Inspection Activities

Jaime Vidaurre-Henry
International Consultant

Outline

- The IAEA
- The Department of Safeguards of the IAEA
- The IAEA Safeguards System
- Summary

The International Atomic Energy Agency

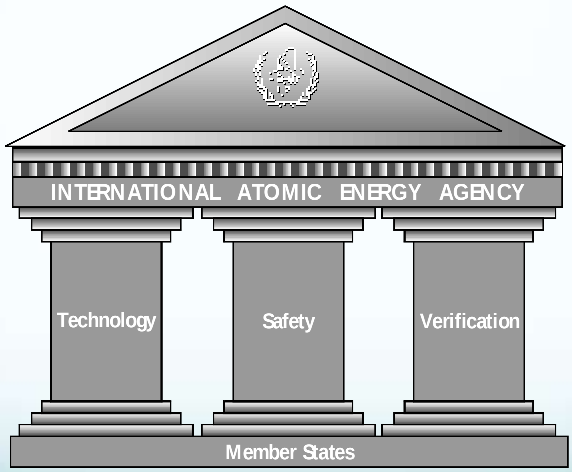
- Created in 1957
- Composed of
  - *Policy Making Organs*
    - Board of Governors (35 Members)
    - General Conference (154* States)

      *As of April 2012
  - *Secretariat*
    - 2338 Professionals and Support staff (2011)

The IAEA

- Independent intergovernmental, science and technology organization
- Within the United Nations system

The Three “Pillars” of the IAEA



Science and Technology

Assists Member States to mobilize peaceful applications of nuclear science and technology for critical needs in developing countries.

Safety and Security

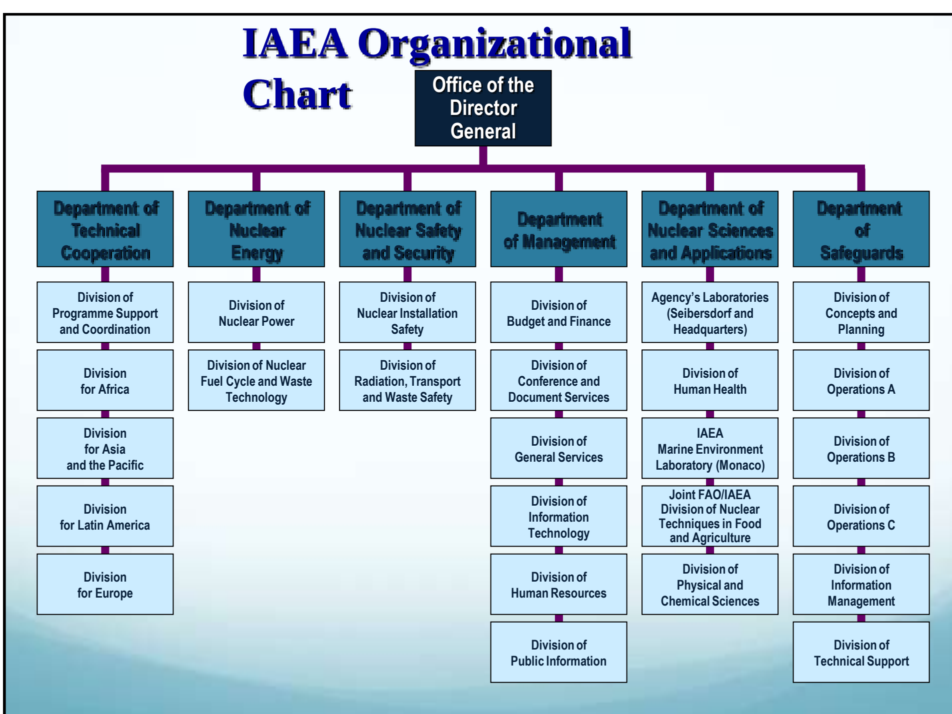
Deals with the protection of people and the environment against radiation exposure, while responding to the (nuclear) safety and security related needs of the Member States.

Verification and Safeguards

Verifies correctness of a State's declaration to provide meaningful assurance to the *non-diversion of declared nuclear material;* and

Verifies completeness of a State's declarations to provide credible assurance on the *absence of undeclared nuclear material and activities.*


Who is who at the IAEA
Y. Amano, Director General
Janice Dunn Lee, Head Department of management
Kwaku Aning Head, Department of Technical Cooperation
Daud Mohamad, Head, Department of Nuclear Sciences and Applications
Herman Nackaerts, Head, Department of Safeguards
Alexander Bychkov, Head Department of Nuclear Energy
Denis Flory, Head, Department of Nuclear Safety and Security


IAEA Organizational Chart
Office of the Director General
Department of Technical Cooperation
Division of Programme Support and Coordination
Division for Africa
Division for Asia and the Pacific
Division for Latin America
Division for Europe
Department of Nuclear Energy
Division of Nuclear Power
Division of Nuclear Fuel Cycle and Waste Technology
Department of Nuclear Safety and Security
Division of Nuclear Installation Safety
Division of Radiation, Transport and Waste Safety
Department of Management
Division of Budget and Finance
Division of Conference and Document Services
Division of General Services
Division of Information Technology
Division of Human Resources
Division of Public Information
Department of Nuclear Sciences and Applications
Agency's Laboratories (Seibersdorf and Headquarters)
Division of Human Health
IAEA Marine Environment Laboratory (Monaco)
Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture
Division of Physical and Chemical Sciences
Department of Safeguards
Division of Concepts and Planning
Division of Operations A
Division of Operations B
Division of Operations C
Division of Information Management
Division of Technical Support

The Department of Safeguards

Safeguards Implementation (as of Dec. 2011)

- 178 States with Safeguards Agreements in force (*)
  - 109 with Comprehensive Safeguards Agreements (CSA) and Additional Protocols (AP) in force (**)
    - 37 with amended SQP
    - 13 with “old” SQP
    - 59 without SQP
  - 61 with CSA only
    - 8 with amended SQP
    - 35 with “old” SQP
    - 18 without SQP
  - 3 with INFCIRC/66 Rev.2 Agreements
  - 5 with Voluntary offer agreements and AP in force

(*) Does not include DPRK

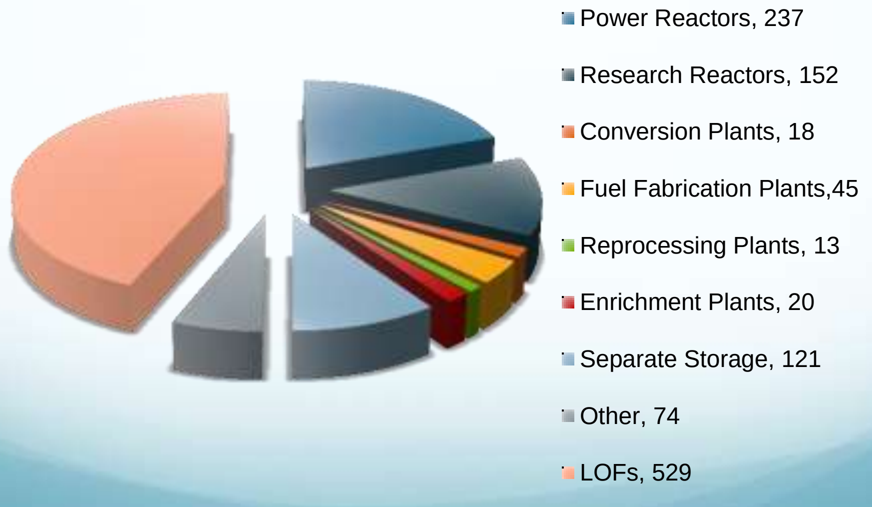
(**) And Taiwan, China

Safeguards in numbers

Budget	124.3 M US$
Inspections	2026
DIVs	604
Complementary Accesses	109
In-field verification days	11937
Total Staff	756
Inspectors	Approx. 250

Data as of 2011

Facilities under Safeguards, Dec. 2011



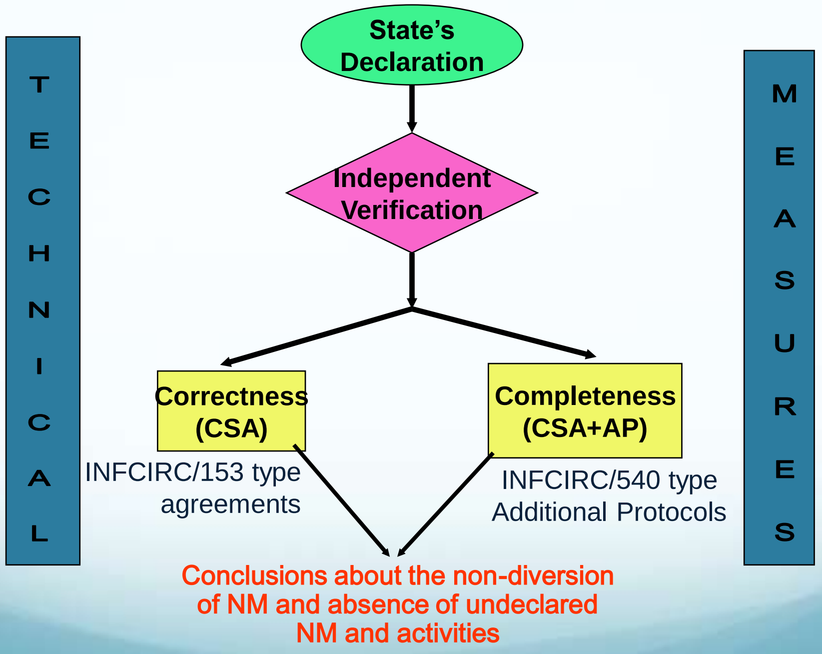
Qualifications and experience of IAEA inspectors

- University degree (P3) - Advanced university degree (P4) in physical sciences or engineering, or an equivalent degree from a recognized specialized technical institute.
- Minimum of 5 years (P3) - 7 Years (P4) of combined relevant experience in the nuclear field at national and/or international level.
- Excellent knowledge of both spoken and written English, including drafting technical documents. Knowledge of another official IAEA language (Arabic, Chinese, French, Russian or Spanish) an asset.

THE IAEA SAFEGUARDS SYSTEM

IAEA Safeguards

A system designed to provide credible *assurance* to the international community on the exclusively *peaceful* use of *nuclear material* and *facilities…..*



Elements of the IAEA SG System

1. Declarations by the State pursuant to a safeguards agreement and an additional protocol.
2. IAEA verification activities under safeguards agreements.
3. IAEA evaluation of all available safeguards information.
4. Drawing safeguards conclusions for a State with a safeguards agreement (and an Additional Protocol).
5. Reporting on safeguards implementation (Annual Report and Safeguards Implementation Report) to States and to IAEA policy-making organs

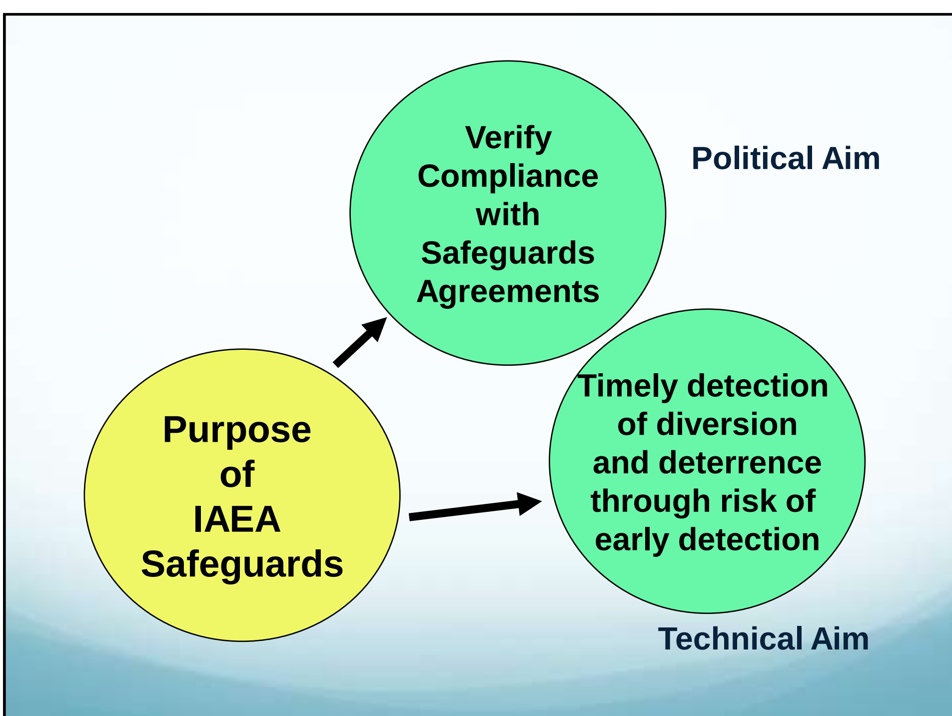
Sources of Information

- Information provided by States
  - Declarations under the safeguards agreement
  - Declaration under an additional protocol
  - Voluntary reports
- Information generated by Agency activities
  - Inspections and design information verification *visits*
  - Complementary accesses
- Other information
  - Collected from Agency internal databases and open sources
  - Provided by third parties

IAEA verification activities

The Comprehensive Safeguards Agreement

INFCIRC/153



Procedures for the Implementation of Safeguards

- State System of Accounting for and Control of Nuclear Material (SSAC)
- Starting and ending point of Safeguards
- Provision of Design information
  - Material Balance Areas (MBA), Key Measurement Points (KMP)

Procedures for the Implementation of Safeguards (cont'd)

- Records System
- Reports System
- Purpose, scope, notice, etc. of inspections
- Reporting results of inspections

Inspection Activities

- Auditing of Accounting and Operating Records
- Comparison of Records and Reports
- Verification of
  - Inventory Changes
  - Inventories
- Application and use of Containment and Surveillance
- Evaluation of data gathered
- Reporting of results and conclusions

Nuclear Material Verification

The basic verification method

used by the IAEA is

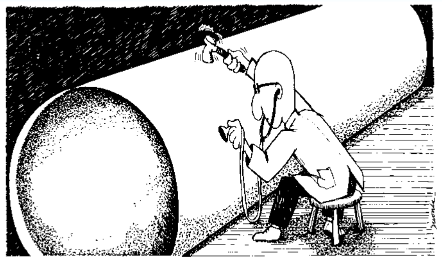
nuclear material accountancy

with

containment and surveillance

as important complementary measures.

Nuclear Material Verification



IAEA inspectors have to make independent measurements to verify declared material quantities

General Working Hypothesis

- Non compliance can not be excluded
- Low but non-zero probability that a diversion can take place
- There is no imaginable form of direct verification that State’s nuclear material declarations are complete that is doable and affordable

(These premises are currently being reassessed.)

Special Fissionable Material

Enriched Uranium (Z=92) $^{233, 235}U$

Plutonium (Z=94) ^{239}Pu

Source Material

Depleted Uranium

Natural Uranium

Thorium

Concepts used in Verification of NM

- **Significant Quantity (Quantity Goal)**
- **Detection Time (Timeliness Goal)**

Significant Quantity

Approximate quantity of nuclear material in respect of which the possibility of manufacturing a nuclear explosive device cannot be excluded

Significant Quantities (*)

Direct use:

- Plutonium
- U^{233}
- HEU ($U^{235} \geq 20\%$)

- 8 Kg Pu (total element)
- 8 Kg U^{233} (total isotope)
- 25 Kg U^{235}

Indirect use:

- U (DNLEU, $U^{235} < 20\%$)
- Th

- 75 Kg U^{235} (or 10 t NU or 20 t DU)
- 20 t Th (total element)

(*) currently under discussion)

Detection/Conversion Time (*)

Material Category	Timeliness Goal
Unirradiated direct use	1 month
Irradiated direct use	3 months
Indirect use	12 months

This generally indicates the time required for detection and conversion of nuclear material to an explosive device – it also determines the frequency of inspections

(*) When integrated Safeguards are applied, timeliness for irradiated direct use materials change to 12 months. If MOX, then it becomes 3 months

Note: values currently under discussion

Safeguards Approaches

Essential Steps

- Design Information Questionnaire (DIQ): DIE/DIV (DIExamination)/(DIVerification)
- Diversion path analysis
- Define safeguards measures
  - Material Balance Areas (MBAs), Key Measurement Points (KMPs): reports, verification
  - Containment and Surveillance (C&S)
  - Unannounced inspections (UI)
- Facility Attachment (FA) [Agreed between State and the Agency]

Types of Inspections (and Visits)

- Ad-hoc Inspections: If no Facility Attachment in force
- Routine Inspections
  - Physical Inventory Verification (PIV)
  - Interim Inspections for Timeliness or for Inventory Change Verification (IIV)
  - Unannounced, Short Notice (SNRI) and Limited Frequency Unannounced Access (LFUA) Inspections
- Special Inspections
- Design Information Examination/Verification *Visits*

Safeguards Measures

The fundamental Safeguards measure

used by the IAEA is

Nuclear Material Accountancy (NMA)

with

Containment and Surveillance (C/S)

As important complementary measures

Inspection Activities

- Examination of Accounting and Operating Records
- Comparison of Records and Reports
- Verification of
  - Inventory Changes
  - Inventories
- Application and use of Containment and Surveillance
- Evaluation of data gathered
- Reporting of results and conclusions

Materials Measured

- Uranium and/or Plutonium in:
  - Fresh fuel
  - Spent fuel
  - In-process materials
  - Storages
  - Feed, product and tails

Measurement Techniques

NDA = Non Destructive Assay

Measuring quantity or specific attributes of nuclear material *without physically affecting the measured item.*

DA = Destructive Assay

Measuring quantity or specific attribute(s) of nuclear material *by chemical analyses.*

Mini MCA* with CdZnTe Detector (MMCC)

Materials: **U, Pu, MOX, fresh & spent fuel**

Detectors: **NaI, CdZnTe (shown), HPGe, ^{3}He (n)**

*multi-channel analyzer

Verification of Fresh Fuel at a Reactor Facility

Photo credit: D. Calma, IAEA

Multichannel analyzer with Germanium detector

High Level Neutron Coincidence Counter (HLNC)

Material: **Plutonium, measures $^{240}Pu_{eff}$ mass**

Detector: **^{3}He tubes in polyethylene, coincidence electronics**

Active Well Coincidence Counter (AWCC)

Material: **^{235}U in UO_2 powder and HEU metal**

Technique: **Active neutron coincidence counting**

Detector: **^{3}He tubes in polyethylene, coincidence electronics**

Improved Cerenkov Viewing Device (ICVD)

Material: **Spent Fuel**

Technique: **Observe Cerenkov glow**

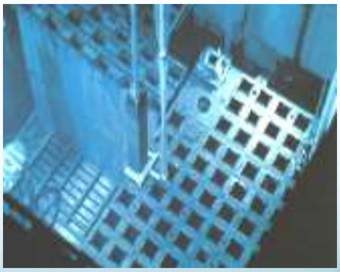
Detector: **Enhanced night vision device. UV filter allows operation with lights on**

Purpose: **Attribute verification of spent LWR assemblies**

GRAND and Fork Detector

Material: **Spent Fuel**

Technique: **Simultaneous neutron and g-ray measurements**



Purpose: **Attribute verification of spent LWR assemblies. Combined with reactor codes it can verify burnup declaration.**

Verification of Spent Fuel at a Reactor Facility

C/S Measures at a Reactor Facility

C/S Devices: Surveillance Systems

New surveillance systems

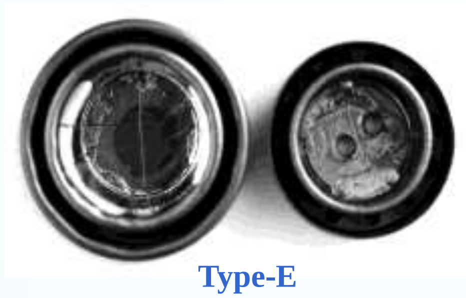
Load-Cell Based Weighing System (LCBS)

Material: **Uranium**

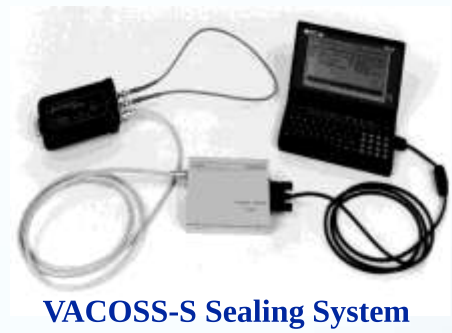
Technique: **Weight**

Purpose: **UF_6 mass in cylinders**

C/S Devices : Sealing Systems



Type-E
Seal



VACOSS-S Sealing System

Metallic Seals
Type-E (CAPS)

(ULCS)

(EOSS)

Advanced Seals
Fibre-optic (COBRA)
Fibre-optic (VACOSS)
Ultrasonic (ARC)

Electronic Optical

Traditional, Strengthened and Integrated Safeguards
Techniques and Technology

Seals (E-type)

Seals Verification:

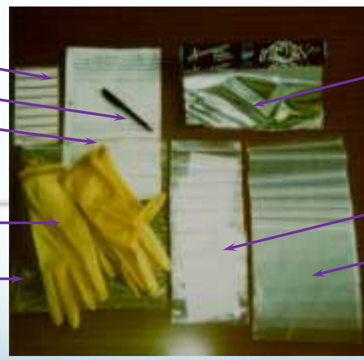
Checks seal for integrity, compares details before application and after return

Also checks seals wires

54

Environmental sampling for Traditional, Strengthened and Integrated Safeguards Techniques and Technology

Swipe Sampling Kit



Labels
Pen
Working Papers
Gloves
Outer Bag
Aluminum Foil
Bag with cotton swipe
Large bag for double bagging

55

Traditional, Strengthened and Integrated Safeguards
Techniques and Technology

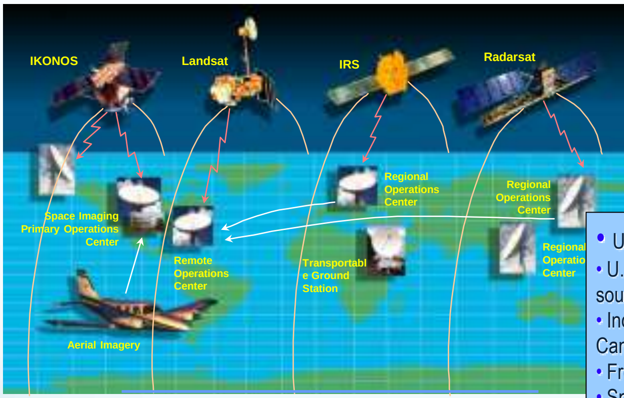
IAEA Clean Laboratory,
rf

Thermal Ionoization Mass Spectrometry

Scanning Electron Microscopy

56

Traditional, Strengthened and Integrated Safeguards
Techniques and Technology



- U.S. Landsat 5/7
- U.S. Corona (declassified source)
- Indian Remote Sensing (IRS) Canadian Radarsat 1
- French SPOT 4
- Space Imaging IKONOS
- Quickbird
- Orbimage Orbview 3/4
- Israeli EROS
- Russian KVR 1000, TK 350

Commercial Overhead Information

57

5 m resolution

58

1 m resolution

59

Results of inspections

- Recorded in a database
- Statement with results sent to Member States
  - (After each inspection)
- Statement with conclusions sent to Member State
  - (At the end of an MBP)
- Results and conclusions for all States reported to BoG (Annually)


END