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Exceptional service in the national interest

Sandia National Laboratories

International Nuclear Safeguards

University of New Mexico (UNM)
WMD Nonproliferation Science and Policy
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International Safeguards and Engagements

Image Source: IAEA Image Bank

U.S. DEPARTMENT OF ENERGY | NNSA

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Outline

- Introduction to the IAEA
- NPT Safeguards: Goals and Methods
  - Objective of NPT Safeguards
  - Elements of Nuclear Safeguards
  - Fundamental Concepts of Safeguards
  - Role of Inspectors
- SNL International Nuclear Safeguards Cooperation
  - Bilateral Cooperation with Latin America, East Asia and Europe
  - Support to IAEA
- Conclusion

International Atomic Energy Agency

- Independent inter-governmental organization

- Established: 1957
  - President Eisenhower's "Atoms for Peace" initiative in 1954

- 167 Member States (As of November 2015)

United Nations, 1957
Source: IAEA Image Bank

IAEA Vienna International Center
Source: IAEA Image Bank

SAND: 2012-5948P

International Atomic Energy Agency

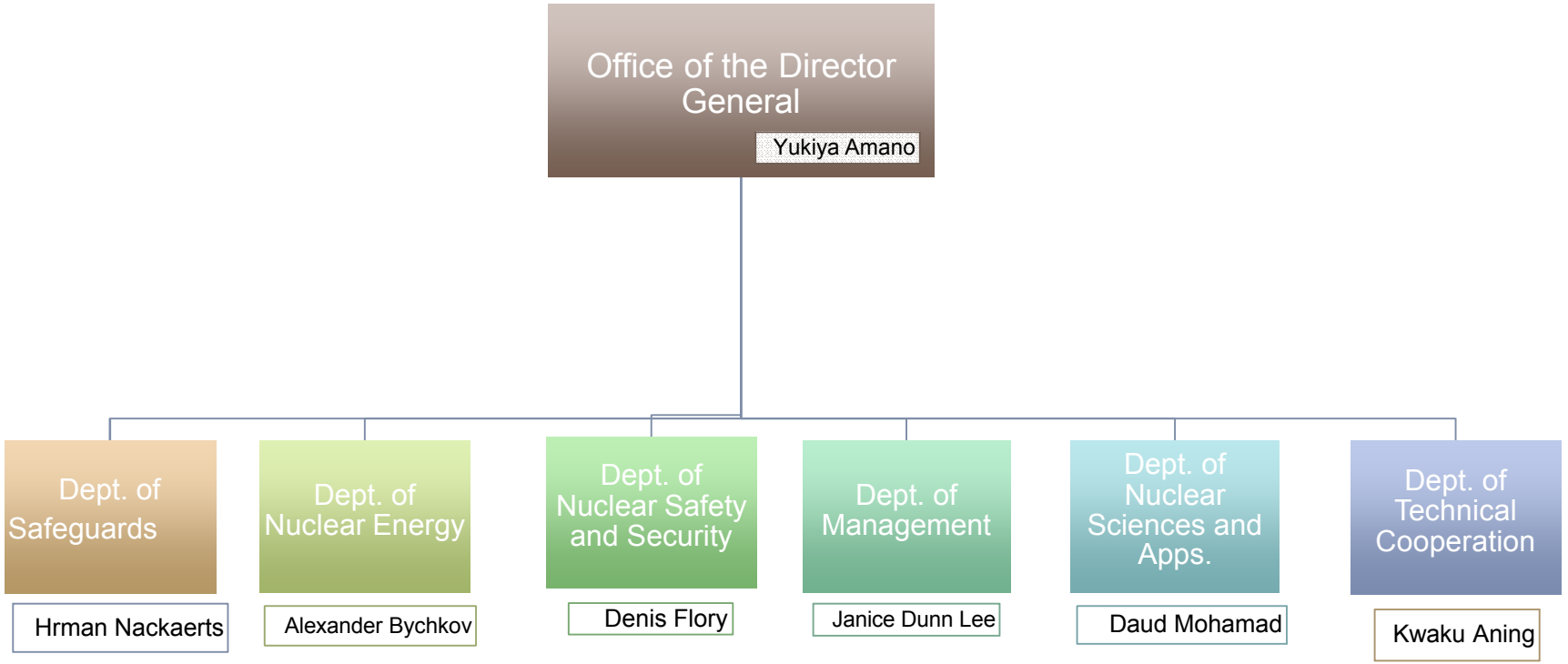
- IAEA: Semi-autonomous body of United Nations

- Unique relationship with the UN Security Council
  - *The Agency shall report to the Security Council and the General Assembly any case of noncompliance…*

IAEA Director General Yukiya Amano
Source: IAEA Image Bank, Dean Calma

UN Secretary General Ban Ki-moon
Source: IAEA Image Bank, Dean Calma

Department of Safeguards: One of six IAEA Departments



SAND:

IAEA Safeguards: The Statute (1)

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- ARTICLE II: Objectives
  - …It shall ensure, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose.

- ARTICLE III: Functions
  - A. The Agency is authorized:
    - 5. To establish and administer safeguards designed to ensure that special fissionable and other materials, services, equipment, facilities and information made available by the Agency…are not used…to further any military purpose…and to apply safeguards, at the request of the parties…to any of that State's activities in the field of atomic energy…

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NPT Safeguards: Goals and Methods

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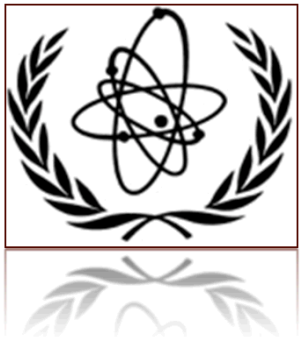
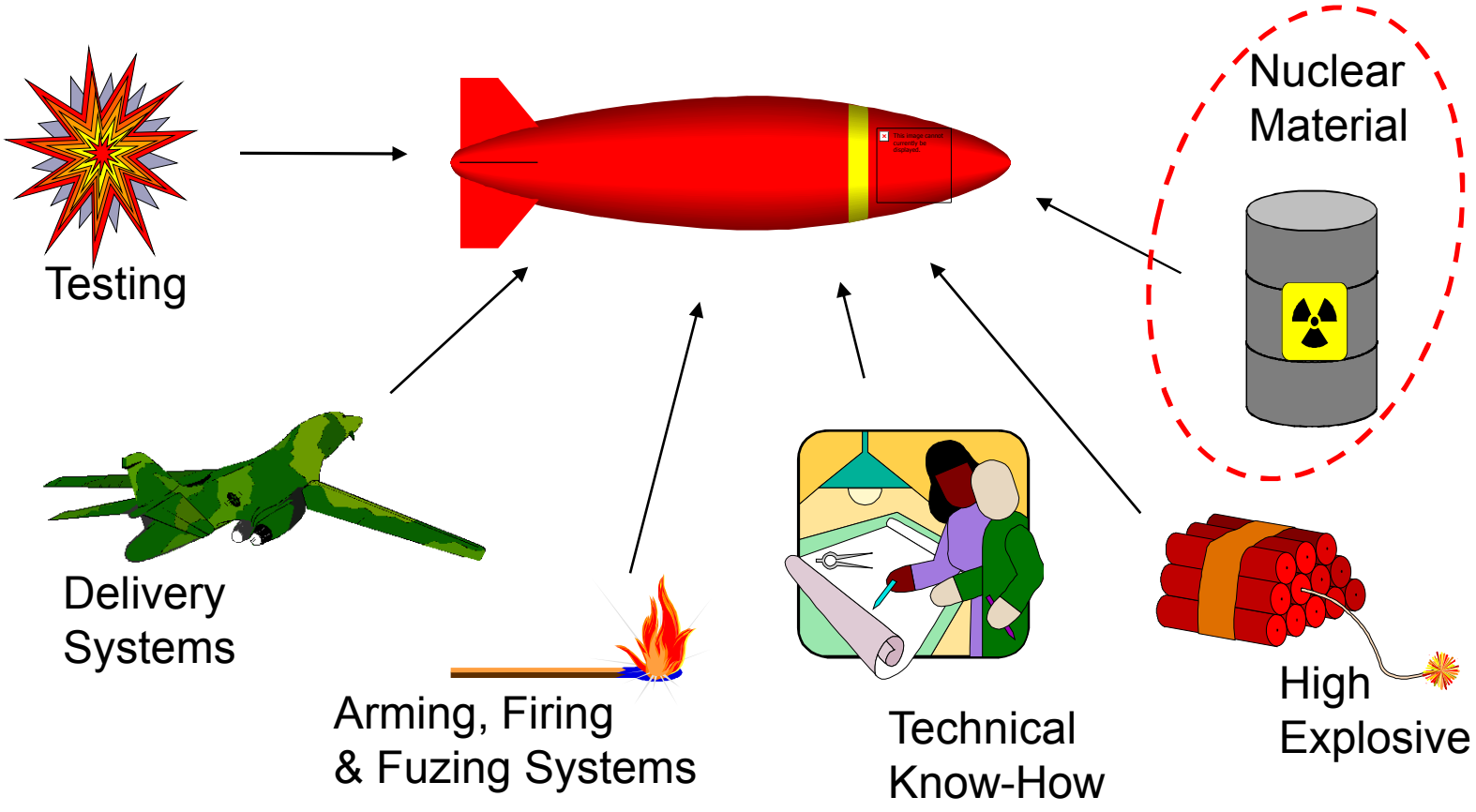
- Article III: Safeguards
  - Each non-nuclear weapons state (NNWS) undertakes to accept safeguards, as set forth in an agreement… with the [IAEA]…with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons…
- Article IV: Peaceful Nuclear Technology
  - Carrot: Right to peaceful uses of nuclear energy, equipment, materials and scientific/technological information
  - NNWS reward for accepting safeguards

What are nuclear safeguards?

Safeguards provide assurance that nuclear materials are properly protected, controlled, accounted for and used for peaceful purposes.



International nuclear safeguards play an essential role to help ensure that nuclear materials are not used to make weapons.



Note: Here "safeguards" are <u>not</u> the same as nuclear safety.

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Objective of NPT Safeguards

- "The purpose of the safeguards system of the IAEA is to provide credible assurance to the international community that nuclear material and other specified items are not diverted from peaceful nuclear uses."

IAEA inspectors conducting a physical inventory verification.
Source: IAEA/Dean Calma

- "Provide credible assurance regarding the non-diversion of declared nuclear material from peaceful activities **and** the absence of undeclared material and activities for a State as a whole."

Source: The Safeguards System of the IAEA
http://www.iaea.org/OurWork/SV/Safeguards/documents/safeg_system.pdf

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Elements of Nuclear Safeguards

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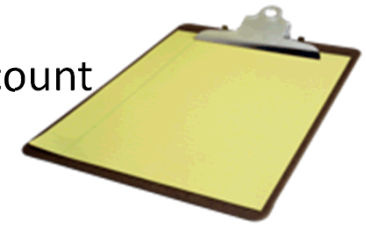
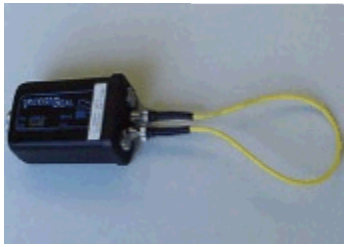


- **Nuclear Material Accountancy:** IAEA Member States must record, account for and report on the location and quantity of nuclear material under their control.

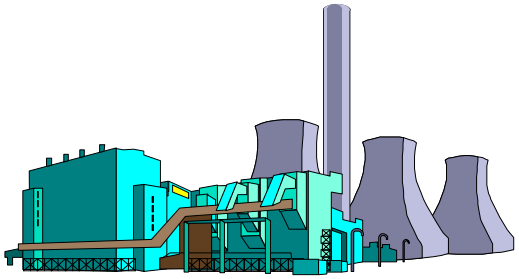


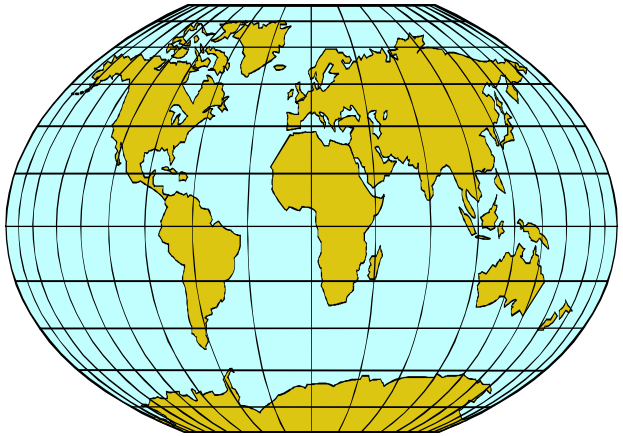
- **Containment:** Using techniques such as tamper indicating seals to prevent undetected movement of materials.

- **Surveillance:** Using cameras and other monitoring devices to detect undeclared activities.

- **Inspection:** Onsite verification by IAEA inspectors of declared information on reports, records and measurements of nuclear materials.

In general, nuclear safeguards exist on different levels, each with different motivations.





- Facility operator

  needs to protect valuable assets, ensure safety, and assure higher-level authorities that nuclear materials are being used properly, while still being able to conduct business

- National authority

  needs to exercise control over facilities, regulate transport, and provide information to regional or international authority

- Regional and/or International authority

  needs to assure other countries that nuclear material is properly protected, controlled, and used appropriately

Source: Slide adapted from INMM International Nuclear Safeguards Tutorial www.inmm.org

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Fundamental Concepts of Safeguards

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- ...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 risk of early detection.
- …use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.
- …the Agency…may…verify the design information [of a facility]
  - - Paragraphs 28, 29 and 48 of model comprehensive safeguards agreement (INFCIRC/153)

Significant Quantity (SQ)
= 25 kg (55lbs) of HEU

8 kg (18lbs) of Pu

Material Accountancy

- IAEA inspects nuclear materials in facilities to independently verify the State's declared nuclear material quantities and locations by:
  - Auditing accounting and operating records
  - Updating the nuclear material book inventory
  - Verifying facility inventory and inventory change
  - Removing, inspecting and replacing seals

IAEA safeguards inspectors at Mochovce nuclear power plant.
Image Source: www.IAEA.org

Containment and Surveillance (C/S)

- Safeguards relies heavily on maintaining "Continuity of Knowledge"
- C/S technologies indicate tampering with nuclear materials, safeguards equipment or processes
- Technologies include:
  - Seals: Essential to information security.
  - Tags: Essential to information security.
  - Surveillance Cameras: Essential to information security.

An IAEA inspector shows broken seals salvaged from DPRK (Vienna, Austria, 2003)
Source: IAEA/Kirstie Hansen

Cameras in their secure housings used for remote monitoring of nuclear sites.
Source: IAEA/Dean Calma

Design Information Verification (DIV)

- Carried out by IAEA at a facility to verify correctness/ completeness of design information provided by State.
- Initial DIV performed on newly built facilities to confirm as-built facility is as declared.
- Performed periodically on existing facilities to confirm continued validity of design information and of safeguards approach.
- IAEA's authority for performing a DIV is a continuing right throughout all phases of a facility's life cycle until the facility has been decommissioned for safeguards purposes

Source: URENCO

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Role of Inspectors

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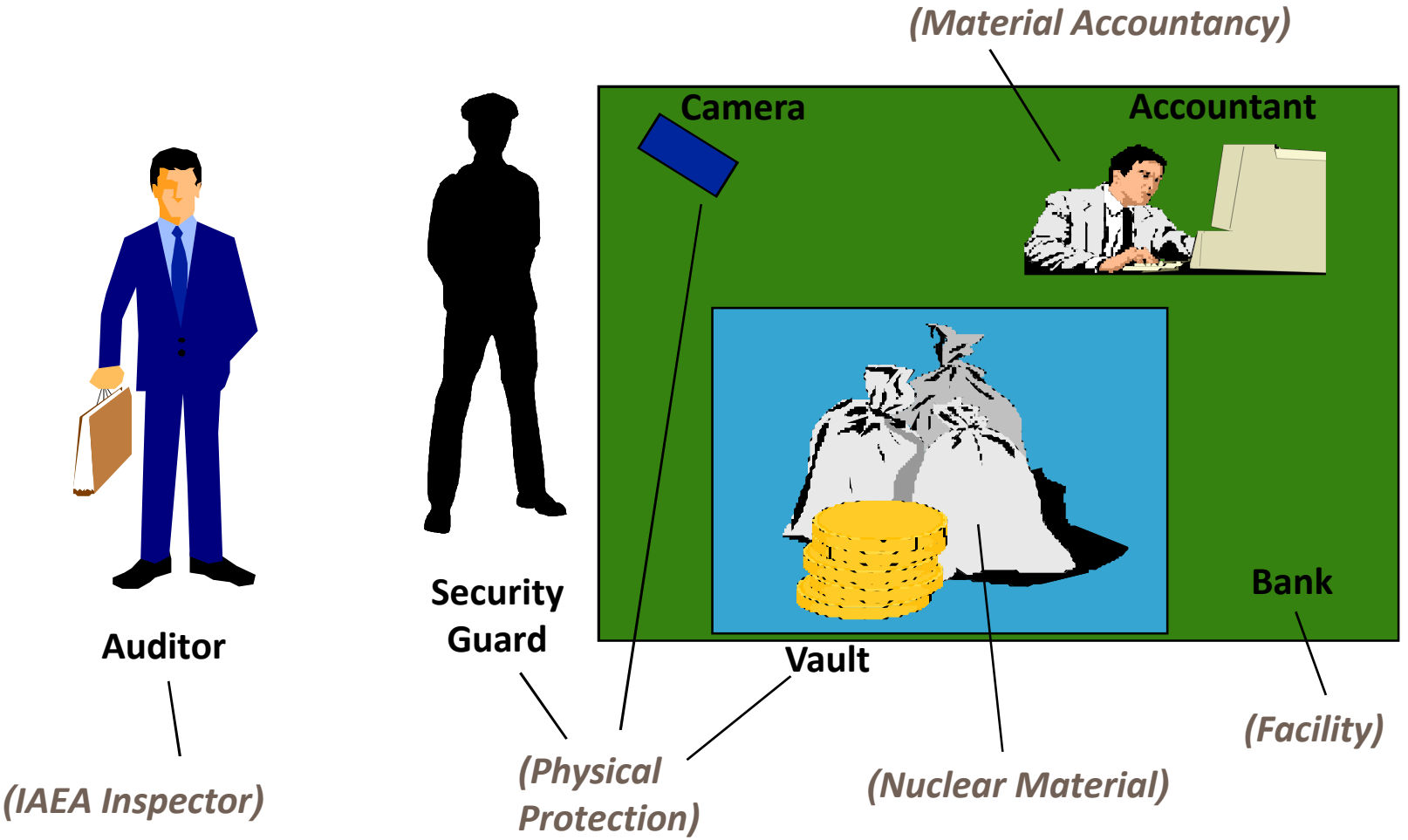
- audit facility bookkeeping records
- determine stratification & sampling
- verify inventory of materials
- perform nondestructive assay measurements
- service containment & surveillance equipment
- take samples for destructive analysis
- take environmental samples where permitted
- perform design information verification (DIV)
- request short-notice access to any building on a site
- observe facility and site operations

- compare state and operator declarations with observations and independently obtained data
- compare state declaration against all known information about the facility and site
- write reports & documentation
- travel
- other
  - negotiate facility attachments
  - assist in development of new measurements
  - train other inspectors

Traditional international nuclear safeguards resemble the auditing function in banking:



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SNL Expertise in Critical Aspects of International Safeguards

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- **Equipment and Information Security**
  - Safeguards authorities must be able to trust the information it collects and ensure it is suitably protected.
  - Key elements: authentication, encryption, tamper indication and system design
- **Remote and Unattended Monitoring**
  - IAEA increasingly relies on information collected by unattended safeguards instruments at facilities worldwide
  - With proper security, much of the information can be communicated to the IAEA remotely by internet, satellite, or telephone
- **Vulnerability Assessments (VA)**
  - Before technologies and systems can be certified for routine Safeguards use, they must survive rigorous independent testing
- **Containment and Surveillance (C/S) technologies**
  - Safeguards relies heavily on maintaining "Continuity of Knowledge"
  - C/S technologies indicate tampering with nuclear materials or processes

SNL Contributions to International Safeguards (continued)

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- **Geological Repository Safeguards**
  - C/S methods: Essential to the safeguards approach for geological repositories!
  - Seismic detection, satellite imagery and other technologies can assure the integrity of a repository isolation zone
  - Challenges: unique canister i.d., long term information management
  - SNL experience: Waste Isolation Pilot Plant (WIPP) and Yucca Mountain repositories

- **Onsite Inspection and Managed Access**
  - Readiness procedures and host/inspector training

- **Other**
  - Extensive science and engineering base: Subject matter expertise for a variety of disciplines relevant to Safeguards, including chemical analysis, materials science, cryptography, cybersecurity and many others

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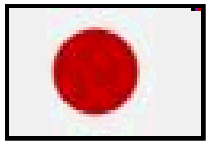
South America Cooperation

- **Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC)**
  - AS-23 (ongoing) Support for inspector training in C/S measures.
  - AS-18 (pending) Develop and deliver a video surveillance system to support unannounced inspection.

- **Autoridad Regulatoria Nuclear (ARN)**
  - AS-11 (complete) Secure communications for nuclear regulatory network; further potential collaboration under discussion
  - AS-18 (pending) New applications for Spent Fuel C/S

- **Comissão Nacional de Energia Nuclear (CNEN)**
  - AS-17 (complete) Help CNEN with secure data communications (2008 - 2010)
  - AS-22 (complete) Assessment of antineutrino monitoring of reactors for safeguards (2012 - 2013)

East Asia Cooperation



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- **Japan**
  - Japan Atomic Energy Agency (JAEA)
  - Upcoming: Training on Containment and Surveillance (C/S)
  - PAS16 (complete) Information Sharing Framework for Regional Nonproliferation Cooperation (2011 – 2013)
  - AS-65 (complete) Regional cooperation in remote monitoring: a secure link between SNL and Joyo was established, upgraded, and maintained (2004-2007)

- **Republic of Korea**
  - Korea Atomic Energy Research Institute (KAERI) and Korea Institute of Nuclear Nonproliferation and Control (KINAC)
  - AS41 (complete) Safeguards for Dry Storage and Repositories (2013 – 2015)
  - AS26 (complete) Information Sharing Framework for Regional Nonproliferation Cooperation (2011 – 2013)
  - AS-12 (complete) Regional cooperation in remote monitoring: secure link between SNL, Idaho National Laboratory, and KAERI was established (2003-2006)

European Cooperation



- **Euratom**
  - AS-41 Enhanced Data Authenticity – Demonstrate authentication of branching operator process instrumentation to meet implementation requirements. (2011 – present)
  - AS-20 (complete) Wireless Data Collection – tested the security of various communication links in collaboration with the European Joint Research Centre (JRC)
  - AS-30 (complete) SNL and JRC comparing and testing 3D sensing technologies for application to Safeguards
- **France**
  - SNL Regional Lead for U.S. National Laboratory Complex engagement with with France on international nuclear safeguards.
  - Separate agreements with the Commissariat à l'Énergie Atomique (CEA) and the Institut de Radioprotection et de Sûreté Nucléaire (IRSN)
- **Germany**
  - SNL Regional Lead for U.S. National Laboratory Complex engagement with with Germany on international nuclear safeguards.
  - AS1 Lifecycle Challenges of Electronic Optical Sealing System (EOSS) (2014 – present)

European Cooperation Continued

- European Safeguards Research and Development Association (ESARDA)
  - Member of ESARDA working groups: C/S, Safeguards Implementation, Verification Technologies & Methodologies
  - Attendance and contribute papers at annual meetings of ESARDA

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Direct support to IAEA Department of Safeguards: Supplementing Regular Budget

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- IAEA relies on extra-budgetary contributions from Member State Support Programs (MSSP)
  - The MSSPs do not conduct routine Agency business
  - Typically for specialized tasks and technology development
  - Cost-free experts are supplemental staff

- U.S. Program of Technical Assistance to IAEA Safeguards (POTAS)
  - Oversight: U.S. government interagency committee:
    - Subgroup on Safeguards Technical Support (SSTS)
    - Members include DOE and other U.S. agencies (NRC, DOS, DOD)
  - Administration done by International Safeguards Project Office (ISPO) at Brookhaven National Laboratory
  - Funding provided by the U.S. Department of State
  - Technical support provided by government, contractor, and commercial providers

POTAS-Funded Support to IAEA: Response to IAEA Requests

- Each POTAS task -- formal process:
  - IAEA issues an "SP-1" request for proposal
  - ISPO relays request to potential technical organizations
    - U.S. National Laboratories
    - Commercial providers
  - If appropriate, SNL will assemble a team to develop/submit a proposal
  - ISPO, IAEA and the SSTS review and decide on a proposal to accept

If SNL's proposal is accepted:

  - Work for Others Interagency Agreement established
  - Project is funded/started
  - Capsule summary of each active task is reported to ISPO quarterly; a financial status update provided monthly

Remotely Monitored Sealing Array (RMSA)

- Active loop seal for IAEA Safeguards application
  - Seal integrity and status reported via authenticated/encrypted wireless transmission to a central "translator"
  - Seals units are optimized for low power consumption and last 4-5 years on battery without replacement
  - Plastic fiber optic seal cable is easy to install and terminate
  - Incorporates advanced tamper indication and communications capabilities
  - Low life-cycle cost

- Task is coordinated jointly with Canberra (manufacturer)
- SNL Principal Investigators:
  - Ross Hymel
  - Maikael Thomas

RMSA pre-production prototype

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Conclusion

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- International nuclear safeguards = key component of NPT regime
- Primary objective: Prevent diversion of nuclear materials to weapons through accountancy, protection, C/S and control.

- Bilateral cooperation strengthens international safeguards
  - Leverages the development of safeguards technologies and systems
  - Demonstrates technologies of potential interest to the IAEA
  - Transfers safeguards skills to bilateral partners
  - Maintains direct technical contact with the international safeguards community

- Direct support of the IAEA through POTAS promotes improved implementation of safeguards
  - Responds to IAEA needs on specific technologies
  - Stimulates growth of the IAEA technical base

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Questions?