

LA-UR-17-28420

Approved for public release; distribution is unlimited.

Title: Non-Proliferation, the IAEA Safeguards System, and the importance of nuclear material measurements

Author(s): Stevens, Rebecca S.

Intended for: Training Course

Issued: 2017-09-18

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by the Los Alamos National Security, LLC for the National Nuclear Security Administration of the U.S. Department of Energy under contract DE-AC52-06NA25396. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.



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

Rebecca Stevens
Los Alamos National Laboratory
LA-UR-17-

-  **SAFEGUARD** NUCLEAR MATERIALS TO
PREVENT THEIR DIVERSION OR THEFT
-  **CONTROL** THE SPREAD OF WMD-RELATED
MATERIAL, EQUIPMENT AND TECHNOLOGY
-  **NEGOTIATE, MONITOR AND **VERIFY****
COMPLIANCE WITH INTERNATIONAL
NONPROLIFERATION AND ARMS CONTROL
TREATIES AND AGREEMENTS
-  **DEVELOP** PROGRAMS AND STRATEGIES TO
ADDRESS EMERGING NONPROLIFERATION
AND ARMS CONTROL THREATS AND
CHALLENGES



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

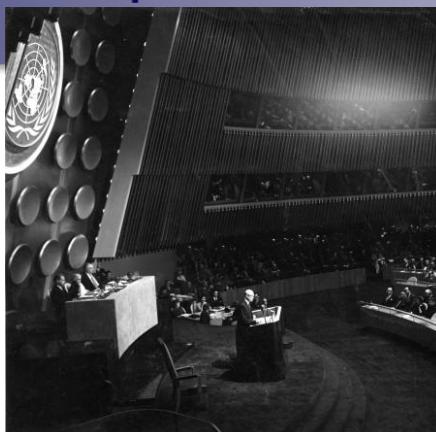


1949

Soviet
Union
tests
nuclear
weapon

1953

Atoms for
Peace
Speech



1957

IAEA
Created



1970

NPT
enters
into
Force



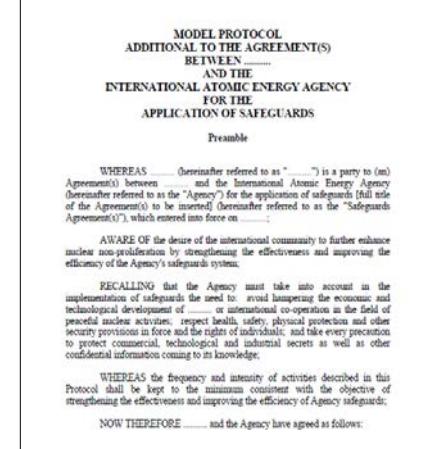
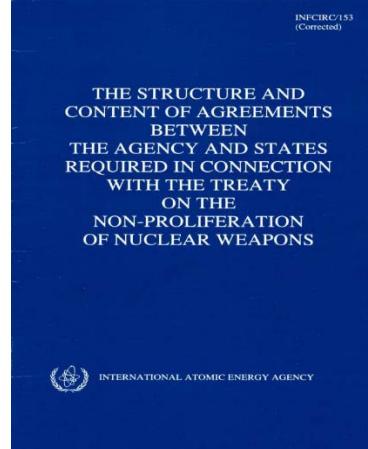
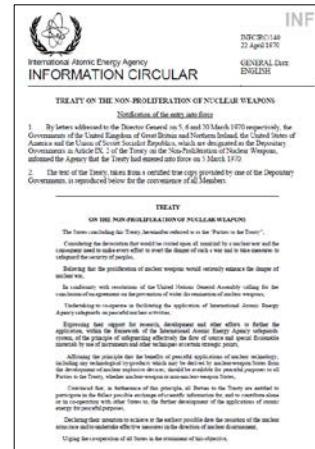
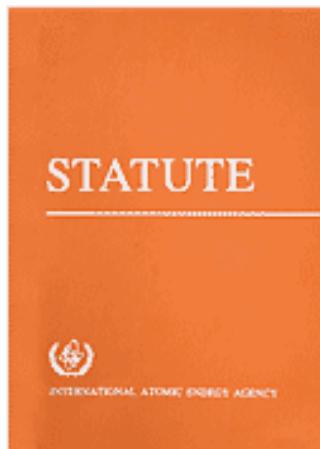
Legal Framework for Safeguards

• 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



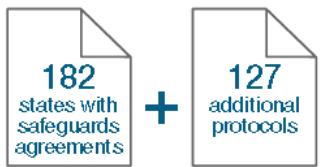
Department of Safeguards

IAEA SAFEGUARDS 2015

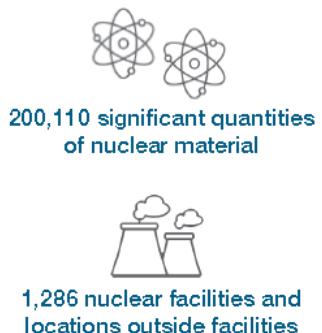
ENSURING THE PEACEFUL USE OF ALL NUCLEAR MATERIAL

I. OUR MANDATE

OUR LEGAL FRAMEWORK

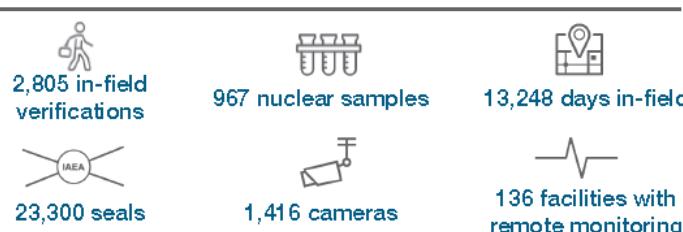
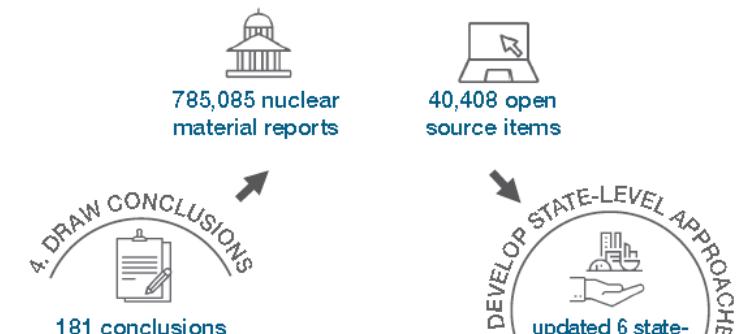


OUR COVERAGE



II. OUR VERIFICATION PROCESS

1. COLLECT AND EVALUATE



III. OUR RESOURCES

OUR BUDGET



OUR WORKFORCE



883 staff and contractors from 96 countries

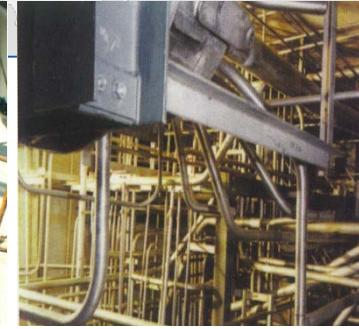


Primary Role:
administer and
implement IAEA
Safeguards

Also contributes to
nuclear arms control
and disarmament



IAEA In-Field Verification Activities



Inspections



Design
Information
Verification

Complementary Access



IAEA Headquarters Activities

Accounting area identification

Report identification

PHYSICAL INVENTORY LISTING (PIL) FORM R.02(c)

COUNTRY: NN
FACTORY: NNB
MATERIAL BALANCE AREA: NN-B

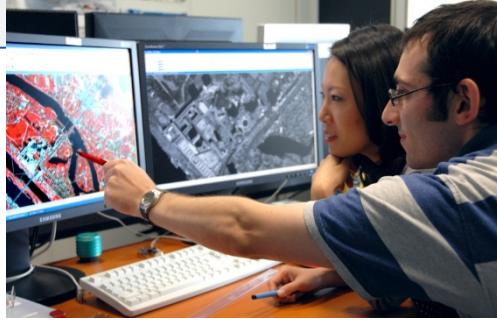
DATE: 03/03/2000
REPORT NO: 44
PAGE NO: 1 OF 8 PAGES
SIGNATURE:

ENTRY NO.	DESCRIPTION	ELEMENT	HEIGHT OF ELEMENT	UNIT OF MEASURE	WEIGHT OF PIECE ROTORIES (UPPERUM ONLY) (D)	ROTORY CODE	ROTORY NUMBER	ACCOUNTING DATA	
								NUMBER OF ITEMS IN BATCH	DESCRIPTION
1	A	IBL 960	1	BV 1P	E	171991	G	5234	
2	A	IBL 968	1	BV 1P	E	171989	G	5215	
3	A	IBL 964	1	BV 1P	E	172193	G	5226	
4	A	IBL 985	1	BV 1P	E	172098	G	5217	

OVERVIEW – ARTICLES 2 AND 3 OF THE ADDITIONAL PROTOCOL:

Material batch information

Category	Sub-Category	Item	Description	Value
Article 2	Article 2	1.1.1	IAEA Activities involving IAEA-authorized or identified by IAEA	Y
		1.1.2	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.3	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.4	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.5	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.6	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.7	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.8	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.9	Activities of IAEA-authorized or identified by IAEA	Y
		1.1.10	Activities of IAEA-authorized or identified by IAEA	Y
Article 3	Article 3	2.1.1	IAEA Activities involving IAEA-authorized or identified by IAEA	Y
		2.1.2	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.3	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.4	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.5	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.6	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.7	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.8	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.9	Activities of IAEA-authorized or identified by IAEA	Y
		2.1.10	Activities of IAEA-authorized or identified by IAEA	Y





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)



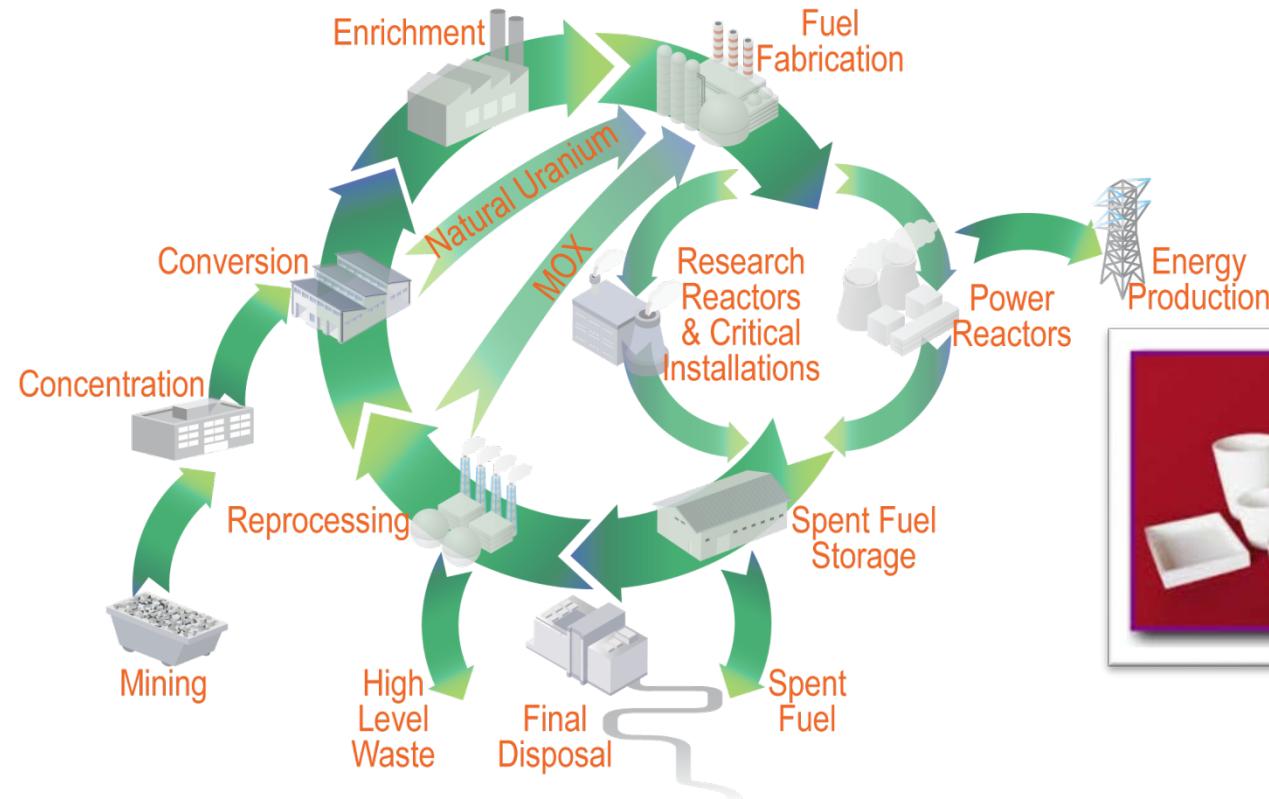
Thorium (Th)

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
Isotopes



Precision scales
for chemical
analyses



Confirmatory NDA systems
for isotopes



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