# International Safeguards Considerations for Advanced Reactors

National Academies of Sciences
October 4, 2021

Anagha Iyengar, Ph.D.
Office of International Nuclear Safeguards

National Nuclear Security Administration

OFFICE OF
NONPROLIFERATION AND
ARMS CONTROL (NPAC)

**INTERNATIONAL NUCLEAR SAFEGUARDS**
Build capacity of the international atomic energy agency and partner countries to implement international safeguards obligations.

**NUCLEAR EXPORT CONTROLS**
Build domestic and international capacity to implement export control obligations.

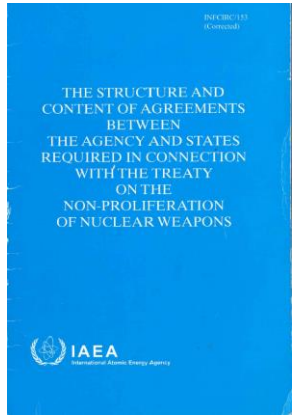
**NUCLEAR VERIFICATION**
Support negotiation of and implement agreements and associated monitoring regimes to verifiably reduce nuclear weapons and nuclear programs.

**NONPROLIFERATION POLICY**
Develops approaches and strategies to address emerging nonproliferation and arms control challenges and opportunities.

# What are IAEA Safeguards?

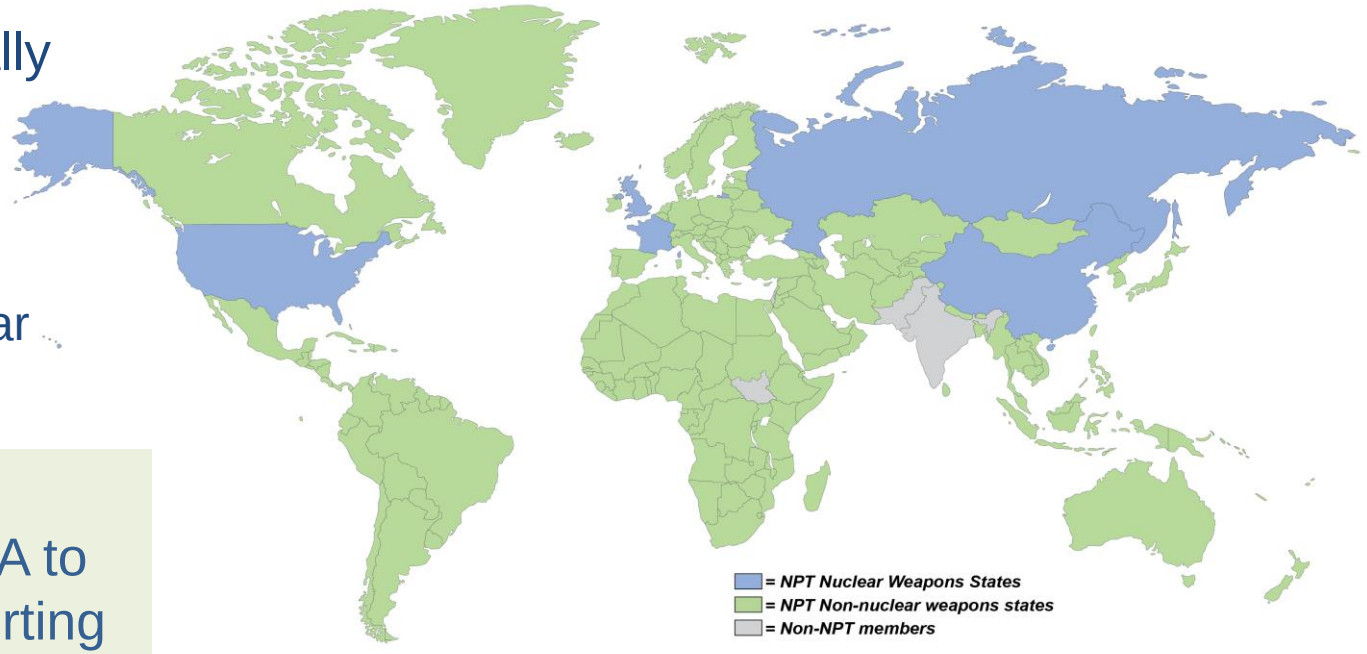
- Safeguards are measures applied by the IAEA to ensure a country's exclusively peaceful use of nuclear material and facilities.
- IAEA Safeguards focuses on state-sponsored proliferation
- Nuclear facilities that are exported internationally will likely be subject to IAEA verification
  - All parties to the NPT **agree to require international safeguards be applied** to nuclear material and equipment transferred to non-nuclear weapon States (NNWS)

IAEA safeguards is a **treaty requirement** undertaken by countries that enables the IAEA to independently verify that a **country** is not diverting nuclear material from declared activities.



Comprehensive Safeguards Agreement (INFCIRC/153)

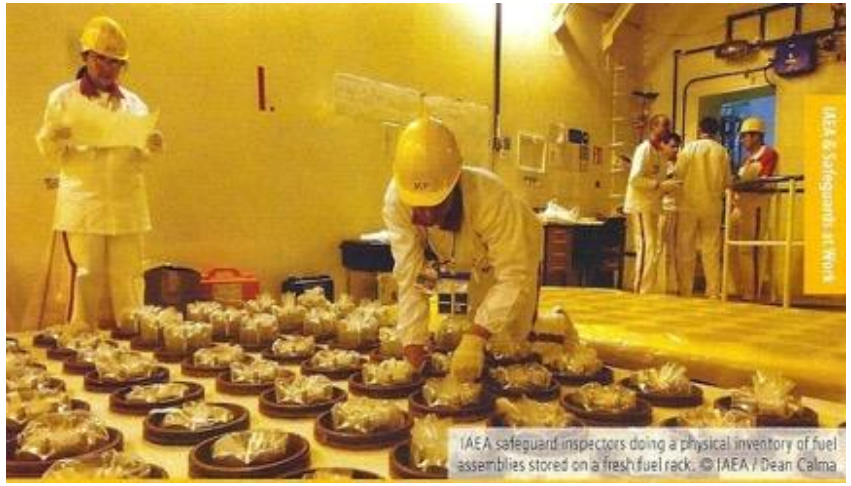
IAEA



# Why are International Safeguards Important to U.S. Advanced Reactor Designers?

- Any reactor, fuel, or major critical components exported to a NNWS will be under IAEA safeguards consistent with U.S. export control laws and regulations, as well as the recipient country's obligations
- Reactors and associated fuel cycle facilities may be subject to U.S. treaty and statutory obligations, if built in the United States
- NRC licensing requirements may not reflect all the aspects necessary for effective implementation of IAEA safeguards

*"IAEA safeguards as required by Article III (2) of the NPT will be applied with respect to any such facilities or material proposed to be exported, to any such material or facilities previously exported and subject to the applicable agreement for cooperation, and to any special nuclear material used in or produced through the use thereof."*
*– 10 CFR Part 110.42*



IAEA safeguard inspectors doing a physical inventory of fuel assemblies stored on a fresh fuel rack. © IAEA / Dean Calma

# Safeguards by Design (SBD)

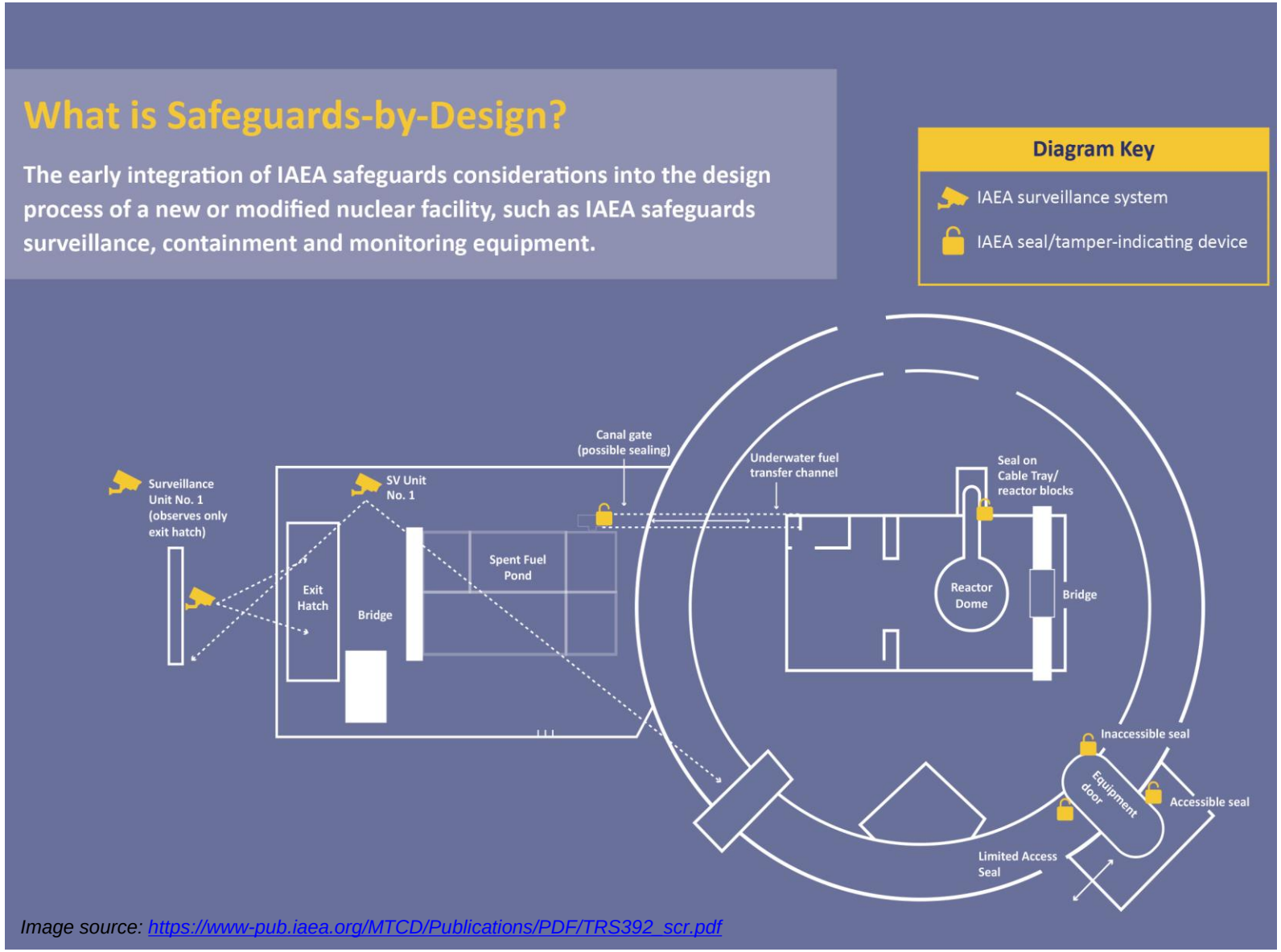
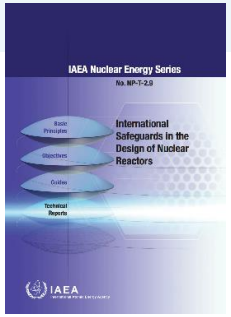
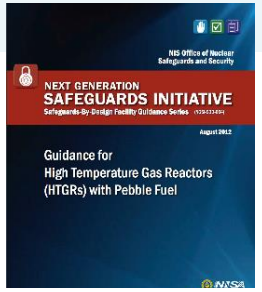



*Image source: https://www-pub.iaea.org/MTCD/Publications/PDF/TRS392_scr.pdf*

- SBD can help mitigate the possibility of design changes necessary to accommodate international safeguards
  - Current safeguards approaches were developed for large LWRs and may not be directly applicable to advanced reactor designs
- SBD is a dialogue where international safeguards considerations are fully integrated into the design, construction, operation, and decommissioning of a nuclear facility




IAEA SBD Guidance




NNSA SBD Reference Documents

# Issues and Factors to Consider

- Advanced reactor designs pose evolutionary safeguards challenges
  - Transportability and novel supply arrangements
  - New fuels / fuel cycles
  - Large range of designs
  - Limited access
  - Novel deployment scenarios / varied roles
  - Longer operational cycles
  - Applicability of traditional monitoring technologies
  - Rapid & continuous on-load re-fueling
- Immediate focus for industry is on domestic requirements

# Defense Nuclear Nonproliferation (DNN) Groups that Support the U.S. Advanced Reactor Community

**International Nuclear Safeguards**
Build capacity of the International Atomic Energy Agency and partner countries to implement international safeguards obligations.

**Advanced Reactor International Safeguards Engagement (ARISE):** supports more effective and efficient IAEA safeguards implementation by engaging with the U.S. advanced reactor community to educate stakeholders on IAEA safeguards and promote timely incorporation of international safeguards by design (SBD).

**International Nuclear Security**
Strengthen partner capacity and commitment to secure nuclear weapons and weapons-usable material.

**Civil Nuclear Security Project (CNSP):** Seeks to build relationships with U.S. nuclear energy industry vendors to support three main objectives: 1) Improve security of future US exports 2) Support nuclear security infrastructure development in Newcomer countries 3) Upholding the global nuclear security regime through IAEA collaboration

**10 CFR Part 810**
Develop policies, programs, and strategies to address emerging nonproliferation challenges and opportunities, and nuclear technology regulation

**Nuclear Technology and Assistance Regulation (10 CFR Part 810):** The Department of Energy (DOE) has statutory responsibility for authorizing the transfer of unclassified nuclear technology and assistance to foreign atomic energy activities within the United States or abroad.

**Convert**
Modify/convert facilities to eliminate the need for weapons-usable nuclear materials in civilian applications.

**Proliferation Resistance Optimization (Pro-X):** collaborating with operators, designers, and other stakeholders to improve proliferation resistance and optimization strategies for individual facility designs

# Program Objectives

Support effective and efficient IAEA safeguards implementation by engaging with the U.S. advanced reactor community to educate stakeholders on IAEA safeguards and promote the timely incorporation of safeguards by design (SBD)

- ✓ Improve the safeguardability of future exports by supporting the U.S. advanced reactor industry to readily incorporate SBD early in the design process
- ✓ Support the development of safeguards approaches and concepts for advanced reactors and associated fuel cycle facilities / technologies through technical and policy initiatives that help the IAEA to prepare for the evolving safeguards challenges.
- ✓ Provide clear and consistent messaging and advice on international safeguards requirements to the advanced reactor stakeholder community in close collaboration with other USG programs

# Program Focus Areas

## Safeguards Analyses

- Survey of potential safeguards challenges posed by reactor / fuel cycle concepts
- Technical gap analyses to ID limitations of current approaches
- Crosswalk of domestic / international regulations
- Collect data / case studies on regulatory incentives / international 'demand'

## External Engagement

- Outreach to U.S. AR stakeholders on IAEA safeguards
- Support U.S. industry via national lab partnerships
- Coordinate with IAEA
- Coordinate messaging and outreach with relevant USG programs

## Propose Solutions

- Propose solutions to safeguardability challenges
- Identify and evaluate safeguards concepts
- Develop design-specific safeguards approaches
- Disseminate lessons learned and findings

# Support U.S. Industry

## Research and Development Phase

- Intro to IAEA safeguards
- Explanation of:
  - SBD analysis of proposed fuel cycle
  - Diversion pathway analysis
- Identify accountancy R&D needs
- Share prior relevant fuel cycle safeguards assessment results

## Preconceptual Design

- Intro to IAEA safeguards
- SBD analysis
- Explain accountancy requirements, DIV, DIQ, DIE
- Identify accountancy R&D needs
- Suggest design revisions
- Share prior relevant fuel cycle safeguards assessment results

## Preliminary Design

- Intro to IAEA safeguards
- SBD analysis
- Develop proposed safeguards approach
- Identify design focus areas
- Work with vendor to incorporate design changes
- Promote engagement with IAEA
- Review marketing materials

## Final Design / Demonstration-ready

- Prepare for safeguards application in U.S. & abroad
- SBD analysis
- Intro to IAEA safeguards
- Develop proposed safeguards approach
- Identify design focus areas
- Test potential technologies for verification / monitoring
- Help draft facility attachment with all IAEA systems + design information submitted to IAEA
- Connect with IAEA

** List is not exhaustive – engagements can be customized based on specific vendor priorities and needs*

**Collaborations implemented under NDAs or CRADAs between vendor and DOE National Labs to protect IP**

# FY22 Priorities

- In line with Congressional direction
  - Coordinate with DOE-NE programs and the NRC to reach U.S. industry
  - Streamline existing international safeguards activities for advanced reactors
- Support and align priorities and focus areas with IAEA efforts
  - Ensure representation in IAEA Technical Meetings and Consultancies
- Support to U.S. industry
  - Understand vendor decision points and timelines to integrate into process better
  - Coordinated outreach to industry
  - Encourage vendors to reach out to NNSA directly or via the U.S. Nuclear NEXUS
    - https://nuclear-nexus.nsis.anl.gov/nexus
  - Public solicitation to engage with industry
    - NNSA funds collaborations via DOE National Laboratories

# Thank you for your attention!

Dr. Anagha Iyengar
anagha.iyengar@nnsa.doe.gov