



VERIFIED DENUCLEARIZATION OF NORTH KOREA

ELEMENTS OF A PHASED APPROACH

Alex Glaser

Program on Science and Global Security
Princeton University

Washington, DC, June 13, 2018

Revision 1a

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

Suspension of Fissile Material Production

(REMOTE) MONITORING

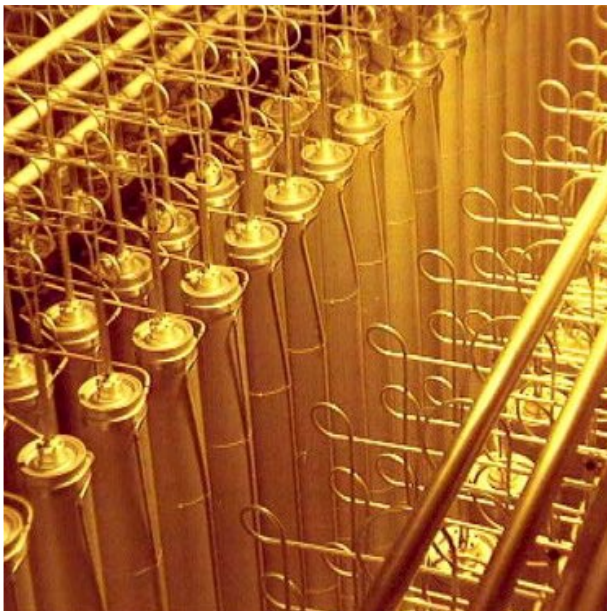
OF A FREEZE ON FISSILE MATERIAL PRODUCTION



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)
Total material produced
Removals and losses (including material consumed in weapon tests)
Inventory as of [DATE]
<i>Of this, material currently in weapons or weapon components</i>

(Several options: public, private, cryptographic escrow)

DATA EXCHANGE

AS A BASIS FOR A MORE ROBUST VERIFICATION FRAMEWORK



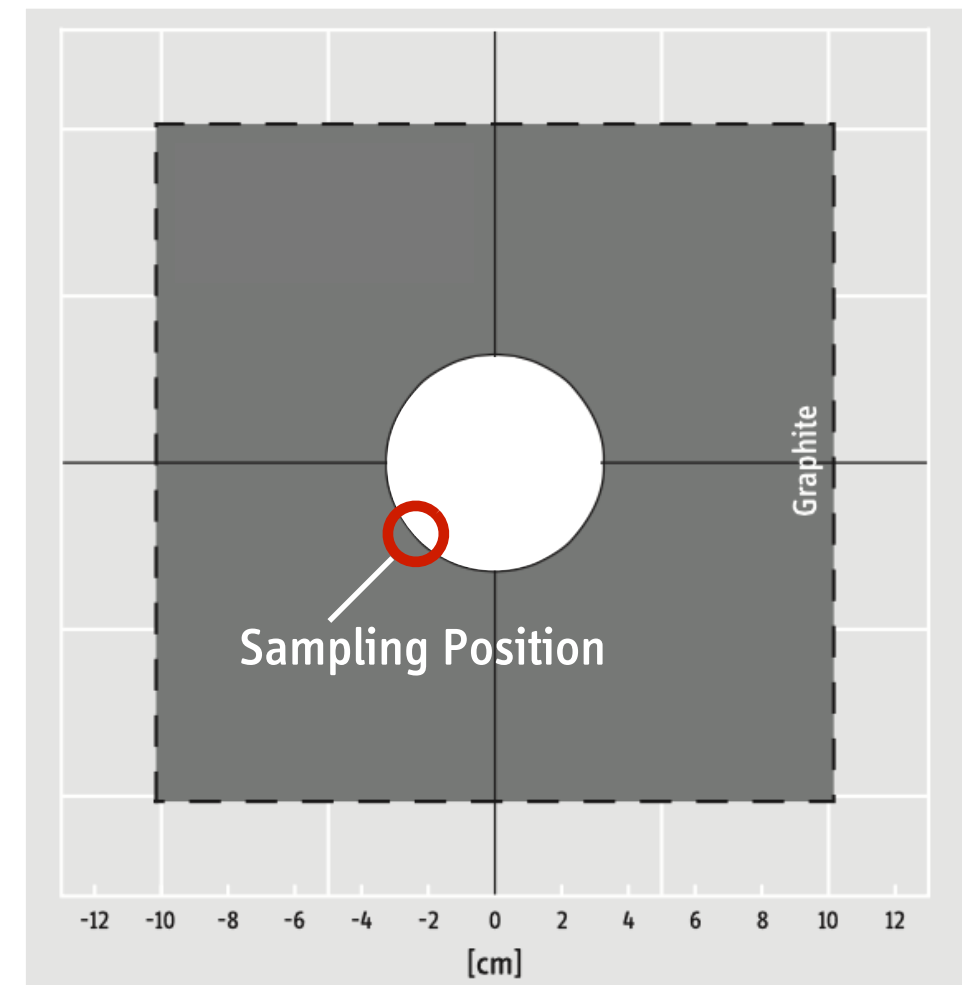
In May 2008, North Korea made available about 18,000 pages of operating records with information on operation of its plutonium production reactor and the associated reprocessing facility since 1986

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

FORENSIC ANALYSIS OF GRAPHITE SAMPLES COULD CONFIRM TOTAL PLUTONIUM
PRODUCTION IN NORTH KOREA WITHIN AN UNCERTAINTY OF ± 3 KG



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



Unit cell of the DPRK Yongbyon reactor

UNDERSTANDING URANIUM SUPPLY

TO GAIN CONFIDENCE IN THE ABSENCE OF UNDECLARED PRODUCTION



URANIUM MINING IN NORTH KOREA

Mining activities at few (perhaps only one or two) locations;
ore grade previously reported as 0.26%, i.e., it takes 300–400 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

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 stocks of fissile material

Source: Google (top) and Rio Tinto (bottom)

Ways to Approach Verified Reductions

(COMPLEMENTARY) APPROACHES TO VERIFIED REDUCTIONS



MONITORED STORAGE OF NUCLEAR WARHEADS (AND MISSILES)

Storage location of containerized items can remain unknown/secret
May need some type of confirmation measurement



STEPWISE REDUCTIONS IN THE ARSENAL

Based on agreed schedule for reductions, DPRK would offer warheads for dismantlement (or specified amounts of fissile material for safeguards)



STEPWISE DOWNSIZING OF THE WEAPONS COMPLEX

Footprint of weapons complex would “shrink” over time, and additional sites would then be offered for inspections; see also “Deferred Verification” concept (UNIDIR)

Source: Sandia National Laboratories (top), KCNA (middle), fws.gov (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*