What is NSSPI?

The Nuclear Security Science and Policy Institute (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 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, 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 holds observer status with the IAEA and is actively engaged in providing training and educational support to the agency. We also have Master Task Agreements or Memoranda of Understanding in place with Los Alamos, Lawrence Livermore, Pacific Northwest, and Sandia National Laboratories.

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.

NSSPI employs science, engineering, and policy expertise to:

- Conduct research and 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

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.
NSSPI Activities

Students
Through the classroom and one-on-one interaction with NSSPI faculty, both graduate and undergraduate students learn about the science and policy concerns in safeguards, security, and nonproliferation.

Distance Education
NSSPI develops and conducts distance education courses for Texas A&M master’s students. Basic courses on safeguards concepts are also available to the public through our web portal.

Hands-on Safeguards Education
NSSPI regularly brings students to national laboratories to gain direct, practical experience with safeguards technology.

Workshops
NSSPI hosts and organizes domestic and international workshops on global nuclear security topics.

Curriculum Development
NSSPI faculty offer curriculum development help to professionals from other universities across the globe looking to incorporate nuclear security topics in their courses.

Research
Faculty and students in NSSPI conduct innovative research on all aspects of safeguards, security, and nonproliferation.

International Collaborations
NSSPI maintains close ties with international colleagues to share information and promote joint research efforts.

Hands-on Safeguards Education
Faculty/Scientist Exchange
NSSPI hosts faculty visitors from other organizations and provides instructors to other universities to give courses on nuclear security topics.

Facility

Hands-on Safeguards Education
NSSPI regularly brings students to national laboratories to gain direct, practical experience with safeguards technology.
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, 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. Each of these teams typically includes at least one policy expert.

NSSPI Research Areas:

- Nuclear Security & Risk Analysis
- Safeguard Systems & Instrument Development
- Combating Nuclear Terrorism
- Nuclear Forensics & Attribution
- Arms Control & Treaty Verification
- Ensuring the Peaceful Use of Nuclear Energy
Research Accomplishments

- Became the first university research team to mount and record radiation data from a crane used in port operations (see photo, facing page top)
- Designed the Self-Interrogation Neutron Resonance Densitometry (SINRD) detector for nuclear safeguards measurements with Los Alamos National Laboratory for testing by the IAEA (see photo, facing page bottom right)
- 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 the PRAETOR tool and a latency method for proliferation risk analysis
- 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
- Built Bench-top scale PUREX lab to separate plutonium for nuclear forensics research
- Developed dynamic agent-based modeling using the Bayesian framework for addressing intelligent adaptive nuclear nonproliferation analysis
- Performed nuclear forensics analysis on Weapons-grade Plutonium Sample Employing PUREX Combined with ICP-MS and Gamma Spectrometry

NSSPI is at the forefront of innovative research on all aspects of nuclear safeguards, security, and nonproliferation.

Selected Theses and Dissertations

18. Alison Goodsell, “Flat Quartz-Crystal X-Ray Spectrometer for Nuclear Forensics Applications” (2012)
19. Adrienne Lafleur, “Development of Self-Interrogation Neutron Resonance Densitometry (SINRD) to Measure the Fissile Content in Nuclear Fuel” (2011)
NSSPI is changing the model for educating safeguards and security experts through the programs it has implemented at Texas A&M. These 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 nuclear security certificate program.

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 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. NSSPI is also embracing new instructional technologies like virtual classrooms and distance education.

NSSPI provides its students with unique opportunities for hands-on safeguards education and professional development.

NSSPI-funded research has contributed to the production of 52 master’s-level theses and 18 Ph.D. dissertations in nuclear engineering with a specific focus on nuclear nonproliferation. After graduation, these NSSPI students have gone on to occupy positions in the national laboratories, industry, government, etc. (see figure, left).

**Summer Internships**

Students in the 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.
Laboratory Short Courses

NSSPI joins with staff at Oak Ridge National Laboratory (ORNL) to provide the opportunity for graduate students within the MS-NNP program to complete a week-long practical course in ORNL’s Safeguards Laboratory. 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 as a unique opportunity for university students 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 universities the opportunity to visit advanced nuclear fuel cycle facilities, such as reprocessing plants, enrichment plants, and waste facilities, in countries like Japan (see photo left, top), the United Kingdom, Switzerland, and France.

Educational Support beyond Texas A&M

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, including:

- **training programs** for students and professionals;
- **asynchronous self-paced online courses**, accessible via the Nuclear Security & Safeguards Education Portal (NSSEP); and
- **distance education** (NUEN 630, NUEN 650, and NUEN 651) and **continuing education** courses.

NSSEP
Nuclear Security & Safeguards Education Portal

Modules include:
- Basic Nuclear and Atomic Physics
- The Nuclear Fuel Cycle
- Basic Radiation Detection
- Introduction to Statistics
- Containment & Surveillance
- Nuclear Material Accountancy
- Physical Protection Systems
- Threats to Nuclear Security
- Insider Threats
- Nuclear Security Culture
- Spent Nuclear Fuel Safeguards

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

MS-NNP Specialization Courses Offered at Texas A&M

NUEN 605 – Radiation Detection and Nuclear Materials Measurement
NUEN 610 – Nuclear Reactor Design & Critical Analysis
NUEN 630 – Monte Carlo Methods for Particle Transport
NUEN 650 – Nuclear Nonproliferation and Arms Control
NUEN 651 – Nuclear Fuel Cycles and Nuclear Material Safeguards
NUEN 657 – Emergency Response Dose Assessment
NUEN 451 – Nuclear Security Systems Design
CHEM 681 – Radiochemistry and Nuclear Forensics
MATH 664 – Inverse Problems in Nuclear Forensics
INTA 617 – Deterrence and Coercion
INTA 620 – International Security
INTA 652 – The Role of Intelligence in Security Affairs
INTA 669 – Nuclear Terrorism Threat Assessment & Analysis
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 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.

**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 Security (PNS) 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.

**Nuclear Security & Safeguards Training Programs**

Under sponsorship from PNS 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, tours, experiments, hands-on activities, group projects, and cultural experiences. In the past, NSSPI has hosted groups from Japan, Brazil, Indonesia, Jordan, Nigeria, and India, as well as several multi-national groups at Texas A&M.

**International Visitor Scholars**

Researchers at various stages of professional development have come to Texas A&M to collaborate on projects with NSSPI faculty and staff. NSSPI has hosted graduate student
interns from Harbin Engineering University in China, the Tokyo Institute of Technology in Japan, and Tomsk Polytechnic Institute in Russia. We have hosted visiting scholars from the Indian Institute of Technology of Kanpur and Pandit Deendayal Petroleum University in India, as well as the Universidade Federal do Rio de Janeiro in Brazil and the Jordan Atomic Energy Commission.

The Gulf Nuclear Energy Infrastructure Institute

The Gulf Nuclear Energy Institute (GNEII) is a Khalifa University institute whose education program offers both classroom instruction and hands-on experience in topics related to nuclear energy safety, security, safeguards, and nonproliferation. GNEII strives to promote a nuclear energy security and safety culture in countries in the region that are considering implementing nuclear energy programs. NSSPI worked with Sandia National Laboratories to develop the curriculum and supply the instructors for the GNEII classroom modules. The start-up of GNEII was sponsored by offices of the U.S. Departments of Energy and State.

The Nuclear Security Training Series for Indian Universities

NSSPI hosts the first part of the Nuclear Security Training Series (NSTS) for Indian University faculty and students, sponsored by PNS. The NSTS is designed to inculcate the tenets of nuclear security and nuclear security culture and to stimulate discussion on nuclear security research. At Texas A&M, participants in the NSTS attend lectures on insider threats and nuclear security culture, as well as nuclear security related thesis and dissertation presentations from former nuclear engineering students. They also tour Texas A&M facilities and NASA and take part in an outdoor radiation source recovery exercise at Disaster City.

Exchange Program with the Tokyo Institute of Technology

Through NSSPI faculty and staff, Texas A&M has been collaborating with the Tokyo Institute of Technology (TiTech) as part of the DOJO Nuclear Security Program. Every year, TiTech invites Texas A&M students to attend a 2-week-long symposium in Japan focused on nuclear security, safety, and safeguards. In exchange, each fall a group of TiTech students come to Texas A&M to participate in a week-long security and incident response exercise at the Disaster City facility.

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

NSSPI has formal agreements in place with the following international institutions:
COPPETEC (Brazil), Indian Institute of Technology - Kanpur (India), Khalifa University (UAE), Pandit Deendayal Petroleum University (India), Tomsk Polytechnic University (Russia), Universidade Federal do Rio de Janeiro (Brazil), and Universitas Gadjah Mada (Indonesia)

NSSPI has also collaborated with the following international organizations:
International Atomic Energy Agency (IAEA), the International Nuclear Security Education Network (INSEN), Japan Atomic Energy Agency (JAEA), European Safeguards Research & Development Association (ESARDA), the Institute for Energy Technology (IFE-Norway), AFRican Center for Science and International Security (AFRCSIS), and the Integrated Support Center for Nuclear Nonproliferation & Nuclear Security (ISCN-Japan).
Facilities

NSSPI Laboratories

Nuclear Forensics and Radiochemistry Laboratory
- glove box and fume hood for handling 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

Nuclear Security and Emergency Response Laboratory
- mechanically-cooled HPGe
- radiation isotope identification devices
- emergency response radiation detection equipment
- neutron coincidence detection capability
- vehicle-mountable scalable gamma detection array
- comprehensive surveillance system apparatus (camera, IR, motion)
- HPGe system for determining U and Pu sample enrichment

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

Images: detectors from NSSPI’s Radiation Detection & Measurements Laboratory (left); glove box in NSSPI’s Nuclear Forensics & Radiochemistry Laboratory (right)
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 was established in 1876 as the first public institution of higher education in Texas and is one of the state’s flagship universities. It was also the first university in the U.S. to receive land, sea, and space grant designations. Home to more than 50,000 undergraduate students, Texas A&M is the sixth-largest university in the country, with more than 370,000 former students worldwide. Texas A&M ranks in the top 20 among U.S. universities for total research expenditures ($820 million plus).

Furthermore, Texas A&M boasts the nation’s largest nuclear engineering department with knowledgeable faculty members spanning a large spectrum of expertise. The program is ranked second in undergraduate and third in graduate studies among public universities in the U.S.. In 2008, the department was identified by the IAEA as one of only two U.S. programs listed in their “world’s best colleges” for nuclear engineering education.

Department of Nuclear Engineering Facilities

AGN-201M Research Reactor
The Fuel Cycle and Materials Laboratory
The Ion Beam Laboratory
Multi-Node Linux Cluster

Texas A&M System Facilities

Nuclear Science Center TRIGA Reactor
The Cyclotron Institute
Disaster City
Parallel Computing Resources

Created by the Texas A&M Engineering Extension Service, Disaster City is the world's largest search-and-rescue training facility.

NSSPI Sponsors

The U.S. Department of Energy (NE, NNSA)
The U.S. Department of Homeland Security (DNDO)
The U.S. Department of State (PNS)
The U.S. Department of Education
The U.S. Department of Defense (DTRA, AFTAC)
The U.S. Department of Agriculture
The U.S. Nuclear Regulatory Commission
The U.S. National Science Foundation
U.S. National Laboratories

Non-Governmental Organizations: IAEA, Carnegie Endowment for International Peace, Carnegie Corp. of New York, CRDF Global

Industry: Zel Technologies, Science Applications International Corporation (SAIC), and Luminant, Inc.