

Protecting People and Planet

March 2023

Security and Safeguards

River Bennett
University of Michigan



NRIC



Idaho National Laboratory

*INL is a U.S. Department of Energy National Laboratory
operated by Battelle Energy Alliance, LLC.*

ACKNOWLEDGEMENTS

This document was sponsored by the National Reactor Innovation Center (NRIC). NRIC is a national program funded by U. S. Department of Energy's Office of Nuclear Energy and is dedicated to the demonstration and deployment of advanced nuclear energy. Neither the U.S. Government nor any agency thereof makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe on privately owned rights. References herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise do not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. Government or any agency thereof.

Protecting People and Planet

1. INTRODUCTION

To produce energy, civilian nuclear power plants require fuel. Most existing plants rely on solid ceramic fuels that contain concentrations of about 3–5% of the element uranium-235. This specific isotope is well suited to sustain the chain reaction type required for a nuclear reactor to harness the heat produced by nuclear fission.

Title I of the United States Atomic Energy Act of 1954 defines “special nuclear material” as plutonium, uranium-233, or uranium-enriched isotopes uranium-233 or uranium-235. This label identifies materials that can be used at high concentrations to produce nuclear weapons. The United States and the broader international community are fully committed to ensuring the peaceful use of nuclear energy by committing to practices known as safeguards.

1.1 International Cooperation

Nonproliferation is an exercise in transparency and international diplomacy. The “Treaty on the Non-Proliferation of Nuclear Weapons,” also known as the NPT, is widely recognized as one of the most successful international treaties in history. Its objective is to prevent the spread of nuclear weapons, promote cooperation in the peaceful uses of nuclear energy, and work toward a future in which global nuclear disarmament is achieved.

The physical and political structures derived from this commitment are different in each country but share a common commitment to maximizing the benefits of nuclear technology while minimizing the risks. The United States is the global leader in this commitment and actively exports best practices to other countries when selling its civilian nuclear energy technologies.

1.2 Domestic Commitment: From the Nuclear Regulatory Commission^a

The Nuclear Regulatory Commission’s (NRC) domestic safeguards program ensures that special nuclear material within the United States is not stolen or otherwise diverted from civilian facilities for clandestine use in fissile explosives and does not pose an unreasonable risk to radiological sabotage. Users of special nuclear material and certain quantities of byproduct material apply safeguards to protect against sabotage, theft, and diversion. These broadly fall into two main categories:

- Physical protection of facilities and special nuclear material at both fixed sites and during transportation
- Material control and accounting for special nuclear material.

To determine how much physical protection is enough, the NRC has a threat assessment program to maintain awareness of the capabilities of potential adversaries and threats to facilities, materials, and activities.

There are three arms to the NRC’s approach to applying safeguards: Regulations, licensing, and oversight.

^a <https://www.nrc.gov/security/domestic.html>

1.2.1 Regulations

The NRC's "Regulations, Guidance, and Communications" guide defines the security structure that civilian nuclear power plants must maintain to operate. The topics within this structure include the following: ^b

- Security and security staff organization
- Barriers and designated areas
- Access controls, subsystems, and procedures
- Detection, surveillance, and alarm subsystems
- Contingency response plans and procedures
- Transportation
- Evaluation criteria
- Personnel security and fitness for duty
- Cybersecurity
- Physical protection
- Material control and accounting.

1.2.2 Licensing

A facility can only handle special nuclear material if it is licensed by the NRC. The license is contingent upon the approval of proposed protocols that account for the following: ^c

- Physical protection, safeguards contingency, and training and qualification plans
- Materials control and accounting.

1.2.3 Oversight ^d

The NRC inspects security programs for nuclear power reactor licensees on a continual basis. These inspections evaluate access authorization, access control, security equipment testing, security force training, physical barriers inspection, intrusion detection and alarm assessment monitoring systems, and other areas. Routine inspections include security evaluations of the licensee's ability to protect the plant from design-based threats of radiological sabotage and theft and diversion. These inspections, which have been conducted since 1992, are realistic mock attacks that challenge the plant's security force and systems. In late 2004, these NRC-evaluated force-on-force exercises were fully integrated into the inspection program for physical protection.

Inspections are also conducted on the implementation of material control and accounting programs. NRC regulations require licensees to keep complete records of receipt, transfer, and inventory of all special nuclear material; develop and follow written procedures that adequately account for and control all special nuclear material possessed; and perform periodic physical inventories. The NRC's inspections of material control and accounting at power reactors and fuel cycle facilities assess the licensee's ability to account for and control special nuclear material.

b <https://www.nrc.gov/security/domestic/reg-guide.html>

c <https://www.nrc.gov/security/domestic/licensing.html>

d <https://www.nrc.gov/security/domestic/oversight.html>

1.3 Post 9/11 Security: From the NRC^e

The NRC has issued numerous advisories to licensees in response to the events of September 11, 2001, which advised licensees to take additional measures to augment security. Some specific measures implemented by the licensees in response to the advisories include increased patrols, augmented security forces and capabilities, additional security posts, installation of additional physical barriers, vehicle checks at greater standoff distances, enhanced coordination with law enforcement and military authorities, and additional restrictive site access controls. These advisories include working with representatives of the Federal Aviation Administration and Department of Defense to strengthen airport and airline security measures.

1.4 Advanced Nuclear Safeguards

As the United States develops and deploys advanced nuclear energy systems, reactor designers, operators, owners, and regulators are continuously focused on improving the proliferation resistance of new technologies. In addition to maintaining strong physical security, new plants also benefit from technological innovations:

- Sealed reactor vessels. Many advanced designs incorporate sealed and replaceable reactor cores that will be swapped in and out like batteries over the lifetime of a power plant. This is different from existing plants where reactor cores are capable of being opened and the fuel materials inside are accessible during refuelings every several years.
- Installation of the reactor below ground level provides more protection from natural (e.g., seismic or tsunami according to the location) or human-made (e.g., aircraft impact) hazards.
- The application of distributed ledger technology, commonly known as blockchain, to material control and accounting increases efficiency, trust, and transparency in nuclear safeguards information management.

1.5 Importance of American Presence in Nonproliferation

Of all the innovations taking place in nuclear energy security, the most important is the continued presence of the United States in global nuclear energy trade. The United States' historic ability to offer reliable exports of nuclear technology, fuel, and services has provided the nation with considerable leverage to impose strict nonproliferation standards in its export agreements. In many cases, these restrictions have gone beyond those required in the NPT and by the International Atomic Energy Agency (IAEA). They include prohibitions on domestic fuel enrichment and reprocessing and restrictions on fuel and technology re-export. Enforcing compliance through bilateral trade agreements, the United States paved the way for IAEA inspections that have taken place in over 170 countries.^f Increased international competition puts the United States' position at risk, making American advanced nuclear and the success of its security imperative increasingly important during this century.

^e <https://www.nrc.gov/security/faq-911.html>

^f Expert assessments of strategies to enhance global nuclear security