

# Nuclear Nonproliferation

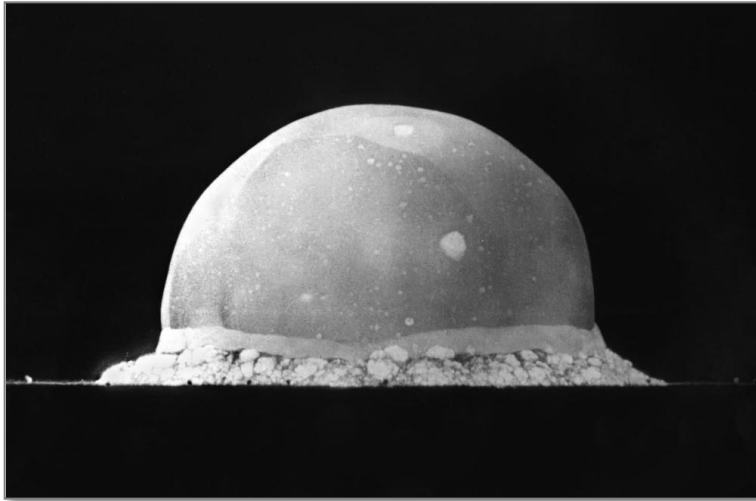
July 21, 2011



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E Program Manager

**Global Security Principal Directorate**

# The Nuclear Dilemma



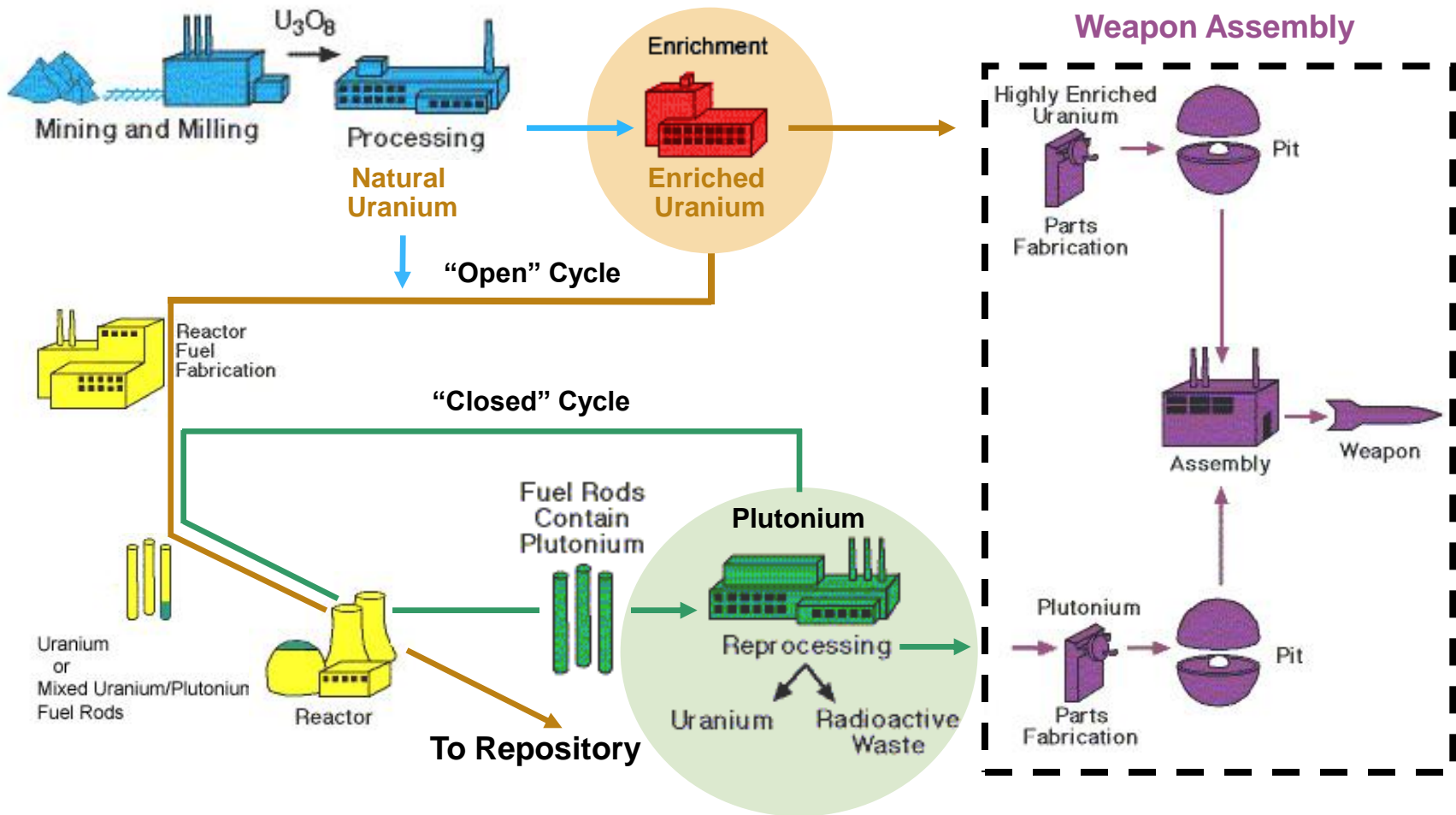
- Trinity Test—first test of nuclear weapons technology
- 20 kT TNT
- July 16, 1945 in Alamogordo, NM



- Experimental Breeder Reactor Number One (EBR-I)—first experimental nuclear power plant
- Lit four light bulbs
- December 20, 1951 in Arco, ID

**How does the world achieve balance?**

# Civil and Military Fuel Cycles Can Overlap



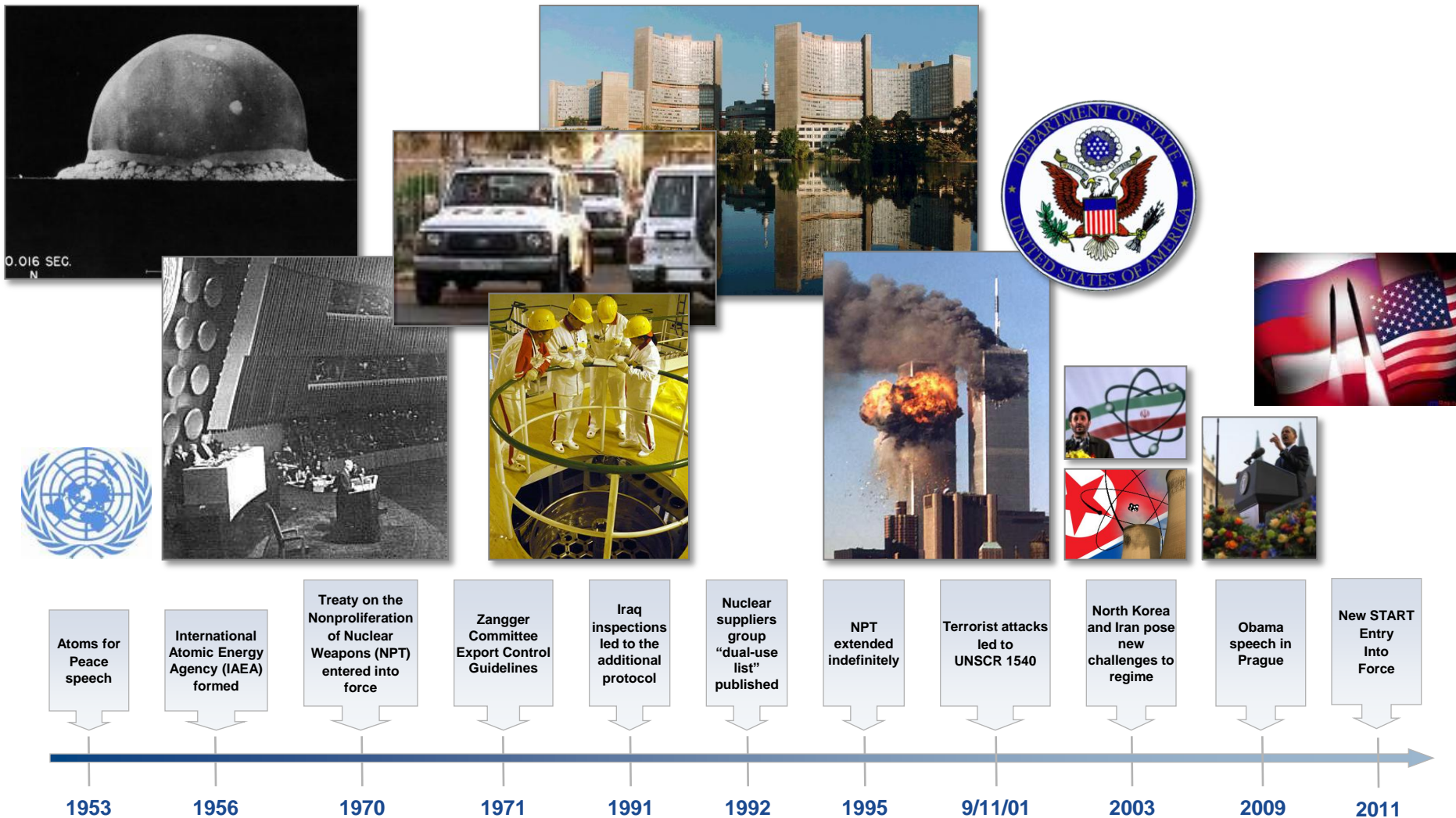
# Outline of Talk

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- Evolution of the Nonproliferation Regime
- Implementing the Nonproliferation Regime
  - International safeguards
  - Export control and interdiction
  - Reducing, securing, and converting vulnerable nuclear materials
  - Arms control and transparency



# Historical Perspectives





# Atoms for Peace

“The United States knows that if the fearful trend of atomic military build up can be reversed, this greatest of destructive forces can be developed into a great boon, for the benefit of all mankind.”



“The Governments principally involved...make contributions from their stockpiles of normal uranium and fissionable materials to an international Atomic Energy Agency...under the aegis of the United Nations.”

“The Atomic Energy Agency could be made responsible for the impounding, storage, and protection of the contributed fissionable and other materials. The ingenuity of our scientists will provide special safe conditions under which such a bank of fissionable material can be made essentially immune to surprise seizure.”

*President Dwight Eisenhower before the General Assembly of the United Nations on Peaceful Uses of Atomic Energy, New York City, December 8, 1953*

# The International Atomic Energy Agency

- Created in response to Eisenhower's 1953 "Atoms for Peace" proposal Created by the Statute of the IAEA (1957)
- An independent inter-governmental organization; not directly part of the UN
  - Unique relationship with the UN Security Council
  - Has its own 140 member states
- Mission
  - Promote peaceful use of nuclear energy
  - Promote a nuclear safety culture
  - Verify nuclear material is being used exclusively for peaceful purposes
- Statute authorizes IAEA to establish and administer safeguards



# The International Atomic Energy Agency

- Prior to establishment – sale and transfer of things nuclear were bilateral matters between the supplier and receiver state
- At establishment – suppliers and receivers and IAEA conclude agreements of safeguards to specific facilities, materials and equipment
- The continue spread of nuclear technology and facilities under Atoms for Peace meant more countries were developing technical infrastructure that could be used to pursue nuclear weapons if there was political will

**Need for a political arrangement to restrain spread of nuclear weapons**

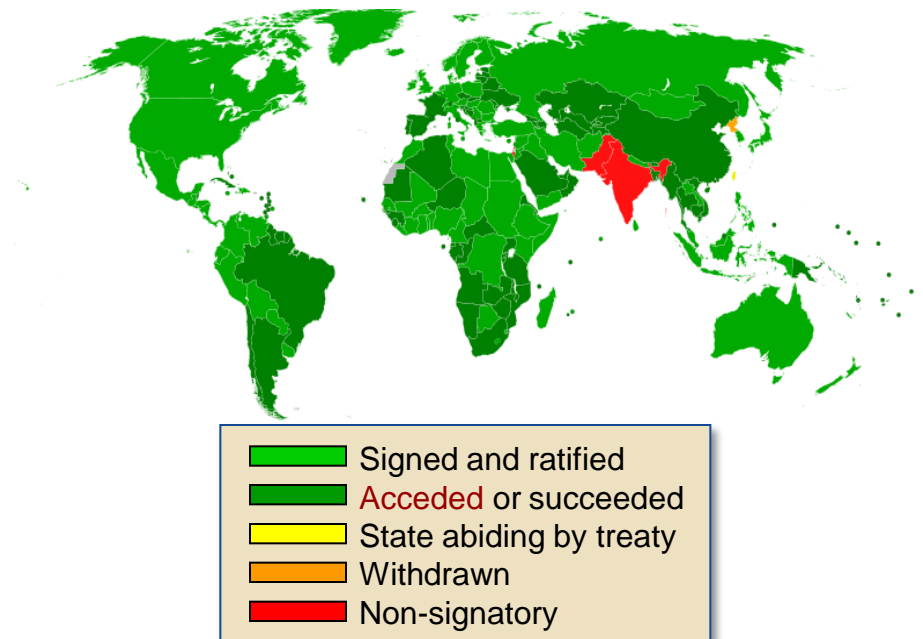


# Nonproliferation Treaty

Signators agree:

- NWS
  - No transfer nuclear weapons and no assistance, encouragement or inducement to NNWS to manufacture or otherwise acquire them
- NNWS
  - No receipt of nuclear weapons from any transferor, and not to manufacture or acquire them
  - Place all nuclear materials in all peaceful nuclear activities under IAEA safeguard
- All parties
  - Obligated to facilitate and participate in exchange of equipment, materials and S&T information for peaceful uses of nuclear energy
  - Pursue negotiations in good faith on effective measures relating to the cessation of the nuclear arms race and to nuclear disarmament under strict and effective international control

- Opened for signature in 1968
- Entered into force March 5, 1970
- 188 Parties
- Global in scope
- Extended indefinitely by decision of states parties, May 11, 1995
- Eighth Review Conference to take place in NYC, May 2010



# Comprehensive Safeguards Agreements

- Measures established within INFCIRC/153
  - All NNWS must conclude CSA with the IAEA
- Information
  - Initial report on all nuclear material
  - Initial list of all nuclear facilities, facility design information
  - Record keeping for nuclear activities
  - Reporting of inventory changes (flow), including imports and exports
  - Confidentiality of information provided to the IAEA by states
    - Requires protection of commercial and industrial secrets
    - Agency required to set up a stringent regime, including classification levels, marking, physical control, etc.
- Access
  - Verification of facility design information
  - Inspections: Ad hoc, Routine, Special

**IAEA does not have authority to provide States' nuclear material accountancy information to some other U.S. or international material monitoring system (Safeguards confidential)**

# Additional Protocol

- Some measures required new legal authority—INFCIRC/540
- Additional information
  - Exempted, terminated, and pre-safeguards material
  - All activities at sites of nuclear facilities
  - Nuclear fuel cycle infrastructure not involving nuclear material
- Broader access to locations – complimentary access
  - Any place on a site; any location where nuclear material is present
  - Decommissioned facilities and locations outside facilities
  - Other locations identified with nuclear related R&D; functionally related
  - Any location specified by the Agency for environmental sampling

# Zangger Committee

- Formed in 1971 to assemble a “trigger list”
  - Source or special fissionable materials, and
  - Equipment or materials especially designed or prepared for the processing, use, or production of special fissionable materials
- Under NPT these items should be subject to IAEA safeguards if supplied by NPT parties to any non-nuclear weapon states
- Three conditions of supply:
  - A non-explosive use assurance
  - An IAEA safeguards requirement
  - A retransfer provision that requires the receiving state to apply the same conditions when re-exporting these items
- Also referred to as the Nuclear Exporters Committee



# Nuclear Suppliers Group (NSG)

- Founded in 1974
- Agreement on guidelines for export were published by IAEA as INFCIRC/254
- Listed items could only be exported to non-nuclear states if certain IAEA safeguards were agreed to or if exceptional circumstances relating to safety existed
- Decisions on export applications are made at the national level in accordance with national export licensing requirements
- In 1992, the NSG agreed on guidelines that would apply even to certain “dual use” items that could be used for nuclear or non-nuclear purposes



# UN Security Council Resolution 1540

- Obliges States to refrain from supporting by any means non-State actors from developing, acquiring, manufacturing, possessing, transporting, transferring, or using nuclear, chemical, or biological weapons and their delivery systems
- Imposes binding obligations on all States to establish domestic controls to prevent the proliferation of nuclear, chemical, and biological weapons, and their means of delivery, including by establishing appropriate controls over related materials
- Encourages enhanced international cooperation on such efforts, in accord with and promoting universal adherence to existing international nonproliferation treaties
- Unanimously adopted by the UN Security Council in 2004
- Extended in 2006 by UNSCR 1673





# Proliferation Security Initiative

- Announced by President Bush May 31, 2003
- From the National Strategy to Combat Weapons of Mass Destruction issued in December 2002
- Global initiative aimed at interdicting shipments of weapons of mass destruction, their delivery systems, and related materials worldwide
- Focus on interdiction –search of planes and ships carrying suspect cargo
- Relies on voluntary actions using existing authorities—national and international—to disrupt WMD-related trafficking
- Partnership of more than 90 countries



# Obama Administration Policy Thrusts



- Prague, Czech Republic – April 5, 2009
- Calls for:
  - Negotiation of START follow-on
  - Initiate Deep Cuts negotiations
  - Ratify CTBT and work for entry into force
  - Secure all nuclear material in 4 years
  - Negotiate Fissile Materials Cut off Treaty (FMCT) with verification regime
  - Strengthen NPT regime
  - Create international nuclear fuel bank

# START Treaty signing in Prague



START I – 1992

START II – 1996

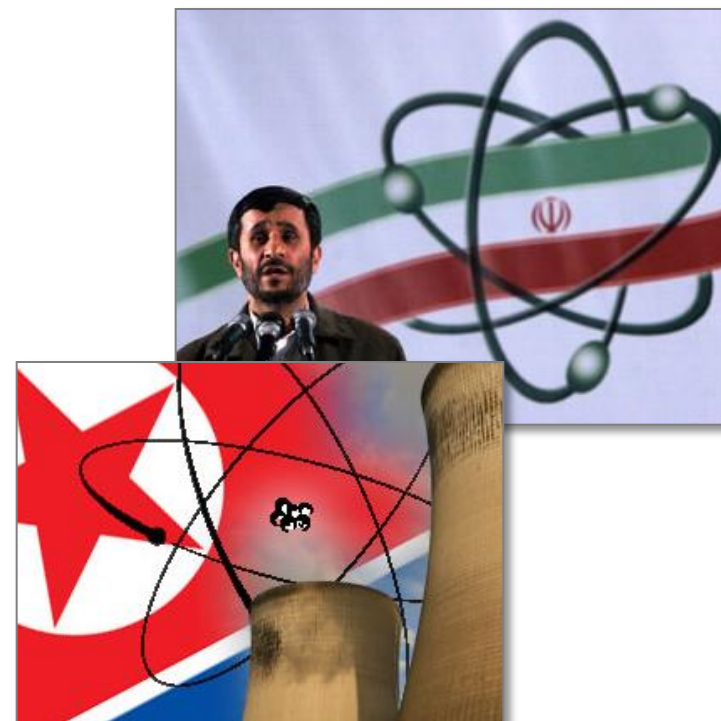
New START

- May 2009  
Negotiations begin
- March 2010  
Agreement reached
- April 2010  
Agreement signed
- December 2010  
Senate ratified
- February 5, 2011  
Entry into Force

Stablize the strategic balance between the US and Russian Federation at lower levels of nuclear forces

# Non-Compliance

- IAEA Board Findings of Non-Compliance:
  - Iraq 1991: Extensive undeclared activities, including enrichment, reprocessing, weapons design
  - Romania 1992: Undeclared irradiation and reprocessing experiment by former regime
  - DPRK 1993, 1994, 2003: Clear evidence of incomplete declaration, failure to cooperate with required inspections
  - Libya 2003: Undeclared fuel cycle efforts, voluntarily dismantled
  - Iran 2005: Undeclared nuclear materials, facilities, enrichment and reprocessing activities for 18+ years



# International Safeguards—Technical Objective

*“... the objective of 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 the risk of early detection.”*

INFCIRC 153 Para. 28

Two aspects:

- Verification of declarations – no diversion of declared material to undeclared activities
- Detection of undeclared uses/activities

# International Safeguards—IAEA Significant Quantities

Nuclear material	Significant quantity
Plutonium (<80% Pu-238)	8 kg Pu
Uranium-233	8 kg U-233
HEU (20% or more U-235)	25 kg U-235 content (for 80% HEU, 1 SQ = 31.25 kg)
LEU (<20% U-235)	75 kg U-235 content (for 3.75% LEU, 1 SQ = 2 tons U)
Natural uranium	10 tons
Depleted uranium	20 tons
Thorium	20 tons



# International Safeguards—Nuclear Material Accountancy

- State declares nuclear facilities and nuclear materials
- Independent inspections periodically verify the declaration:
  - Confirm facility design information
  - Examine operator records and reports
  - Identify and count items
  - Assay nuclear materials
- Containment and surveillance measures ensure continuity of knowledge
  - Seals, video cameras, radiation monitors

**Principles and practices borrowed from property accounting, statistical quality control and financial accounts auditing**

## DESIGN INFORMATION QUESTIONNAIRE\*

CONTENTS, FORMAT AND STRUCTURE OF  
REPORTS TO THE AGENCY

### 1. ACCOUNTING REPORTS



# International Safeguards

- A Material Balance Area (MBA) is “an area in or outside of a facility such that:
  - (a) The quantity of nuclear material in each transfer into or out of each ‘material balance area’ can be determined; and
  - (b) The physical inventory of nuclear material in each ‘material balance area’ can be determined when necessary, in accordance with specified procedures, in order that the material balance for Agency safeguards purposes can be established.”
- A Key Measurement Point (KMP) is...
  - “...a location where nuclear material appears in such a form that it may be measured to determine material flow or inventory. KMPs thus include, but are not limited to, the input and outputs (including measured discards) and storages in MBAs.”

**Design information is crucial in selecting MBAs and KMPs**

# International Safeguards—Rokkasho (Japan)

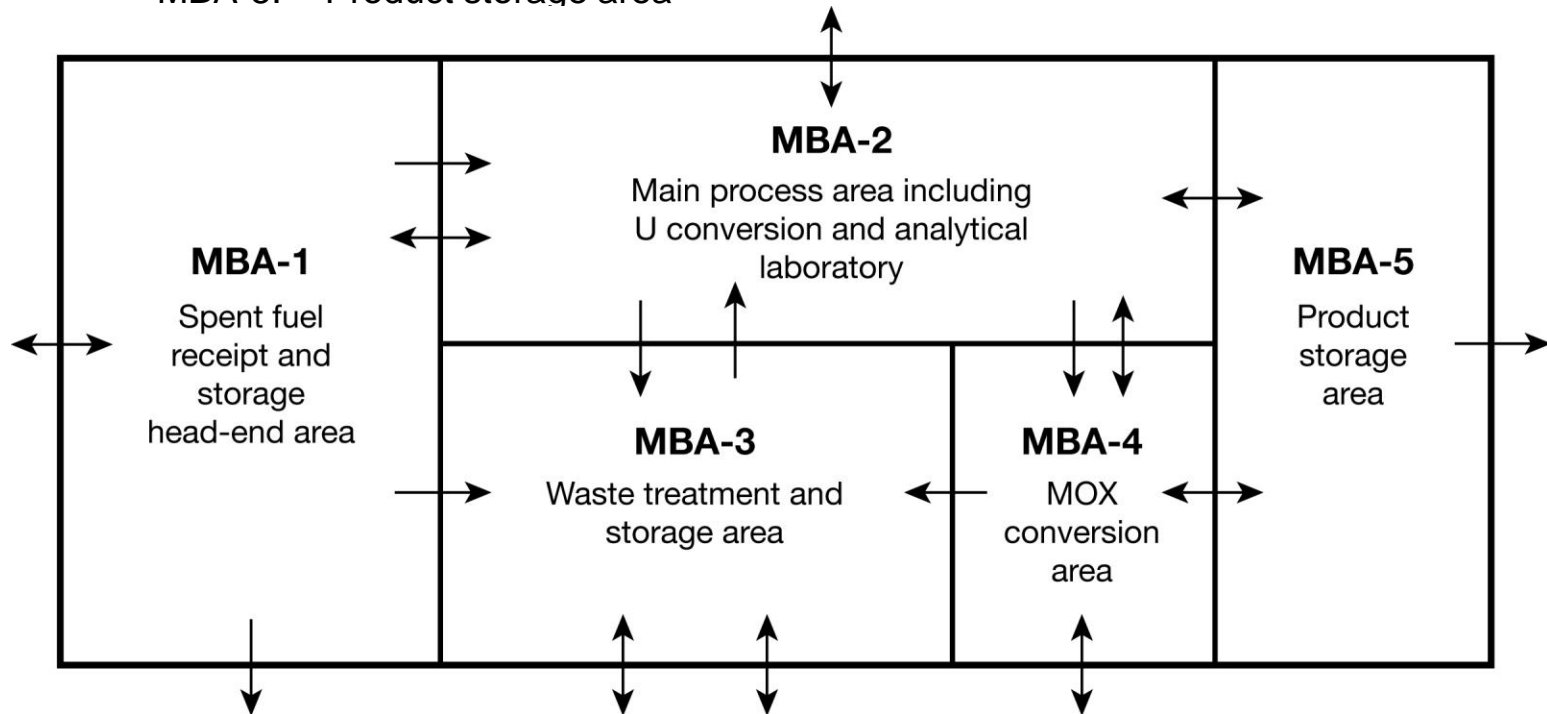
- The Japanese Nuclear Fuels Limited (JNFL) Reprocessing plant has a planned operating throughput of 800 tU/y, containing approximately 8 t of Pu
- New experience for IAEA safeguards—scale of operation, type of operation, involvement from design phase
- Safeguard features include:
  - Design validation during construction
  - IAEA resident inspectors
  - On-site analysis laboratory



# International Safeguards—Rokkasho Reprocessing Plant (Japan)

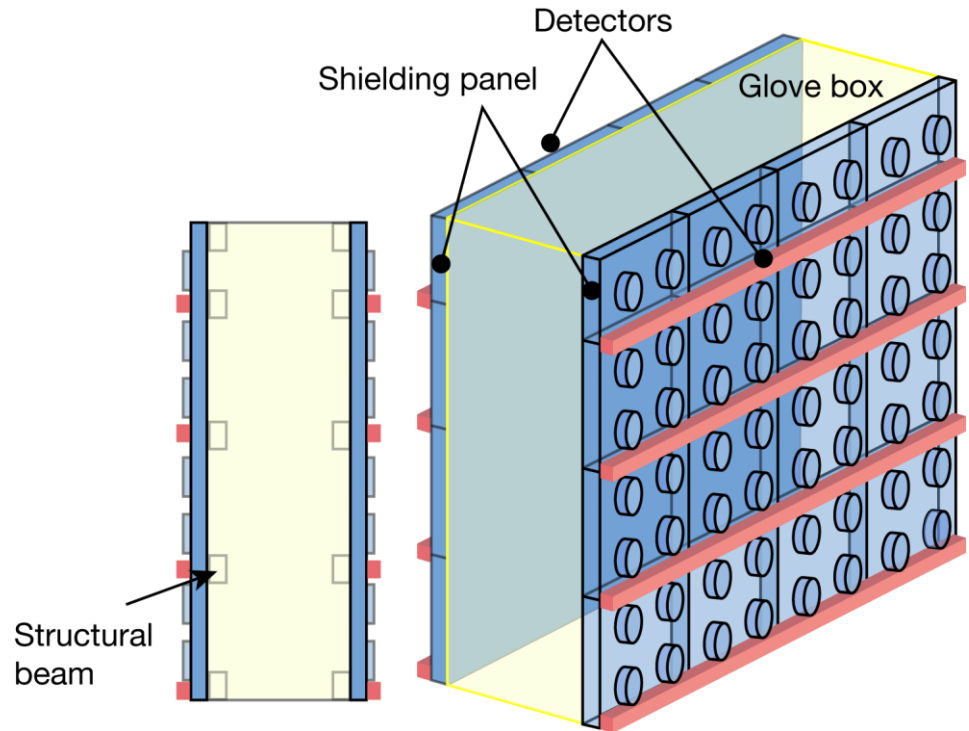
(MBA):

- MBA-1: Spent fuel receipt and storage area, head-end area
- MBA-2: Main process area (including  $\text{UO}_3$ , conversion and laboratories)
- MBA-3: Waste treatment and storage area
- MBA-4: MOX conversion area
- MBA-5: Product storage area



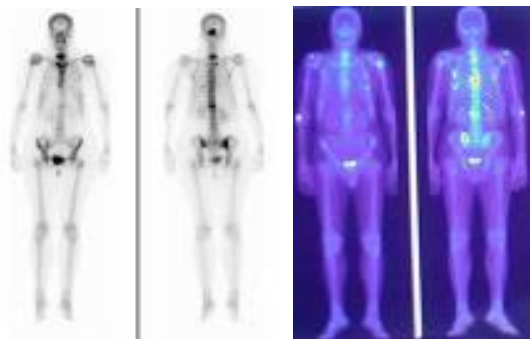
# International Safeguards—GUAM Prototype Glove Box System

- Unattended glovebox assay system (GUAM)
- List-mode data collection
- 2 Gloveboxes each with 8 channels of data
- Provides state of health and analysis flexibility
  - Spatial dependent efficiency correction
  - Authentication of cable runs
- Fielded two years ago at Plutonium Fuel Production Facility (PFPP) in Japan
- Planned for IAEA use at Japan's MOX fuel fabrication facility (JMOX)



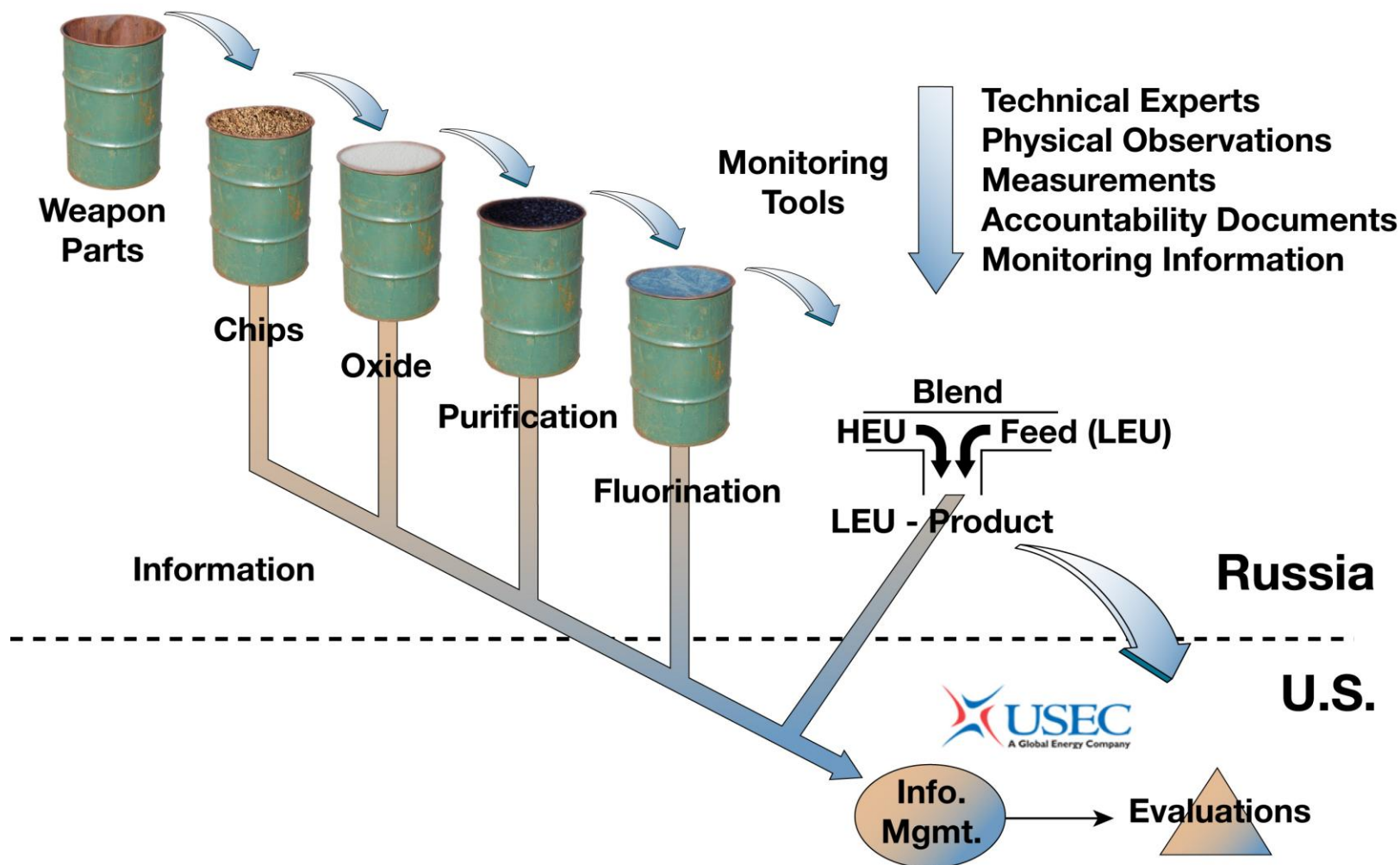
# Reducing Vulnerable Materials— Medical Isotope Production Without HEU (U.S.)

- A National Academics study mandated by U.S. Congress in Energy Policy Act of 2005
- Sponsored by Department of Energy, National Nuclear Security Administration
- Mandate reflects an effort by Congress to strike a balance between two important national interests:
  - Availability of reasonably priced medical isotopes in the United States
  - Proliferation prevention
- Study Charge—Part 1
  - Feasibility of procuring supplies of medical isotopes from commercial sources that do not use HEU
  - Current and projected demand and availability of medical isotopes in regular current domestic use
  - Progress being made by DOE and others to eliminate all use of HEU in reactor fuel, reactor targets, and medical isotope production facilities
  - Potential cost differential in medical isotope production in reactors and target processing facilities if the products were derived from production systems that do not involve fuels and targets with HEU





# Converting Vulnerable Materials— HEU to LEU Conversion (Russia)



# Because the Russian HEU to LEU conversion also has arms control benefits, the parties agreed to implement certain transparency measures

- To provide assurance that the HEU being purchased is from dismantled weapons and that the same HEU is converted, processed, and blended to LEU

2004  
Installation  
in Seversk



Glove box used to burn uranium metal and produce uranium oxide



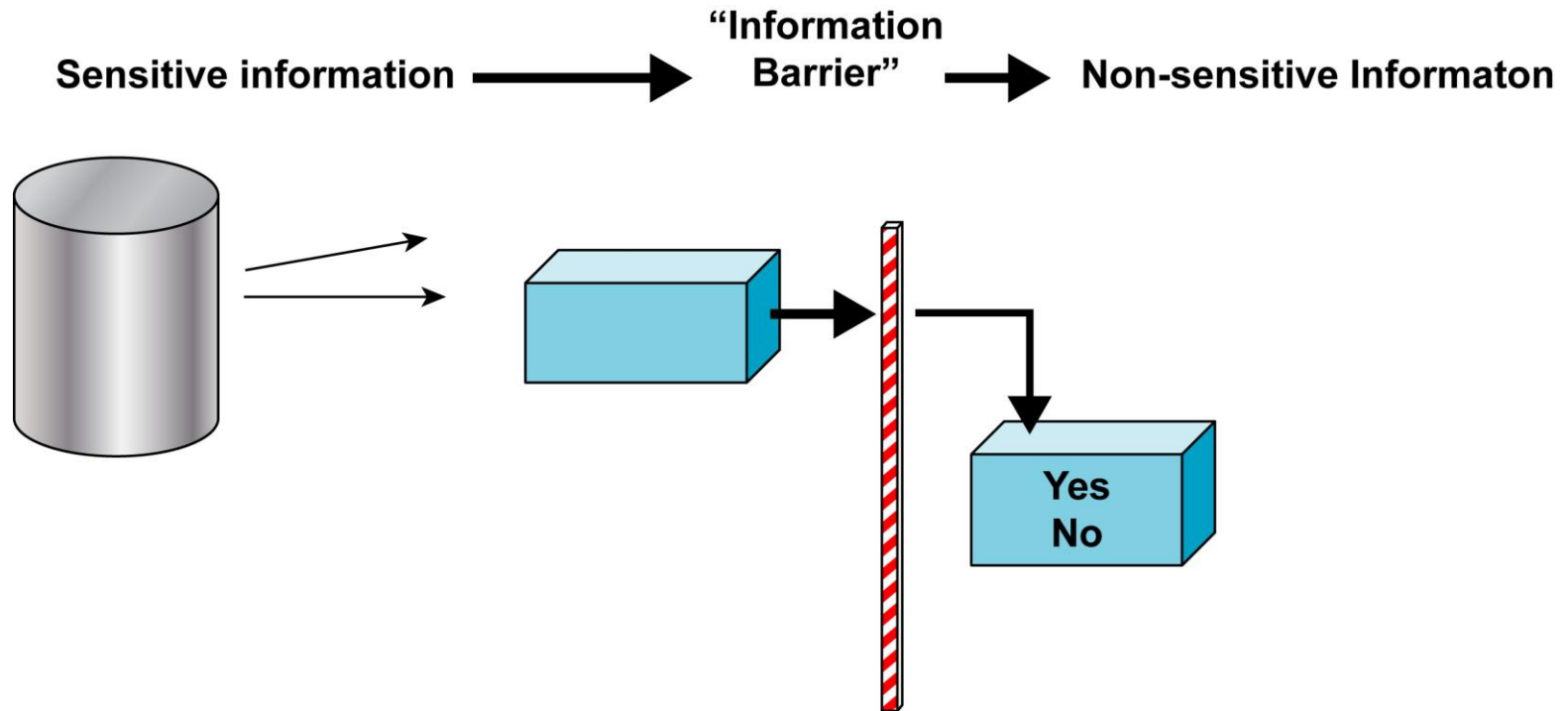
Blend Down Monitoring System equipment placed on the pipes of Russian down blending facilities

# Transparency

- Goals are political and differ significantly from those traditionally applied to academia, national laboratories, and private industry
  - Traditional Technology—Advance the State-of-the-Art, desirable new product
  - Transparency Technology—Achieve policy objectives
- Success measures
  - Traditional Technology—Faster, better, cheaper
  - Transparency Technology—Instrumental in moving negotiations forward, adopted as an inspection tool

**Protects national security interests while providing sufficient confidence that agreement is upheld**

# Transparency—Information Barriers



**Permits necessary measurements and provides useful results  
without revealing classified information**

# Acknowledgements

- “An Overview of IAEA Safeguards,” Dr. George Anzelon, Lawrence Livermore National Laboratory – private communication
- “A Technical Perspective on Arms Control Transparency,” Dr. Thomas Gosnell, Lawrence Livermore National Laboratory, LLNL-Pres-403102
- “Cooperative Monitoring of HEU, Pu and Nuclear Power Production,” Dr. Duncan MacArthur, Los Alamos National Laboratory, LA-UR08-06501
- “IAEA Safeguard: A Legal Primer,” a presentation by Laura Rockwood, IAEA Office of Legal Affairs
- “International Nuclear Safeguards,” Dr. George Baldwin, Sandia National Laboratories, SAND 2006-4071P
- “Next-Generation Safeguards Initiative Opportunities,” Dr. Mona Dreicer, Lawrence Livermore National Laboratory, LLNL-PRES- 403114
- “Safeguards Approaches for Gas Centrifuge Enrichment Plants,” Dr. Brian Boyer, Los Alamos National Laboratory, LA-UR-08-03736
- “The System of Strengthened Safeguards,” Mr. Rich Hooper (Director of Concepts and Planning, IAEA Department of Safeguards), IAEA Bulletin 394

*This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344*