Nuclear Safeguards
Domestic and International Safeguards

David Chichester, Idaho National Laboratory
Richard Lanza, Massachusetts Institute of Technology
Safeguards (means different things to different people)

**State → domestic safeguards**  **IAEA → international safeguards**

• The **Nonproliferation and Security Regime** is an elaborate arrangement of formal and informal systems, both political and technical in nature, that has evolved to address the need to secure, track, and inventory fissionable material and other radioactive material.

• Individual countries develop and employ a **state system of accounting and control (SSAC)** which is their **domestic safeguards** program; it protects their own interests, guarding fissionable material from theft or sabotage. A strong SSAC is fundamental to assuring a strong international safeguards program.

• Groups of countries work together to develop, employ, and enforce **international safeguards** programs, lead foremostly by the IAEA within the framework of the Nuclear Nonproliferation Treaty, with the goals of preventing the unregulated spread of nuclear material and building confidence among nations that undeclared nuclear weapon related activities are not underway.

• Other important components of worldwide nonproliferation include:
  - Import/export controls (Zanger Committee: i.e., the **Nuclear Exporters Committee**)
  - US Section 123 Agreements
  - **Global Initiative To Combat Nuclear Terrorism (GICNT)**
  - United Nations Security Council Resolution (UNSCR) 1540

  *Section 123 of Atomic Energy Act of 1954 (42 U.S. Code §2153 - Cooperation with other nations)*
Safeguards Evolves to Meet New Challenges

Nonproliferation and disarmament foundation

Additional reporting, expanded scope, environmental sampling and remote monitoring, state system of accounting for and control of nuclear material (SSAC)

Today’s holistic all-source approach

Nuclear Nonproliferation Treaty (1970)

Intl. Safeguards Comprehensive Safeguards Agreements

Strengthened Measures under CSA’s (1991-93)

State Level (Safeguards) Approach

Additional Protocol (1997+)

CSA = Comprehensive safeguards agreement

Accountancy, containment, and surveillance; independent verification and inspections

Expanded declarations, complementary access visits, new administrative measures

Today's holistic all-source approach
Domestic Safeguards (SSAC)
Domestic Safeguards

2. OBJECTIVES

2.1. The objectives of the State’s physical protection system should be:
(a) To establish conditions which will minimize the possibilities for unauthorized removal of nuclear material or for sabotage,
(b) To provide information and technical assistance in support of rapid and comprehensive measures by the State to locate and recover missing nuclear material.

2.2. The objectives of the Agency are:
(a) To provide a set of recommendations on requirements for the physical protection of nuclear material in use, transit and storage. The recommendations are provided for consideration by the competent authorities in the States. Such recommendations could provide guidance but could not be mandatory upon a State and would not infringe on the sovereign rights of States; and
(b) To be in a position to give advice to a State’s authorities in respect of their physical protection systems at the request of the State. The intensity and the form of assistance required are, however, matters to be agreed upon between the State and the Agency.

It should be noted that the Agency has no responsibility either for the provision of a State’s physical protection system or for the supervision, control or implementation of such a system. The Agency may informally advise the State on results of observations made during its normal safeguards activities. Further assistance by the Agency will be provided only when so requested by the State.

Domestic safeguards are part of a nation's internal security activities; this provides critical input into the IAEA system.

Key parts of domestic safeguards activities are Physical Protection, Material Control and Accounting, and Cybersecurity.

This is SSAC in IAEA parlance.
NRC Domestic Safeguards (10CFR1 Parts 1-199)

• Part 11 - Criteria and Procedures for Determining Eligibility for Access to or Control Over Special Nuclear Material
• Part 25 - Access Authorization for Licensee Personnel
• Part 26 - Fitness for Duty
• Part 70.51 - Material balance, inventory, and records requirements
• Part 73 - Physical Protection of Plants and Materials
• Part 74 - Material Control and Accounting of Special Nuclear Material
• Part 76 - Certification of Gaseous Diffusion Plants
• Part 95 - Facility Security Clearance and Safeguards of National Security Information and Restricted Data

**Physical Protection**

• NUREG/BR-0252
  Users Guide to Physical Protection Documents
• NUREG-0908
  Acceptance Criteria for the Evaluation of Power Reactor Security Plans
• NUREG-1322
• NUREG-1619

**Material Control & Accounting**

• NUREG-1280
  Category I SNM - Standard Format and Content Acceptance Criteria for the Material Control and Accounting (MC&A) Reform Amendment
• NUREG-1065
  Category III SNM - Acceptable Standard Format and Content for the Fundamental Nuclear Material Control Plan Required for Low-Enriched Uranium Facilities
• ANSI N15.8-2009
  Methods of Nuclear Material Control - Material Control Systems - Special Nuclear Material Control and Accounting Systems for Nuclear Power Plants

**Cyber Security**

• U.S. NRC REGULATORY GUIDE 5.71
  Cyber Security Programs for Nuclear Facilities

www.nrc.gov
The Key Challenge for Domestic Safeguards

- Detecting and identifying the threat
  - Outsiders: thieves, terrorists, hackers, …
  - Insiders: employees, contractors, …

- Insiders present the most commonly encountered threat
  - Knowledge of operations and security plans
  - Unescorted access
  - In broad terms, 41% of crimes committed against assets are committed by guards!

- Depending upon the situation different protection systems are more or less important
Material Control

• The use of control and monitoring measures to prevent loss or detect loss when it occurs or soon afterward

• Control
  - Storage containers
  - Vaults
  - Access gates
  - Key cards
  - Biometrics
  - Guards

• Monitoring
  - Radiation area monitors
  - Radiation portal monitors
  - Bar code readers
  - Surveillance cameras
  - Physical inspection and inventories
  - Guards

A worker at the Novosibirsk Chemical Concentrates Plant (Russia) sorts post-sintered fuel pellets destined for use in a VVER reactor

https://wonderfulengineering.com/these-pictures-show-how-nuclear-fuel-is-produced/
Material Accountancy

The use of statistics and accounting measures to maintain knowledge of the quantities of SNM present in each area of a facility; it includes the use of physical inventories and material balances to verify the presence of material or to detect the loss of material after it occurs, in particular, through theft by one or more insiders.

Simple Approach:
- Measure what goes in, measure what come out
- Account for the difference
- Periodically verify inventory to reconcile accounting

Two accounting regimes
- Items: intact whole items (e.g., reactor fuel elements)
- Bulk: material in “loose” form
  - Dissolved Pu concentration in a PUREX plant
  - Hold-up trapped in process piping
  - 400,000 pebbles in a PBMR core

In practice, material accountancy is not very photogenic.
Key Aspects of Accountancy

• Accounting practice using *generally accepted accounting principles* to track movement and inventory of materials

• **Key Measurement Points (KMPs)** to determine material flow and inventory
  - Determine/verify material flow
  - Perform inventory measurement
  - Input/Output points
  - Storage areas

• **Material Balance Areas (MBAs)** to enable material accounting and measurement
  - Requires a defined area where material inventory can be determined
  - Transfers into or out of the MBA can be tracked and accounted
  - KMPs are often MBA boundaries
  - Size of the MBA (or, rather, the amount of material within it) should reflect the ability to measure the material inventory and allow for tracking and isolating processes involved in losses

• Periodic inventories to determine material quantities

• A measurement program using either (or both) non-destructive and destructive assay techniques
Methods of Safeguards Accountancy

**Safeguards Techniques:**
1. Environmental Sampling (ES) (international)
2. Containment and Surveillance (C/S) (domestic & international)
3. Nondestructive Assay (NDA) (domestic & international)
4. Destructive Assay (DA) (domestic & international)

**Balancing the books ... Inventory difference (ID)**

\[
ID \equiv (BI + I - R - EI)
\]

- \( BI \) = beginning inventory
- \( I \) = new inputs into a system
- \( R \) = removals from a system
- \( EI \) = ending inventory

The NRC and DOE use the term "inventory difference" (ID)

"MUF" is the term used by the IAEA

"Nuclear Safeguards, Security, and Nonproliferation"
International Safeguards
International Safeguards

"… the objective of safeguards is the timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection."

"To this end the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures."

"The Agreement should provide that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated."

• For international safeguards IAEA inspectors carry out the safeguard activities
• The facility owner may or may not be an enthusiastic partner
• Individual measurements are like domestic safeguards, but the tasks and challenges and conclusions are very different

IAEA, INFCIRC 153
Key Definitions

Timely detection – the time required to convert different forms of nuclear material to the components of a nuclear explosive device

- For metallic Pu and HEU conversion time is estimated as 7-10 days; IAEA detection goal is 1 month
- For pure unirradiated compounds of these materials such as oxides or nitrates conversion time is estimated as 1-3 weeks; IAEA detection goal is 1 month
- For Pu or HEU in irradiated fuel conversion time is estimated as 1-3 months, IAEA detection goal is 3 months
- For low-enriched uranium conversion time is estimated as 1 year, IAEA detection goal is 1 year

Significant quantity (SQ) – the approximate quantity of nuclear material in respect of which, taking into account any conversion process involved, the possibility of manufacturing a nuclear explosive device cannot be excluded

- For plutonium (<80% $^{238}$Pu) the SQ is 8 kg
- For $^{233}$U the SQ is 8 kg
- For highly enriched uranium (HEU) the SQ is 25 kg of $^{235}$U
- For low-enriched uranium (LEU) the SQ is 75 kg of $^{235}$U
Comparing Sizes …

• According to the International Atomic Energy Agency (IAEA), 25 kg of $^{235}\text{U}$ (about the size of a large grapefruit) or 8 kg of plutonium (about the size of a soda can) represent a “significant quantity” required to make a crude nuclear weapon.

$\text{Density for uranium and plutonium } \approx 19 \text{ g/cm}^3$

- Large grapefruit ($5.4'' \phi$): $R = 6.8 \text{ cm}, V = 1,320 \text{ cm}^3 \rightarrow M = 25 \text{ kg}$
- 12'' softball ($3.8'' \phi$): $R = 4.8 \text{ cm}, V = 463 \text{ cm}^3 \rightarrow M = 8.8 \text{ kg}$
- Soda can: $H = 12.2 \text{ cm}, R = 3.2 \text{ cm}, V = 387 \text{ cm}^3 \rightarrow M = 7.4 \text{ kg}$
The IAEA's Challenge…

- As of December 2006 – 925 Facilities were under IAEA Safeguards
- Safeguarded Nuclear Material (excluding source material)
  - 980 Metric Tons of Plutonium ( Majority in Spent Fuel)
  - 16 Metric Tons of High Enriched Uranium
  - 1120 Metric Tons of Low Enriched Uranium
- “The IAEA should be able to provide credible assurance not only about the declared nuclear material in a State but also about the absence of undeclared material and activities.”
- Primary safeguards goal is the timely detection of the diversion of a significant quantity
  - **Abrupt Diversion** – The immediate diversion of a significant quantity or greater in a short time (typically a conversion period: 2 weeks to 1 month)
  - **Protracted Diversion** – The diversion of portions of a significant quantity over extended periods of time leading to a significant quantity or greater (typically an inventory period: 6 months – 1 year)
# International Atomic Energy Agency – An Overview

- The IAEA 2021 Operational Budget and other Agency resources at a glance

<table>
<thead>
<tr>
<th>Program Area</th>
<th>2021 Budget, M€</th>
<th>Professional Staff, FTE</th>
<th>General Staff, FTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nuclear Power, Fuel Cycle and Nuclear Science</td>
<td>42.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Nuclear Techniques for Development and Environmental Protection</td>
<td>42.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Nuclear Safety and Security</td>
<td>37.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Nuclear Verification</td>
<td>151.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Policy Management and Administrative Services</td>
<td>82.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Totals**  
\[ \text{M€} 383.8 \]  
\[ \text{(as of 2019)} \]  
\[ \text{($418M)} \]

The US is the largest financial contributor to the IAEA, providing ~$200M (~€183M) annually in contributions. The US contribution of the total IAEA budget is close to 48%.
IAEA Nuclear Verification – An Overview

• In 2020, safeguards were applied for 183 States with safeguards agreements in force; 136 of these States had an additional protocol (AP) in force
  - 10 State Parties to the NPT without CSA (no safeguards applied)
  - 5 nuclear weapons states with voluntary offer agreements and APs
  - 3 States with Safeguards agreements from INFCIRC/66/Rev.2 (India (but as an AP), Israel, and Pakistan)
  - 44 States with CSA
  - 131 States with CSA and AP

• Circa 1990s, approximately 60% of the IAEA Nuclear Verification budget was spent for safeguards activities in Canada, Germany, and Japan
  - Approximately 1/3 of this was spent to safeguard the Japanese fuel reprocessing facilities at Rokkasho and Tokai-Mura

• In 2020 the Agency had:
  - Carried out 2850 verification activities, spent more than 12700 days in the field conducting those activities
  - Had 1611 unattended safeguards data streams from 142 facilities in 31 states
  - Had 1530 cameras at 260 facilities in 37 States
  - Collected 489 nuclear material samples, 460 environmental samples and
Comprehensive Safeguards Agreements (CSAs)

- INFCIRC/153 – The Structure & Content of Agreements Between the Agency & States in Connection with the NPT

- PART I, paragraph 4
  The Agreement should provide that safeguards shall be implemented in a manner designed:
  - To avoid hampering the economic and technological development of the State … in the field of peaceful nuclear activities, including international exchange of nuclear materials;
  - To avoid undue interference in the State’s peaceful nuclear activities, and in particular in the operation of facilities; and
  - To be consistent with prudent management practices required for the economic and safe conduct of nuclear activities.

- Methods
  - Documentation reviews, open source data collection, IAEA member state contributions, physical inspections with on-site inspectors, unattended monitoring
Using the United Arab Emirates CSA as an Example
UAE Agreements – The Nuclear Nonproliferation Treaty

• “Agreement between the United Arab Emirates and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-proliferation of Nuclear Weapons”
  – Signed in Abu Dhabi 15 December 15 2002; entered into force 9 October 2003

• The United Arab Emirates accepts safeguards on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices

• The Agreement is designed:
  – to avoid hampering the economic and technological development of the UAE or international co-operation in the field of peaceful nuclear activities, including international exchange of nuclear material
  – to avoid undue interference in the UAE's peaceful nuclear activities, and in particular in the operation of facilities
  – to be consistent with prudent management practices required for the economic and safe conduct of nuclear activities
The UAE shall …

- **Establish and maintain a system of accounting** for and control of all nuclear material subject to safeguards under this Agreement.

- **Provide the Agency with information concerning nuclear material** subject to safeguards under this Agreement and the features of facilities relevant to safeguarding such material.

- Take the necessary steps to **ensure that Agency inspectors can effectively discharge their functions** under this Agreement.

- Accord to the inspectors the same privileges and immunities as those set forth in the relevant provisions of the Agreement on the Privileges and Immunities of the International Atomic Energy Agency.

- Give the Agency advance notification of intended transfers of nuclear material subject to safeguards under this Agreement out of the United Arab Emirates.

- Agree with the Agency, before the material is so used, on the circumstances under which the safeguards on materials may be terminated.
When does UAE Safeguards Monitoring Start/End?

• **START:** When any nuclear material of a composition and purity suitable for fuel fabrication or for isotopic enrichment leaves the plant or the process stage in which it has been produced, or when such nuclear material, or any other nuclear material produced at a later stage in the nuclear fuel cycle, is imported into the United Arab Emirates, the nuclear material shall become subject to the other safeguards procedures specified in this Agreement.

• **END:** Upon determination that the material has been consumed, or has been diluted in such a way that it is no longer usable for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable.

• International shipments:
  - Safeguards starts when responsibility ceases to lie with the exporting State, and no later than the time at which the material reaches its destination.
  - Safeguards ends when the recipient State assumes such responsibility, and no later than the time at which the nuclear material reaches its destination.

• Safeguards does not apply to material in mining or ore processing activities

• Exemptions exist
Key Components to the State Agreement

- An Inventory of all safeguarded material in UAE, created by the IAEA
- National system of accounting for and control of nuclear material
  - Based on a structure of material balance areas
  - For the determination of the quantities of nuclear material received, produced, shipped, lost or otherwise removed from inventory, and the quantities on inventory
  - The evaluation of precision and accuracy of measurements and the estimation of measurement uncertainty
  - Procedures for identifying, reviewing and evaluating differences in shipper/receiver measurements - taking a physical inventory - evaluation of accumulations of unmeasured inventory and unmeasured losses
- Design information for safeguards-related facilities must be provided to the IAEA
  - Identification of the facility, stating its general character, purpose, nominal capacity and geographic location
  - A description of the form, location and flow of nuclear material and the general layout of important items of equipment which use, produce or process nuclear material
  - A description of features of the facility relating to material accountancy, containment and surveillance
  - A description of the existing and proposed procedures at the facility for nuclear material accountancy and control, with special reference to material balance areas established by the operator, measurements of flow and procedures for physical inventory taking
Safeguards Technology
Containment

IAEA Metal E-Cap Seal

VACOSS 5 Seal and System

COBRA Fiber Optic Seal and Verifier

"IAEA Safeguards Equipment"
Installation of Sensors in a Facility

- Installation of flow sensor above, and the final assembly to the right, showing the final system with a containment cover ready for affixing IAEA seals
Surveillance

Current IAEA surveillance systems are based on the DCM14 digital camera module
- Scene change detection
- Image compression
- Image/data authentication & encryption
- Power management & battery back-up
- External triggers
- State of health
- Removable image and data recording media

Surveillance is used to:
- Detect and/or confirm all movements of nuclear material and spent fuel containers
- Confirm that containment is maintained
- Confirm that information related to locations and quantities of nuclear material is valid
- Confirm IAEA devices are not tampered with
- Ensure the absence of undeclared operations
- Continuously monitor a specific activity for a short period of time
Special Nature of Safeguard Surveillance Cameras

As with nearly all safeguards instrumentation the cameras used for monitoring and surveillance are specialized and custom made:
- Tamper resistant/tamper indicating
- Data authentication
- Self powered (but limited backup)
- Redundancy

Installation of an IAEA camera in an HEU down blending facility in Kazakhstan

"IAEA Safeguards Equipment" & "Addressing Verification Challenges"
Safeguards at the Site

• HM-5 Hand Held Assay Probe: a portable handheld photon and neutron detector for detecting and identifying nuclear and other radioactive materials

• HHNC – Hand-Held Neutron Counter: a portable handheld neutron detector
Monitoring Fuel in the Core and the Spent Fuel Pool

**Goal:** Detect the removal/replacement of an entire fuel assembly (full defect) or a portion of the rods in an assembly (partial defect, 50% threshold); verify operator declarations

- Accounting
- Visual Inspection
  - Vendor markings, serial number, location
- Cherenkov light intensity
- Measurements made in the water:
  - Gross neutron and gamma-ray activity
  - Neutron and gamma-ray profiles
  - Gamma-spectrometry ($^{137}$Cs using CZT detectors)
  - Neutron coincidence counting
- Measurement determined parameters:
  - Burn-up, initial enrichment, cooling time, flux profile, partial defect detection
Safeguarding a Nuclear Power Plant

- Analysis to monitor diversion pathways and detect undeclared production
  - One fuel assembly = ~ 1 SQ
- Factors addressed in safeguards analysis:
  - Measurement methods and techniques available to the Agency
  - Design features of the facility
  - Form and accessibility of the nuclear material
  - Possible existence of unsafeguarded nuclear activities
  - Inspection experience
- For reactors there are two main approaches:
  - Item accountancy and containment and surveillance (C/S) measures
- Activities:
  - Audit of accounting records and comparison with reports to the Agency
  - Examination of operating records and reconciliation with accounting records
  - Verification of fresh fuel before core loading, fuel in the core, and spent fuel pool.

"Handbook of Gamma Spectrometry Methods"
The DCVD photographs Cherenkov light, the "blue glow" seen in water-cooled reactors and spent fuel storage pools, which is used for safeguards monitoring.

Photo of the Advanced Test Reactor shortly after shutdown, showing Cherenkov light from fuel elements.
DCVD Images

• Field of view of a 40,910 MWd/t BWR spent fuel element after 6 years of cooling using an 80 mm focal length UV lens.

"Addressing Verification Challenges" & "Status on Two Novel IAEA Canadian Support Programme Technologies"
Fork Detector (FDET)

Neutron detectors are housed in a submersible "fork" assembly that is lowered into spent fuel storage pools. SF assemblies are raised and placed between the forks; analysis is performed to assay/verify spent fuel burn-up.
Unattended Monitoring Systems

- Systems that automatically monitor the flow of nuclear materials 24 hours a day / 365 days a year without the need for human interaction
  - Permanently installed in a nuclear facility
  - Computer based for data retrieval either on-site or remotely
  - May use a variety of sensors such as radiation, pressure, temperature, flow, vibration, & electromagnetic fields to collect qualitative or quantitative data
  - All external components are in tamper indicating enclosures

- They provide the highest level of safeguards assurance through continuous monitoring of activities in nuclear facilities

- They minimize impact on the facility operator by allowing uninterrupted facility operation

- They minimize the impact on the Agency by reducing inspector visits and thereby inspection resources including the high cost of world-wide travel

- They reduce radiation exposure to personnel and can operate in radiation areas too dangerous for humans
State-Level Monitoring

• Detecting undeclared activities

• Greatly supported under the Additional Protocol – “Any place on a site.”

• Different tools and techniques:
  – Satellites imagery
  – Environmental monitoring
  – Unconventional methods
  – Other open-source information
Satellite Imagery

Satellite Imagery is being used to help evaluate Additional Protocol Declarations

"IAEA Safeguards Equipment"
Destructive Analysis for IAEA Environmental Samples

- Environmental safeguards sampling and analysis is a powerful method for verifying declared operations at safeguarded facilities.
- Analyses completed at IAEA Network of World Analytical Laboratories (NWAL):
  - Collect environmental sample (swipe)
  - Non-destructive assay gamma-ray spectrometry
  - Uranium assay by ICP-MS or ID TIMS
  - Plutonium assay and isotopics by ID TIMS
- Rigorous QA program:
  - Process blanks with each set of samples
  - Blind QC samples analyzed at least once per year

ICP-MS: Inductively-coupled plasma – mass spectrometry
ID TIMS: Isotope dilution thermal-ionization mass spectrometry
Summary

- Safeguards, nonproliferation, and arms control are inherently linked activities
- Safety, Security, and Safeguards by Design (3SBD)
  - Ensure safety, security, and safeguard goals are met
  - Reduce risk to budget and schedule
  - Potentially reduce costs

- Domestic safeguards
  - The host supports and implements the safeguard activities
  - Terrorism, sabotage, and insider threats are the key challenges
  - Focus on physical protection, material control, and material accountancy

- International Safeguards
  - The IAEA implements the safeguards activities
  - The host may or may not support the safeguards activities
  - The primary 'concern' is the host nation, with immense resources and capabilities
  - Adversarial situations can arise
  - Strong focus on seals, cameras, unattended monitoring, and on-site inspectors
  - MPC&A plays a strong role but the challenges are very different
"In regard to nuclear proliferation and arms control, the fundamental problem is clear: Either we begin finding creative, outside-the-box solutions or the international nuclear safeguards regime will become obsolete."

Discussion Topics
Naval Nuclear Propulsion

- **Treaty on the Non-Proliferation of Nuclear Weapons** (INFCIRC 140)
- **The Structure and Content of Agreements Between The Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons** (INFCIRC 153)
  - Paragraph 14: Non-Application of Safeguards to Nuclear Material to be Used in Non-Peaceful Activities
  - Applicable when a State intends to exercise its discretion to use nuclear material outside of safeguards, in a military activity → e.g., nuclear naval propulsion

The State assures the IAEA that:
1. The use of the material will not be in conflict with prior commitments to the IAEA and only be used in a peaceful activity
2. The material will not be used for the production of nuclear weapons or other nuclear explosive devices

The State informs the Agency of:
1. The total quantity and composition of unsafeguarded material
2. Any exports of the material

Safeguards shall be reapplied as soon as the material is reintroduced into a peaceful activity

What are the real, "big picture" implications of Paragraph 14?
2020 NPT Review Conference (RevCon)

- Every five years the IAEA hosts an NPT Review Conference; due to COVID the 10th RevCon (2020) is postponed until August, 2022
- Prior to the RevCon the States develop an agenda of issues to be discussed, in relation to the three NPT pillars
  1. Peaceful Uses of Atomic Energy
  2. Nonproliferation
  3. Disarmament
- There are many complicated issues, a lot can happen between now and August
  - Russian invasion of Ukraine
  - Iran and JPCOA
  - Nuclear-free weapons zones
  - Nuclear weapon modernization in China, Russia, and US
  - Australian nuclear navy developments
  - Agreement that nuclear war cannot be won?
  - Advances towards a fissile material cutoff treaty

See:
- https://www.friendsofeurope.org/insights/the-npt-review-conference-is-finally-going-to-happen-but-what-can-it-achieve/
References

The following reference materials were used to create this lecture. In most cases specific citations are presented but, in some cases, there may be omissions. For this I apologize in advance. To learn more about the subject of Nuclear Safeguards I encourage you to explore through these papers, reports, presentations, and websites as your interests take you.

• www.state.gov/www/global/arms/treaties
• www.nrc.gov
• "The Structure and Content of Agreements Between The Agency and States Required in Connection with the treaty on the Non-Proliferation of Nuclear Weapons," IAEA Document INFCIRC/153 (Corrected), International Atomic Energy Agency, Vienna, Austria (1972).
• Miller, M., "Are IAEA Safeguards on Plutonium Bulk-Handling Facilities Effective?," http://www.nci.org/k-m/mmsgrds.htm
References

• Park, W.-S., "The Mission of the IAEA’s Department of Safeguards" www.bnl.gov/ispo/BNLWorkshop07/Presentations/Park_Mission_of_IAEA.ppt
References

• Pemberton, W. J., "Fuel Cycle Separations Group An Overview"
• radchem.nevada.edu/images/Fuel Cycle Separations.pdf
• Charlton, W. S., and Boyle, D. R., Lecture Notes From Course NUEN 689 "Nuclear Fuel Cycle and Safeguards," Texas A&M University, College Station, Tex.
• Von Hippel, F., "Scope and Verification of a Fissile Material (Cutoff) Treaty: Progress Report from the International Panel on Fissile Materials (IPFM)"
References

  www-pub.iaea.org/MTCD/publications/PDF/P1298/p1298_posters.pdf
  www-pub.iaea.org/MTCD/publications/PDF/P1298/p1298_contributed_papers.pdf
References