NMMSS, Nuclear Archaeology, and the Verification of Nuclear Disarmament

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A New Era of Transparency?
United States

May 2010 Declaration of U.S. Nuclear Weapon Stockpile

“As of September 30, 2009, the U.S. stockpile of nuclear weapons consisted of 5,113 [active and inactive] warheads. This number represents an 84 percent reduction from the stockpile’s maximum (31,255) at the end of fiscal year 1967, and over a 75 percent reduction from its level (22,217) when the Berlin Wall fell in late 1989.”

United Kingdom
March 2009 and May 2010 Declarations

“Our operationally available warheads now number fewer than 160”
UK Prime Minister Gordon Brown, March 2009

Total number of nuclear weapons in the UK stockpile does not exceed 225

(4 submarines x 16 missiles per boat x 3 warheads per missile = 192 warheads)
France

March 2008 Announcement by French President N. Sarkozy

“I can tell you that our arsenal will include fewer than 300 nuclear warheads. [...]"

I have decided to invite international experts to observe the dismantlement of our Pierrelatte and Marcoule military fissile material production facilities.”

Nicholas Sarkozy, President of the French Republic
Presentation of "Le Terrible" in Cherbourg
21 March 2008
Fissile Material Stocks
HEU Stockpiles, 2010

Global stockpile is about 1475 tons, about 99% is in weapon states.
Plutonium Stockpiles, 2010

Global stockpile is about 485 tons, more than half is civilian and this stock is growing

Metric tons [MT]

- Military stockpile
- Excess military material
- Additional strategic stockpile
- Civilian stockpile, stored in country (Jan. 2010)
- Civilian stockpile, stored outside country (Jan. 2010)

*Estimate

Chart showing the distribution of plutonium stockpiles among different countries and types.
Fissile Material Declarations
# Content of Declarations and Sequencing of Information Release

<table>
<thead>
<tr>
<th>Level of Detail</th>
<th>Example</th>
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<tbody>
<tr>
<td>Aggregate</td>
<td>Total inventory</td>
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<tr>
<td>By Type</td>
<td>Historical production data for different materials (and selected characteristics)</td>
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<td>By Site / Facility</td>
<td>Same by site/facility</td>
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<td>By Item</td>
<td>Location, mass, composition of each item or container</td>
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**Initial Declarations (unverified)**

**Verified Declarations**
Content of Initial Declarations

1. Material available for weapons
   (in warheads, warhead components and working stocks)

2. Material that has been declared excess for weapons purposes

3. Highly enriched uranium for naval and other military-reactor use

4. Civilian material

Declarations organized along those lines would not go (far) beyond what the United States and the United Kingdom have already made public.
The 1996 and 2001 U.S. Declarations
(based on NMMSS)
Examples from the U.S. Declarations

(Plutonium Production by Year and Site)

Plutonium: The First 50 Years: United States Plutonium Production, Acquisition and Utilization from 1944 Through 1994
Example from the U.S. Declarations

(Stockpile of Highly Enriched Uranium by Category)

1994

- Stockpile available for weapons: 618
- Fresh naval fuel reserve: 100
- Irradiated naval fuel: 100
- Excess (to be used as civilian HEU): 100
- Excess (irradiated, for direct disposal): 151

1996

- Stockpile available for weapons: 457
- Fresh naval fuel reserve: 100
- Irradiated naval fuel: 23
- Excess (to be used as civilian HEU): 151
- Excess (irradiated, for direct disposal): 23

2009

- Stockpile available for weapons: 250
- Fresh naval fuel reserve: 128
- Irradiated naval fuel: 100
- Excess (to be used as civilian HEU): 86*
- Excess (irradiated, for direct disposal): 23

Inventory [metric tons]

*(151-124+52+7)
The US and UK Declarations Have Also Emphasized the Challenges of Preparing Them

“A major problem encountered in examining the records was that a considerable number had been destroyed from the early years of the programme. [...] Even where records have survived, other problems have been encountered, including: ... [list follows]”

*Historical Accounting for UK Defence Highly Enriched Uranium*

UK Ministry of Defence, March 2006, [www.ipfmlibrary.org/mod06.pdf](http://www.ipfmlibrary.org/mod06.pdf)
Verifying Declarations
Nuclear Archaeology for Plutonium

(U.S. Hanford B Reactor, 1944–1968)
Graphite Isotope-Ratio Method (GIRM)

Jungmin Kang, “Using Graphite Isotope Ratio Method to Verify DPRK’s Declaration of Plutonium Production,” under review
North Korea’s Yongbyon Reactor, 2008

Credit: CNN/Brian Rokus
Similar Methods Need to be Demonstrated for Other Types of Production Reactors

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Nuclear Archaeology for Uranium Enrichment

(Former Storage area for cylinders of depleted uranium in 2001 at K-25 Site, Oak Ridge, TN)
Measurements on Uranium Tails

M. Sharp, “Applications and Limitations of Nuclear Archaeology,” in preparation
Both the US and the UK Are Pursuing UF₆ Deconversion Projects

700,000 metric tons of DUF₆ in storage at Oak Ridge, Paducah, and Portsmouth
(39,000 cylinders at Paducah and 25,000 cylinders at Portsmouth; deconversion will take about 25 years)

**Lifetime Plan: Capenhurst Site Summary**
UK Nuclear Decommissioning Authority, 2006, [www.ipfmlibrary.org/nda06b.pdf](http://www.ipfmlibrary.org/nda06b.pdf)
Weren’t the Production Strategies of the P5 Nuclear Weapon States Too Complex to Be Independently Verified?
Integrated Operation of the U.S. Gaseous Diffusion Plants

Production Modes Leave Characteristic Signatures in the Fissile Materials

Direct measurements of the fissile materials themselves could considerably enhance confidence in nuclear archaeology (but would require countries to declassify isotopic information)
The Way Forward

NMMSS as a model for other nuclear weapon states?

Uncertainties in military fissile material stockpiles are already significant

NMMSS is essential in keeping these uncertainties as small as possible
(and in maintaining confidence in authenticity of the data)

Opportunities for re-measurements and further consistency checks exist

Need to preserve production records, facilities, and (waste) materials
in a condition that will permit these measurements
(and future verification of fissile material declarations)
The Way Forward

NMMSS as a model for other nuclear weapon states?

The 2010 NPR has emphasized the importance of work in this area

“Initiating a comprehensive national research and development program to support continued progress toward a world free of nuclear weapons, including expanded work on verification technologies and the development of transparency measures.”

Some precedents and many opportunities for cooperative initiatives

Start with joint demonstration exercises to establish the methods and tools for all types of relevant plants