CBRNE 2018 IW | Countering Radiological and Nuclear threats

4th International CBRNe Workshop

Rome, 8th November 2018

DEFUSING THE BOMB

A PHASED APPROACH FOR A VERIFIED DENUCLEARIZATION OF NORTH KOREA

Alexander Glaser

Program on Science and Global Security

Princeton University

REVISION 1

USA
6,800

U.S. Nuclear Weapon

Russia
7,000

United Kingdom
215

France
300

Israel
80

Pakistan
135

India
125

China
270

North Korea
15

North Korean Nuclear Weapon

There remain about 15,000 nuclear weapons in the world today

Hans Kristensen and Robert Norris, Nuclear Notebook, Federation of American Scientists and thebulletin.org/nuclear-notebook-multimedia

POLICY FORUM

ARMS CONTROL

Denuclearizing North Korea: A verified, phased approach

The process must reflect existing levels of trust at each stage

By **Alexander Glaser** *and* **Zia Mian**

At the June 2018 Singapore Summit, North Korea agreed to the goal of "complete denuclearization" in exchange for "security guarantees" by the United States, including an end to enmity (*1*). Like earlier efforts in the 1990s and 2000s, the current round of diplomacy may well fail because of the challenges of balancing North Korean insistence on the primacy of building trust and cooperation with U.S. demands for progress on denuclearization. Any successful attempt to balance these priorities will have to resolve the thorny question of verification. Here, we propose a phased approach for verified denuclearization that relies on technical measures and tools to allow for the scope, pace, and intrusiveness of denuclearization to reflect progress in political confidence building. More broadly, successfully bridging the goals of denuclearization and political security for North Korea could inform judgments by the international community about how to approach verified disarmament for other states that currently have nuclear weapons.

Although the process of "denuclearization" has not been spelled out explicitly in the current United States–North Korea talks, the two sides seem to have settled on the phrase "complete denuclearization." For the purposes of this analysis, this is taken to include the key nuclear weapon–related obligations agreed on in the 1992 Joint Declaration of South and North Korea on the Denuclearization of the Korean Peninsula, namely to "not test, manufacture, produce, receive, possess, store, deploy or use nuclear weapons" and that these commitments would be verified (*2*).

In March 2018, North Korea announced a moratorium on nuclear weapons and ballistic missile testing. Maintaining this moratorium is seen as the foundation for moving forward with talks and implementing whatever eventually is agreed as the denuclearization process. A more formal commitment to not carry out further nuclear weapon tests would be for North Korea to join the Comprehensive Nuclear Test Ban Treaty (CTBT). Even though the CTBT is not in force, under customary international law, signature of an international treaty confers the obligation to not take actions that would undermine the purpose of the treaty.

Moving forward, eliminating North Korea's nuclear weapons program and related facilities will need a freeze on current weapon-related activities; an agreed baseline of current stockpiles of nuclear weapons, fissile materials, ballistic missiles, and key components; and verified reductions of these stockpiles and downsizing of North Korea's weapons complex. There are already a few proposals for drawn-out, perhaps decade-long, step-by-step approaches that lead to eventual denuclearization, in contrast to demands from Trump administration officials that North Korea "dismantle all of their W.M.D. and ballistic missile programs in a year," but in neither case is attention paid to how verification might assist or hinder such efforts (*3*). To be sustainable, every step in such a process will need to reflect the actual existing level of trust between the United States and North Korea and seek to increase this trust so as to permit future steps. Given the preponderance of U.S. military force, North Korea may set the pace of denuclearization and intrusiveness of the verification measures in case the present process fails, as happened with prior attempts via the 1994 Agreed Framework and the 2003–2009 Six-Party Talks.

We assume that a new framework agreement would contain provisions similar to those in some other arms-control agreements, under which the parties agree not to interfere with specified remote-monitoring techniques or use concealment measures intended to obstruct verification.

FREEZE ON FISSILE MATERIAL

Since North Korea's withdrawal from the Nuclear Non-Proliferation Treaty (NPT) in 2003, there have been essentially no international inspection efforts in North Korea. At the same time, North Korea has expanded the scale and complexity of its nuclear weapons program. On the basis of information available via open sources, it is not clear how many nuclear weapons North Korea possesses today, of what kind (including possibly thermonuclear weapons), and whether they use plutonium or highly enriched uranium (HEU) or both as fissile material. Nor is there reliable information on its ballistic missile capabilities. To establish a basis for moving forward, North Korea could add to its freeze on nuclear weapon and ballistic missile tests a freeze on fissile material production. This can be verified primarily through agreed-on nonintrusive provisions.

Originally, North Korea launched its weapons program with plutonium recovered from the spent fuel of the graphite-moderated (5 MW-electric) plutonium production reactor at Yongbyon. The demolition of its cooling tower in 2008 temporarily made reactor operation impossible and constrained plutonium supply in the following years, but plutonium production at Yongbyon appears to have resumed more recently. In the meantime, North Korea may have shifted the emphasis of its program to uranium enrichment and uranium-based weapons. Today, North Korea most likely produces both plutonium and HEU and may have available material for dozens of nuclear weapons. The question now is how such a freeze could be monitored for both plutonium production and uranium enrichment. North Korea (and South Korea) could permanently refrain from plutonium separation and uranium enrichment, as agreed in their 1992 Joint Declaration.

In the case of plutonium, satellite imagery can be sufficient to confirm the operational status of reactors in North Korea. Imagery can be used to observe heat signatures, vapor plumes, cooling water discharges, and other activities near the reactor (*4*). All these indicators would provide good evidence for a suspension of plutonium production at Yongbyon. Regional krypton-85 monitoring, ideally with a small number of detectors placed around the Yongbyon site, could confirm that remaining spent fuel is not reprocessed (*5*). There are also simple measures to permanently disable the Yongbyon reactor—for example, by blowing boron dust through the core's cooling channels—but North Korea may not agree to such actions until the later stages of the denuclearization process.

The situation with regard to uranium enrichment is more difficult. It may be possible to confirm remotely the shutdown status of the Yongbyon enrichment plant and a possible second plant suspected to

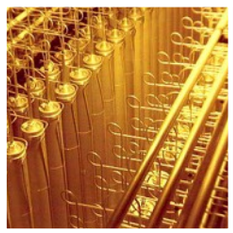
Program on Science and Global Security, Princeton University, Princeton, NJ, USA. Email: alx@princeton.edu

Published by AAAS

MILESTONES TOWARD DENUCLEARIZATION

MORATORIUM ON NUCLEAR WEAPON AND BALLISTIC MISSILE TESTING

North Korea announced such a moratorium in March 2018; it could now also join the CTBT



(VERIFIED) FREEZE ON FISSILE MATERIAL (AND BALLISTIC MISSILE) PRODUCTION

Ideally, such a freeze could rely primarily on remote-monitoring techniques

BASELINE DECLARATIONS OF WARHEAD AND FISSILE MATERIAL INVENTORIES

Confirming correctness and completeness would be a longer-term objective

(VERIFIED) REDUCTIONS IN THE NUCLEAR ARSENAL

Different options and approaches depending on priorities/preferences

Source (from top to bottom): KCNA, Urenco, Chung Sung-Jun/Getty Images, Sandia National Laboratories

THREE LEVELS OF ACCESS FOR POSSIBLE INSPECTIONS

REMOTE MONITORING

Satellite imagery in particular could be an important tool to confirm the operational status of nuclear facilities or observe (the absence of) related activities

STANDOFF DETECTION

For facilities where onsite access is considered too intrusive, at least initially, nearby sensors could provide reassurance of compliance with agreed provisions

ONSITE INSPECTIONS

Direct inspector access to declared sites and (upon request) to other sites access offers the greatest level of reassurance; but they may only become relevant in longer term

Source: DigitalGlobe (top), NASA (middle), IAEA (bottom)

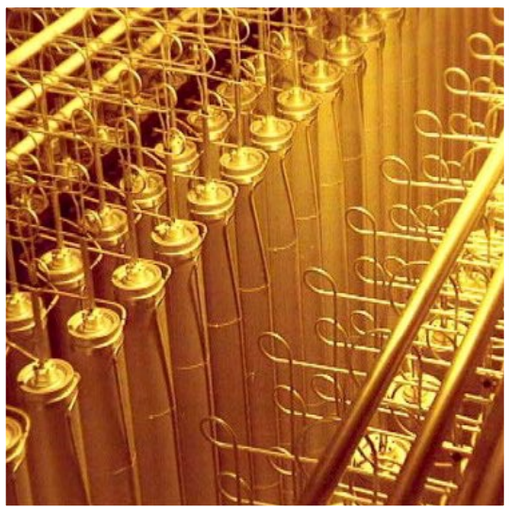
Monitoring a Suspension of Fissile Material Production

MONITORING A FREEZE ON FISSILE MATERIAL PRODUCTION

PLUTONIUM PRODUCTION

Satellite imagery can be used to observe heat signatures, vapor plumes, cooling water discharges, and other onsite activities; these provide good evidence for a suspension of plutonium production at Yongbyon

Regional krypton-85 monitoring could provide further evidence of a freeze



NON-PRODUCTION OF HIGHLY ENRICHED URANIUM

Shutdown status of enrichment plant could (possibly) be monitored remotely; if plant is allowed to operate, then unattended measurement systems (OLEM, C/S, and perhaps even environmental sampling) could confirm non-production of HEU

Source: Google (top) and Urenco (bottom)

Making Declarations

POSSIBLE BASELINE DECLARATIONS

OF NUCLEAR WARHEAD AND FISSILE MATERIAL INVENTORIES

WARHEAD DECLARATION	
	Inventory
Total number of warheads as of [DATE]	.....
Warheads, by type/designation	.....
Additional warhead components in storage, by type/designation	.....

FISSILE MATERIAL DECLARATION			
	Plutonium	**HEU**	**(Tritium)**
Inventory as of [DATE]	.....	.....	.....
Of this, material currently in weapons or weapon components	.....	.....	.....

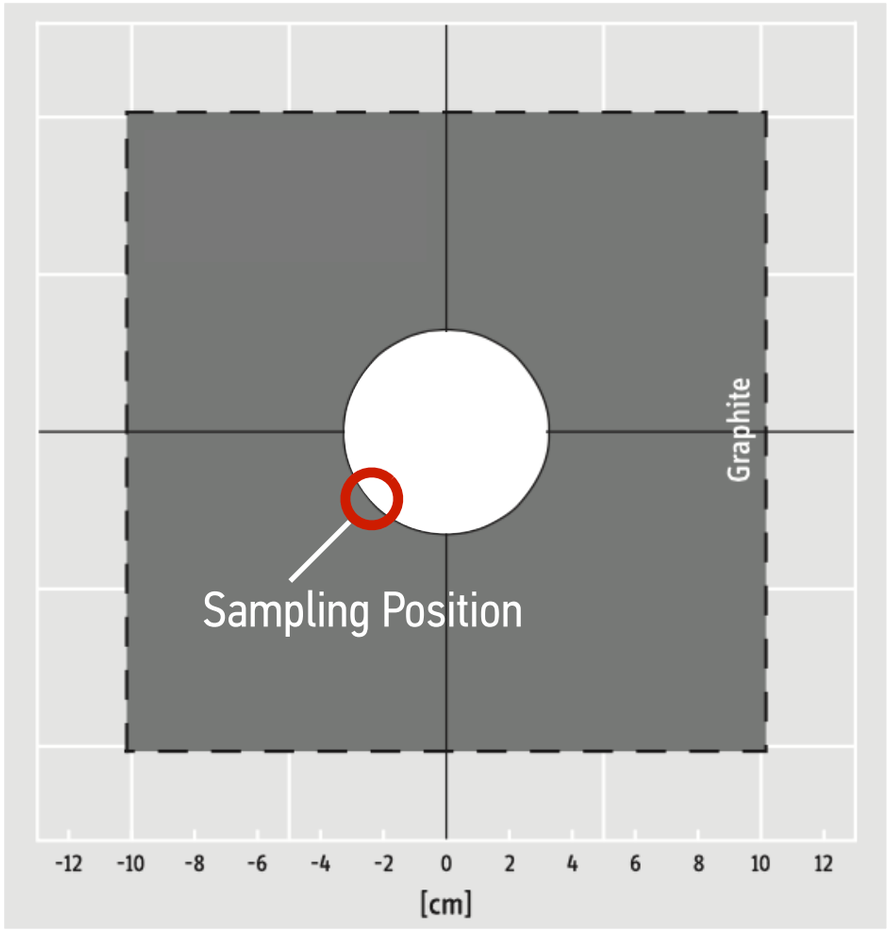
DATA EXCHANGE

AS A BASIS FOR A MORE ROBUST VERIFICATION FRAMEWORK

In May 2008, North Korea made available about 18,000 pages of operating records
with information on operation of its plutonium production reactor and the associated reprocessing facility since 1986

NUCLEAR ARCHAEOLOGY COULD BE USED TO VERIFY A NORTH KOREAN PLUTONIUM DECLARATION

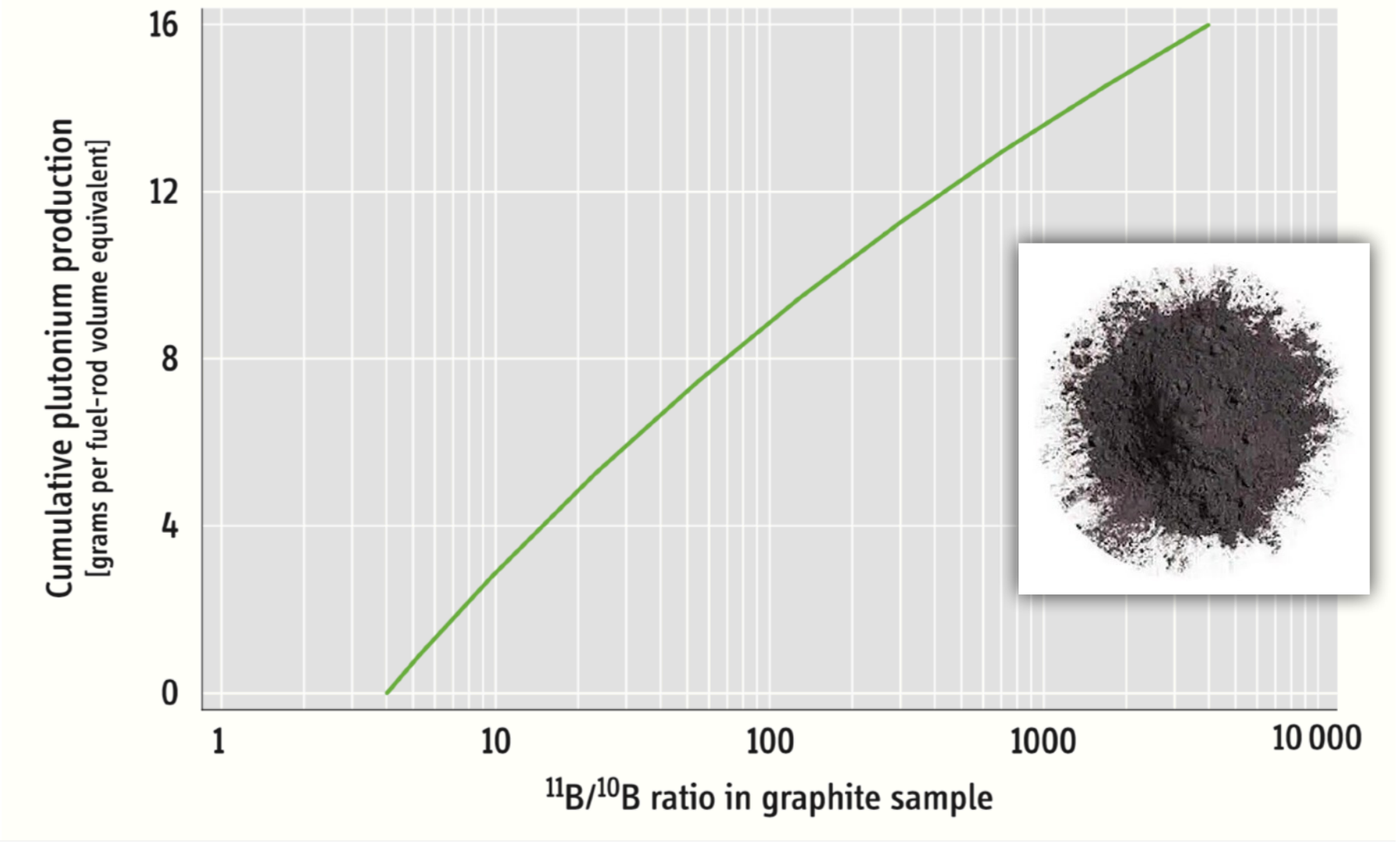
The banner reads: "Let's protect Dear General Kim Jong Il desperately!"
Credit: CNN/Brian Rokus, 2008



Unit cell of the DPRK Yongbyon reactor

ESTIMATING LIFETIME PLUTONIUM PRODUCTION

BASED ON THE MEASUREMENT OF A SINGLE (BORON) ISOTOPE RATIO



Calculations by Jungmin Kang, *Global Fissile Material Report 2009,* International Panel on Fissile Materials, www.ipfmlibrary.org/gfmr09.pdf

UNDERSTANDING URANIUM SUPPLY

URANIUM MINING IN NORTH KOREA

Mining activities at few (perhaps only one or two) locations;
ore grade previously reported as 0.26%, but can be expected to vary;
it takes several hundred tons of ore to extract one ton of uranium

Jeffrey Lewis, August 12, 2015, www.38north.org/2015/08/jlewis081215/

RECONSTRUCTING NORTH KOREA'S URANIUM SUPPLY HISTORY

About 2000 tons of ore are required to make 25 kg of weapon-grade HEU
or 5 kg of weapon-grade plutonium

Understanding historic uranium production in North Korea could help dispel concerns about undeclared enrichment plants and/or undeclared stocks of fissile material

Source: Google Earth

Enabling Verified Reductions

PHASED (AND "SECURE") VERIFIED REDUCTIONS

1

DEMATING AND (JOINT) CONTAINERIZATION OF NUCLEAR WARHEADS

May need some type of confirmation measurement

Warheads are then placed in containers, sealed, and prepared for long-term storage

2

MONITORED LONG-TERM STORAGE OF NUCLEAR WARHEADS (AND MISSILES)

Storage location of containerized warheads can remain unknown/secret

Possibility of confirming integrity of seals and containers remotely

3

STEPWISE REDUCTIONS IN THE ARSENAL

Based on agreed schedule for reductions, DPRK would offer warheads

for verified dismantlement (or specified amounts of fissile material for safeguards)

Source: U.S. Department of Energy (top), Sandia National Laboratories (middle), KCNA (bottom)

UNCONVENTIONAL APPROACHES

(SIMPLE, NON-INTRUSIVE, QUICKLY IMPLEMENTABLE)

Entrance to Storage Magazine at Pantex, Zone 4
Uses massive concrete blocks to prevent unauthorized access
Credit: U.S. DOE

Tethered balloons for 24/7 site surveillance
Widely used for civilian and military applications
Credit: Altave Omni, www.altave.com.br

NEXT STEPS / WAY FORWARD

SHORT-TERM GOALS

- Declarations and freeze of fissile material production
- Confirmed storage and stepwise reductions (several options)
- Emphasis on verification approaches that are non-intrusive
  (e.g. using remote-monitoring techniques) and quickly implementable

LONGER-TERM GOALS

- Disposition pathways for fissile materials and/or weapon components
- Return to NPT and/or accession to Ban treaty (before or after elimination of North Korea's weapons program)

Source: W. Keith Luse, CISAC (top) and author (bottom)