

IAEA Safeguards: Background, Tools, & Opportunities

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a passion for discovery





International Atomic Energy Agency

- Established in 1957, following President Eisenhower's "Atoms for Peace"
- U.N. system organization
 171 member countries
- Headquarters located in Vienna, Austria





Nobel Peace Prize for 2005 to IAEA and its Director General



International Atomic Energy Agency

Mission:



1) Promote the peaceful uses of nuclear technology

2) Promote a nuclear safety culture

3) Verify that nuclear material is being used exclusively for peaceful purposes



INTERNATIONAL ATOMIC ENERGY AGENCY





Department of Safeguards

Ensuring that nuclear material is not diverted from peaceful nuclear activities by confirming the <u>correctness</u> and <u>completeness</u> of Member State declarations

"Effective IAEA safeguards remains the cornerstone of the world's nuclear non-proliferation regime aimed at stemming the spread of nuclear weapons and moving towards nuclear disarmament."

- Olli Heinonen, Former Deputy Director General





Treaty on the Nonproliferation of Nuclear Weapons (NPT)

Non-Nuclear Weapons States	Nuclear Weapons States
Commit to nonproliferation	No transfer of technology to NNWS
Conclude an agreement with the IAEA for the application of Safeguards	Work towards disarmament



What does the Dept of Safeguards Do?

- Receive States' declarations
- Perform inspections
 Collect inspection data on materials and facilities)



- Compare inspection data to State declarations
- Search for undeclared activities (open source information, satellite imagery, environmental sampling)



Civilian (Power Generation) and Defense Nuclear Fuel Cycles



Safeguards Inspections - Facilities

Enrichment Plants





Safeguards Inspections - Facilities

- Power Reactors
- Research Reactors



NATIONAL LABORATORY

Safeguards Inspections - Facilities

Reprocessing Plants





Traditional international safeguards resembled auditing in banking



14

(Material Accountancy)

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Nuclear Materials Accountancy



Material Balance:

(Beginning Inventory) + (In) - (Out) = (Ending Inventory)

Any apparent difference is termed "Material Unaccounted For" (MUF):
 MUF = (Beginning Inventory) + (In) - (Out) - (Ending Inventory)
 Note: MUF>0 does *not* necessarily mean that material has been lost!

Nuclear Material Accountancy How is accounting verified?

- State Declaration: State reports nuclear materials inventory and transactions (receipts, shipments, in-process)
- **IAEA inspections:** to verify the State declaration
 - examine operator records and reports
 - identify and count items
 - sample and assay nuclear materials
 - destructive analysis
 - non-destructive analysis
- Containment and surveillance measures: complement material accountancy
 - seals
 - cameras



Tools and Techniques

- Destructive Analysis
- Nondestructive Analysis
- Containment and Surveillance
- Environmental Sampling
- Open Source Information Collection and Analysis



Destructive Analysis (DA)

- Quantitative methods for determining elemental composition, elemental assay, or isotopic composition of a sample
- All or part of the sample is consumed in analysis
 - Sample cannot be recovered (eg. it is volatilized)
- Sample is irreversibly altered
 - Dissolved
 - Radiochemically purified
- Does not necessarily mean important sample attributes are destroyed
 - Analyte separated from matrix, but preserved





Nuclear Material Laboratory (NML)

Groundbreaking



7 September 2011





Inauguration

23 September 2013



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Detection of gamma radiation is used in a variety of nuclear material measurements













Gamma Ray Spectroscopy -Detectors

Sodium lodide (scintillator) – short count times (efficient), low resolution

Germanium (semi conductor) – large crystals, excellent resolution

- required a dewar of liquid nitrogen
- now electronically cooled versions



Cadmium Zinc Telluride (semi conductor) – Small size, good resolution, room temperatur expensive



Detector Resolution



FIG.1. Comparison of high- and low-resolution gamma spectra.



22

Passive Non-Destructive Analysis (NDA)

- Most nuclear materials emit alpha particles, which then react locally to produce (single) neutrons
- Plutonium also fissions spontaneously, so it can simultaneously release *multiple* neutrons
- Coincidence counting identifies this fission neutron signal to assay plutonium



High Level Neutron Coincidence Counter



Calorimetry



- Used to measure heat from decay
- Used to measure Pu and tritium in large quantities
- Very precise
- Long measurement times



Spent Fuel Measurements – Cerenkov Viewing Device







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Spent Fuel Measurements – Fork Detector



- Measures neutron and gamma activity
- Made for BWR, PWR and VVER fuel



Containment and Surveillance

Continuity of Knowledge

- When inspectors are not present at the facility
- Tamper Indicating Seals
- Surveillance Systems



Tamper Indicating Devices

Passive - Metal Seal





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Active - Remote Monitored Sealing Array



Surveillance



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Attended and Unattended Monitoring

Attended:

- portable instrumentation that is used during inspections to take measurements (e.g., multi-channel analyzer)
- Large instruments that are installed in the facility but require inspector presence for operation (Fork detector)
- Unattended
 - Instrumentation that is installed in the field for continuous operation (e.g., radiation monitors, containment/surveillance equipment)
 - Integrated into systems that are capable of storing data
 - Provide the opportunity for remote monitoring



Environmental Sampling

- Primary means for detecting clandestine or undeclared nuclear activities
- Inspectors collect samples
- Aamples are evaluated, separated, archived and distributed for analysis
- Analysis conducted by the Network of Analytical Laboratories



Sampling Kit



IAEA Clean Laboratory at the Seibersdorf Analytical Lab



Environmental Sampling



Sampling Kit

Seibersdorf Analytical Lab



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32

Open Source Information Collection and Analysis

- Uses all unclassified sources of information
 - Newspapers
 - Internet
 - Scientific publications
- Important means of detecting undeclared activities
- Information systems collect, analyze and organize information
- Compared to declarations and data collected in the field to draw conclusions

Natanz Enrichment Facility (Iran)



20 September 2002



29 February 2004

Open Source Information Collection and Analysis Commercial Satellite Imagery

- Provides ability to perform broad area searches in instances where exact location information may not exist – but this is difficult
- High resolution permits detailed analysis of facility infrastructure
- Change detection detect even subtle changes in suspect facility





20 September 2002

29 February 2004 Natanz Enrichment Facility (Iran)





Interested in learning more?

BNL's Safeguards Textbook

Deterring Nuclear Proliferation: The Important of IAEA Safeguards

by Michael D. Rosenthal

Available for download, free, from – https://www.bnl.gov/NNS/IAEAtextbook.php



Opportunities in IAEA Safeguards

IAEA:

- Regular staff positions
- Cost Free Experts
- Junior Professional Officers







- JPOs are entry-level employees that obtain professional experience while performing essential safeguards duties
- > Two to three year assignments
- Assignments are based on official IAEA requests that are advertised on the ISPO website

www.bnl.gov/ispo





Objectives

Introduce a new generation to international civil service and the nuclear industry

 Create entry level positions for students and recent graduates to obtain work experience
 Stepping stone to regular staff or temporary assignments with the IAEA and positions in the U.S. national laboratories and government agencies

> Assist IAEA with basic yet essential work



Specific JPO Requirements

- U.S. citizens or permanent resident aliens
- Degree in relevant field
- 0-2 years work experience
- Less than 32 years of age
- Availability for at least one year
- Ability to work independently



Living and Working in Vienna

- Vienna is a culturally rich city
- Very safe Low crime
- Working language is English
- Excellent public transportation
- Maintain American citizenship





Information on JPO Positions

- Website of the International Safeguards Project Office (ISPO)
 - > www.bnl.gov/ispo
 - Sign up for job alerts be informed when new jobs open
 - Get assistance in strengthening your application



Opportunities in the United States

- > Internships
- Short courses
- Graduate Fellowships





<u>Internships</u>

- Available through all DOE national laboratories
 Undergraduate and graduate
- All areas of research, including safeguards
- > At BNL
 - Stipends and housing provided
 - Participation in Intern Symposium
 - Publications possible





Tuition-Free Short Courses

- Nuclear Nonproliferation, Safeguards and Security in the 21st Century
 - Conducted at BNL
 - Delivered by internationally-recognized experts
 - For graduate students in technical and policy programs
 - Housing and need-based stipend provided
 - Find information at <u>https://www.bnl.gov/nnsscourse/</u>

➤ 2020 Course will be held virtually August 3-14





Nonproliferation Graduate Fellowships

- Sponsored by National Nuclear Security Administration
- Managed by Pacific Northwest National Laboratory
- Assignments available in multiple U.S. government agencies
- For students or recent graduates in engineering, science, nuclear nonproliferation, international affairs, security, emergency operations, and other related disciplines
- Highly competitive; highly respected
- Excellent entree into U.S. government service
- Find information at https://nnsa.energy.gov/federalemployment/ourjobs/graduateprogram





Thank You!

Questions?



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46