laboratory
- Interphase Transport Phenomena Laboratory
- Microbeam Cell Irradiation Facility
- Multi-Node Linux Cluster
- Nuclear Heat Transfer Systems Laboratory
- Systems Radiobiology Laboratory
- Thermal-Hydraulic Research Laboratory



# Online Professional Certificates in Nuclear Security and Safeguards Fundamentals

The NSSEP Professional Certificate in Nuclear Safeguards Fundamentals covers fundamental concepts related to nuclear safeguards, including an overview of the elements of the nuclear fuel cycle, basic and applied statistics for safeguards, nuclear material accountancy, containment and surveillance, spent nuclear fuel safeguards, and uranium enrichment safeguards.

The NSSEP Professional Certificate in Nuclear Security Fundamentals covers fundamental concepts related to nuclear security, including a basic understanding of the properties of nuclear materials, the elements of the nuclear fuel cycle, the basics of radiation detection, nuclear security threat assessment, the design of nuclear security systems, as well as nuclear security culture and human reliability programs.

Students will earn 3 CEUs as well as a professional certificate for each program they complete.

**Cost: \$300 per certificate**

Contact: Kelley Ragusa, Online Training Coordinator  
Phone: 979.862.2626  
kelleyragusa@tamu.edu

**<https://nsspi.tamu.edu/education/professional-certificates/>**

# NSSPI

**CENTER FOR NUCLEAR SECURITY  
SCIENCE & POLICY INITIATIVES**

3473 TAMU  
Texas A&M University  
College Station, TX 77843-3473  
Phone: 979.845.7092  
Fax: 979.845.7497

nsspi@tamu.edu

**Dr. Sunil Chirayath, Director**

Phone: 979.862.2616  
sunilsc@tamu.edu

**Dr. Craig Marianno, Deputy Director**

Phone: 979.845.6093  
marianno@tamu.edu



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**nsspi.tamu.edu**



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