Nuclear Nonproliferation

December 18, 2008

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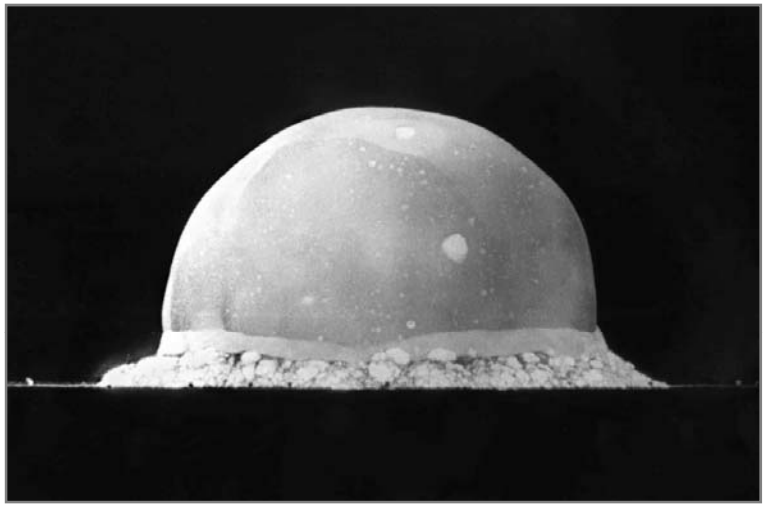
LLNL-PRES-409245

The Nuclear Dilemma

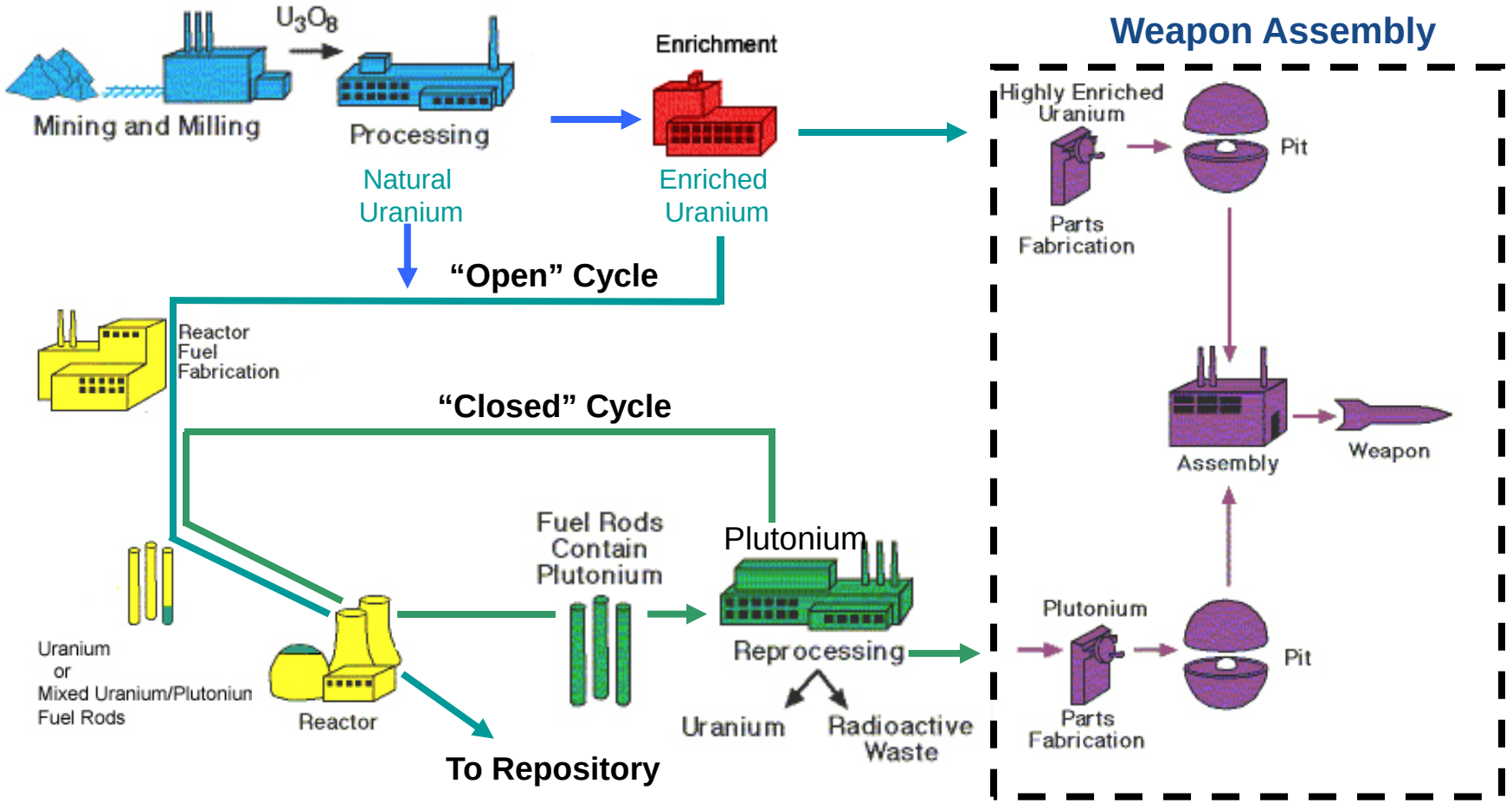


- Trinity Test—first test of nuclear weapons technology
- July 16, 1945 in Alamogordo, NM

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

How does the world achieve balance?

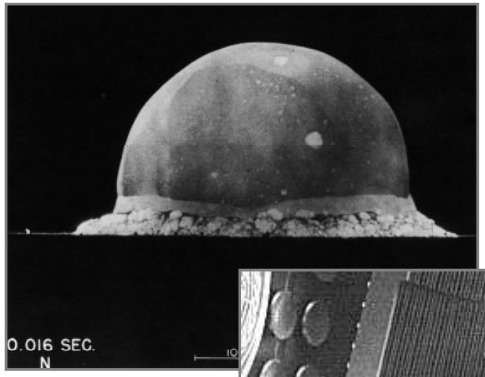
Civil and Military Fuel Cycles Can Overlap

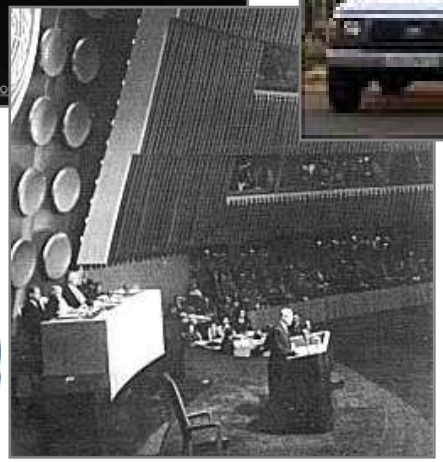


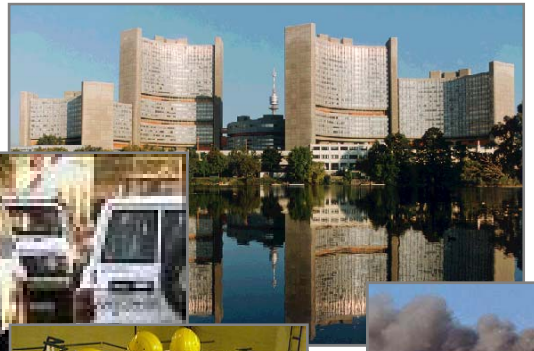
Outline of Talk

- 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
- Challenges ahead

Historical Perspectives







- **1953** — Atoms for Peace speech
- **1956** — International Atomic Energy Agency (IAEA) formed
- **1970** — Treaty on the Nonproliferation of Nuclear Weapons (NPT) entered into force
- **1971** — Zangger Committee Export Control Guidelines
- **1991** — Iraq inspections led to the additional protocol
- **1992** — Nuclear suppliers group "dual-use list" published
- **1995** — NPT extended indefinitely
- **9/11/01** — Terrorist attacks led to UNSCR 1540
- **2003** — North Korea and Iran pose new challenges to regime

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."

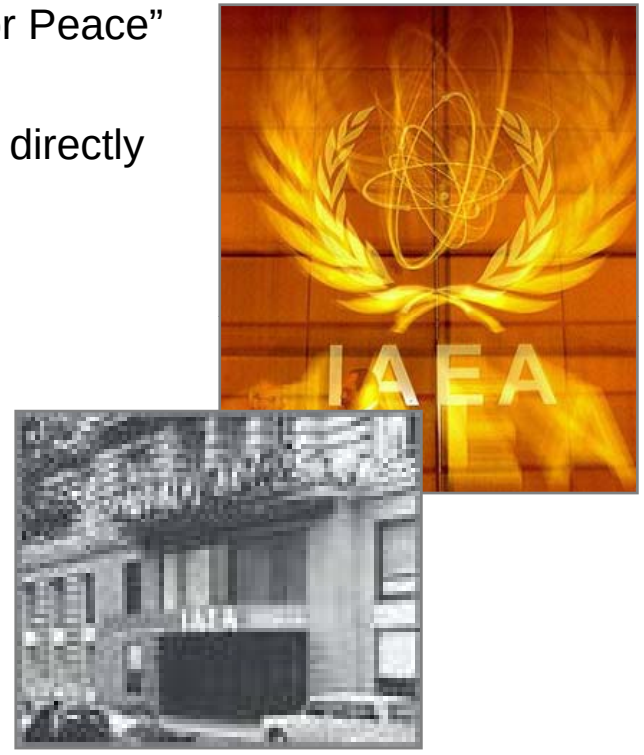
"The Governments principally involved…make contributions from their stockpiles of normal uranium and fissionable materials to an international Atomic Energy Agency…under the aegis of the United Nations."

"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

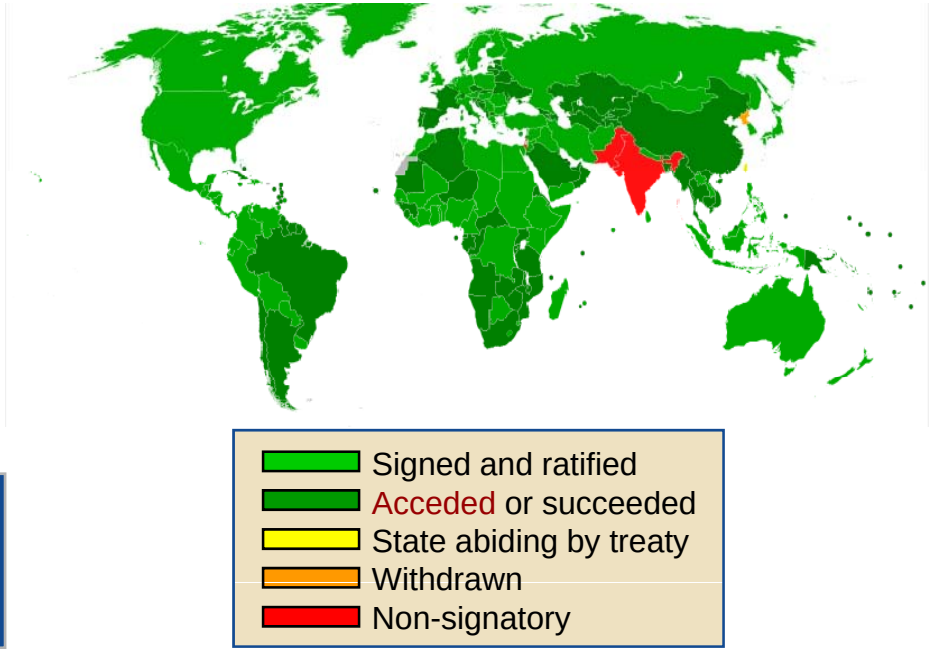


Nonproliferation Treaty

- Each NNWS Party "undertakes to accept safeguards, as set forth in an agreement with the IAEA for the exclusive purpose of verification of the fulfillment of its obligations assumed under this Treaty with a view to preventing diversion of nuclear energy from peaceful uses to nuclear weapons or other nuclear explosive devices."
- Safeguards "shall be applied on all source or special fissionable material in all peaceful nuclear activities within the territory of such State, under its jurisdiction, or carried out under its control anywhere."

NPT established comprehensive safeguards for non-nuclear weapons states parties

- 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



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

Comprehensive Safeguards Agreements

- Measures established within INFCIRC/153
  - NPT Implementing agreement
- 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

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
  - 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

Nuclear Suppliers Group

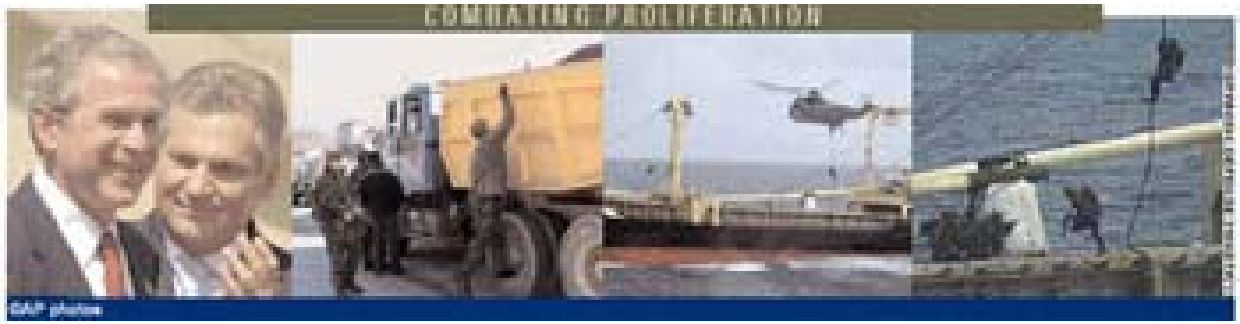
- Founded in 1974
- Observation—some non-weapons specific nuclear technology could be readily used in weapons development
- Agreement on guidelines for export were published by IAEA as INFCIRC/254
- Listed items could only be exported to non-nuclear states if certain IAEA safeguards were agreed to or if exceptional circumstances relating to safety existed
- Decisions on export applications are made at the national level in accordance with national export licensing requirements
- Sometimes referred to as “London Club,” “London Group,” or “London Suppliers Group”

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

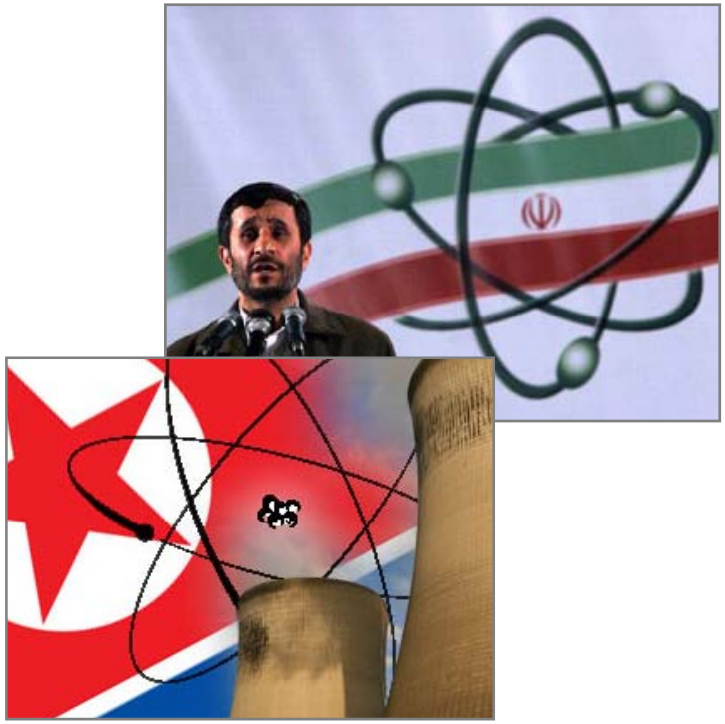
Proliferation Security Initiative

- 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 stopping shipments of weapons of mass destruction, their delivery systems, and related materials worldwide
- Focus on interdiction
- Relies on voluntary actions using existing authorities—national and international—to put an end to WMD-related trafficking—supports UNSCR 1540
- Supported by more than 90 countries

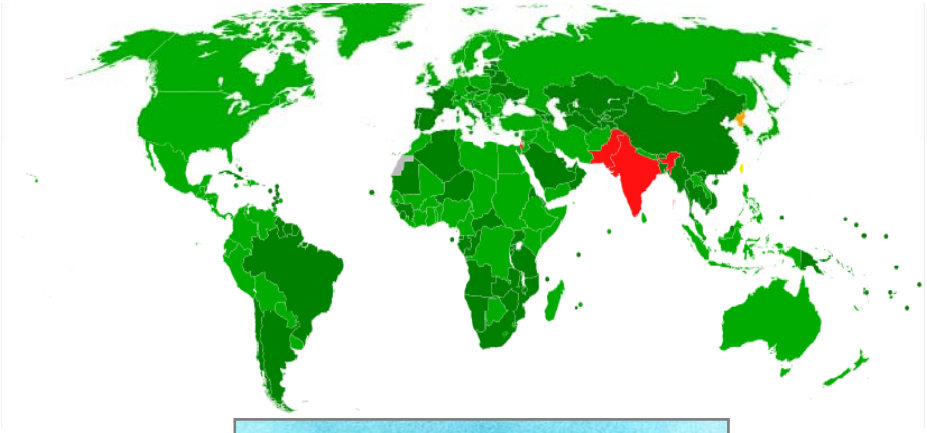


Non-Compliance

- 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



Nuclear Nonproliferation Regime—Political Will

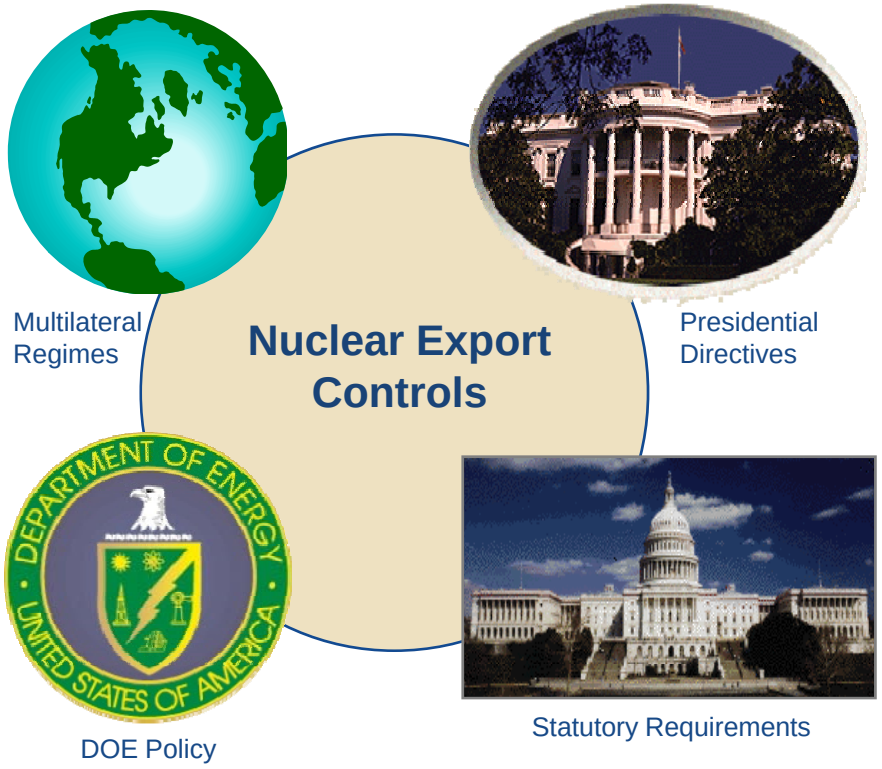


- Nonproliferation Treaty
  - Non-nuclear weapons states pledge to forego nuclear weapons and put peaceful nuclear activities under IAEA safeguards
  - Non-nuclear weapons states entitled to access to benefits of peaceful nuclear energy
  - Nuclear weapons states pledge to pursue good-faith negotiations on disarmament

Nuclear Nonproliferation Regime—Nuclear Materials

- Safeguards are measures to verify that nuclear materials and facilities are not diverted from peaceful use
- Security and physical protection measures:
  - Protect nuclear materials during storage, use, and transport to prevent acquisition by unauthorized persons
  - Protect nuclear facilities and materials against sabotage

Nuclear Nonproliferation Regime—Technology



- Export Controls
  - Controlling the dissemination of nuclear and nuclear-related dual-use equipment, materials, and technology
  - Department of Energy role is to:
    - Identify technologies of concern
    - Assist in the negotiation of multilateral controls on these technologies, and
    - Control exports through license reviews

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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

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

DESIGN INORMATION QUESTIONNAIRE*

CONTENTS, FORMAT AND STRUCTURE OF REORTS TO THE AGENCY

1. ACCOUNTING REPORTS

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

International Safeguards—Material Balance Area (MBA)

A Material Balance Area 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."

Design information is crucial in selecting MBAs

International Safeguards—Key Measurement Points (KMPs)

- A Key Measurement Point 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."

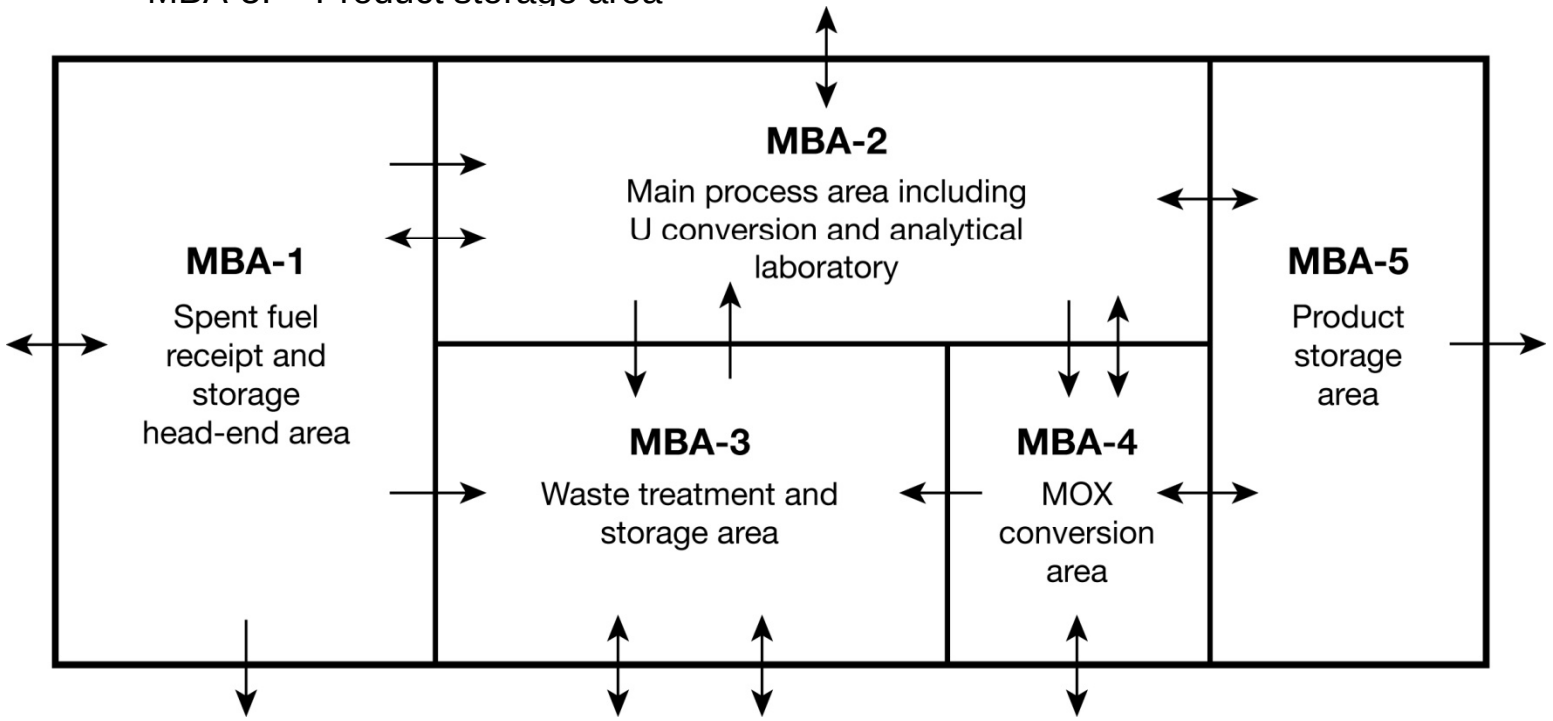
International Safeguards—Rokkasho (Japan)

- The Japanese Nuclear Fuels Limited (JNFL) Reprocessing plant has a planned operating throughput of 800tU/y, containing approximately 8t 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)

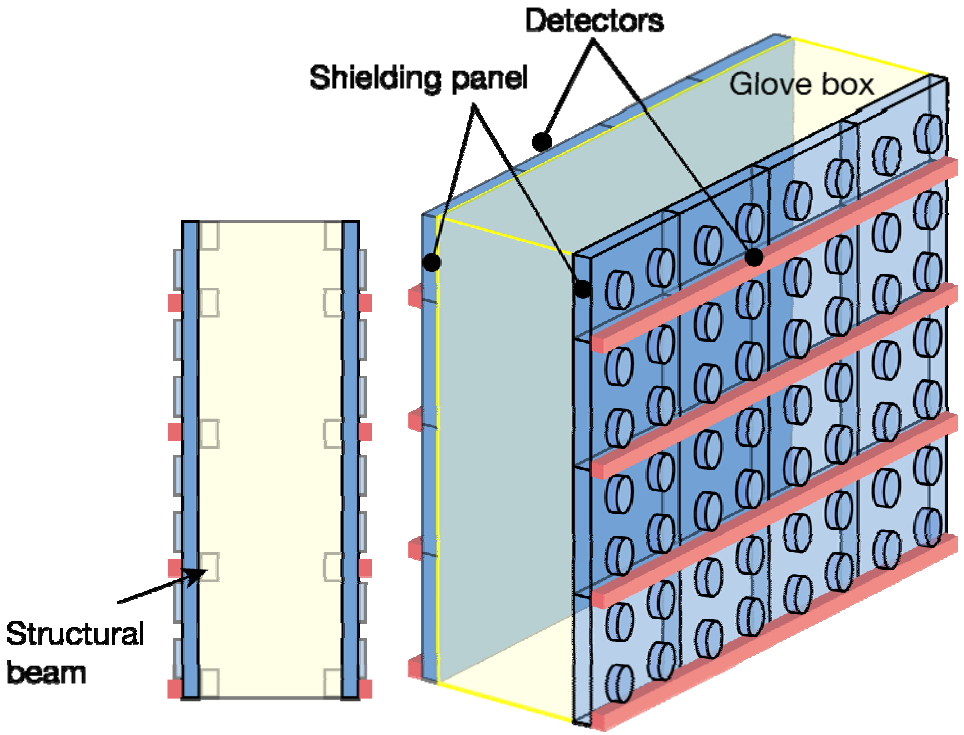
(MBA):

- MBA-1: Spent fuel receipt and storage area, head-end area
- MBA-2: Main process area (including UO_3, conversion and laboratories)
- MBA-3: Waste treatment and storage area
- MBA-4: MOX conversion area
- MBA-5: Product storage area

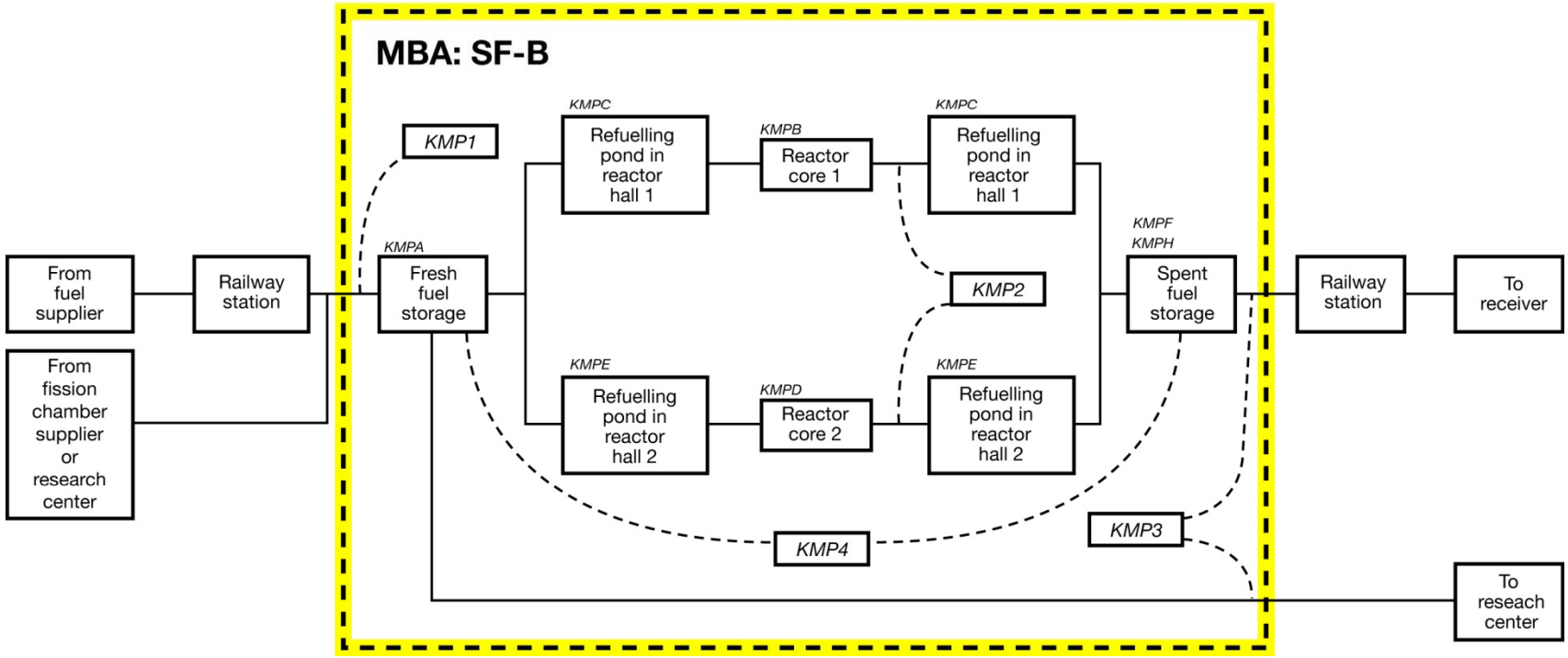


International Safeguards—GUAM Prototype Glove Box System

- 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 (PFPF) in Japan
- Planned for IAEA use at Japan's MOX fuel fabrication facility (JMOX)



International Safeguards—Nuclear Power Plant

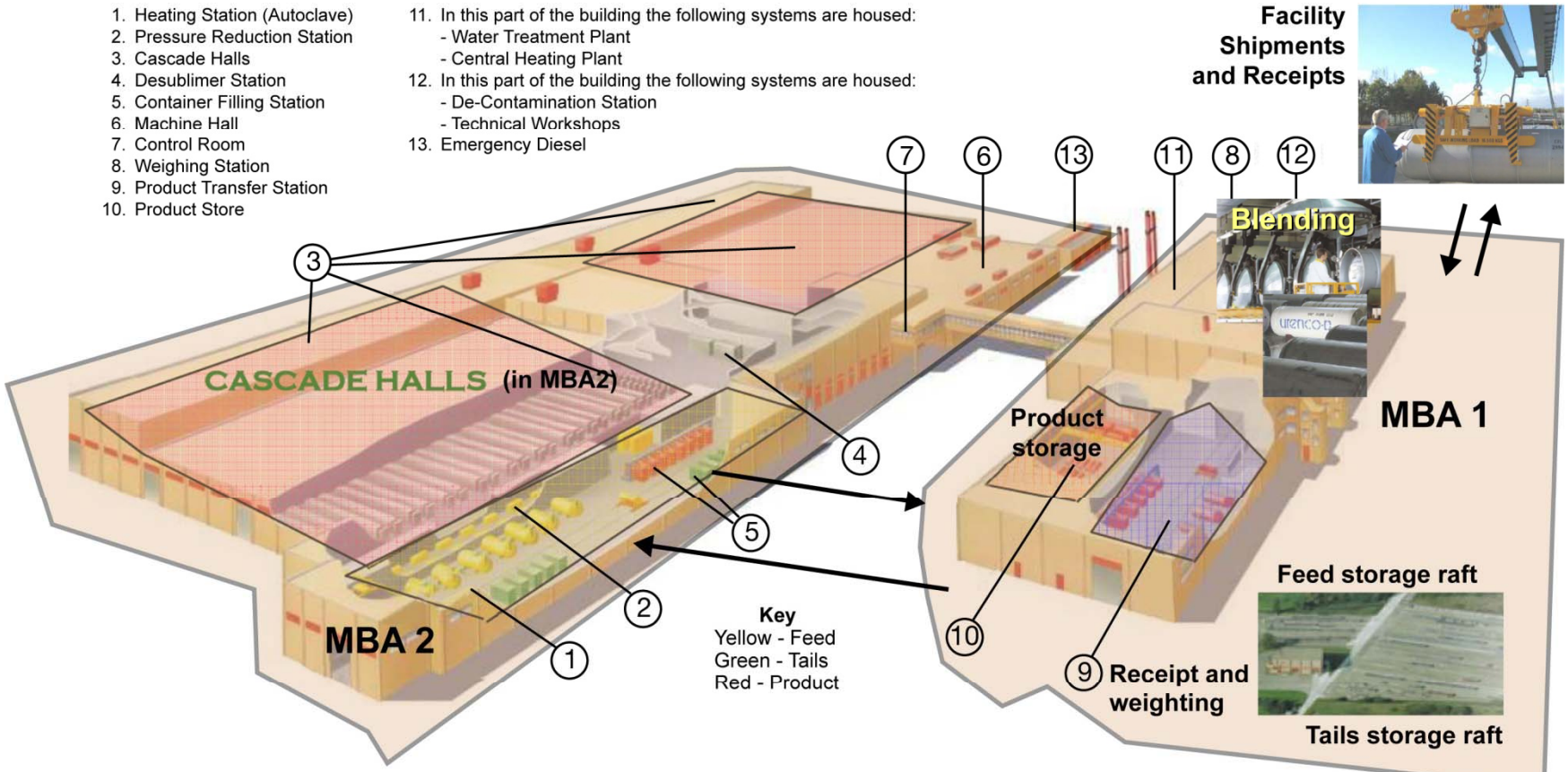


KMPs for nuclear material flow:
KMP1—Receipt of nuclear material
KMP2—Nuclear loss and production
KMP3—Shipment of nuclear material
KMP4—Rebatching

KMPs for physical inventory:
KMPA—Fresh fuel storage
KMPB—Reactor, Unit 1
KMPC—Refueling ponds and well in Unit 1
KMPD—Reactor, Unit 2
KMPE—Refueling ponds and well in Unit 2
KMPF—Spent fuel storage 1
KMPH—Spent fuel storage 2
KMPG—Other locations of nuclear material

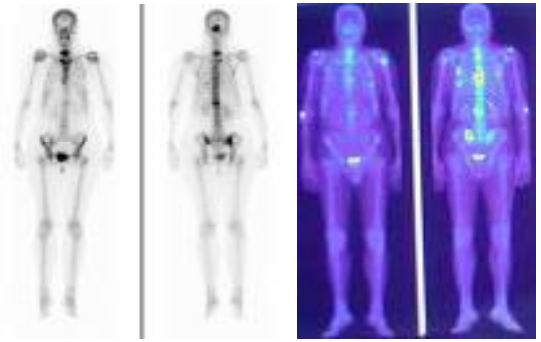
International Safeguards—Gas-Centrifuge Enrichment Facility

1. Heating Station (Autoclave)
2. Pressure Reduction Station
3. Cascade Halls
4. Desublimer Station
5. Container Filling Station
6. Machine Hall
7. Control Room
8. Weighing Station
9. Product Transfer Station
10. Product Store
11. In this part of the building the following systems are housed:
    - Water Treatment Plant
    - Central Heating Plant
12. In this part of the building the following systems are housed:
    - De-Contamination Station
    - Technical Workshops
13. Emergency Diesel



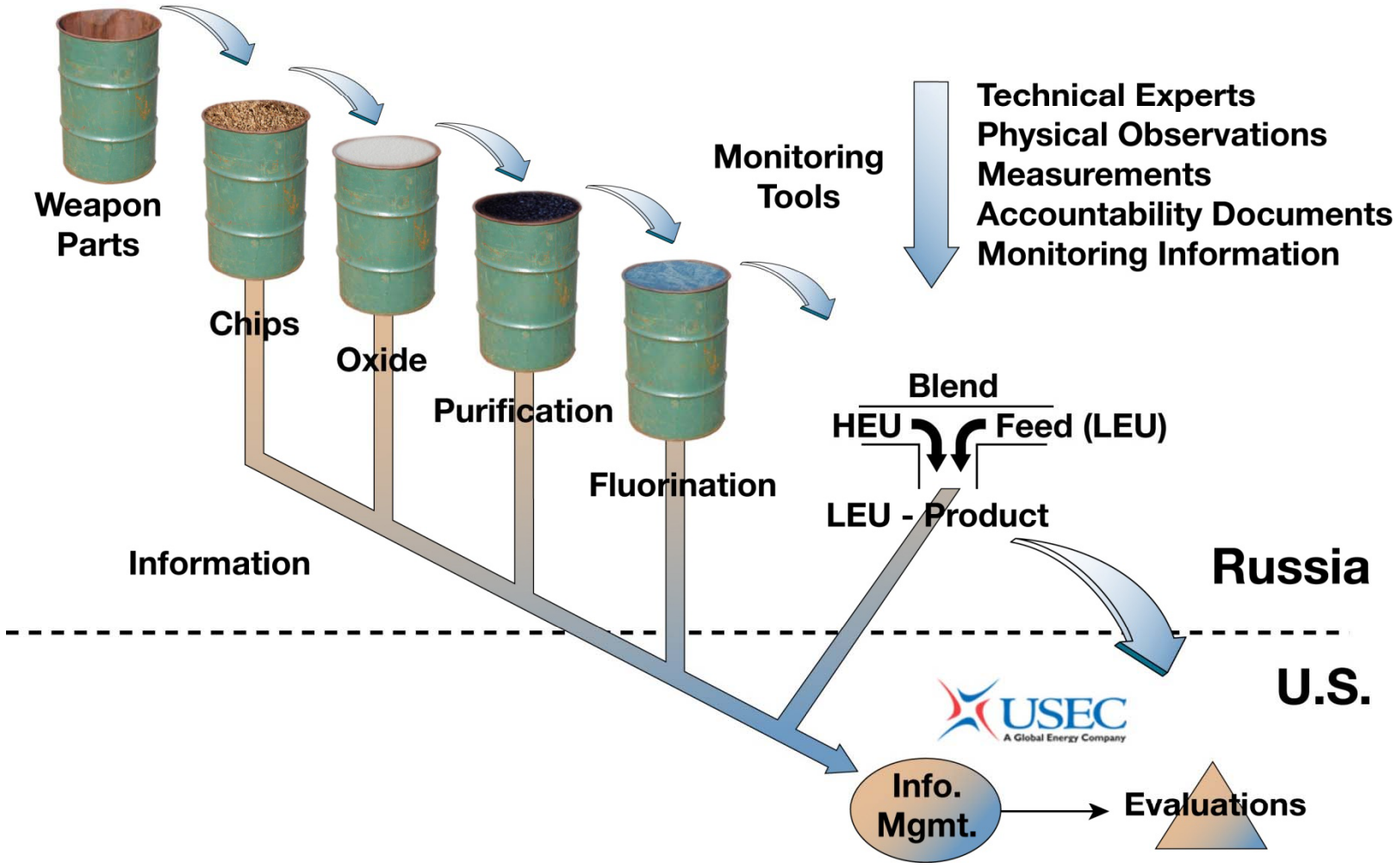
Reducing Vulnerable Materials—
Medical Isotope Production Without HEU (U.S.)

- 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)



Converting Vulnerable Materials—HEU to LEU Conversion (Russia)

- 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

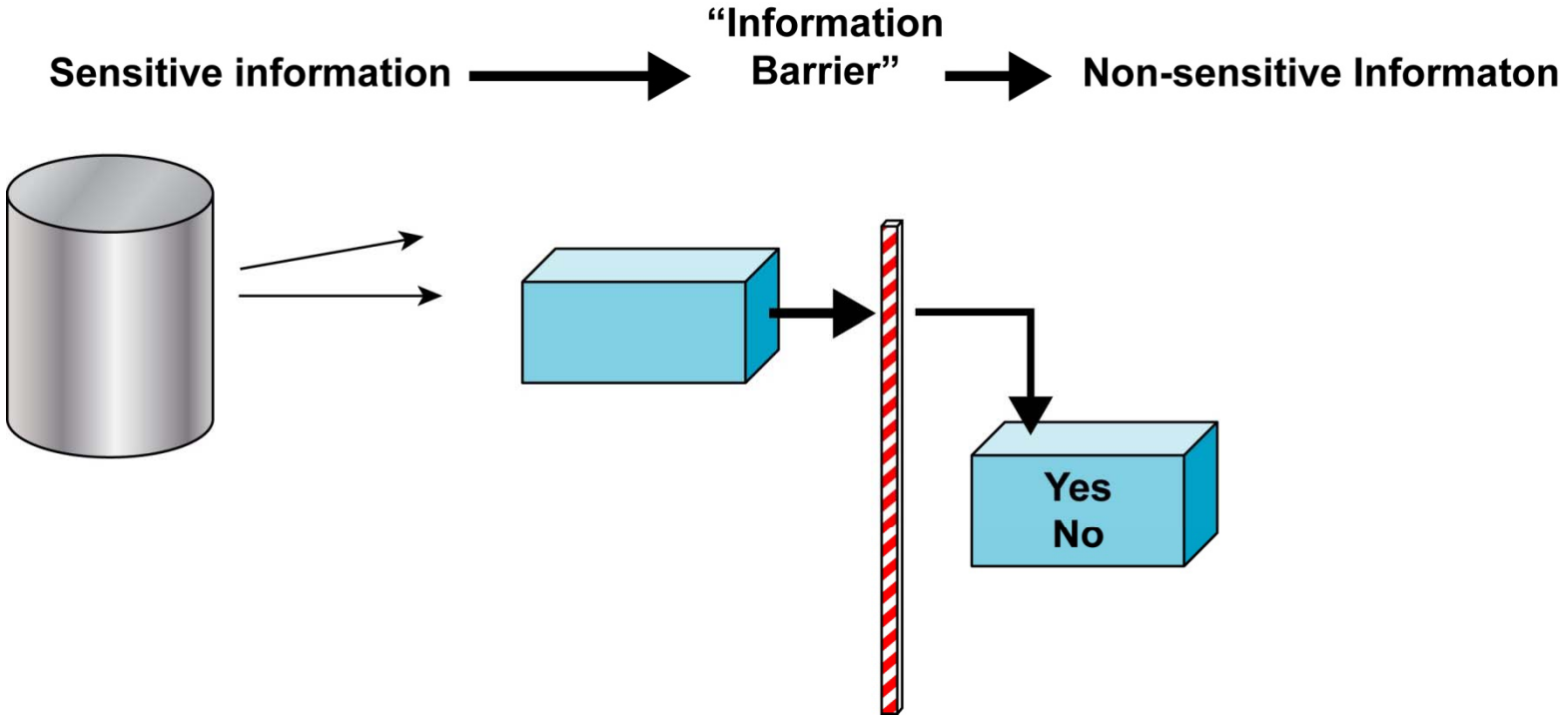
Glove box used to burn uranium metal and produce uranium oxide

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

Transparency—Information Barriers



Permits necessary measurements and provides useful results without revealing classified information

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Next Generation Safeguards Initiative

- NNSA review of international safeguards
- Situation
  - More material in more facilities of more complexity
  - Growing challenges of undeclared nuclear activities and proliferation networks
  - IAEA's safeguards budget is essentially flat, at about the price of one Boeing 737

- Policies and authorities
  - IAEA can accomplish much of its expanding mission using existing inspections and investigative authorities
- Resources
  - Safeguards communities in the U.S. and the IAEA face a looming human capital crisis
- Technology
  - Safeguards technologies have been slow to incorporate advances in detection, automation, and information technology, which can compromise safeguards effectiveness/efficiency

NNSA/NA-20 Priorities

- Secure nuclear weapons and weapons and weapons-usable materials at potentially vulnerable sites in Russia/elsewhere
- Secure radiological materials worldwide that could be used in dirty bombs
- Reduce quantities of nuclear/rad materials and equipment of concern
- Downsize FSU nuclear weapon ingrastructure
- Bolster border security overseas and domestically
- Develop cutting-edge n/p and national security-related technologies
- Strengthen international n/p export control regimes
- Roll back of black marked and illicit procurement networks
- Facilitate non-weapons employment for WMD Scientists in the FSU, Libya and Iraq
- Strengthen foreign emergency management capabilities

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 Affair
- "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.