International Nuclear Safeguards

INMM Tutorial

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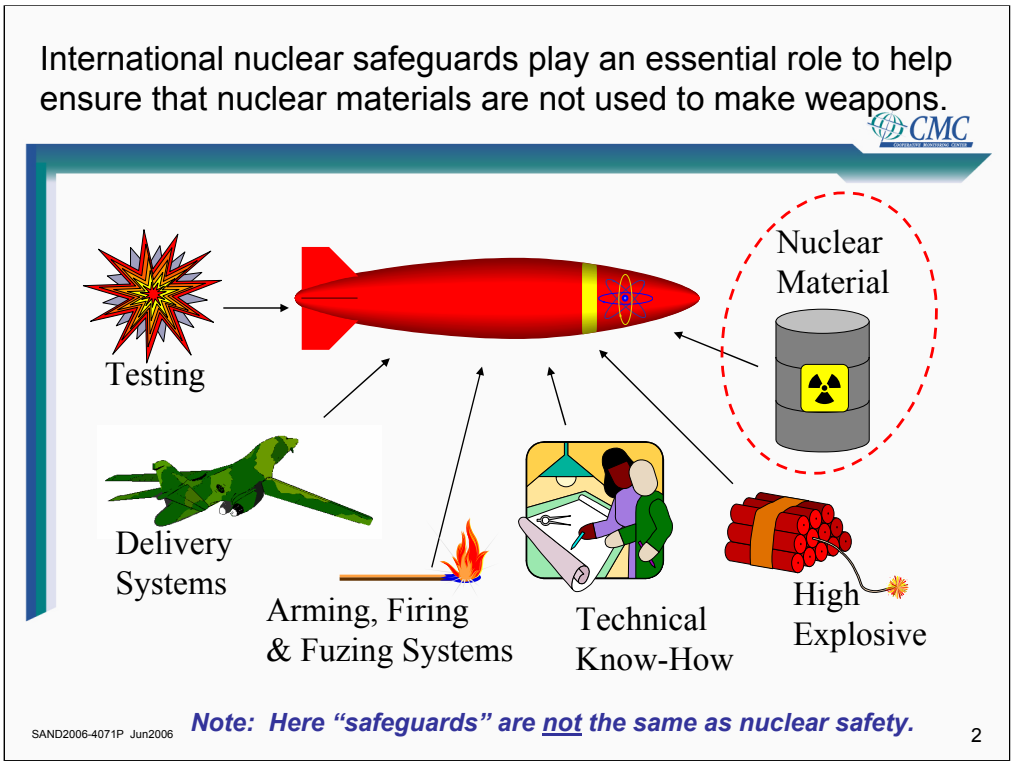
Sandia is a mulitprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company for the United States Department of Energy under contract DC-AC04-94AL85000



There are many essential components to produce a nuclear weapon.

Safeguards comprise just one approach to control the proliferation of nuclear weapons:

> If an essential ingredient (that is a limited resource and not readily available, such as HEU and plutonium) is kept tightly controlled ("safeguarded"), we can make weapons proliferation more difficult.

Other aspects complement material safeguards: e.g., test bans, export/import controls, classifying information, etc.

The technical objective of International Nuclear Safeguards is:

"…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."

IAEA Information Circular (INFCIRC)153
paragraph 28

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Information Circular (INFCIRC) 153 is the document that spells out how the IAEA implements comprehensive, "full scope" Safeguards (more in slide 35)

International Nuclear Safeguards have been enormously successful for non-proliferation: How do they work?

Outline of this tutorial:

- What are “nuclear” and “fissile” materials?
- What are the technical tools that can be used for nuclear material safeguards?
- How are the technical measures applied to achieve a Safeguards objective?
- How are Nuclear Safeguards applied internationally?
- How have Safeguards evolved to meet challenges to the nuclear nonproliferation regime?

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Major objectives for this tutorial are to:

review the materials subject to Safeguards: what they are and their major characteristics

introduce some of the equipment used to assay nuclear materials

explain the technical approach for safeguards: material balance accounting, complemented by containment & surveillance

give the legal and policy context for international nuclear safeguards

describe the major international and regional organizations for nuclear material safeguards: IAEA, Euratom, ABACC

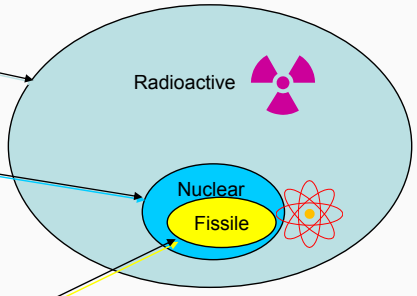
survey the implementations of (traditional) IAEA safeguards: project agreements, comprehensive agreements, voluntary offers

show how measures to strengthen Safeguards help ensure that declarations are not only correct, but also complete

What are nuclear and fissile materials?

Safeguards are concerned with nuclear—especially *fissile*—materials and associated technology.

- Radioactive Materials
- Nuclear Materials:
  - Uranium (U)
  - Plutonium (Pu)
  - Thorium (Th)
  - Includes metals, alloys, and chemical compounds
  - Does not normally include ore and ore residue
- Fissile Materials
  - Weapons-usable
  - Dual use



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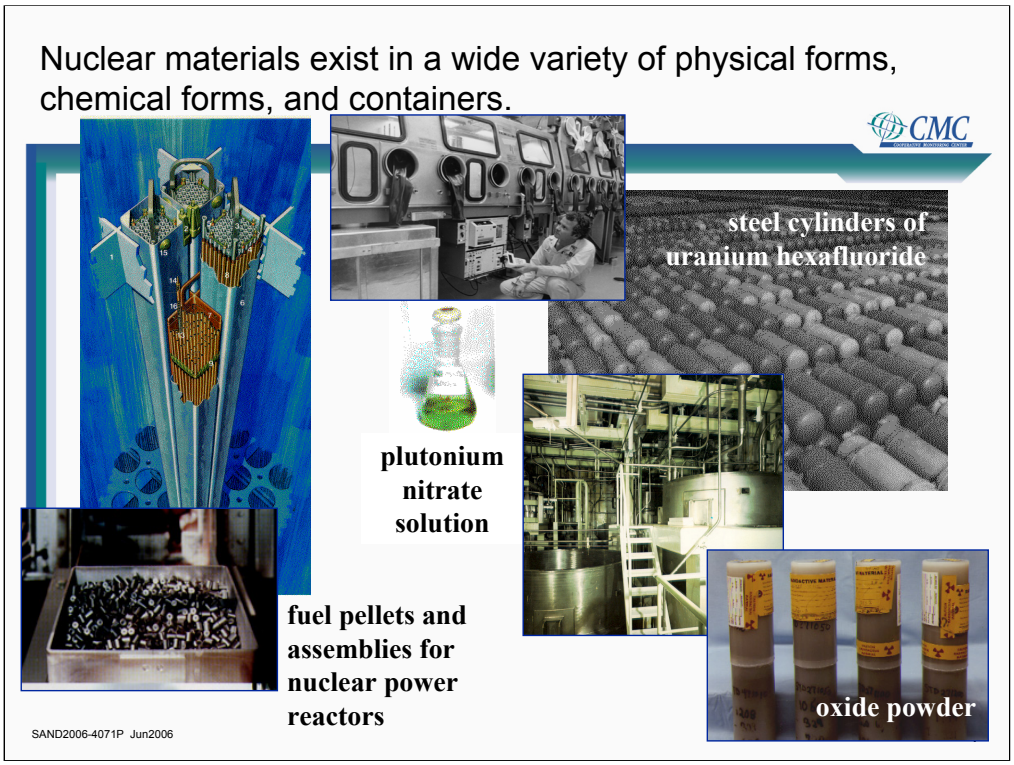

Examples shown here:

Physical forms:

- solid (pellets, oxide fuel)
- liquid (Pu nitrate solution from a spent fuel reprocessing stream)
- gas (UF6 at room temperature & pressure)
  - —but it's a solid in the cylinders shown here because it's under pressure

Chemical forms:

- oxide
- pure metal
- nitrate, hexafluoride

Containers:

- box (of pellets)
- alloy cladding (fuel pins)
- glove box (for remote handling)
- sealed cylinders
- process piping

Nuclear material has different isotopic composition.

- Nuclear material is present in different nuclear forms called *isotopes*
  - same element, but different numbers of neutrons in the nucleus
  - for example: important isotopes of uranium include ^{235}U, ^{238}U
- Nuclear reactions and radioactive decay can change ("transmute") isotopes from one type to another
- Isotopes have different nuclear properties
- However, isotopes have the same chemical properties

It is <u>very</u> difficult to separate isotopes

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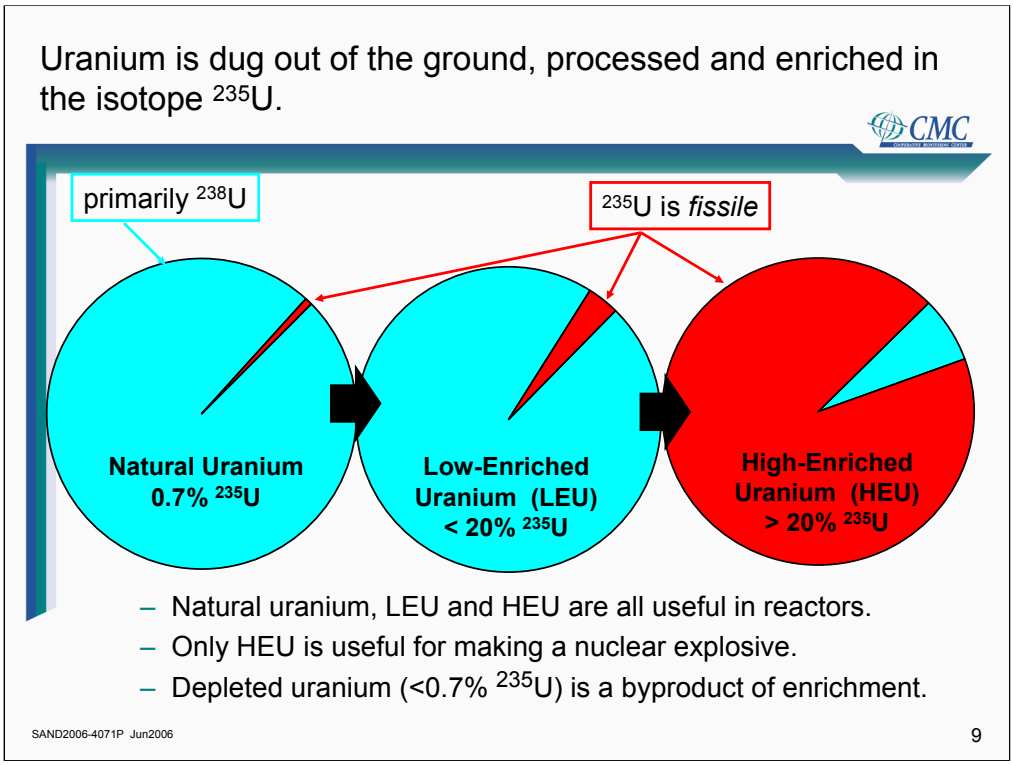
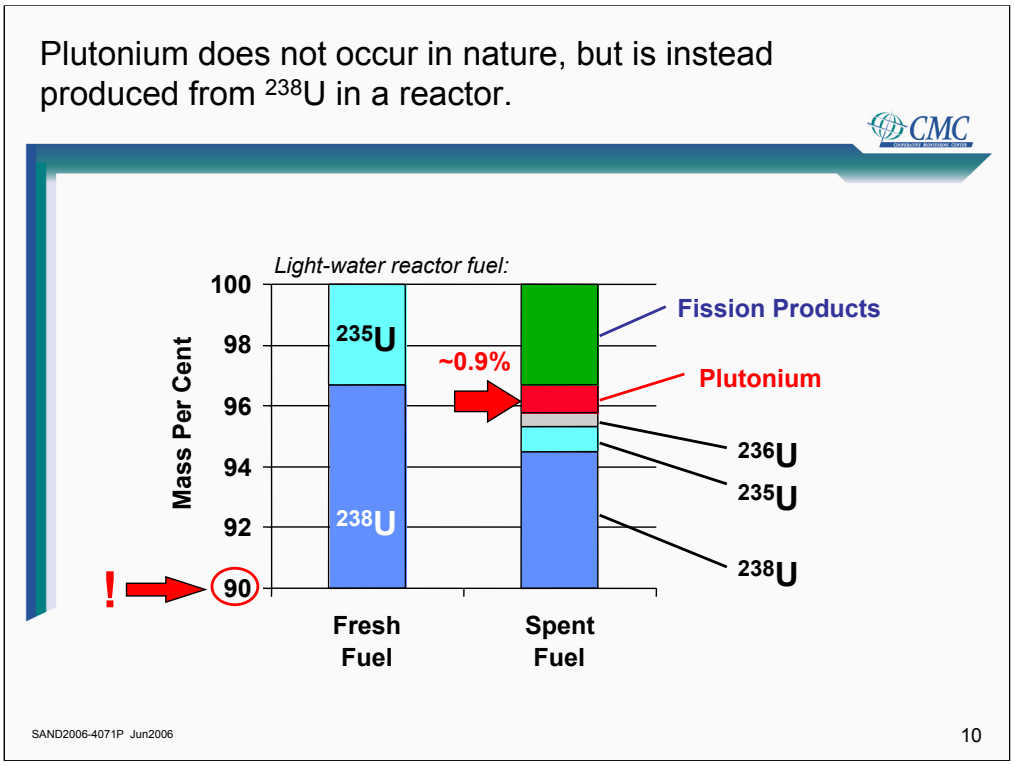


There is nothing magical about the 20% enrichment number:

- it is a somewhat arbitrary, administrative threshold to distinguish relative significance of the uranium for potential weapons use
- it does reflect the amount of separative work required to increase enrichment, however:
  - once beyond 20%, you've already done most of the separative work required to get to a weapon



When low-enriched uranium fuel is "burned" in a reactor, two major things happen:

1) U-235 is consumed: it undergoes fission, producing highly-radioactive fission products, and

2) Plutonium is formed when neutrons are absorbed in U-238

Actual amounts in spent fuel depend upon "burnup":

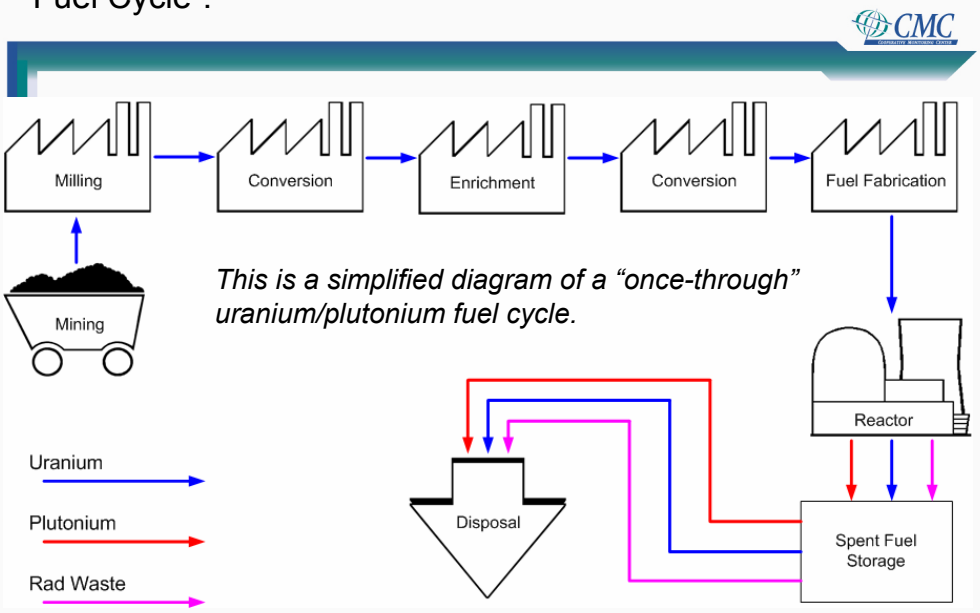
how long the fuel was in the reactor, and the reactor power during that time

The constituents aren't separate, as shown here, but they are all mixed up and distributed throughout the fuel

Spent fuel is intensely radioactive for many, many years--mainly due to activity of the fission products

Once the plutonium has been chemically separated from spent fuel, the plutonium is no longer self-protected

The use of nuclear materials is described by the "Fuel Cycle".



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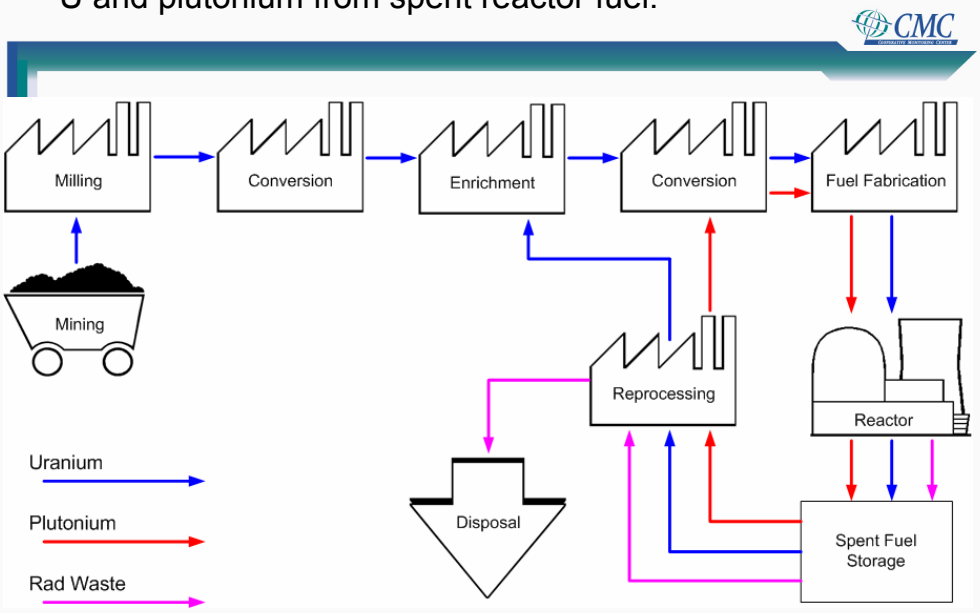
Recycle: A fuel cycle with reprocessing recovers unburned ^{235}U and plutonium from spent reactor fuel.



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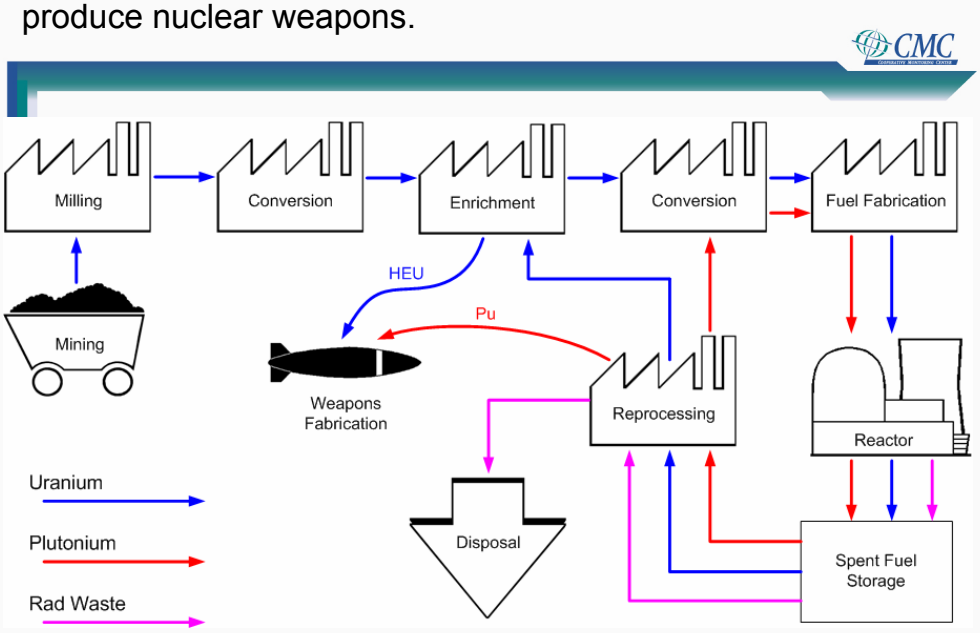
Plutonium and high-enriched uranium might be used to produce nuclear weapons.



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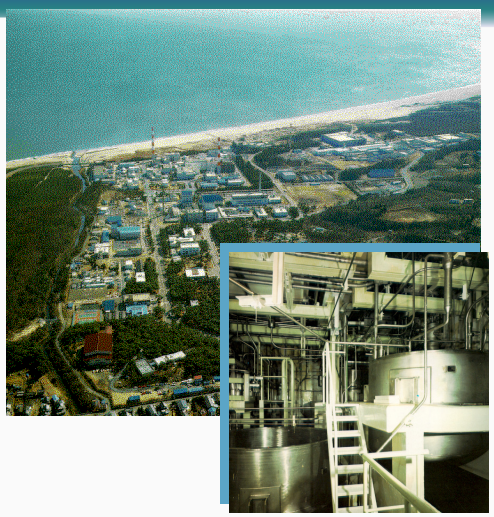
The nuclear fuel cycle can become very complex.

- Nuclear materials have potential dual use, both civilian and military.
- Paths of nuclear materials within facilities are often complicated, and may be inaccessible for monitoring.
- The fuel cycle may involve more than one country.



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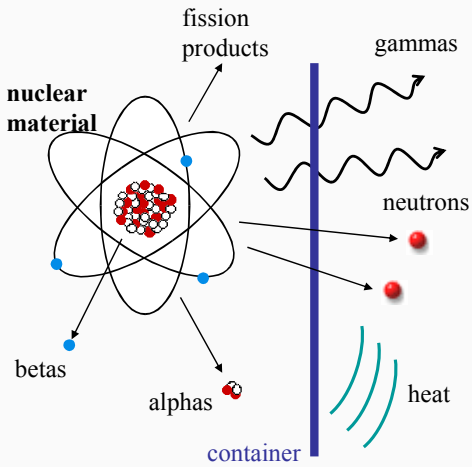
What are the technical tools that can be used for nuclear material safeguards?

Nuclear materials emit penetrating neutron and gamma radiation, which can be monitored readily.



- The type and intensity of the radiation can reveal precisely what nuclear material (and how much of it) is present. It is a "*signature*" of the nuclear material.
- Emission is affected by other elements present.
- The time distribution of neutrons can also convey information.

A wide variety of technical measures exist to detect, identify and assay nuclear and fissile materials.

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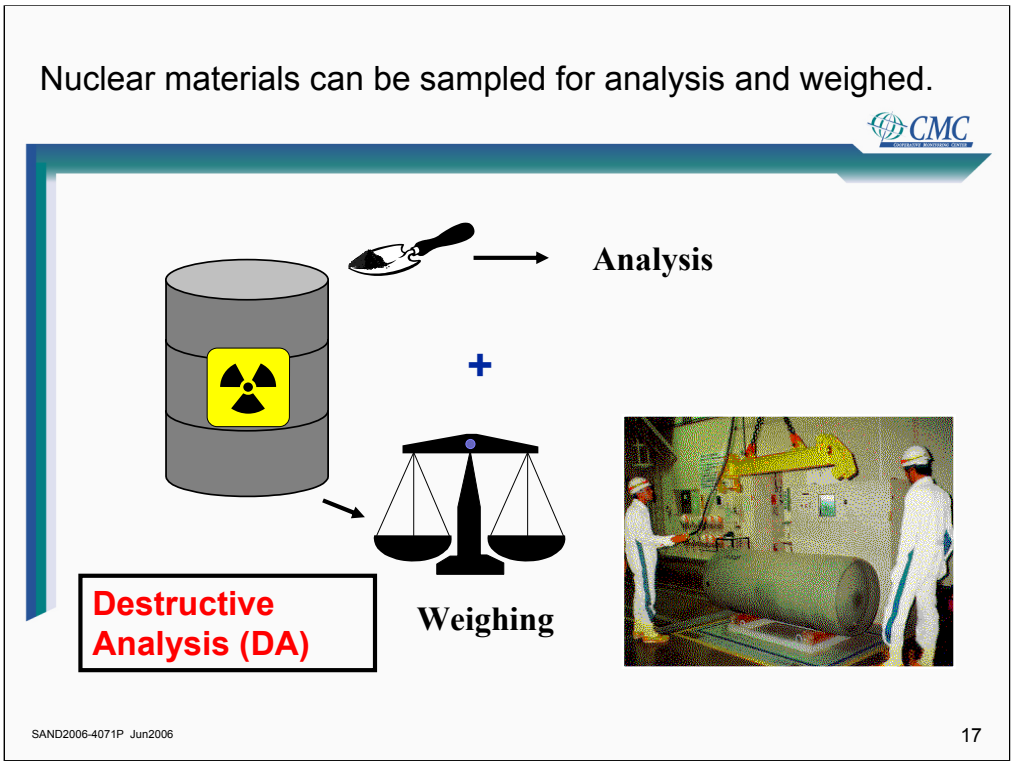
Radiation detection can provide both qualitative and quantitative information:

Is something there? What is it?

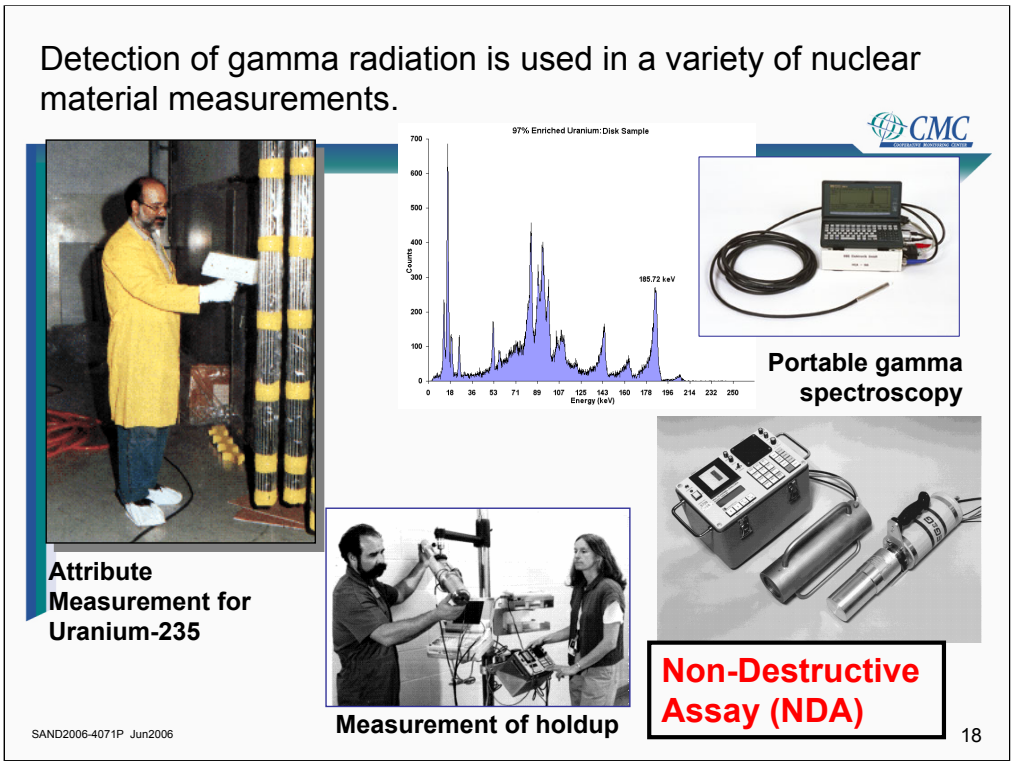
How much material is present?



Picture shows operators weighing a UF6 cylinder with a “load cell”

Samples sent to separate laboratory to determine density, chemical composition, stoichiometry, and concentration, isotopic composition

Could also use non-destructive assay in place of analysis



Handheld “HM4” detector (left) is used to find the “active” length of reactor fuel (non-active material is in the ends of the fuel pins)

Gamma spectroscopy makes it possible to identify precisely what nuclear materials are present:

- the chart shows the number of gamma rays vs. energy:
- the right-most peak at 186 keV reveals the presence of U-235

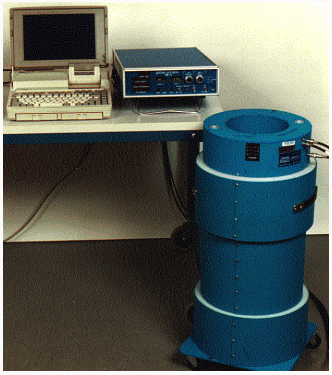
Portable multichannel analzer with sodium iodide or Germanium detector (lower right) are examples of older technology

Upper right is much smaller cadmium-telluride detector (pencil-shaped device) connected to miniaturized electronics + computer

“Holdup” is the accumulation of nuclear material in pipes and tanks

Passive NDA using coincidence neutron detection is used to assay plutonium.

- Most nuclear materials emit neutrons, but as singles (one at a time)
- Plutonium fissions spontaneously, so it can also release multiple neutrons simultaneously
- Coincidence counting identifies this fission neutron signal to assay plutonium



High Level Neutron Coincidence Counter

Combination of neutron counting and gamma spectroscopy

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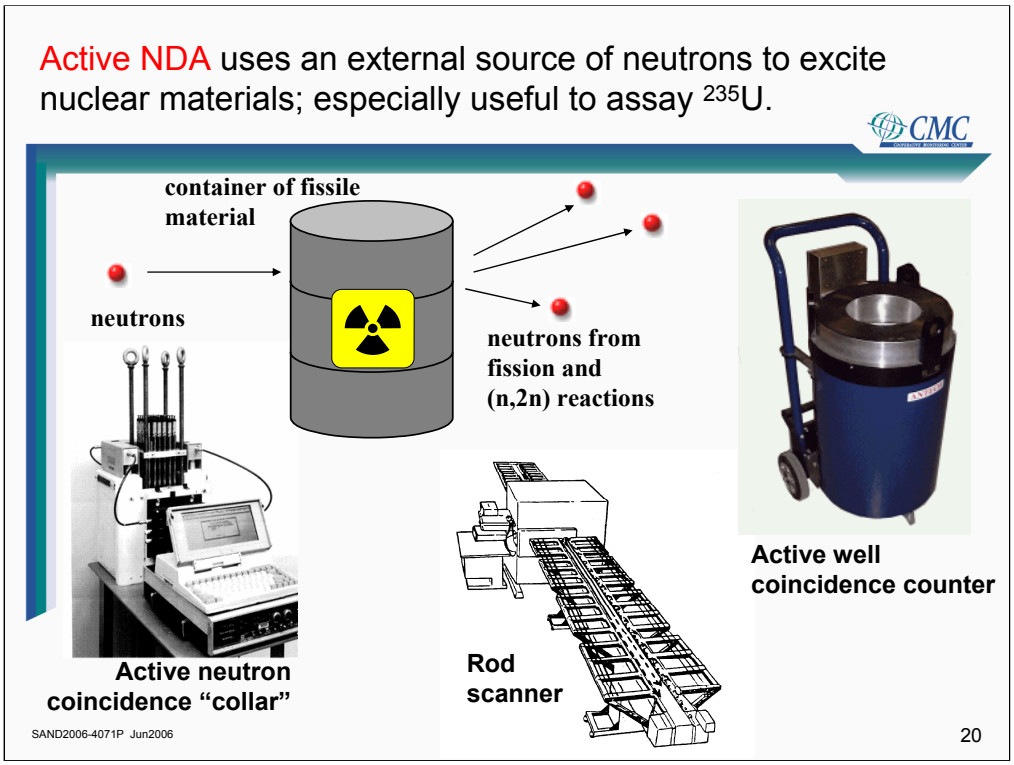
High level neutron coincidence counter uses several He-3 tubes arrayed in a ring around a central well (where Pu samples are placed)

The He-3 tubes are embedded in polyethylene moderator to help detect the neutrons

An early-90's vintage portable computer with separate electronics unit (called a "shift register") is shown



Unlike plutonium, uranium doesn't spontaneously give off enough neutrons to reveal how much is present

But we can cause the neutrons to be given off, by inducing the uranium to fission

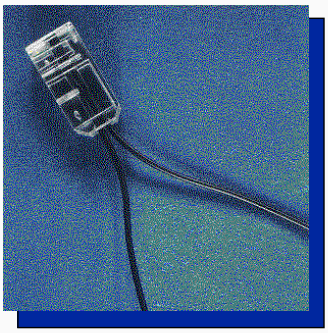
- external neutrons are usually provided by a compact "alpha-n" neutron source, such as americium-lithium

The neutron coincidence collar (left) assays reactor fuel assemblies to determine U-235 mass per unit length

Individual fuel rods can be measured with the rod scanner (center)

The well counter (right) is used for bulk uranium samples

Containment & Surveillance methods assure "continuity of knowledge" about nuclear materials.



Cobra seal

DCM-14 video camera

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These technologies stay at the facility between inspections

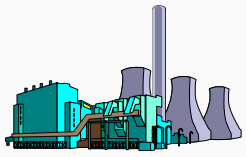
Many versions of loop seals exist; Cobra is a passive fiber-optic design

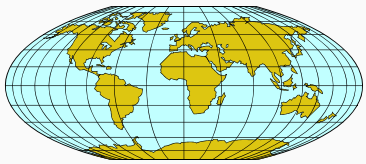
Video surveillance is now mostly digital

The enclosure around the camera illustrates tamper indication: the need to ensure that the monitoring system itself is secure

How are the technical measures applied to achieve a Safeguards objective?

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
- National authority
  needs to exercise control over facilities, regulate transport, and provide information to the international authority
- International authority
  needs to assure other countries that nuclear material is properly protected, controlled, and used appropriately

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Measures for nuclear material safeguards depend upon the form, amount, and strategic value of the material.

- Form: Item , or Bulk
- Amount:
  - "Significant Quantity" (SQ)
  - as defined by the International Atomic Energy Agency

Plutonium 8 kg

HEU 25 kg

- Strategic Value:
  - "Direct Use": plutonium, HEU, and ^{233}U
    - unirradiated
    - irradiated
  - "Indirect Use": uranium except HEU, and thorium

The *timeliness* of Safeguards measures is dictated by the strategic value of the material.

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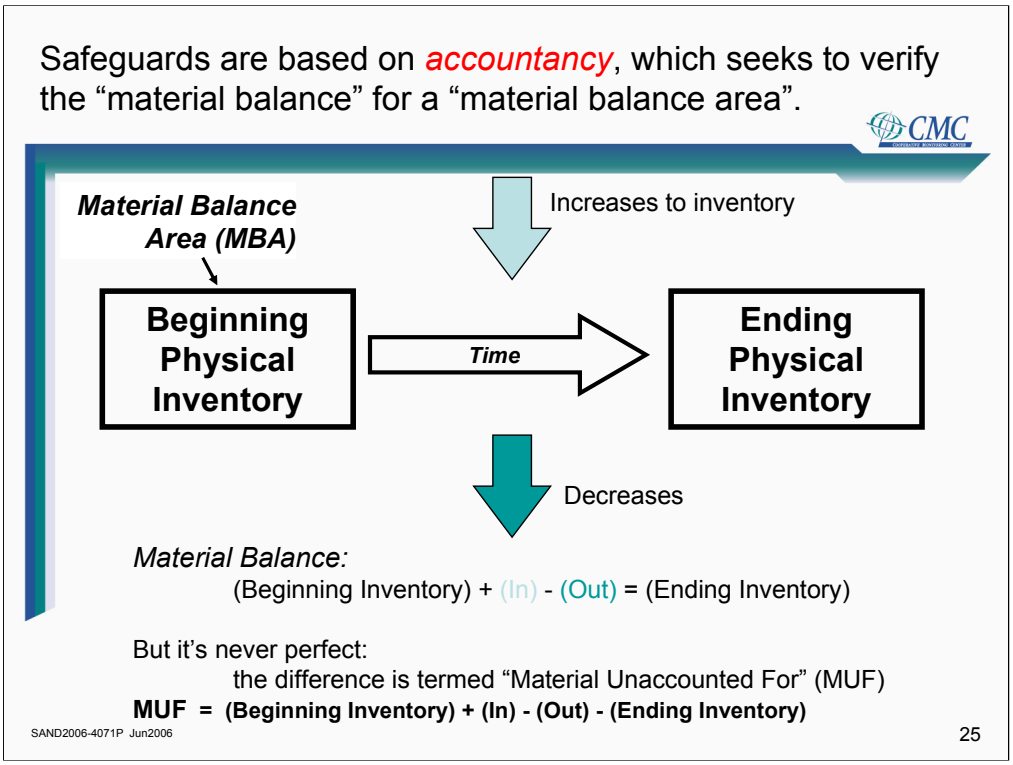
In assaying the amount of nuclear material, there are three levels of precision:

"gross" defect: typically, a whole item is missing

"partial" defect: part of an item, or appreciable fraction, is missing

"bias" defect: a relatively small fraction is missing

Measures for material assay are designed to meet one or more of these levels of precision with a particular "probability of detection"



Reveal sequence displays this flow diagram step by step

The MBA might be a vault, a room, a building, a facility… (can have nested MBAs)

Inventory increases = material received or produced

Inventory decreases = material shipped, consumed or decayed

Statistical analysis is used to determine whether or not the MUF is acceptable:

- may be due to error or measurement uncertainties
- may be classified as a "discrepancy"

MUF can be tracked on a cumulative basis to identify gradual diversion of small quantities of material

For international nuclear safeguards, accountancy assures that nuclear materials are present and used as intended.

- State declares nuclear materials and facilities
- Independent inspections periodically verify the declaration:
  - confirm facility design information
  - examine operator records & reports
  - identify & count items
  - assay nuclear materials
- Containment and surveillance measures ensure "Continuity of Knowledge": i.e., that no changes occur between inspections
  - tags & seals
  - video cameras

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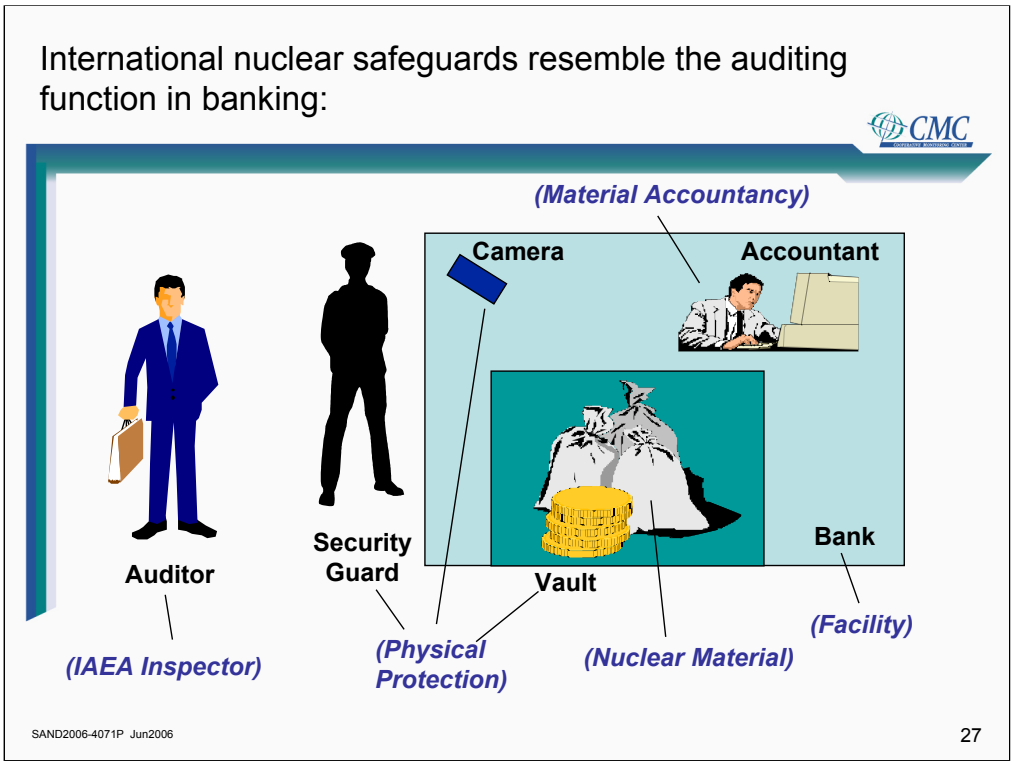

Analogy to illustrate the role of the IAEA as the auditor, not the accountant

A variety of other forms of control complement international nuclear safeguards.

- Domestic material control & accounting
- Physical protection
- Licensing of facilities
- Regulation of transport
- Import/export restrictions
- Engineering standards & certification

Portal monitoring

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How are Nuclear Safeguards applied internationally?

"Traditional" IAEA Safeguards

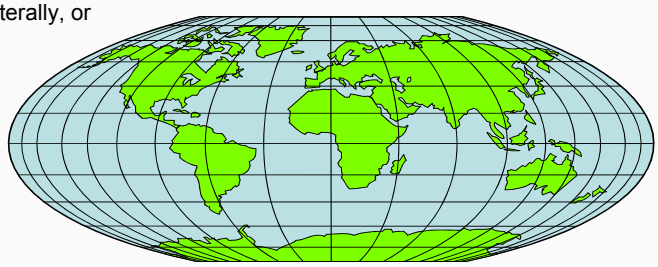
Here we'll consider the policy context…

"Traditional" IAEA Safeguards is described first; the scope of IAEA Safeguards expanded during the 1990's with the "Additional Protocol," which we discuss later.

International safeguards are called for by treaties and other agreements between parties.

For assurance that nuclear materials are properly protected, controlled, accounted for, and used for peaceful purposes:

- Parties monitor each other bilaterally, or



- A 3rd party (international authority) is delegated the monitoring function

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Premise: Nuclear materials are owned and/or controlled by states.

The goal of international safeguards is to permit commerce in peaceful use of nuclear technology, while assuring the world community that such commerce doesn't promote and spread its use for weapons.

International Safeguards evolved over time:

originally bilateral (e.g., seller monitors the buyer's use of nuclear materials after the sale… this became cumbersome and inefficient)

that role was eventually taken over by an independent 3rd party (e.g., IAEA)

Some international safeguards still involve direct bilateral verification (e.g., U.S.-Russia).

In allowing international control, states pay a price in some loss of sovereignty to obtain the benefits of nonproliferation.

The International Atomic Energy Agency (IAEA) both promotes and safeguards atomic energy.

- Created in 1957 by Statute
- Affiliated with the United Nations
- Objective:
  "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world."
- Now comprises 140 Member States, which
  - participate in formulating Agency policies
  - are eligible for technical assistance in the peaceful use of nuclear energy
  - share the costs of its operation

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IAEA is an autonomous organization within the United Nations System.

Headquarters: Vienna, Austria

other offices in Geneva, New York, Toronto, Tokyo, Trieste...

Eighteen ratifications were required to bring the IAEA's Statute into force

Entry into Force (EIF): 29 July 1957

Member state: a State that has signed the IAEA Statute, after approval by the General Conference, upon recommendation of Board of Governors

140 Member states (as of March 2006):

For current list, see http://www.iaea.or.at/About/Policy/MemberStates/index.html

Two states were formerly members of the IAEA but have since withdrawn:

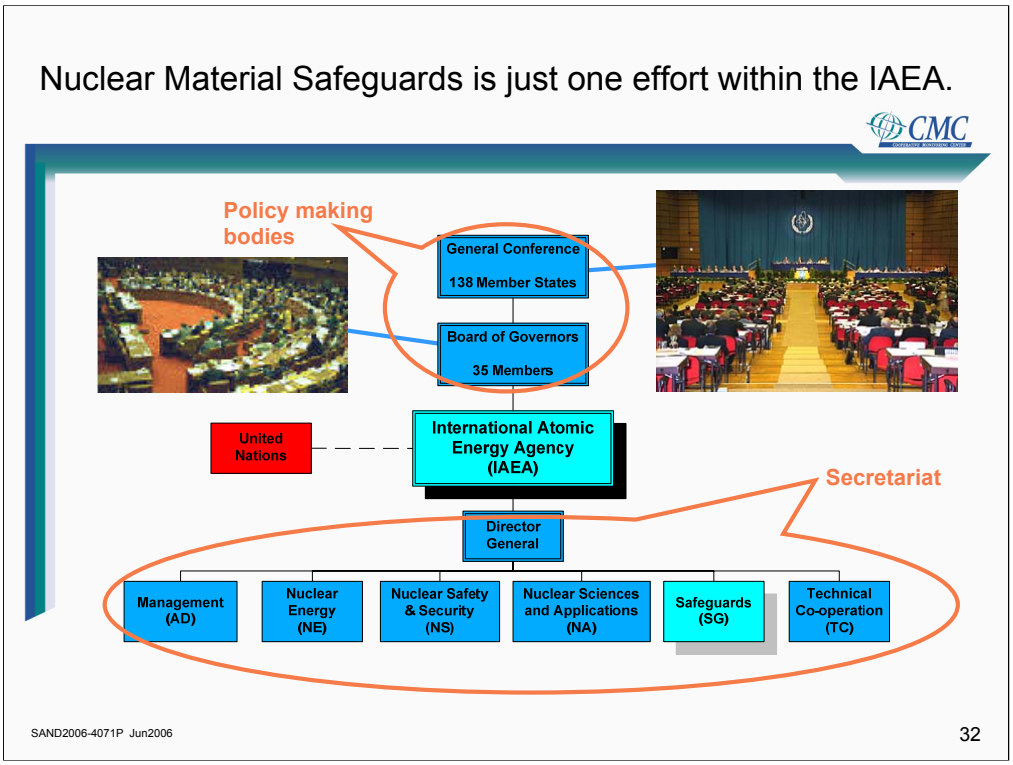
Cambodia: joined in 1958, withdrew in 2003

Democratic People´s Republic of Korea (DPRK): joined in 1974, withdrew in 1994

Three states are members of the IAEA but *not* signatories of the NPT

Israel, India, Pakistan (all joined in 1957)

52 states are NPT signatories but *not* Member States of the IAEA



IAEA policy-making organs = Board of Governors and General Conference

General Conference: Ref: Article V of the IAEA Statute

Annual meeting of all member states (can also hold special sessions); one representative with one vote per Member State

Elects a President for each meeting

Board of Governors: Ref: Article VI of the IAEA Statute

35 States, partly designated by the outgoing Board of Governors per instructions in the Statute; 22 are elected by the General Conference

meets five times per year (Mar, Jun, twice in Sep, Dec)

IAEA Secretariat: ref: Article VII of the IAEA Statute

carries out programmes and activites approved by the policymaking organs

Personnel: international civil servants; minimum permanent staff

2,200 professional + support

Director General (DG), the chief administrative officer, heads the Secretariat

4-year term, appointed by the Board; approved by the General Conference

currently (2006) Dr. Mohamed ElBaradei (Egypt)

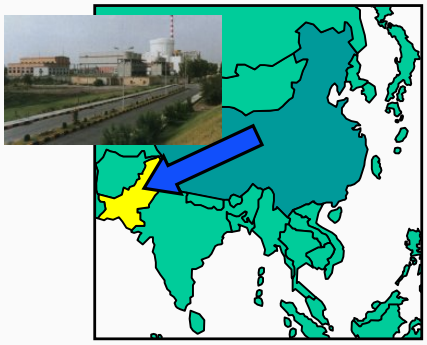
Six Deputy Director Generals (DDG) head the six separate departments

Regular Budget (2006): €273.6M,

of which €106.3M is for "nuclear verification" (Safeguards)

IAEA INFCIRC 66 describes how Safeguards are applied to individual projects, such as an international reactor sale.

- Example of an INFCIRC 66 project agreement:
  "Agreement of 24 February 1993 Between the International Atomic Energy Agency and the the Government of the Islamic Republic of Pakistan for the Application of Safeguards in Connection with the Supply of a Nuclear Power Station from the People's Republic of China" (INFCIRC 418)
- 300 MWe pressurized light water reactor at Chashma, built by China National Nuclear Corporation



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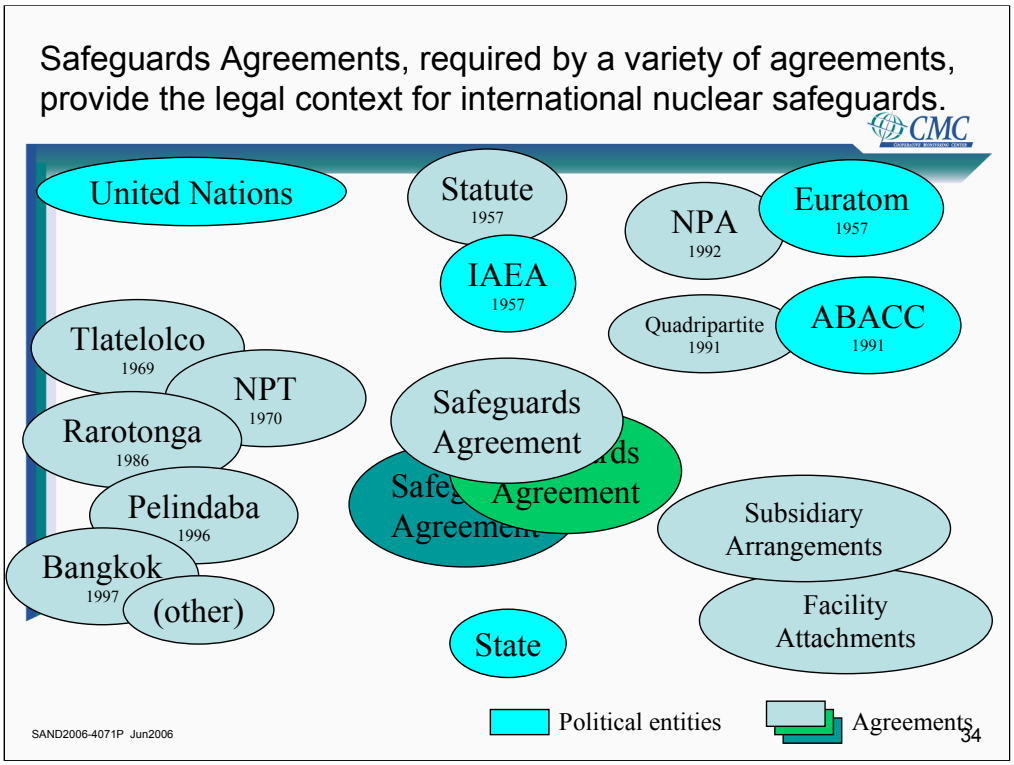
INFCIRC/66/Rev 2.: "The Agency's Safeguards System (1965, as Provisionally Extended in 1966 and 1968)" 16 September 1968

INFCIRC 66 safeguards were developed between 1965 and 1968

Most INFCIRC 66-type agreements have been superseded by comprehensive safeguards agreements

INFCIRC 66-type agreements are still applied in 3 states (India, Pakistan and Israel)



Reveal sequence dictates the points to be made:

1) a Safeguards (SG) agreement between a state and the IAEA is the legal basis for Safeguards

2) IAEA is part of the UN system, established by statute, but semi-autonomous

3) treaties may require a SG agreement; they don't spell out SG themselves

4) not just treaties: project agreements, voluntary offer agreements: these result in different "flavors" of SG agreement

5) not just states, but regional entities too (Euratom, ABACC)

6) SG agreements have implementing details: Subsidiary Arrangements and Facility Attachments

A "Safeguards Agreement" is the legal basis for the IAEA to undertake Safeguards, concluded between a State (or Regional Authority) and the IAEA.

Safeguards Agreements are not always driven by treaty obligations

The Safeguards Agreements corresponding to comprehensive agreements, project agreements, voluntary offers, etc. are each somewhat different—hence the different-colored overlapping ovals in this diagram

"Subsidiary Arrangements" are technical and administrative procedures for implementing a Safeguards Agreement.

"Facility Attachments" further describe details of implementation.

The Treaty on the Nonproliferation of Nuclear Weapons (NPT) led to Comprehensive Safeguards Agreements (CSAs).

- Under a CSA, Safeguards are applied to all nuclear activities within a state
- All non-nuclear weapons state (NNWS) parties to the NPT are expected to conclude a CSA with the IAEA
- IAEA Safeguards for a CSA are documented in Information Circular (INFCIRC) 153, as corrected:

"The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons"

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Treaty on the Non-Proliferation of Nuclear Weapons (= INFCIRC 140)

NPT designates the IAEA as the verification instrument for the treaty:

Article III.1: "Each non-nuclear weapon State Party to the Treaty undertakes to accept safeguards, as set forth in an agreement to be negotiated and concluded with the [IAEA] in accordance with the Statute of the [IAEA] and the Agency's safeguards system…"

Adopted 12 June 1968; opened for signature on 1 July 1968; EIF March 5, 1970

Status (as of June 2006): 189 states parties + Taiwan

(ref: http://disarmament.un.org/TreatyStatus.nsf)

Status of NPT-related (Comprehensive) Safeguards Agreements (as of 5/17/2006):

(ref: http://www.iaea.org/OurWork/SV/Safeguards/sir_table.pdf)

in effect with 152 of 184 NNWS

32 States still had not brought into force an IAEA Safeguards Agreement:

(10) signed but not yet in force; (3) approved by the IAEA Board of Governors but not yet signed; (19) have yet to be concluded

Treaty for the Prohibition of Nuclear Weapons in Latin America (Tlatelolco Treaty) also calls for NPT-like CSAs:

Article 13: "Each Contracting Party shall negotiate multilateral or bilateral agreements with the [IAEA] for the application of its safeguards to it its nuclear activities."

All 33 States in Latin America and the Caribbean have signed the Treaty, ratified and have signed Safeguards Agreements with the IAEA.

Five Nuclear Weapon State parties to the NPT have concluded "Voluntary Offer Agreements."

- NPT does not require Safeguards in the nuclear weapon states (NWS)
  - Major industrialized non-nuclear weapon states objected (unfair competitive advantage)
  - NWS offered to accept Safeguards on all nuclear activities, except national security
  - Compromise solution to limit cost:
    - NWS submit lists of "eligible facilities"
    - IAEA selects which facilities to inspect
- Framework for NPT Article VI
  - 1993 U.S. placed materials "excess to defense needs" under IAEA Safeguards

- United Kingdom
  - Aug. 1978
  - INFCIRC 263
- United States
  - Dec. 1980
  - INFCIRC 288
- France
  - Sep. 1981
  - INFCIRC 290
- Russia
  - Jun. 1985
  - INFCIRC 327
- China
  - Sep. 1989
  - INFCIRC 369

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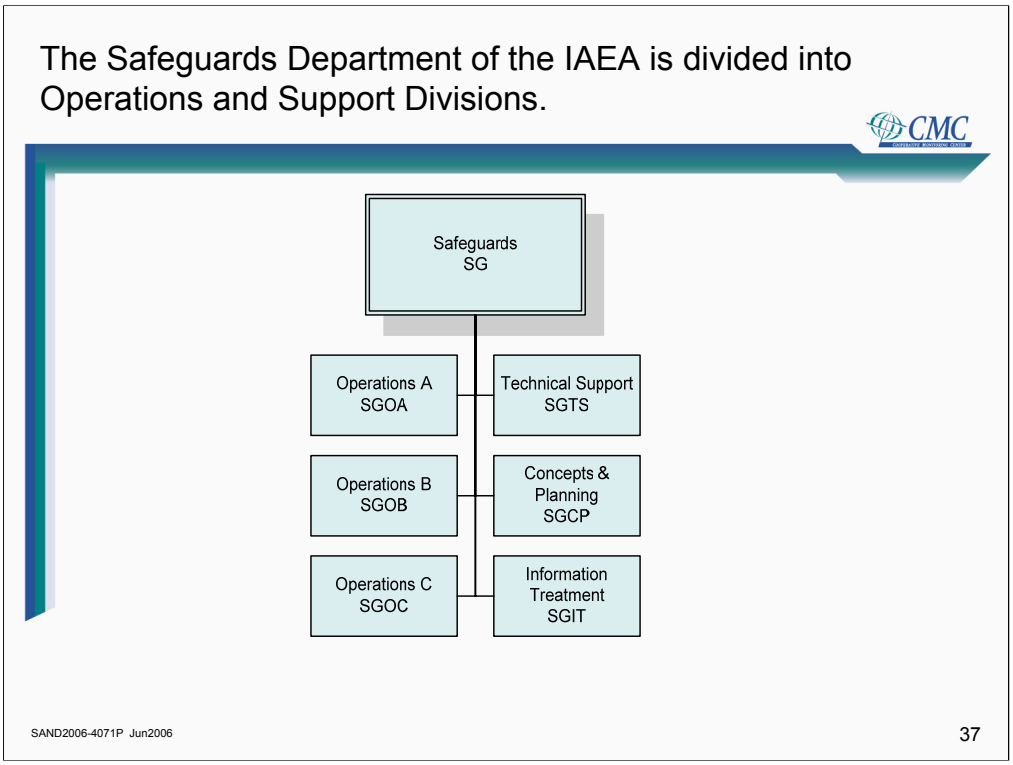

Agency Safeguards are described by Article XII of the IAEA Statute

At the end of 2004:

237 Safeguards Agreements in effect with 152 States (+ Taiwan)

Safeguards activities underway in 71 States (+ Taiwan) at 923 facilities

2,302 Safeguards inspections performed in 2004

Annual costs for Safeguards approximately $120M (103.7M regular + 16.3 extra-budgetary)

The $16.3M extra-budgetary funds were supplied by 17 Member State (and 1 multinational: European Union) support programs for Safeguards

ref: IAEA Annual Report 2004, p. 5

http://www.iaea.or.at/Publications/Reports/Anrep2004/anrep2004_full.pdf

An IAEA Inspector is expected to perform a wide range of tasks.

- audit bookkeeping records of a facility
- determine stratification & sampling
- verify inventory of materials
- perform nondestructive assay measurements
- service containment & surveillance equipment
- count controlled items
- take samples for destructive analysis
- perform design information verification

- carry out complementary access
- write reports & documentation
- travel
- other
  - negotiate facility attachments
  - develop new measurements
  - train other inspectors

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IAEA Safeguards serve to audit a state's declaration of its nuclear materials and facilities.

- Declaration:
  - A party to a Safeguards Agreement establishes and maintains a State System of Accounting and Control (SSAC) for its nuclear materials.
  - The party declares its nuclear materials and facilities to the IAEA.
- Verification:
  - The IAEA inspects the nuclear materials and facilities periodically to verify accuracy of the declaration.
  - The IAEA reports its conclusions.
- Many states having little or no nuclear activity qualify for a reduced inspection and reporting regime:
  - Small Quantities Protocol (SQP)

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"Traditional" Safeguards assumes that the state has declared all of the required materials and facilities to the IAEA

- verification doesn't check whether anything was omitted
- "completeness" of the declaration is one objective of measures to strengthen Safeguards

A "State System of Accounting and Control" (SSAC) is responsible for reporting a state's declaration.

- Some member states of the European Union no longer have an SSAC.

The IAEA treats information from declarations and inspections as "Safeguards Confidential"

As of 17 May 2006,

- half of all states states with CSAs in force (76) were under the SQP
- the other 76 were subject to most of the detailed provisions under Part II of a CSA
- 12 additional states will qualify for a SQP when their CSA enters into force (currently only signed or approved by the IAEA board)

The SQP is often considered a potential weakness in Safeguards implementation

- Eligibility for SQP: states with less than one *effective kilogram** of nuclear material in the entire state, *and* none of it in a "facility" as defined by INFCIRC 153 (corr), paragraph 106
  - *examples of one effective kilogram: 1 kg Pu or HEU; 10 t natural U; 20 t thorium
- IAEA Board of Governors strengthened the SQP in September 2005 by requiring initial reporting on all nuclear material and planned nuclear facilities, and by reaffirming the IAEA's right to inspect

The IAEA announces a Safeguards conclusion annually, but does not share Safeguards data.

- For states with a Comprehensive Safeguards Agreement (CSA) only, the affirmative conclusion states:
  "All declared nuclear material in these… States has remained in peaceful nuclear activities or has been otherwise adequately accounted for."
- For states with both a CSA *and* an Additional Protocol in force, the positive conclusion goes on to say:
  "In addition… the Agency completed sufficient activities and evaluation and found no indication of undeclared nuclear material or activities for the State as a whole. On this basis, the Agency concluded that all nuclear material in these States remained in peaceful nuclear activities or was otherwise adequately accounted for."

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From the IAEA 2004 Annual Report 40

The IAEA also reports the number of states in each category, as well as the number of states party to the NPT still without any Safeguards Agreement in place.

Safeguards conclusions are also reported for the three states with only INFCIRC 66 Safeguards in place and for the five NPT nuclear weapons states with voluntary offer agreements.

Exceptions:

the Agency may not always be able to draw a positive conclusion, and instead report, for example, that a state "had been found to have been previously engaged in nuclear activities which it had failed to report. Corrective actions are being taken by the State. Verification of the correctness and completeness of this State's declarations is ongoing."

when the Agency has difficulties implementing Safeguards, the text of the statement may instead say that it "can't draw conclusion" or is "unable to implement mandated activities"

EURATOM: European Atomic Energy Community

- Nuclear energy in Europe was poised for rapid development in the mid- to late- 1950's
- 1957: Euratom established by treaty
  - six Member States originally, 25 parties in 2006
  - operates its own professional Safeguards inspectorate
  - Summary report by European Commission to the European Assembly (annual)
- IAEA-Euratom Cooperation
  - 1973 agreement concerning Safeguards for NPT (INFCIRC/193)
  - 1990's: New Partnership Approach (NPA)
  - Efforts are ongoing to coordinate overlapping responsibilities to ensure effectiveness and efficiency

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Europe had major industrialized nations technically capable of exploiting nuclear energy, but not the uranium or thorium resources. Supply arrangements with the US and Canada needed assurances of peaceful use. Euratom was able to take over bilateral agreements verified by US inspectors.

European Union:

Austria, Belgium*, Cyprus, Czech Republic, Denmark, Estonia, Finland, France*, Germany*, Greece, Hungary, Ireland, Italy*, Latvia, Lithuania, Luxembourg*, Malta, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, The Netherlands*, United Kingdom

(* denotes the six original signatory States in 1957)

Ref: http://europa.eu/abc/governments/index_en.htm

Original IAEA-Euratom cooperation agreement = InfCirc 25/Add. 5

NPA = "New Partnership Approach" arrangements seek to reduce inspection burden on the IAEA while maintaining effectiveness of Safeguards verification

Note: there was a second regional undertaking that has since been suspended:

ENEA (European Nuclear Energy Agency) of the OECD (Organisation for Economic Co-Operation and Development)

"Security Control" began in 1959; small inspection staff, suspended in 1976 (re: IAEA, Euratom)

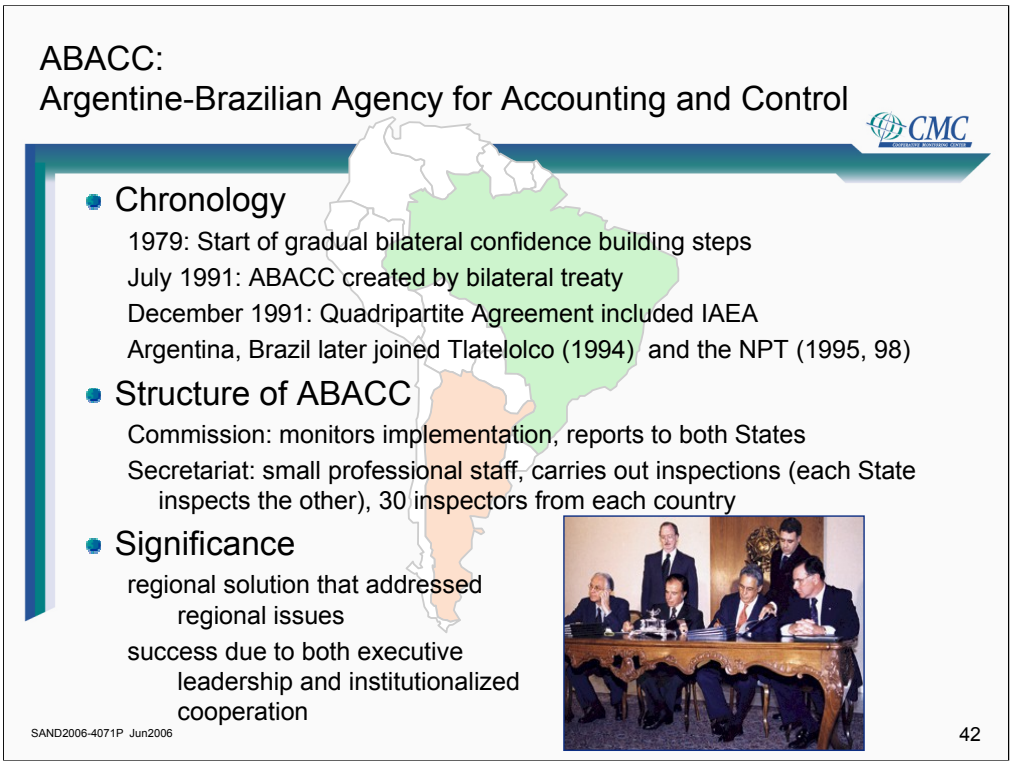


Photo is of the signing ceremony for the 5-year anniversary of ABACC

History (CBMs, economic and political events) leading up to the formation of ABACC:

1979 Treaty on joint use of water resources

1980 Treaty on nuclear cooperation; Presidential visit

1983 Argentina transitions to civilian government

1985 Brazil transitions to civilian government; Presidential visit (Feb); Establish Joint Working Group; Declaration of Foz de Iguazu (Nov): Joint declaration on nuclear policy

1986 Argentine-Brazilian Economic Integration Pact (industry specific trade agreements)
Declaration of Brasilia (Dec)

1987 Declaration of Viedma (Jul): Joint visit to Argentine uranium enrichment facility

1988 Declaration of Ipero (Apr): Joint visit to Brazilian enrichment facility
Declaration of Ezeiza (Nov): Joint visit to Argentine national laboratory
Common Market Pledge: Common market within 10 years

1991 Mercosur (Southern Common Market): Four nation common market by 1994

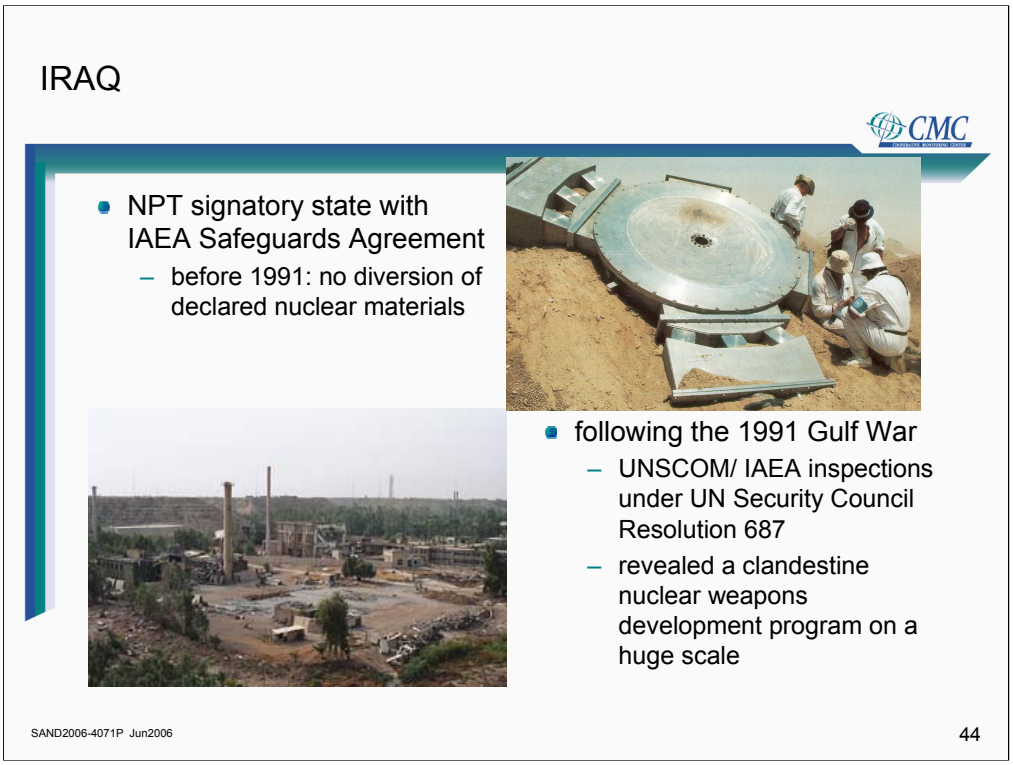
Four Commissioners (2 Argentine; 2 Brazilian): monitor implementation, supervise the Secretariat, inform states parties of activities and discrepancies

Secretariat

Permanent Staff (10): Director; Deputy Director (annual rotation); six Senior Professional Technical Officials; two Professional Administration Officials

Inspectors (30/country): nominated, on call/loan, responsible for implementation, administration, schedule inspections, designate inspectors, evaluate inspections and reports, inform the Commission immediately of any discrepancy, report regularly to the Commission on ABACC activities

How have Safeguards evolved to meet challenges to nuclear nonproliferation regime?



Special inspections under UNSC Resolution 687 included intelligence information provided by UN member states

Inspectors had greater authority to follow leads and expand their scope

Not typical of a treaty-based *inspection*, more characteristic of a criminal *investigation*

Size and sophistication of the Iraq nuclear weapons program was altogether unexpected

- 5-10 billion $
- employed 7,000 scientists and 20,000 workers
- possession of export-controlled equipment
- electromagnetic enrichment approach came as surprise

Treaty-proscribed activities occurred at the same site as NPT-declared and inspected activities (800kW French reactor and 5MW Soviet reactor at Tuwaitha under Safeguards)

Deception and efforts to conceal the program were ongoing

NORTH KOREA

- Prompt detection of undeclared activities
  - possibility of undeclared plutonium
  - late 1992: IAEA alerted UN Security Council
- IAEA was already using additional tools
  - enhanced data analysis
  - third party information
  - authority to request additional information and special inspections
- Initial crisis
  - DPRK withdrew from IAEA membership but its Safeguards agreement remained binding
  - 1994 deal: Freeze program and accept two power reactors
- Status
  - DPRK claims to be reprocessing fuel to recover plutonium
  - IAEA verification work was halted in December 2002
  - Application of safeguards under the DPRK's INFCIRC/66 safeguards agreement has been suspended
  - DPRK status under the NPT is not clear
  - Six-Party Talks attempting to resolve the current impasse

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DPRK signed NPT in December1985

Safeguards Agreement entered into force in April 1992 (late!)

Inset photo: Severed e-cup seals (Dr. Yousry Abushady, unit head responsible for DPRK safeguards implementation, on right)

The IAEA "Programme 93+2" responded to the new demands on Safeguards.

- How can the charter of IAEA Safeguards be expanded to:
  - Detect clandestine nuclear activities?
  - Make safeguards more efficient?
- Important to verify not only the *correctness* of a declaration, but also its *completeness*
- "Programme 93+2" began in 1993, intended to be completed within two years
- Additional measures were identified to strengthen Safeguards

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1993 + 2 = 1995, i.e., in time for the NPT Review and Extension Conference

Issue of universality, nondiscrimination was a big hurdle:

93+2 sought to strengthen ability to detect/deter horizontal proliferation, which exacerbated the divisions between the nuclear weapon "haves" and "have-nots"

Additional Safeguards measures were split into two categories.

- Part I
  - No additional legal authority would be required
  - IAEA Board of Governors agreed to implement these measures in June 1995
- Part II
  - Additional legal authority would be required
  - "Model Additional Protocol" drafted as the basis for negotiating this authority with parties to existing Safeguards Agreements
  - approved by the IAEA Board of Governors in May 1997

INFCIRC 540 (corrected)

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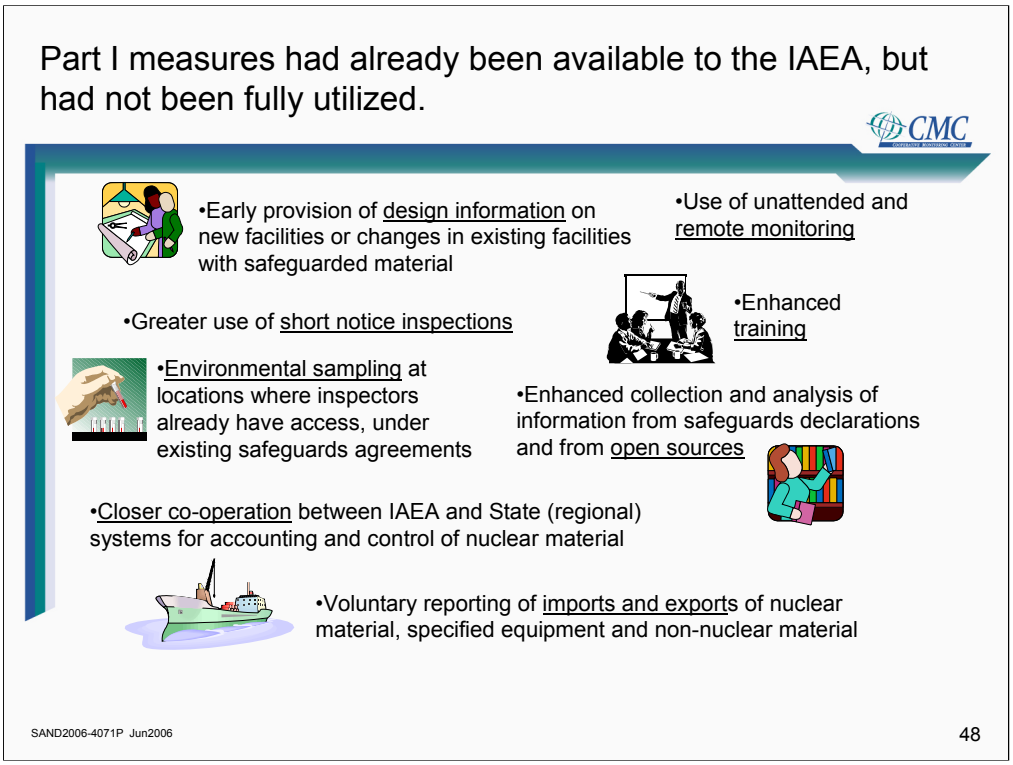
Decision to divide the measures into two parts was made by the IAEA Board of Governors at the March 1995 meeting.

Part I measures were things that the IAEA already was empowered to do (but just hadn't been doing them)



Ref: condensed slightly from the IAEA 1999 Annual Report, Overview Section, p. 13, Box 6: Measures to Strengthen Safeguards

"Expanded declaration" = design and import/export information

Short-notice inspections: include no-notice inspections at "strategic points"

Collection & analysis includes better use of computerized systems for information cross-referencing

Part II measures extended the scope of IAEA Safeguards.

- Provision of information about, and inspector access to, all aspects of a State's nuclear fuel cycle;
- Provision of information on, and short notice inspector access to, any place on a nuclear site;
- Provision of information about and access to nuclear fuel cycle related R&D;
- Provision of information on the manufacture and export of sensitive nuclear related technologies, and access to manufacturing and import locations;
- Environmental sampling at locations beyond those provided under safeguards agreements;
- Improved access: Simplified procedures for designation of inspectors, and issuance of multiple-entry visas
- Right to use internationally established communications systems.

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Ref: condensed slightly from the IAEA 1999 Annual Report, Overview Section, p.13, Box 6: Measures to Strengthen Safeguards

Complementary Access

Additional legal authority covered by the Model Additional Protocol

- expanded declaration:
  - fuel-cycle related R&D
  - reporting of sensitive technology imports & exports
- streamlined procedures for designating inspectors
- improved access for inspectors
- environmental monitoring

The Additional Protocol is gradually being implemented.

- Status of Protocols Additional to Safeguards Agreements (as of 17 May, 2006)
  - Additional Protocol in force in 75 States and Euratom
  - 107 states have signed an Additional Protocol
  - 114 states have been approved by the Board of Governors
- Implementation
  - Declarations and verification inspections underway since 1997
  - Field trials to test verification measures (e.g., two sites in Japan)
  - Euratom agreement in force since April 2004
- Current IAEA Safeguards incorporate two main elements
  - a much enhanced role of "all source" information collection, review and analysis
  - an emphasis on state-level evaluation, supporting the state-level safeguards conclusions

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Status of Additional Protocol implementation from http://www.iaea.or.at/OurWork/SV/Safeguards/sg_protocol.html

Latest Status (17 May 2006):

114 States had board approval, 107 had signed, 75 in force (not including Euratom, which is in force)

As of 7/11/2003: 80 States had board approval, 74 had signed, 35 in force

As of 9/28/2001: 57 had signed

U.S. has signed an AP (1998) that is on the verge of ratification

Information sources include open publications, commercial satellite imagery, environmental sampling, third party information

Summary

- International Nuclear Safeguards have been enormously successful for non-proliferation.
- Safeguards require international cooperation and a legal framework for implementation.
- A variety of technical tools enables safeguards to provide accountancy and continuity of knowledge of nuclear materials.
- Challenges to the international safeguards regime have led to major, but evolutionary improvements.

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