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New Verification Technologies for Arms Control and Disarmament

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Nuclear Verification Challenges and Opportunities
Vienna Center for Disarmament and Non-Proliferation and
James Martin Center for Nonproliferation Studies
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Revision 5

Two Ways of Looking at the Problem

“Mission-focused” vs “Technology-focused”

Verification Challenges for Existing and Next-generation Arms Control Treaties

(Comprehensive Test Ban Treaty)

Fissile Material Cutoff Treaty

Next-generation Nuclear Disarmament Treaties

Emerging Technologies

Quasi Real-time Satellite Imagery … “for Everyone”

New Media and Crowdsourcing

Verification Challenges for Existing and Next-generation Arms Control Treaties

Nuclear Arms Control Treaties

(and their Verification)

Comprehensive Test Ban Treaty (CTBT)

Bans all nuclear explosions in all environments
and would be verified by extensive verification mechanisms

Fissile Material Cutoff Treaty (FMCT)

At a minimum, treaty would ban fissile material production for weapons purposes
(Verification could use many tools/approaches developed for the NPT)

Next-generation Nuclear Disarmament

Agreements that place limit on total number of nuclear warheads in arsenal
would pose qualitatively new verification challenges

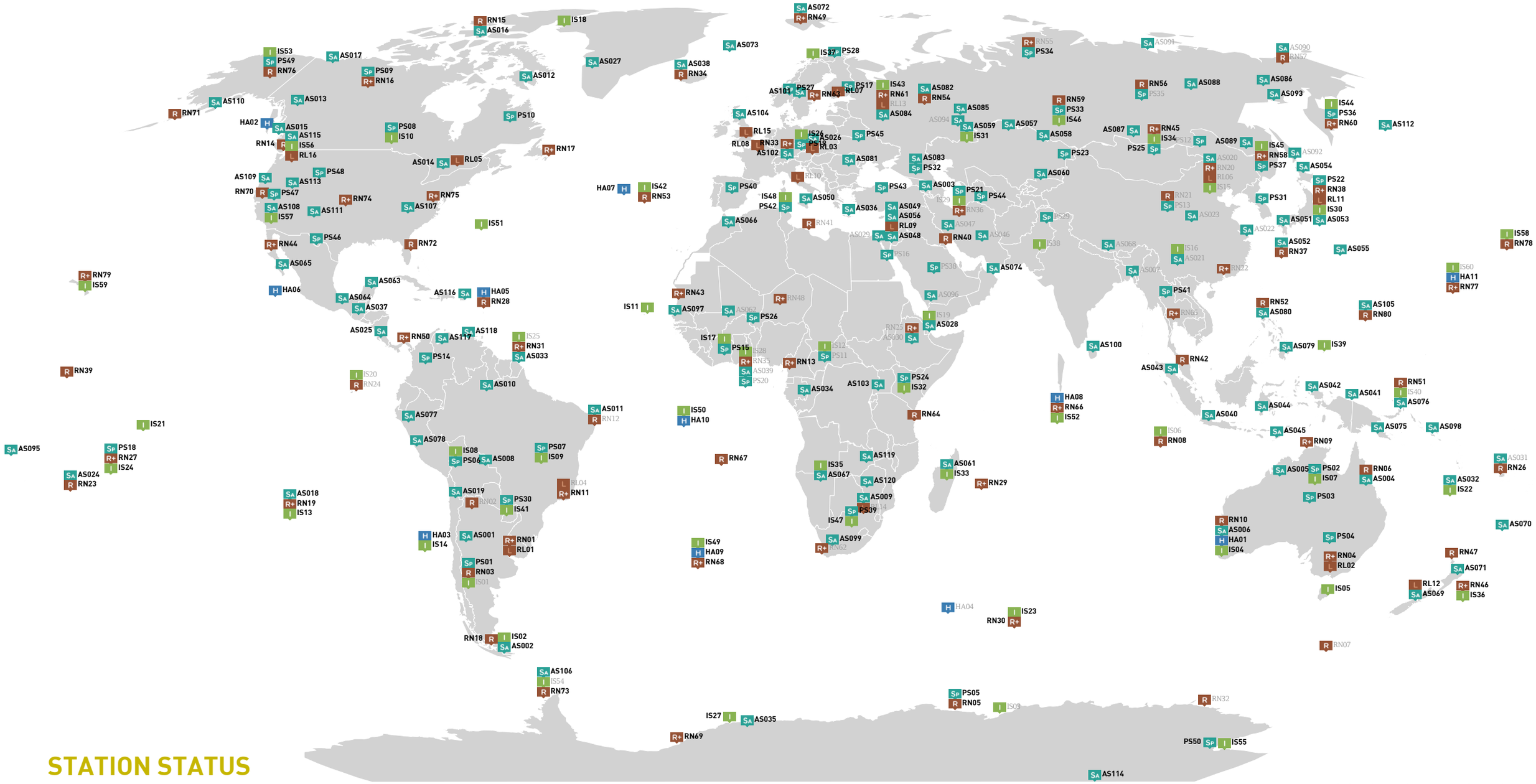
Verifying the Comprehensive Test Ban Treaty

INTERNATIONAL MONITORING SYSTEM

GLOBAL OVERVIEW - CERTIFIED STATIONS AND NON-CERTIFIED STATIONS

15 JUNE 2014

CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization



STATION STATUS

DATE	15 Jun 2014
TOTAL STATIONS	337
CERTIFIED	273
NOT CERTIFIED	64

Primary Seismic | Auxiliary Seismic | Infrasound | Hydroacoustic | Radionuclide | Radionuclide w/ Noble Gas | Radionuclide Lab

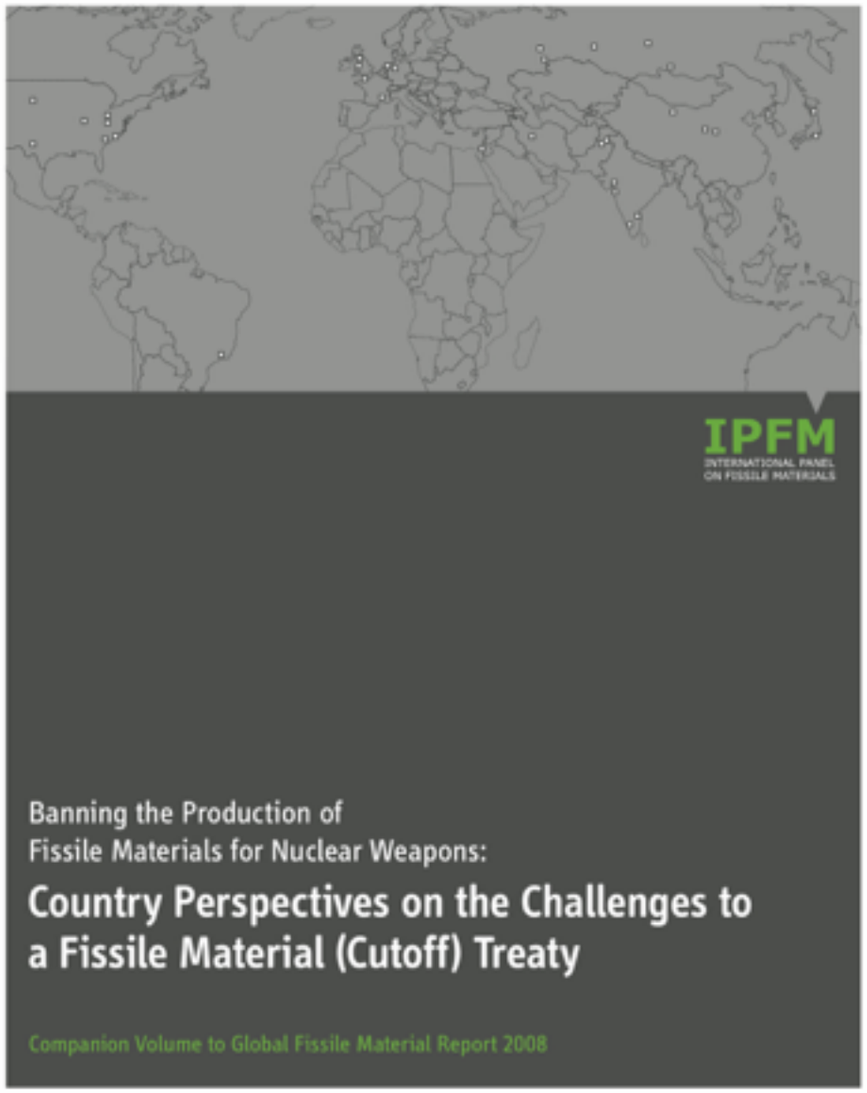
WWW.CTBTO.ORG

Verifying the Fissile Material Cutoff Treaty

(skipping)

Global Fissile Material Report 2008

www.ipfmlibrary.org/gfmr08.pdf and www.ipfmlibrary.org/gfmr08cv.pdf



Verification Challenges

1. Shutdown facilities
2. Operational enrichment plants
3. Operational reprocessing plants
4. Challenge inspections at military nuclear sites

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depending on scope of FMCT

5. Naval-reactor fuel cycle
6. Weapon-origin fissile material

Precedents for verification exist in NPT safeguards
in non-weapon states, but some (important) differences

Verifying Nuclear Disarmament

Going “Beyond New-START”

“While the new START treaty is an important step forward, it is just one step on a longer journey. As I said last year in Prague, this treaty will set the stage for further cuts. And going forward, we hope to pursue discussions with Russia on reducing both our strategic and tactical weapons, including non-deployed weapons.”

U.S. President Obama, upon signing the New START Treaty, April 2010

Thousands of Nuclear Weapons Are No Longer Deployed and Currently In Storage

W87/Mk-21 Reentry Vehicles in storage, Warren Air Force Base, Cheyenne, Wyoming

Photo courtesy of Paul Shambroom, www.paulshambroom.com

What Are We Worried About?

(The Challenges of Nuclear Disarmament Verification)

Main Cheating Scenarios and Associated Verification Challenges

Verification Challenge 1

Party offers hoax or tampered devices instead of authentic treaty accountable items (TAI) so that real warheads, warhead components, or fissile material can be "diverted" to a secret stockpile of nuclear weapons

⇝ Authenticating (and verifying the dismantlement of) nuclear warheads

Verification Challenge 2

Party provides incomplete baseline declarations so that some treaty accountable items (e.g. warheads) are never part of the verification regime

⇝ Verifying the completeness of declarations

Verified Warhead Dismantlement

Warhead Dismantlement Verification

Some Precedents Exist and Future Work Can Build on Them

Inspection System developed as part of the 1996–2002 Trilateral Initiative during a demonstration at Sarov
Source: Tom Shea

Visual contact with a mockup nuclear weapon during a UK-Norway Initiative Dismantlement Exercise
Source: UK Norway Initiative, David Keir

Rationale behind verifying warhead dismantlement is to provide confidence that actual warheads are destroyed and that the fissile material they contained is recovered and accounted for

Information Barriers Have Been Critical Elements

for inspection systems measuring classified information

UK-Norway Initiative, 2nd Prototype Information Barrier

David Chambers et al., "UK-Norway Initiative: Research into Information Barriers to Allow Warhead Attribute Verification Without Release of Sensitive or Proliferative Information," INMM 51st Annual Meeting, Baltimore, MD, USA, July 11–15, 2010

Many Challenges for Verified Warhead Dismantlement Remain

Development and Demonstration of Practical Inspection Systems

that assure the inspecting party that instrument works as described
and assure the host state that sensitive information is not leaked during the inspection

Trilateral Initiative developed focused only on plutonium

Demonstrate Viability of Cooperation Between Nuclear and Non-nuclear Weapon States

UK Norway Initiative has broken new ground in this area

but secrecy issues tend to make research and development outside the weapons labs difficult

Verifying the Completeness of Declarations

What About the Secret Nuclear Weapons Stockpile Stashed Away on that Remote Island?

Verifying the Completeness of Nuclear Warhead Declarations May Be Impractical

Instead, establish confidence in the completeness of fissile material declarations

(to assure that no covert warheads exist outside the verification regime)

Warheads Fabricated, 1945–2010	
United States	70,000
Russia	55,000
United Kingdom	1,200
France	1,260
China	600
TOTAL	128,000

Left: Dismantlement of the last 10-Megaton B53 bomb, October 25, 2011, www.energy.gov/articles/dismantling-final-b53-bomb

Right: Estimates from R. S. Norris and H. M. Kristensen, "Global nuclear weapons inventories, 1945–2010" *Bulletin of the Atomic Scientists*, July/August 2010, bos.sagepub.com/content/66/4/77

How Much Fissile Material is There?

Most weapon states have not yet made public their fissile material holdings

(United States and Britain are the exceptions)

Independent stockpile estimates carry significant uncertainties

(up to 20%, ton quantities in the case of Russia)

A Two-Step Process

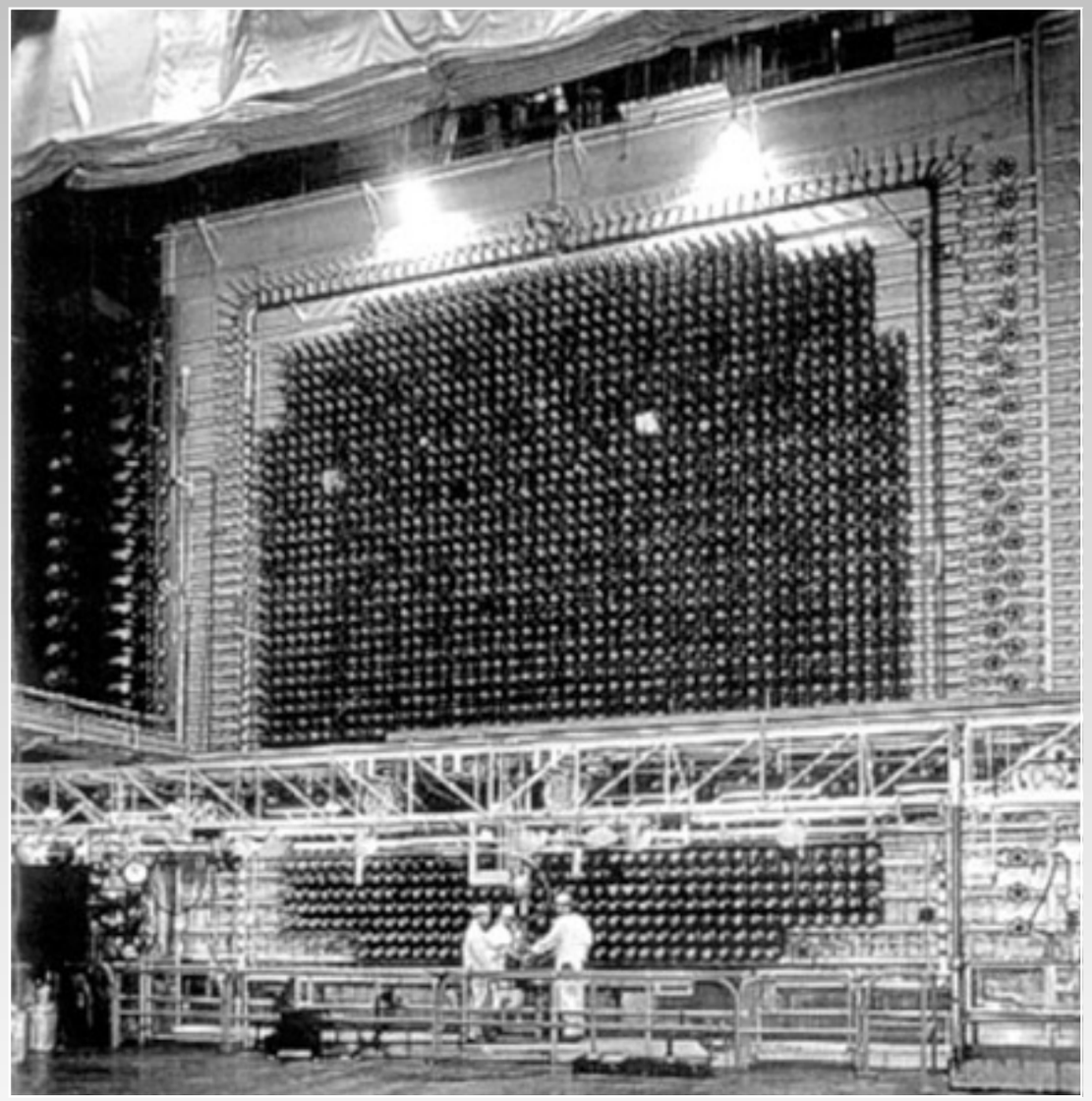
Baseline declarations of fissile material stocks (Transparency)

Establishing confidence in the completeness of declarations (Verification)

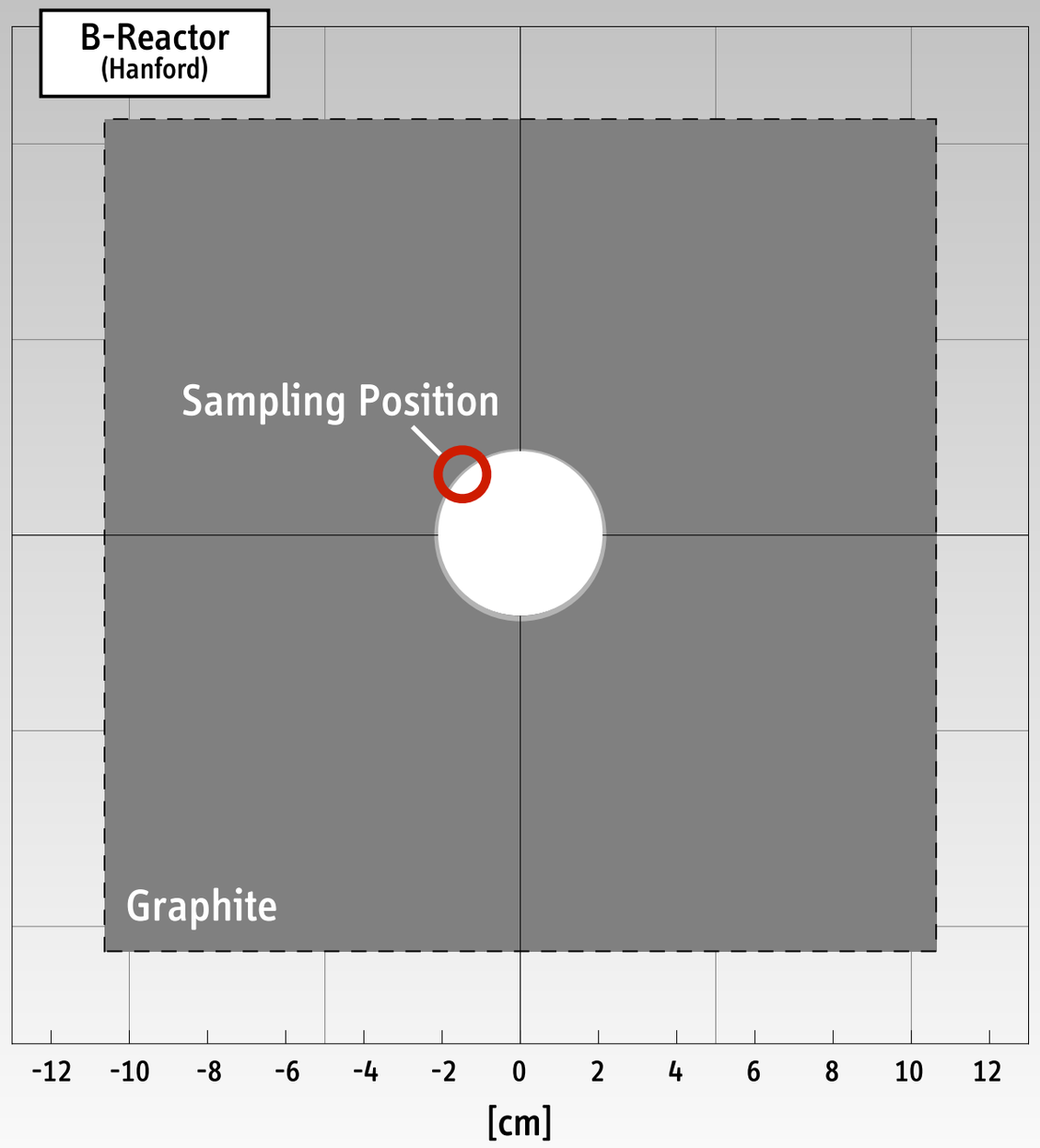
(Some similarity with "initial reports" required by INFCIRC/153, §62)

Nuclear Archaeology

Using Nuclear Forensic Techniques to Reconstruct Historic Fissile Material Production



U.S. Hanford B Reactor, 1944–1968



North Korea's Yongbyon Reactor, 2008

Nuclear archaeology would have been used to verify North Korea's plutonium declaration

Credit: CNN/Brian Rokus

“The Clock is Ticking”

Shutdown production reactors and enrichment plants are being decommissioned

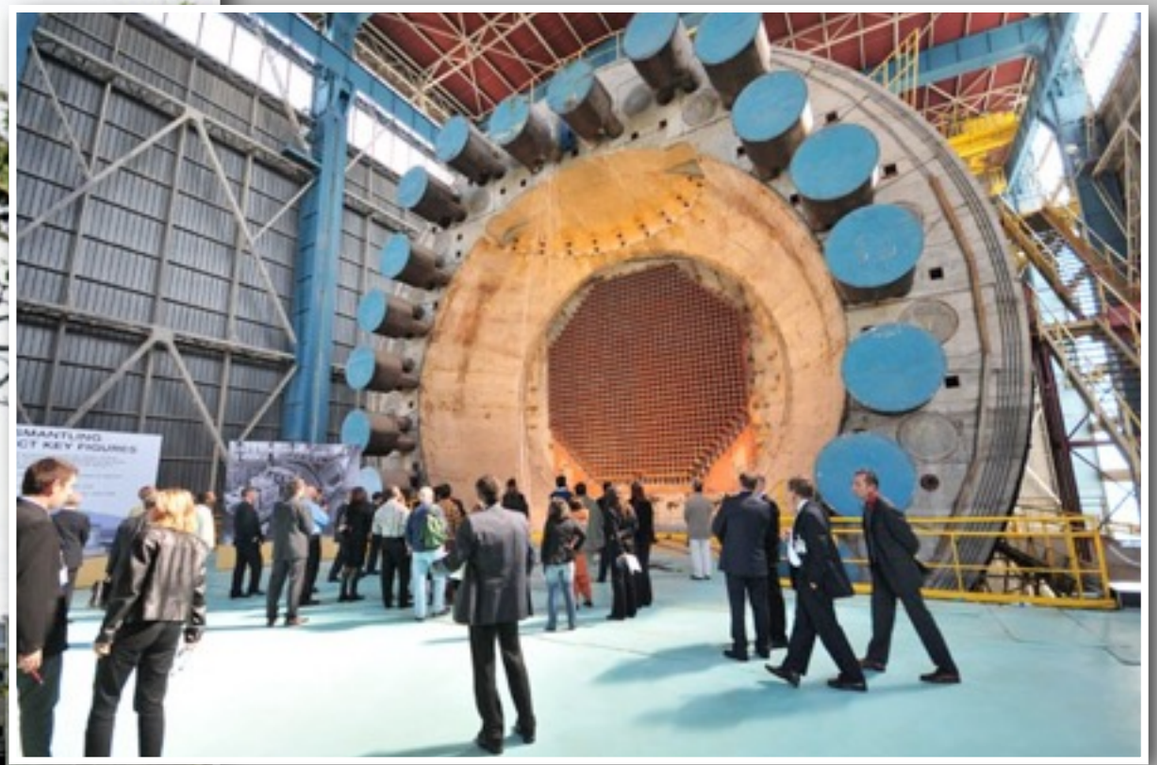
Shutdown of the last Russian plutonium production reactor ADE-2 in Zheleznogorsk, 2010
Source: U.S. Department of Energy

Demolition of the K-25 uranium enrichment plant began in December 2008 and has been completed in 2012
Source: Bechtel Jacobs

**In many cases, facilities have been temporarily preserved;
but in other cases, environmental concerns (or site stewardship decisions)
have led to the demolition of former production sites**

Offer Test Beds for Nuclear Archaeology

To begin countries could offer single sites or facilities as test beds and invite partners with similar production facilities to engage in "site-to-site exercises" to jointly demonstrate verification approaches and measurement techniques



Left: Windscale Piles, www.sellafieldsites.com
Right: G2/G3, Marcoule, www.francetnp.fr

Even Many Non-nuclear Weapon States Have Candidate Facilities That Could be Used to Demonstrate Methods Required for Nuclear Archaeology

NRX, Canada

Ågesta Reactor (105 MWt), near Stockholm, Sweden

Emerging Technologies

(skipping)

Wrapping Up

Summary

New Verification Technologies for Arms Control and Disarmament

Requirements for Existing or Next-generation Arms Control Treaties

Technology gaps for CTBT/FMCT verification small

BUT: Nuclear disarmament verification requires new approaches and techniques

Important opportunities to initiate new development and demonstration projects

Nuclear Warhead Authentication and Verified Dismantlement

Develop and demonstrate practical inspection systems
Demonstrate viability of cooperation between nuclear and non-nuclear weapon states

Nuclear Archaeology

Agree on most important types of operating records and infrastructure to be preserved
Develop and demonstrate the required forensic techniques