Technical Realities Confronting Peaceful Uses of Atomic Energy

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The amount of weapon-grade Pu required to make a pure fission nuclear explosive with a yield of 1 to 20 kt, is quite small—1 to 3 kg—with the exact amount depending on the sophistication of the design and the desired yield.

Using typical reactor-grade Pu would increase the Pu needed by a small factor—on the order of two or three.

A one kiloton ground-burst device detonated in New York or Tokyo could result in casualties comparable to those at Hiroshima or Nakasaki.

While reactor-grade Pu is less desirable than weapon-grade Pu for military applications, the isotopic composition of the plutonium typically produced in civil power reactors does not represent a serious obstacle to the fabrication of efficient and powerful weapons as well as crude terrorist devices.

Typical stocks of LEU fuel for power reactors provide more than one-half of the separative work otherwise required to produce HEU suitable for use in simple gun-type uranium weapons, such as the weapon which destroyed Hiroshima and the six weapons that were stockpiled by the former white minority government of south Africa.

Significant Quantity (SQ) is the quantity the IAEA uses to represent the minimum amount of material required by a non-weapon state to construct a single nuclear explosive device.

Current IAEA safeguards are based on technically erroneous SQ values for direct-use Pu (8 kg) and HEU (25 kg).

The SQ values should be reduced roughly eightfold, particularly if the international community is to place primary reliance in the future on safeguards rather than arsenals to deter the use of nuclear energy for weapons purposes.

Even using erroneous SQ values, current IAEA safeguards are incapable of providing timely warning of theft or diversion of an SQ of Pu and HEU from bulk handling facilities and other sites that store or process weapon-usable fissile material in non-weapon states.

Plutonium-fueled fast-reactors, which rely a closed fuel cycle, have large in-reactor inventories and large associated fuel cycle inventories of Pu.

Fast reactors provide a technical potential to produce large quantities of weapon-grade Pu.

Advanced enrichment technologies under development in several countries will permit rapid enrichment of reactor-grade Pu to weapon-grade.

Continued pursuit of fast reactor and inertial confinement fusion (ICF) in leading industrial countries worldwide, and the availability of increasingly capable computers and simulation codes, will likely result in the future replication of nuclear scientific cadres in many nations with relevant skills for the design of nuclear and thermonuclear explosives, not all of which would be classified today as "crude" devices.

Threat Categories:

- **State Threat**
- **Non-State Threat**
- **State—Non-State Collusion**

State Threat Diversion Paths:

Safeguarded Facilities

- **Diversion**
- **Conversion**

Unsafeguarded Facilities

- **Overt**
- **Covert**

Non-State Diversion Paths:

- **Internal Diversion**
- **External Assault**
  - **With Insider Assistance**
  - **Without Insider Assistance**

The Reality of Uranium Economics

Over time—as higher-grade ore resources are depleted —the real cost of uranium extraction goes down, not up.

Question:

What improvements are needed in inspection and surveillance measures for nuclear power facilities to verify compliance with the NPT and to cope with subnational groups and rogue nations?

Improvements Required to Protect Against the State Threat

- **HEU Facilities**

  - **Research Reactors and Critical Facilities**
    - * Clandestine construction should be viewed as evidence of a nuclear weapon program
    - * Global ban on use of HEU in civil research reactors and critical facilities.

  - **Enrichment plants**
    - * Clandestine construction should be viewed as evidence of a nuclear weapon program
    - * HEU production for civil use and military reactors prohibited
    - * Full-scope and 93+2 IAEA safeguards required

  - **Storage Facilities**
    - * Under IAEA safeguards
    - * Storage of HEU amounts greater than an SQ are not permitted in non-weapon states

Improvements Required to Protect Against the State Threat

- **Plutonium Facilities**
  - **Production in Reactors**
    - Full-scope and 93+2 IAEA safeguards required
  - **Reprocessing Plants**
    - Should not be permitted
  - **Storage Facilities**
    - Under IAEA safeguards
    - Storage of HEU amounts greater than an SQ are not permitted in non-weapon states

Improvements Required to Protect Against the Non-State Threat

- **External Assault**
  Direct-use materials should be given the same level of protection (the same design basis threat) as nuclear weapons

- **Internal Diversion**
  For direct-use materials assume the insider includes a collusion of elements of management and guard force