LA-UR-17-28420
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Title:	Non-Proliferation, the IAEA Safeguards System, and the importance of nuclear material measurements
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Intended for:	Training Course
Issued:	2017-09-18

National Nuclear Security Administration

OFFICE OF
NONPROLIFERATION AND
ARMS CONTROL (NPAC)

Non-Proliferation, the IAEA Safeguards System, and the Importance of Nuclear Material Measurements

Fundamentals of Non-Destructive Assay for International Safeguards

Los Alamos National Laboratory
September 25, 2017

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Los Alamos National Laboratory
LA-UR-17-

Terminal Learning Objective

- Explain the contribution of nuclear material measurements to the system of international verification of State declarations and the non-proliferation of nuclear weapons

Enabling Learning Objectives

- Summarize the primary objective of nuclear non-proliferation
- List the main treaties and agreements that make up the legal framework for international safeguards
- Describe the international safeguards system and the importance of independent verification of nuclear material declarations
- Given the essential need for independent verification, explain the importance of nuclear material measurements

Historical Context

1945 First test of a nuclear weapon

1946 Baruch Plan/ Soviet Response

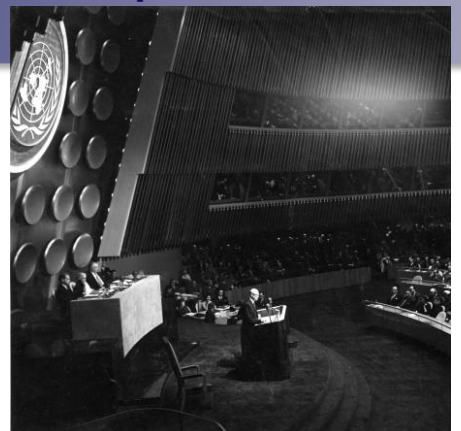
1949 Soviet Union tests nuclear weapon

1953 Atoms for Peace Speech

1957 IAEA Created

1970 NPT enters into Force

First Soviet nuclear test, Joe 1, Semipalatinsk Test Site, 1949.



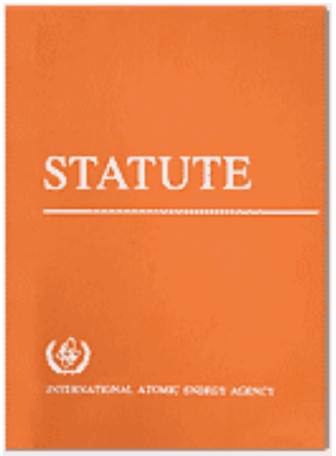
Legal Framework for Safeguards

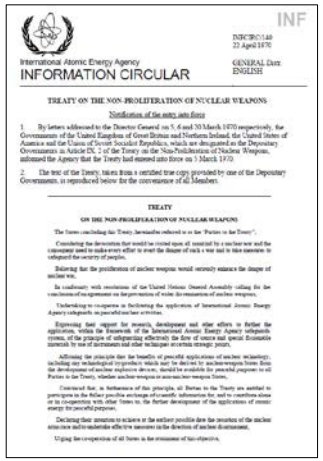
- Non-proliferation Treaty (NPT):

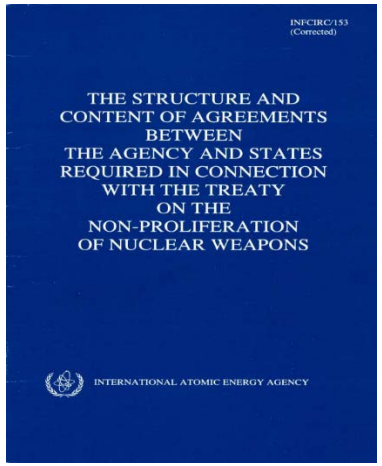
Each Non-nuclear-weapon State Party to the Treaty **undertakes to accept safeguards** […], for the exclusive purpose of verification of the fulfilment of its obligations assumed under this Treaty […]

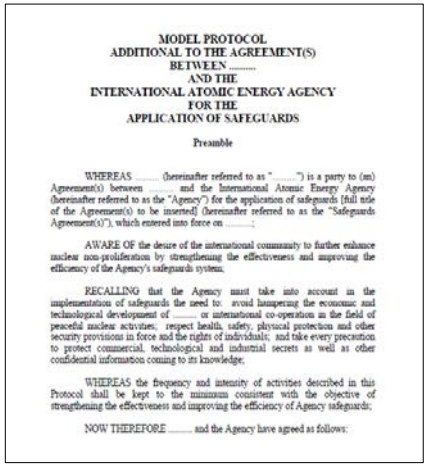
- Comprehensive Safeguards Agreement (CSA):

[…] Agency's right and obligation to ensure that safeguards will be applied **on all source or special fissionable material in all peaceful nuclear activities** within the territory of the State, 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.**









State's Undertaking and the Agency's Right and Obligation

State – Accept safeguards **on all source or special fissionable material** in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere …

INFCIRC/153 (Corr.), para 1

IAEA – Ensure that safeguards are applied **on all source or special fissionable material** in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere …

INFCIRC/153 (Corr.), para 2

CSA: Rights and Obligations

State

- Cooperate with the IAEA
- Establish a State system for accounting and control of nuclear material – an **SSAC**
- Provide **information** to the IAEA
- Provide **access** to IAEA inspectors

IAEA

- Cooperate with the State
- Maintain confidentiality of information
- Conduct independent measurements and observations
- Take account of technological developments

OFFICE OF NONPROLIFERATION AND ARMS CONTROL (NPAC)

INTERNATIONAL NUCLEAR SAFEGUARDS

Department of Safeguards

IAEA SAFEGUARDS 2015

ENSURING THE PEACEFUL USE OF ALL NUCLEAR MATERIAL

I. OUR MANDATE

OUR LEGAL FRAMEWORK

182 states with safeguards agreements + 127 additional protocols

OUR COVERAGE

200,110 significant quantities of nuclear material

1,286 nuclear facilities and locations outside facilities

II. OUR VERIFICATION PROCESS

1. COLLECT AND EVALUATE

785,085 nuclear material reports

40,408 open source items

2. DEVELOP STATE-LEVEL APPROACHES

updated 6 state-level safeguards approaches

3. PLAN, CONDUCT AND EVALUATE

2,805 in-field verifications

967 nuclear samples

13,248 days in-field

23,300 seals

1,416 cameras

136 facilities with remote monitoring

4. DRAW CONCLUSIONS

181 conclusions
67 broader conclusions

III. OUR RESOURCES

OUR BUDGET

€132.5 million
+ €43.3 million extra budgetary

OUR WORKFORCE

883 staff and contractors from 96 countries

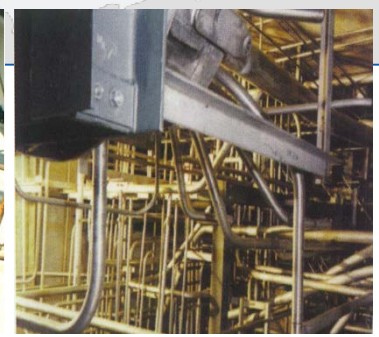
Primary Role: administer and implement IAEA Safeguards

Also contributes to nuclear arms control and disarmament

IAEA In-Field Verification Activities









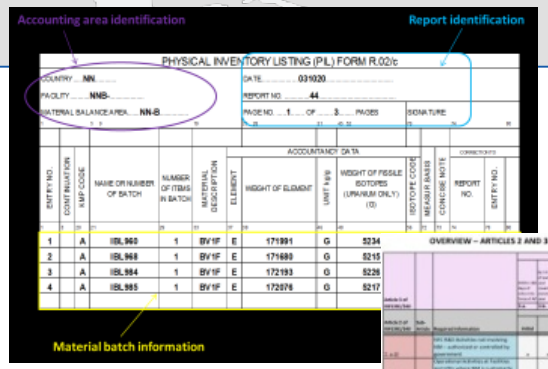

Design Information Verification

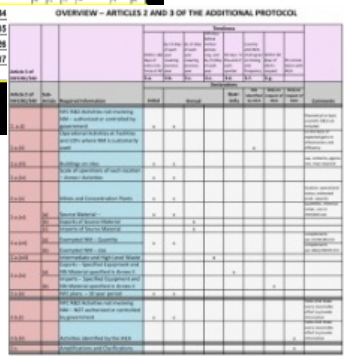
Inspections

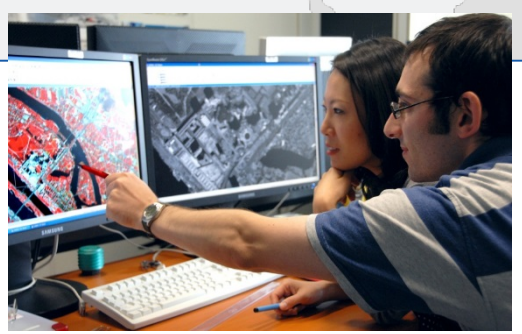


Complementary Access

IAEA Headquarters Activities



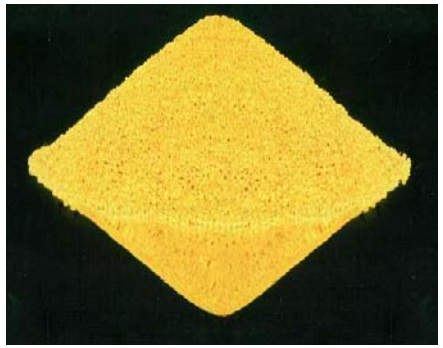




What is Nuclear Material?

Nuclear Material (NM):

- **Any source or any special fissionable material** as defined in Article XX of the Statute.
- **Source material** shall **not** be interpreted as applying to **ore or ore residue**.



Uranium (U)

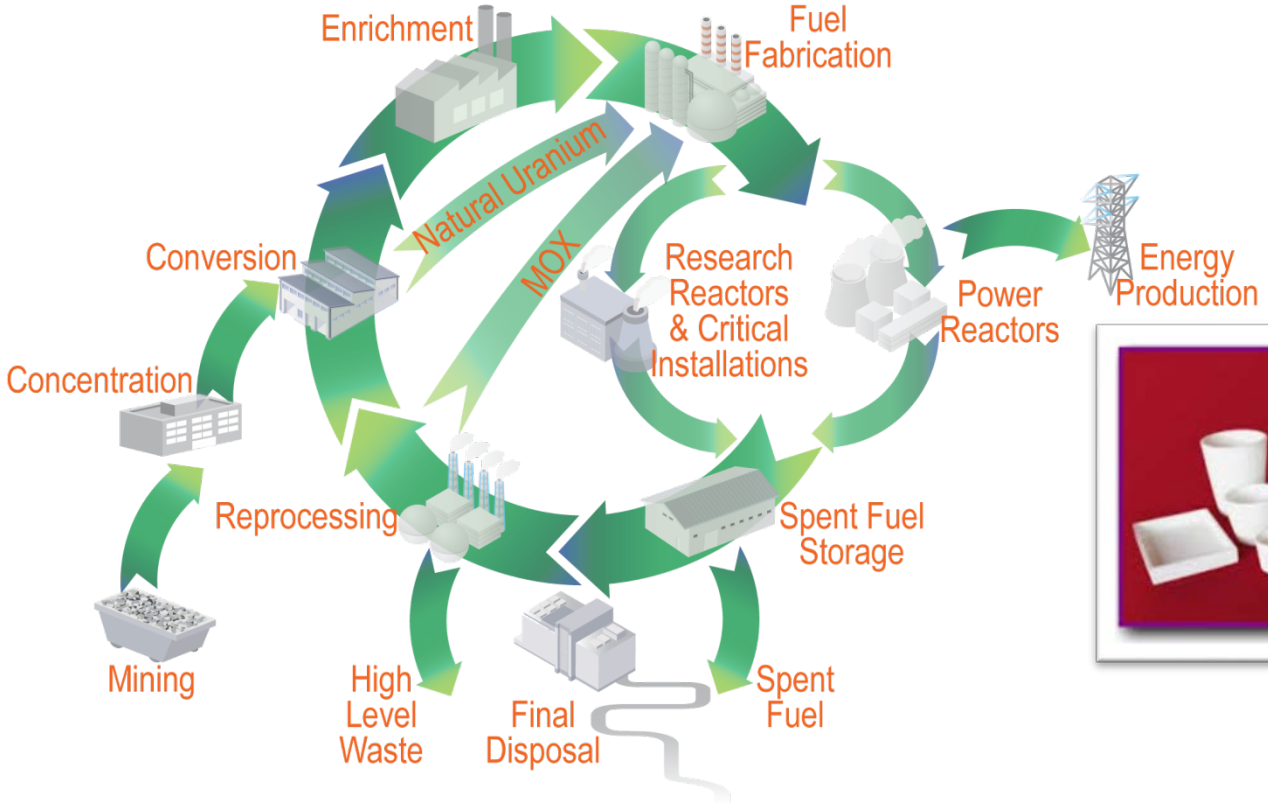
Plutonium (Pu)

Thorium (Th)

in any physical or chemical form and in any quantities *(except ore)*

Where do you find Nuclear Material?

In the Nuclear Fuel Cycle…



…And Non-Fuel Cycle applications

Why Measure Nuclear Material?

For Nuclear Material Accountancy:

- Facility operator
  - **Makes declaration for facility and provides to State Authority**
  - Needs to protect valuable assets, ensure safety, and assure higher-level authorities that nuclear materials are being used properly
- National and/or regional authority
  - **Reviews facility declaration and submits to IAEA**
  - Needs to exercise control over facilities, regulate transport, and provide information to regional or international authority
- International authority
  - **IAEA is responsible for verifying facility declaration**
  - Provides credible assurance to the international community that nuclear material and other specified items are not diverted from peaceful nuclear uses

How do you measure nuclear material?

- Destructive Analysis: determining isotopic content and mass through analysis of a sample of material
- Non-Destructive Analysis: exploit radiation signatures of NM to characterize and measure

Mass spectrometer for Isotopics

Precision scales for chemical analyses

Confirmatory NDA systems for isotopics

Summary

- Nuclear non-proliferation seeks to promote the peaceful uses of nuclear technology while preventing the spread of nuclear weapons.
- The application of international safeguards is an obligation under the Non-Proliferation Treaty
- International safeguards rely on the independent verification of declared values of nuclear materials