# Understanding North Korea’s Nuclear Weapon Capabilities

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# Purpose of Today’s Talk

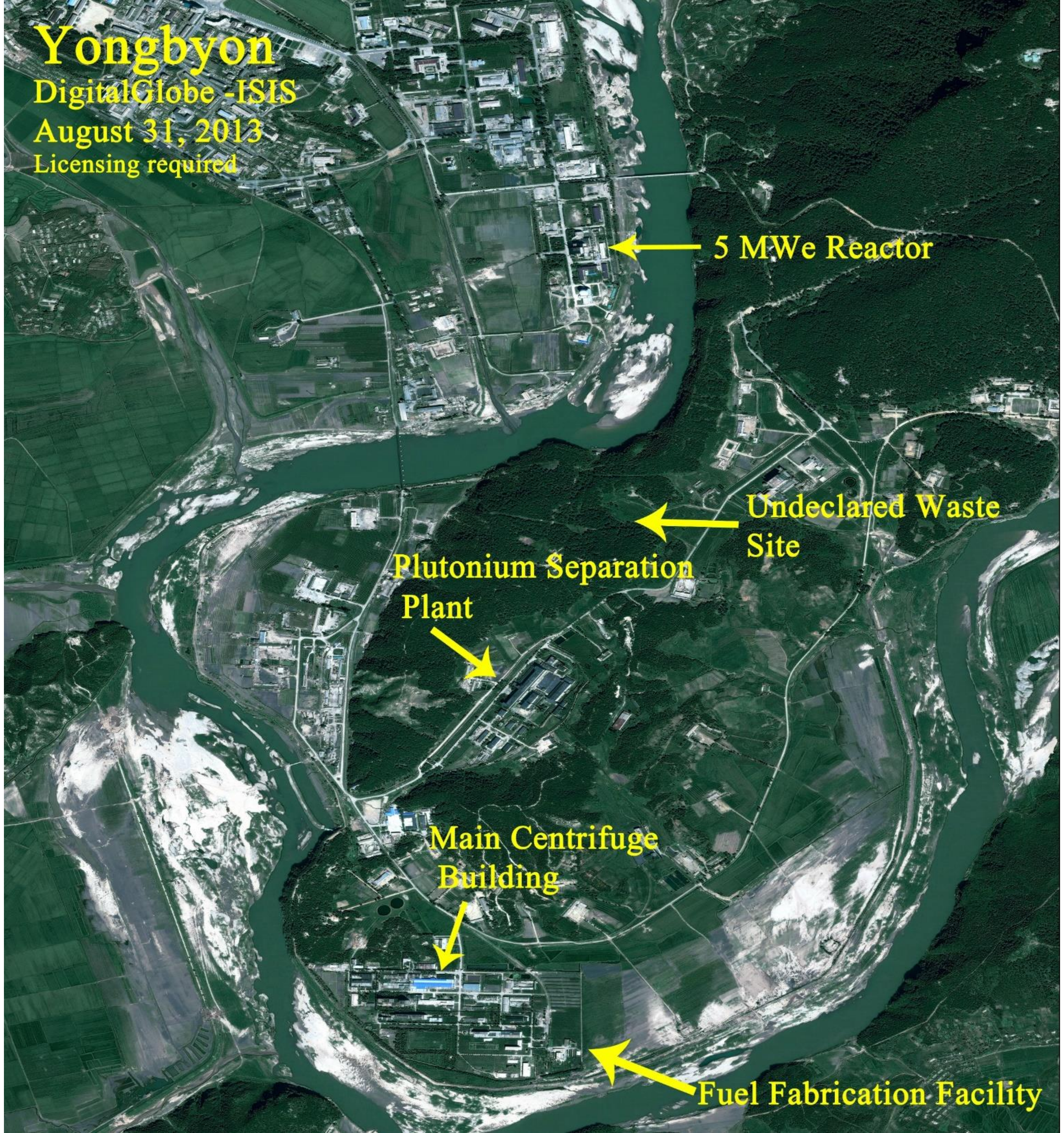
- What is the size and nature of North Korea’s nuclear weapons program?
- What would need to be dismantled verifiably to achieve a denuclearization of North Korea?
- What are some of the looming verification issues?

# Main Nuclear Programs and Activities Subject to Denuclearization

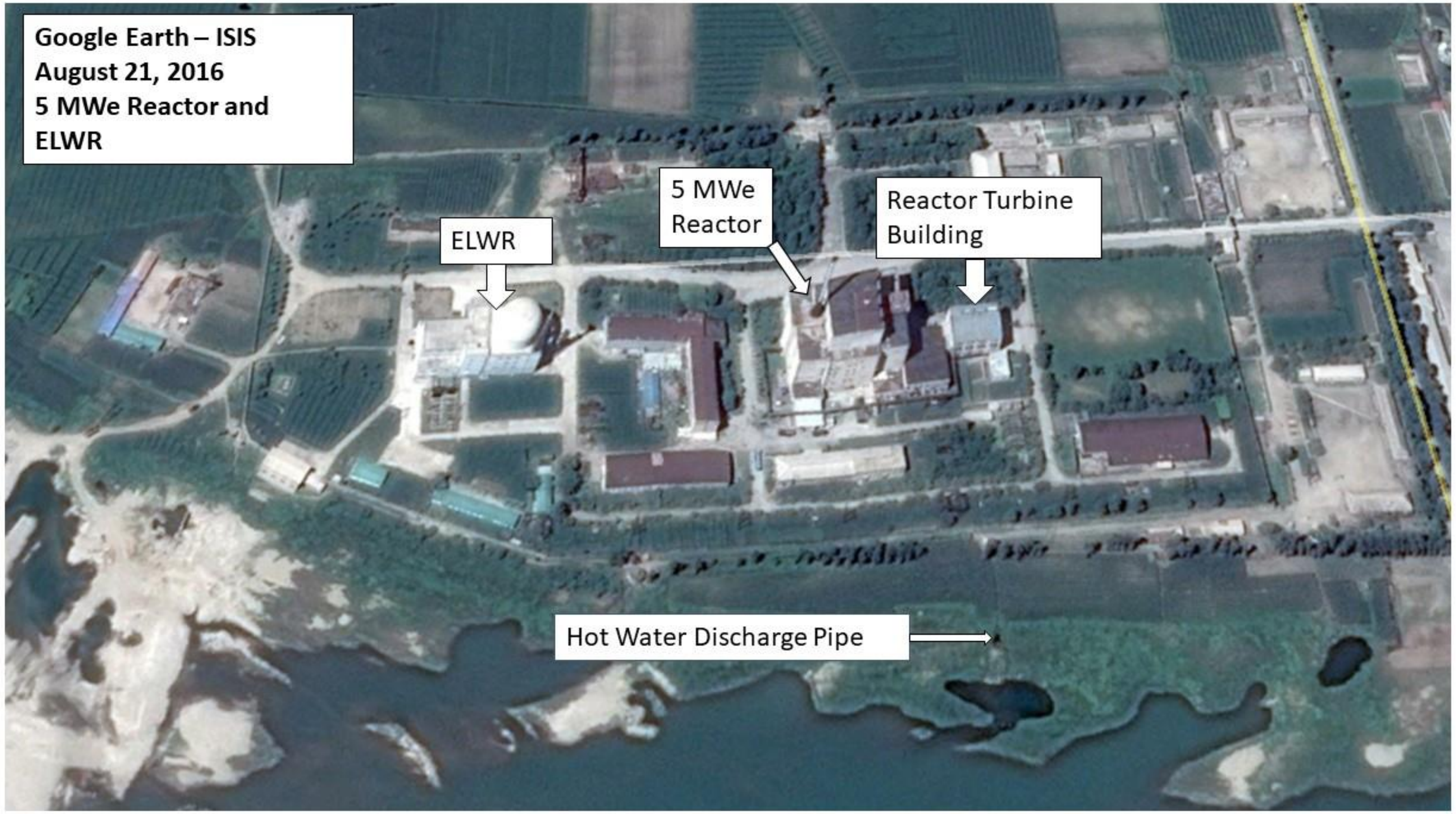
- Plutonium program
- Uranium enrichment program
- Thermonuclear materials production program
- Nuclear Weaponization, including sites to research, develop, manufacture, test, and maintain fission only and fission/thermonuclear nuclear weapons
- Nuclear weapons and associated missile and other delivery systems.
- Proliferation activities, e.g. past nuclear reactor supply to Syria
- North Korea’s illicit nuclear and missile trade and smuggling networks for its own and possibly others’ nuclear or missile programs

# Satellite Imagery Review of the Yongbyon Complex:

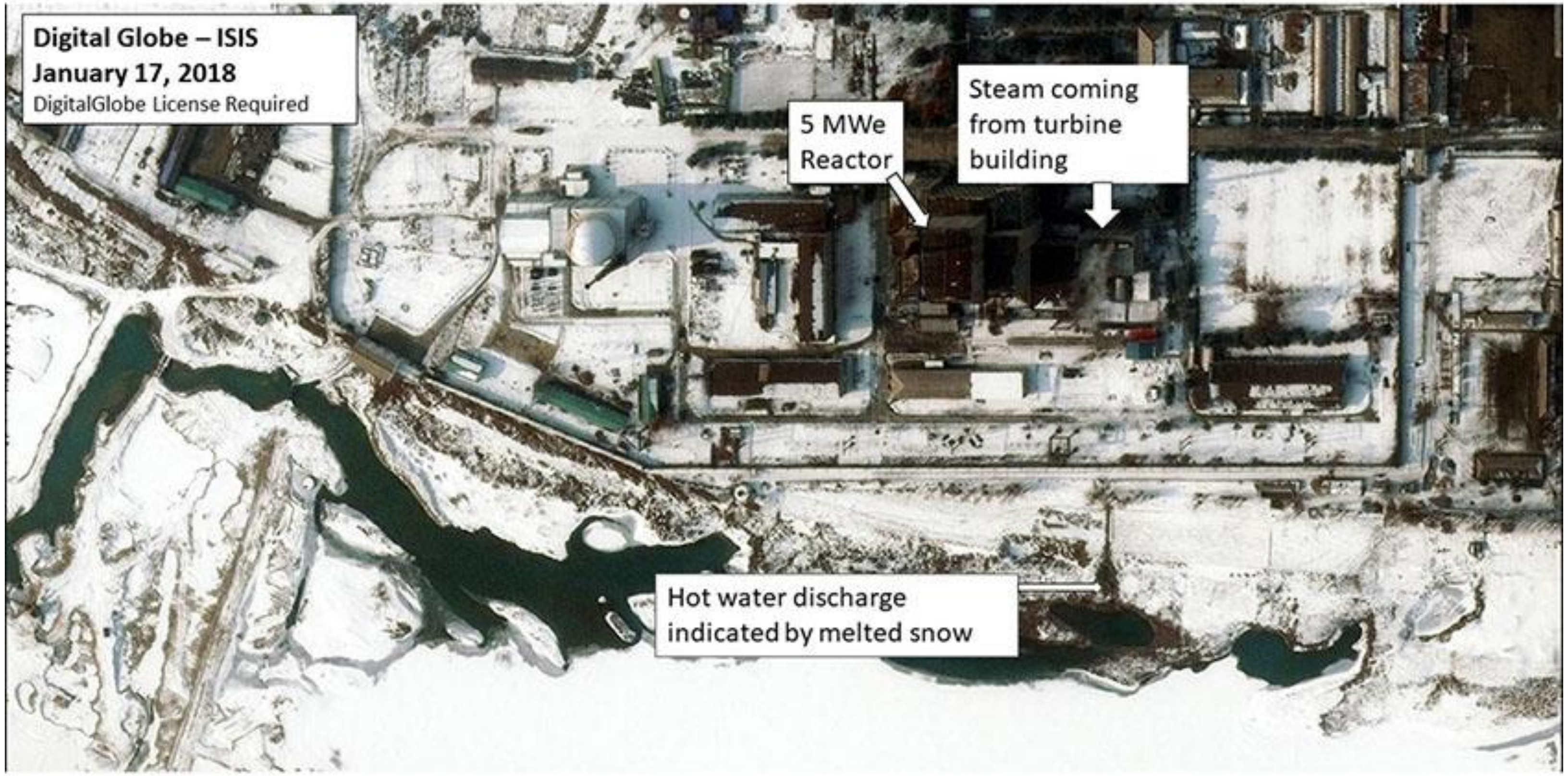
Location of the best known North Korean nuclear sites but mysteries and uncertainties about this site remain


Yongbyon
DigitalGlobe -ISIS
August 31, 2013
Licensing required
5 MWe Reactor
Undeclared Waste Site
Plutonium Separation Plant
Main Centrifuge Building
Fuel Fabrication Facility

# August 21, 2016 Google Earth Image 5 MWe Reactor and Experimental Light Water Reactor (ELWR)



# January 17, 2018 DigitalGlobe image showing 5 MWe reactor, with steam visible from the reactor’s turbine building,



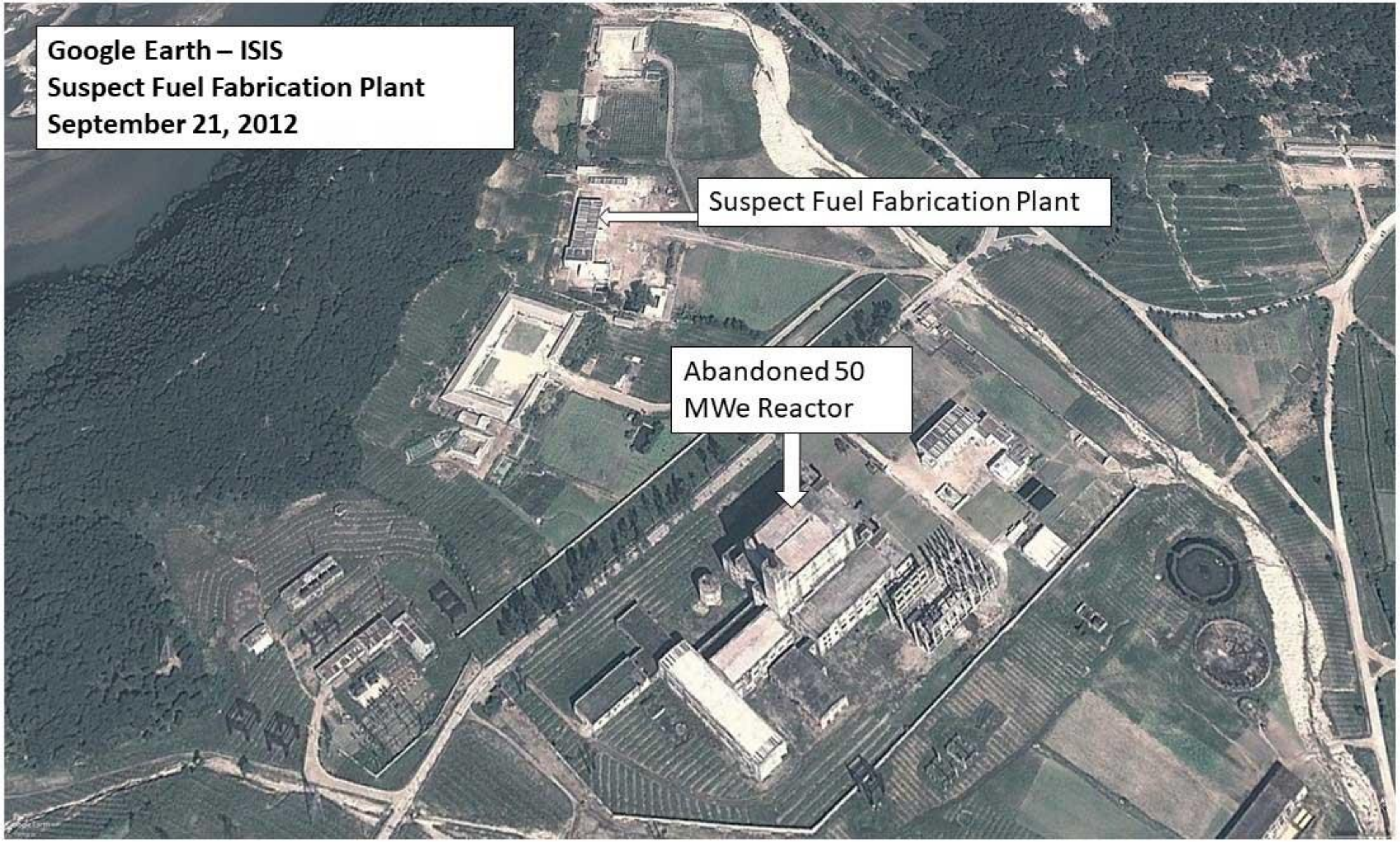
# Radiochemical Laboratory, Plutonium Separation

# Gas Centrifuge Plant and Possible Tritium Separation Plant at Yongbyon


According to a defector from Yongbyon, this facility has only a small centrifuge assembly hall, operated under clean room conditions, where pre-assembled parts are received and assembled into final centrifuge components. He said he was involved in creating the initial centrifuge assembly hall for this plant and had no prior experience assembling centrifuges before the first deliveries of parts.


Airbus– ISIS
January 30, 2018
Possible Isotope Separation Facility
Pleiades © CNES 2018 – Distribution Airbus DS/Spot
Construction Progress:
Roof added

# Unclear where ELWR fuel fabrication occurs



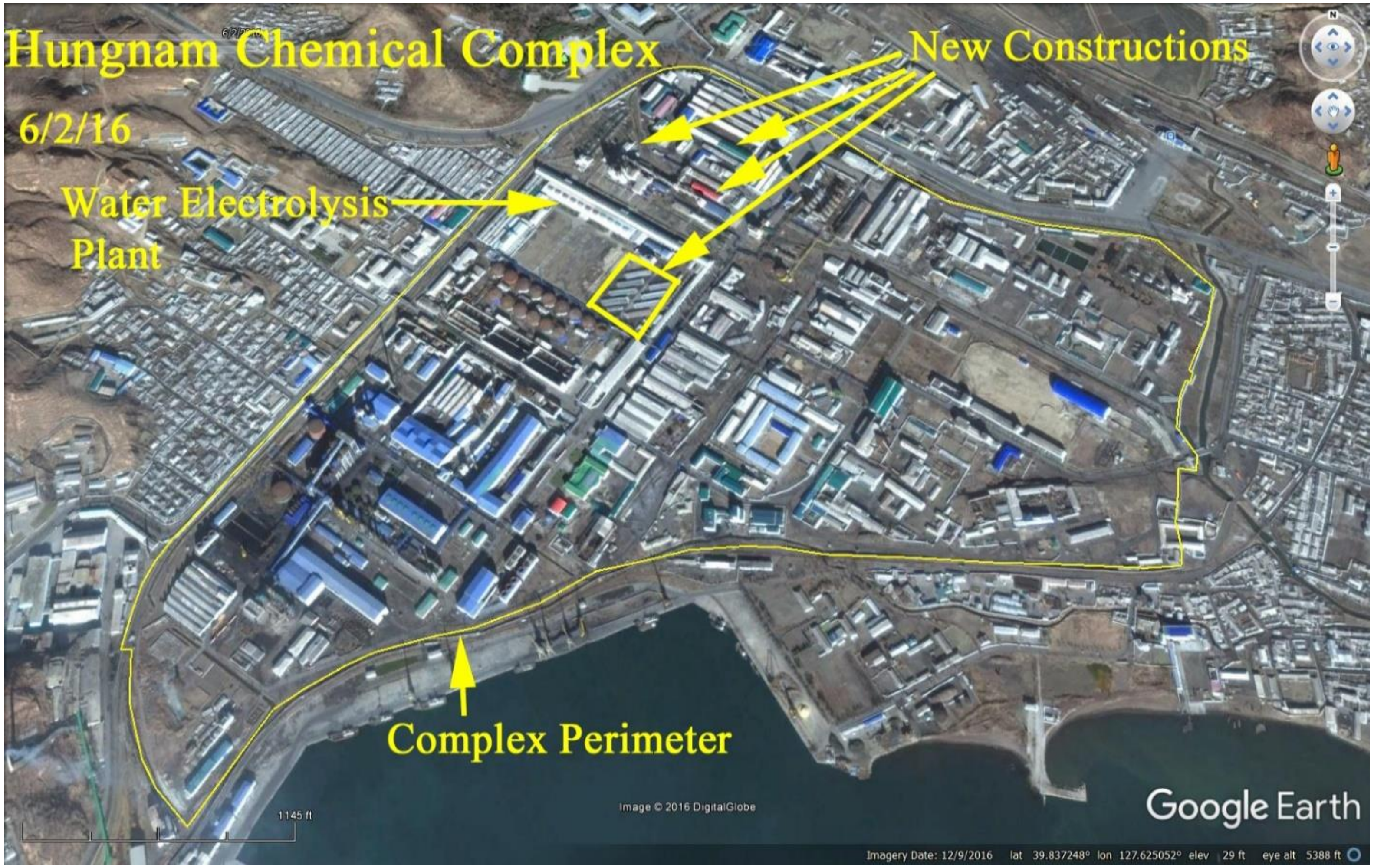
# Nuclear Sites Outside the Yongbyon Complex

# Some of the Unknown Facilities in North Korea Outside Yongbyon

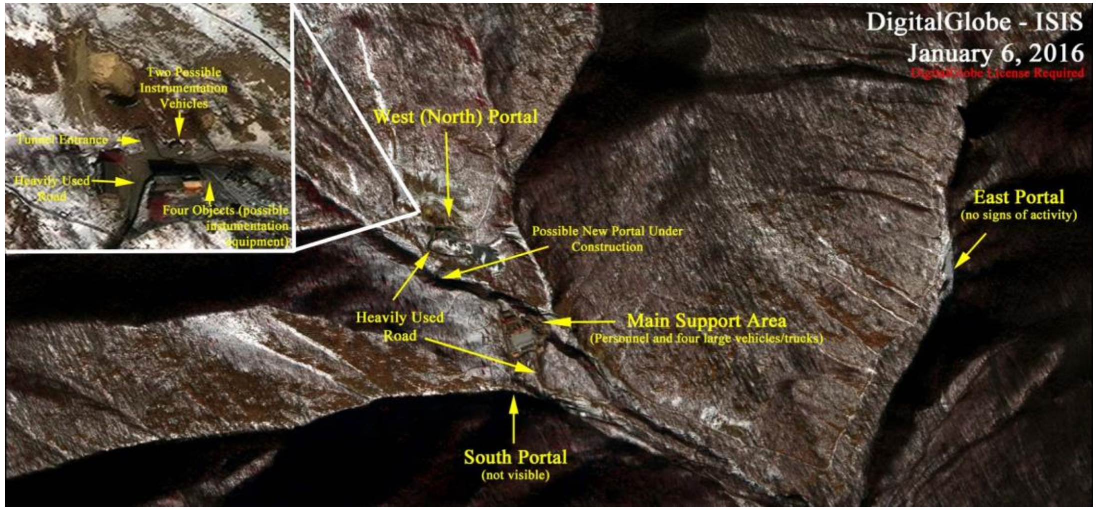
- One official source estimated to us that about half of North Korea’s nuclear facilities are outside the Yongbyon nuclear complex and the Punggye-ri nuclear test site.
- Examples include:
  - The strong possibility of an older, perhaps larger, gas centrifuge plant
  - Uranium mining and milling
  - Centrifuge manufacturing and uranium hexafluoride production facilities
  - Sites to produce thermonuclear materials, such as lithium 6
  - Unknown number of sites to research, develop, and manufacture nuclear weapons and their components
  - Sites associated with nuclear weapon component testing, including full-scale cold-testing that complement underground nuclear testing at the Punggye-ri underground test site;
  - Possible integration facilities that could mate a nuclear warhead to a ballistic missile; and
  - Nuclear warhead storage capabilities.

# Lithium 6 Production Likely at Hungnam Chemical Complex near Hamhung, Exact location unknown

(June 2, 2016 Google Earth Image)



# Punggye-ri Underground Test Site, 2016 images



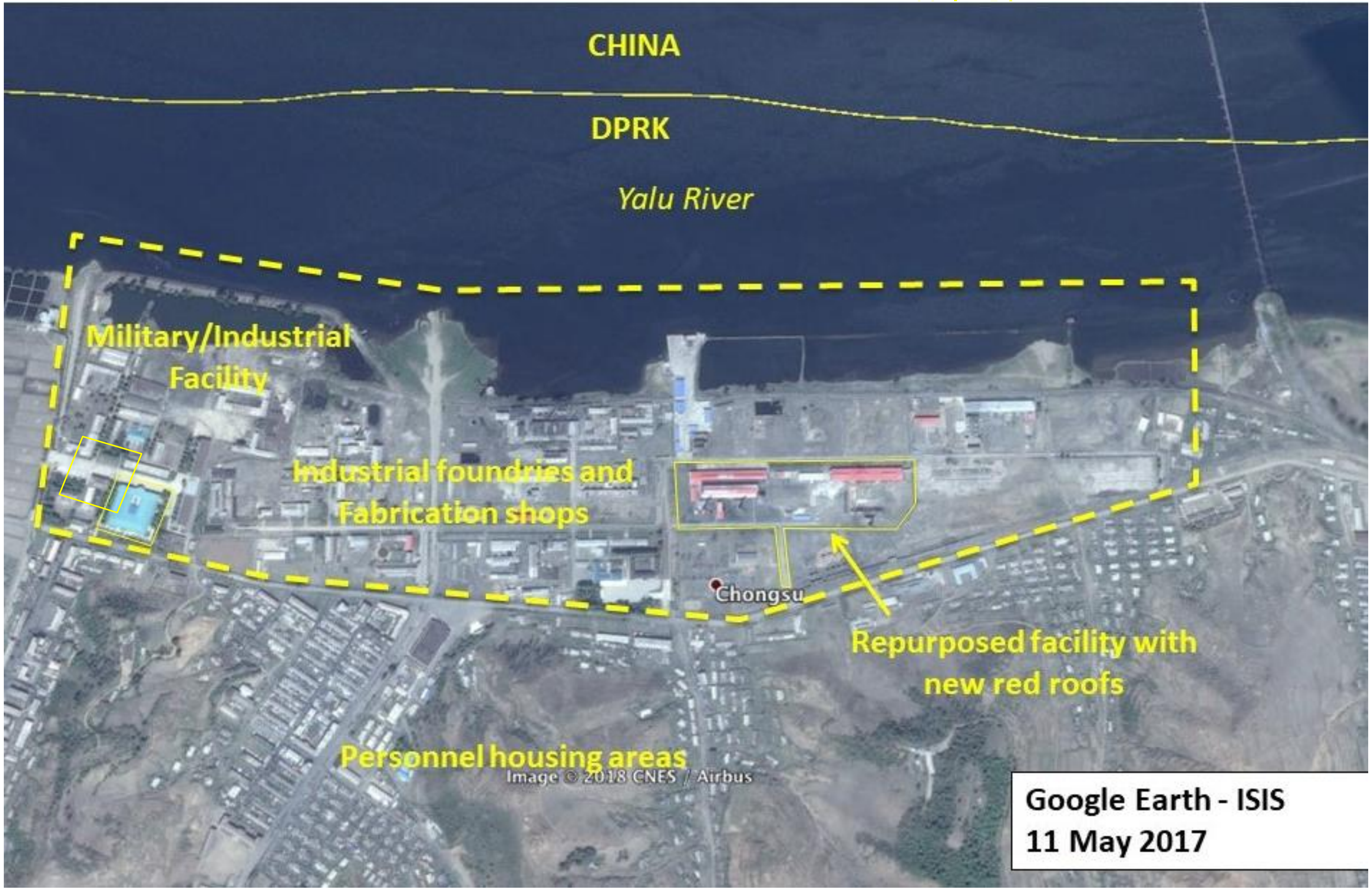


In this 2016 image, a new portal (tunnel) is identified. The names for this new portal and the nearby portal vary.

# Pyongsan Uranium Mine and Mill: Significant Renovation in Last Several Years

Google Earth imagery of location of the early suspect centrifuge R&D plant under the Changgun-dae Mountain at the Panghyon Aircraft Plant. Centrifuge plant stated to be shut down.


# The Suspect Chongsu Nuclear Grade Graphite Production Site Owned by Atomic Establishment



# Is there another, earlier centrifuge plant?

- The evidence for this plant is substantial but remains unconfirmed and controversial. This plant could have made a substantial amount of weapon-grade uranium, complicating further efforts to dismantle and verify denuclearization.
- This other centrifuge plant could have started operation as early as the mid-2000s.
- However, the uncertainty remains substantial, particularly in terms of the amount of weapon-grade uranium it could have produced.
- Later, I will present two sets of estimates that span the uncertainty in this key value.

# Argument for: Weapon-grade uranium detected in North Korea

- Weapon grade uranium was found on materials the United States brought out of North Korea in 2006 and 2007 as part of verification under the Six Party Talks.
- U.S. intelligence agencies assessed that this weapon-grade uranium was made in North Korea at a production-scale plant.
- This assessment was not unanimous in the U.S. intelligence community, however.
- Accepting this assessment implies that North Korea could have been operating a production-scale centrifuge plant by the mid-2000s.

# Argument for: Procurement Information

- Procurement information provides another compelling rationale to believe that the Yongbyon centrifuge plant is not the first one.
- Western countries track North Korea’s procurements for its centrifuge program closely and have spotted several peaks in procurements for the centrifuge program.
- Procurements have been extensive and have followed the types of procurements done by A. Q. Khan for Pakistan’s centrifuge program.

# Chronology of Detected Procurements Related to Centrifuge Plants

- 2002/2003 procurements sufficient for about 8,000-12,000 P2-type centrifuges
- Between 2003 and 2008, many procurements for centrifuge program
- 2008 procurements sufficient for 2,000 centrifuges
- End 2010, procurements for extension of the Yongbyon centrifuge plant.  Procurements sufficient for 500-1000 centrifuges
- Early 2016, procurements detected sufficient for one low enriched uranium (LEU) cascade

# Secret Centrifuge Plant?

- Would North Korea procure so much in the early 2000s and not build a centrifuge plant? Why would it wait until the late 2000s to build one at Yongbyon, ostensibly related at the time of its public declaration in 2010 only to the production of low enriched uranium (LEU)?
- North Korea’s procurement history suggests the existence of a secret or undeclared, production-scale centrifuge plant(s) that was built in the mid-to-late 2000s.
- Assuming that North Korea was following the Khan plan, then the plant could have several thousand P2 centrifuges.
- Could it have 12,000 P2 centrifuges, 6,000 P2 centrifuges?
- How well has it worked?

# Why Not Assume a Second Plant Making Weapon-Grade Uranium?

- On balance, the evidence supports the existence of two production-scale centrifuge plants.
- However, the lack of concrete evidence of the plant raises doubt about its existence. There is also uncertainty about the amount of WGU it could have made, and if the plant experienced start-up and operational problems.
- Moreover, there are plausible explanations that the Yongbyon centrifuge plant is North Korea’s only operating production-scale plant.
    - North Korea could have suffered delays caused by the difficulty of building and operating centrifuges.
    - These difficulties would have been compounded by the unexpected busting of the Khan network in 2003 and 2004, a network that North Korea may have needed to provide substantial on-going centrifuge assistance.

# Plutonium, Weapon-Grade Uranium (WGU), and Nuclear Weapons Estimates*

This section summarizes estimates developed in more detail in other publications, most recently in David Albright, *North Korea's Nuclear Capabilities: A Fresh Look,* Institute for Science and International Security, August 9, 2017, http://isis-online.org/isis-reports/detail/north-koreas-nuclear-capabilities-a-fresh-look-power-point-slides/

# Estimates and Uncertainties

- Plutonium estimates are more reliable and based more on North Korean declarations, IAEA data, and other confirmed information.
- Weapon-grade uranium (WGU) estimates are far less certain. They depend on a range of information, such as procurement successes, defector information, and modeling of centrifuges. These models include several variables including estimates of the total number of centrifuges in a plant, the efficiency of the centrifuges, and the length of operation.
- The conversion to number of weapons depends on estimating the amount of plutonium or weapon grade uranium per weapon, another uncertain process.
- All of these variables, particularly in the second and third bullets, are challenging to understand, mainly because of North Korea’s efforts to keep its nuclear programs secret.
- **This secrecy and opaqueness of North Korea’s nuclear complex and its production history will pose a large challenge to designing verified, negotiated agreements**.

# Why Not Assume a Second Plant Making Weapon-Grade Uranium?

- On balance, the evidence supports the existence of two production-scale gas centrifuge plants.
- However, there is uncertainty about the evidence of the plant and about the amount of WGU it could have made, particularly whether this plant could have experienced start-up and operational problems.
- Based on my experience assessing North Korea’s nuclear material stockpiles, I have developed considerable skepticism about unverified information about North Korean capabilities.

# One or Two Centrifuge Plants?

- On balance, in terms of our estimates of stocks of weapon-grade uranium, we still consider two basic cases:
    - One where North Korea has two centrifuge plants in operation with each having produced significant amounts of weapon-grade uranium.
    - Another case where North Korea has only the Yongbyon centrifuge plant in operation.
- The median of each of these cases is taken as a range of values.
- I should point out that ultimately these cases center on how well North Korea has operated P2 centrifuges, a subject with few data.
- Later, I will discuss the case of two centrifuge plants in more detail, since this more maximal estimate is a better planning tool for future verification efforts.

# Plutonium and WGU Stocks, end of 2017

- My Institute's median estimates of the size of North Korea's plutonium and weapon-grade uranium stocks through 2017 are:
  - 30 kilograms of separated plutonium; and
  - 230-760 kilograms of weapon-grade uranium, where 230 kilograms corresponds to a median estimate for the case of one centrifuge plant and 760 kilograms corresponds to the median estimate for the case of two centrifuge plants.

- See David Albright, *North Korea's Nuclear Capabilities: A Fresh Look,* Institute for Science and International Security, August 9, 2017, http://isis-online.org/isis-reports/detail/north-koreas-nuclear-capabilities-a-fresh-look-power-point-slides/; the estimate on this slide is an update through 2017 of the estimate presented in the August 9, 2017 presentation.

# Estimated Number of Nuclear Weapons, based on Pu and WGU stocks and a reduction of 30 percent

- At the end of 2017, my Institute estimates that North Korea had about 14 to 33 nuclear weapons.
- Each limit is a median from one of two previous estimates, namely one with one centrifuge plant and the other with two centrifuge plants. Each weapon is assumed to contain either plutonium or weapon-grade uranium.
- These values reflect the utilization of 70 percent of the available, estimated stocks of plutonium and weapon-grade uranium. This assumption means that thirty percent of North Korea's total stocks of plutonium and weapon-grade uranium are assessed as in production pipelines, lost during processing, or held in a reserve.

# Trends through 2020

- Currently, we estimate an expansion of roughly 3-5 weapons per year. The Yongbyon site would produce enough fissile material for three of these weapons per year.
- Through 2020, North Korea is assessed as having enough plutonium and weapon-grade uranium for about 24-48, rounded to 25-50 nuclear weapons.
- A worst case, involving the operation of the Experimental Light Water Reactor and its use to make weapon-grade plutonium, is that it would have enough plutonium and weapon-grade uranium for 57, or rounded to up to 60, nuclear weapons by the end of 2020.

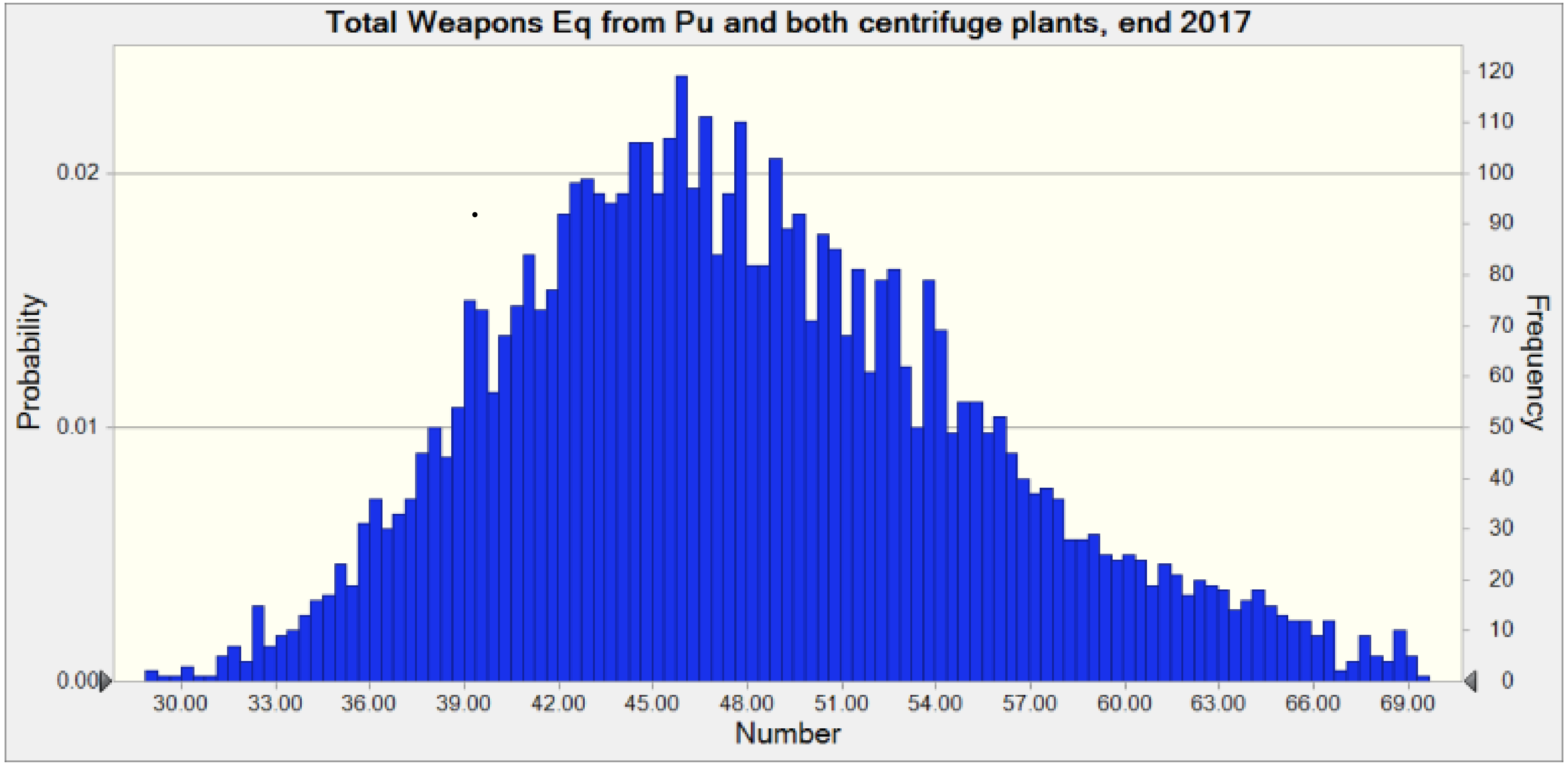
# A Closer Look at the Upper Bound

- As discussed, most analysts believe a second, older enrichment plant exists and has made weapon-grade uranium for a number of years.
- The upper bound of the median estimate presented earlier of the number of nuclear weapons through 2017 includes the production of weapon-grade uranium at a second, unknown enrichment plant.
- Based on discussions with U.S. officials, U.S. estimates of nuclear weapons capabilities assume that this second enrichment plant exists and has contributed significantly to North Korea's stock of weapon-grade uranium.
- Although I am less sure of the resulting weapon-grade uranium estimates, it is useful to focus on the case of two centrifuge plants producing weapon-grade uranium as a basis to think through verification approaches in the event of success in negotiations of North Korean denuclearization.

# Scenario with Two Enrichment Plants

- I will show frequency distributions that have translated estimates of the total amount of plutonium and weapon-grade uranium as of the end of 2017 into an equivalent number of nuclear weapons.
- These distributions rely on estimates of both plutonium and WGU that, as discussed earlier, involve a range of variables, each of which is represented as a range of values with a probability attached to each value, typically a uniform distribution (equally likely to be the case).
- Another variable is the amount of plutonium or WGU per weapon (a range with a probability assigned).
- Each of these variables is sampled by Crystal Ball software, in most cases 5,000 times, resulting in a frequency distribution of results. The idea is that the median value of this frequency distribution is more likely but in fact the range is more representative of the actual situation.
- In the frequency distribution on the next slide, the estimated number of nuclear weapons equivalent is presented, abbreviated by "Eq."

# Weapons from all of the  Estimated Pu plus WGU from Two Centrifuge Plants, end 2017

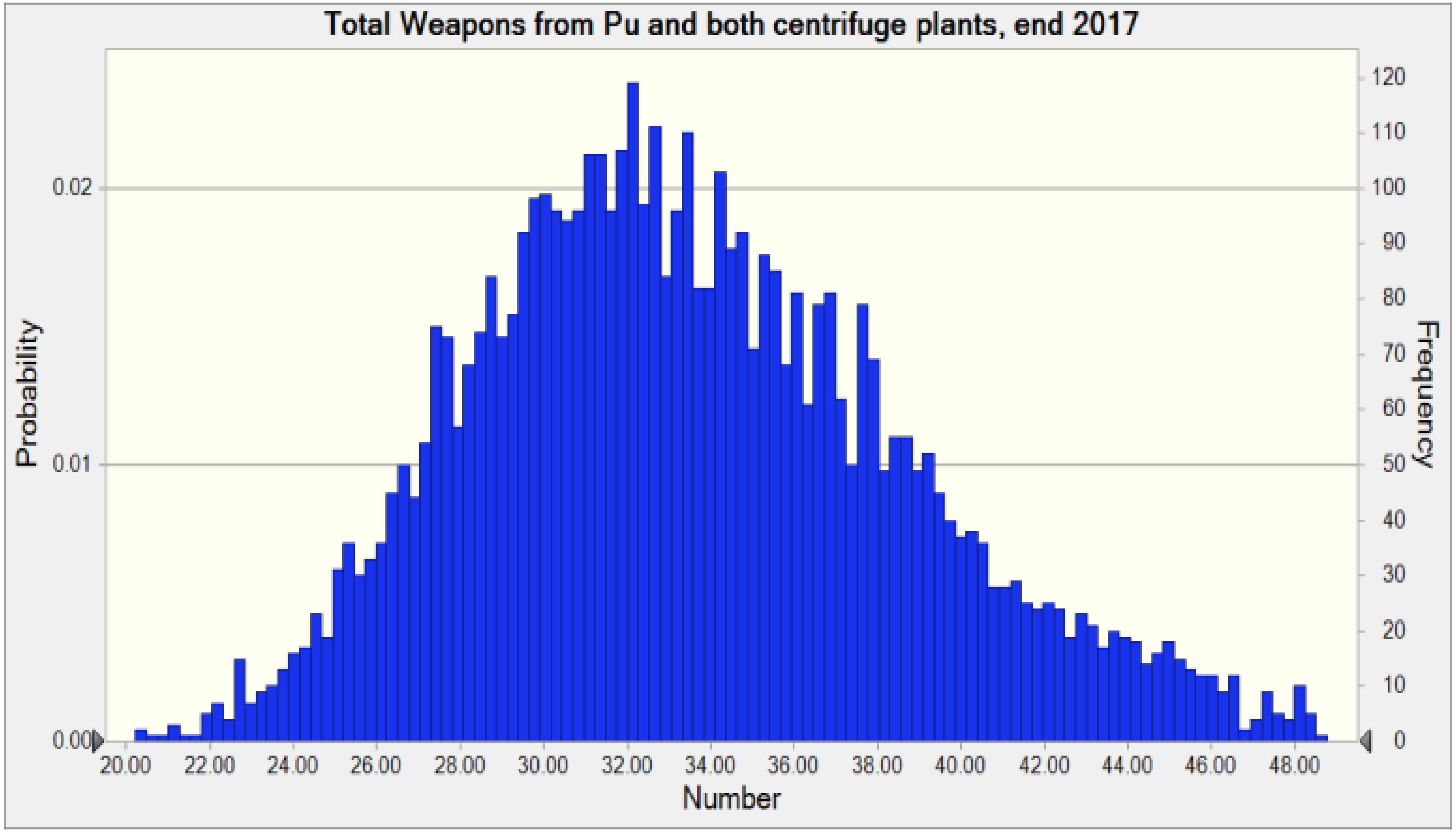



The median of this slightly skewed distribution is about 47 weapons equivalent, with a standard deviation of 7.8 weapons equivalent.  The full range is 26 to 80 weapons' equivalent.  The $5^{th}$ and $95^{th}$ percentile are 37 and 62 weapons equivalent, respectively.

# Estimating the Potential Size of the Arsenal

- As discussed earlier, the actual number of nuclear weapons would be expected to be fewer in number than given by the above nuclear weapons equivalent values. A fraction of the plutonium or WGU would be tied up in the manufacturing complex that makes nuclear weapons components or would be lost during such processing. Some of this material would be expected to be held in a reserve for underground nuclear testing or new types of weapons.
- In these estimates, it is assumed that only 70 percent of the total amount of plutonium or WGU is used in nuclear weapons.
- Accounting for this reduction, the distribution of the estimated number of weapons made from plutonium or weapon grade uranium from two centrifuge plants at the end of 2017 follows on the next slide.

# Number of Weapons, accounting for fissile material losses, pipeline, reserves, end 2017




The median of this slightly skewed distribution is 33 nuclear weapons, with a standard deviation of 5.4 weapons. The full range is 18-57 weapons. The range defined from the 5th and 95th percentiles of this distribution is 26 to 44 nuclear weapons.

# Observations

- These ranges for the scenario of two enrichment plants are relatively broad, about 26-44 nuclear weapons, where I use the 5th and 95th percentiles of the distribution.
- These upper bounds are consistent with media reports in 2017 about certain U.S. government intelligence community estimates of the number of North Korean nuclear weapons.
- In one report, the U.S. indicated that North Korea had up to 60 nuclear weapons.  In our analysis, I would interpret this value as not including losses and being in the upper tail of the first distribution.
- I would stress that in our analysis a value of 60 represents a worst case.
- And I would also stress that our base estimate is 14-34 nuclear weapons, reflecting additional uncertainties about the status and operation of an older centrifuge plant.

# Comparison of Estimated WGU Stock and Total Nuclear Weapons of Two Scenarios Considered Here

- Conservative estimate of one or two centrifuge plants (preferred absent more information):
  - 14-33 nuclear weapons
  - 230-760 kilograms of weapon-grade uranium, where 230 kilograms corresponds to a median estimate for the case of one centrifuge plant and 760 kilograms corresponds to the median estimate for the case of two centrifuge plants.

- Two centrifuge plants estimate (increasingly likely and relevant to developing verification approaches):
  - 26 to 44 nuclear weapons
  - 600 to 1,000 kilograms of weapon-grade uranium

# Findings: Plutonium and WGU Stocks Provide Flexibility to North Korea’s Weapons Options

- North Korea’s numbers of weapons, based on fissile material estimates, are relatively large and growing.
- Although these types of estimates do not predict the actual number built by North Korea so far, it provides the amount that could have been built or will be built in the near term.
- North Korea appears able to produce considerably more weapon-grade uranium than plutonium, providing a pathway to a much greater number of nuclear weapons. Much greater uncertainty surrounds WGU stocks than plutonium stocks.
- North Korea is assessed as having enough plutonium and weapon-grade uranium for many crude fission weapons and several composite core weapons.
- Continued testing would provide opportunities to improve its weapons in terms of less fissile material (plutonium) per weapon, increased miniaturization, and greater explosive yields.
- Developing thermonuclear weapons, which can achieve all three above goals, is a declared priority. It appears capable of doing so, as will be discussed later.

# Types of Nuclear Weapons (warhead and delivery system), based on delivery systems

- **Aircraft dropped bombs**: unknown if bomb designs exist but likely able to design
- **Nodong missile**: miniaturized, plutonium-based warhead likely; unknown if could build miniaturized fission-only composite core design (with both plutonium and WGU) but increasingly possible
- **Medium range missile**, land-based, warhead unknown
- **Intermediate range missile**, land-based, warhead unknown
- **ICBM**, land based, warhead unknown
- **Sea-launched missile**, medium range, warhead unknown
- **Tactical nuclear weapons**, such as backpack bombs and land mines; speculative if exist or are planned

# Observations and Findings about North Korea’s Nuclear Weapons Capabilities

- North Korea appears to have a family of relatively reliable, miniaturized fission weapons with the destructive force rivaling the size of the Hiroshima blast that can use plutonium or weapon-grade uranium and fit on a number of shorter-range ballistic missiles, such as the Nodong.
- North Korea can achieve explosive yields, likely using crude thermonuclear designs, that can destroy modern cities. With time, likely within a few years, it could have a **reliable** capability to deliver and explode such weapons over targets.
- North Korea could use warheads similar to what it uses on its Nodong missiles on its longer-range missiles, although it would need to ensure that they can withstand the harsher environment experienced by these longer range missiles, particularly an ICBM. Moreover, it may experience problems in miniaturization and achieving sufficient warhead ruggedness as it seeks to use cores containing both plutonium and weapon grade uranium or thermonuclear materials. As a result, nuclear warhead miniaturization efforts likely continue.
- Other weaponization issues probably continue to be under development, i.e. reliability, safety, and security of nuclear weapons.

# Observations (cont.)

- North Korea will continue to depend on importing key goods for its nuclear programs from suppliers; but more effective sanctions could prevent North Korea from acquiring what we call perishable goods, creating bottlenecks and operational difficulties in its nuclear and possibly missile programs.
- We should always worry that North Korea could proliferate its capabilities to other nations. Although this aspect of the problem is not discussed here, North Korea's nuclear proliferation to other countries remains a fundamental concern.

# Thermonuclear Weapons

# North Korea's January 2016 and September 2017 Thermonuclear Test Declarations

- North Korea called its January 2016 and September 2017 tests thermonuclear.
- What should one make of the January 6, 2016 test?
  - Seismic data did not reveal a large explosion, e.g. estimates of roughly 15 kilotons.
  - However, the test was detonated at about double the depth of the 2013 test:
    - Roughly 700-800 meters below a mountain peak in 2016 vs. about 350 meters in 2013.
    - This would imply that North Korea expected a larger yield.
  - Would it bluff, e.g. just dig a longer, deeper tunnel? Maybe. Or North Korea may have been using the available space in the mountain.
- No data from radioactive releases has emerged that could shed light on the nature of either test.
- Nonetheless, it is reasonable to  conclude that North Korea detonated some type of thermonuclear device in 2016, but not successfully.
- The September 2017 was a different story, since it achieved a yield of at least 130-140 ktons. It is possible that it was a pure fission explosion but it is more likely it was some type of thermonuclear device.

# North Korea has acquired wherewithal to make thermonuclear materials

- For several years, evidence has accumulated that North Korea was producing or procuring materials needed to make thermonuclear weapons.
- It is assessed as having established a domestic capability to make lithium 6.
- Expressed interest in deuterium.
- Likely constructed a new Isotope Separation Plant at Yongbyon that could separate tritium produced in the 5 MWe reactor or in the nearby, small Soviet-supplied IRT reactor.
    - 5 grams per year of tritium production in 5 MWe would displace roughly 360 grams of weapon-grade plutonium and need about 5 kg of lithium 6 in about 40 percent enriched lithium aluminum targets.

# Purported Mock-Up of a Two Stage Thermonuclear Weapon, September 3, 2017

- Pyongyang released photo of what it claims is a mock-up of a two-stage thermonuclear weapon, near a re-entry vehicle, and with a photo on the wall of warhead inside a re-entry vehicle.
- North Korea stated: "thermonuclear nuke with great destructive power which can be detonated even at high altitudes for super-powerful EMP (electromagnetic pulse) attack according to strategic goals".

# Purported Mock-Up of a Two Stage Thermonuclear Weapon, September 2017

- We should view skeptically North Korean claims that this test was a missile deliverable two-stage thermonuclear device.
- Likewise, the picture of an elongated device distributed by North Korea purporting to show a miniaturized two stage H bomb is likely more aimed at spreading propaganda than something to be taken literally.  North Korea understands our fears and is well practiced in the art of disinformation.
- I believe the object in the picture was a model meant to play on our fears of H bombs, sow division, and bolster their deterrent.  In reality, the picture and North Korea's statements provide no evidence that the object or test used a two-stage thermonuclear design.  Moreover, the shape of the device in the picture and information in its statement do not appear to go beyond in content that which is available in the open literature.
- Absent other information, I believe it would be premature to assess that North Korea, which has had real struggles mastering technological targets, has reached such a difficult goal of building two-stage deliverable thermonuclear weapons.

# Denuclearization and Its Verification—An Introduction

# North Korean Denuclearization

- Denuclearization is a commonly used, albeit vaguely defined, term that in the North Korean context typically means not only its nuclear disarmament but also the elimination of much of its industrial capability to make nuclear weapons.
- The phrase, the denuclearization of the Korean peninsula, is also used and can be subject to varying interpretations.
- But for purposes of achieving U.S. goals, denuclearization is best defined via UN Security Council resolutions, such as resolution 2270 (2016). The Security Council in this resolution "*Reaffirms* its decisions that the DPRK shall abandon all nuclear weapons and existing nuclear programs in a complete, verifiable and irreversible manner, and immediately cease all related activities."
- A straightforward interpretation is that North Korea should verifiably eliminate all of its nuclear weapons and its capability to test, develop, produce, maintain, and proliferate nuclear weapons.
- How longer range missiles will fit into this definition is uncertain. Although UNSC resolutions also call separately for the verified elimination of all North Korean ballistic missiles, ICBMs and their production capabilities are increasingly viewed as part of denuclearization.

# Verification and Dismantlement Targets

- Plutonium program
- Uranium enrichment program
- Thermonuclear materials program
- Nuclear Weapons testing, development, production, and maintenance
- Nuclear weapons
- Proliferation of nuclear weapons and capabilities
- North Korea's illicit nuclear trade and smuggling networks for its own and other nuclear programs

# Past Verification Work

- It should be remembered that there exists a substantial body of work on North Korean complete, verified, irreversible dismantlement (CVID) that was developed in the Six Party negotiations and the subsequent effort to achieve the Leap Day deal. It should more properly be called the verified, irreversible dismantlement of North Korea's nuclear weapons programs.
- The Six Party Talks in the 2000s led to a great deal of clarification of the verification requirements of a denuclearization agreement, even if North Korea was not as cooperative as Libya, South Africa, or Iraq in 1995-98.

# The October 2008 Agreement: Limited Cooperation

- In October 2008, the United States and North Korea agreed tentatively to a deal that made progress on accomplishing the verification arrangements in denuclearization in the context of the Six Party Talks.
- North Korea was preparing to restart plutonium separation at Yongbyon. The negotiations were bitterly opposed by hard-liners on each side. Looking back, this deal was unlikely to succeed and it failed rapidly.
- Despite its rejection later, this deal, by placing emphasis on plutonium while also laying the basis for dealing with uranium enrichment, weaponization, and proliferation, was an important U.S. negotiating accomplishment. Its positive and negative aspects should be assessed as part of the work today to achieve a negotiating model.

# Components of October 2008 Deal

- Written text (applied to plutonium, enrichment, and proliferation);
- Two side conversations between North Korea and the United States;
- Singapore agreement (mid-2008), where North Korea agreed to provide cooperation on uranium enrichment and proliferation activities (including not to proliferate), while decoupling these issues from plutonium;
- Three earlier agreements, Sept 19, 2005 Joint Statement, Feb. 13, 2007 Agreement on Initial Actions, and Oct 3, 2007 Agreement on Second-Phase Actions; and
- Understanding with Chinese expressed in a letter to Chinese chair of Six Party Talks that the United States has an understanding with North Korea, called a "related understanding," which captures the inter-linkages among the above components of the deal. "Chinese chair also understands and supports this position."

# Difficult Verification Issues in October 2008: Still True Today

- North Korea's provision of documents; allowing interviews with key individuals;
- Granting access at declared sites to buildings not included in existing declarations;
- Access to sites not declared, e.g. nuclear test site(s), weaponization facilities, suspected centrifuge facilities;
- Defining the different types of undeclared sites eligible for visits or inspections.
- The sampling and forensics to be allowed and at which facilities (e.g. 5 MWe and IRT reactors and uranium enrichment plants);
- The negotiations led to ambiguous phrases, such "at an appropriate time" in the context of taking key samples,
- Negotiating verification measures piecemeal and incrementally or all at once;
- Participation by Non-Nuclear Weapon States (NNWS) in verification;
- Role of International Atomic Energy Agency (IAEA);
- The need to destroy items rather than store them in during disablement and dismantlement.

# What is needed from North Korea? How to tell if this is all for naught?

- North Korea needs to believe that verified nuclear dismantlement is in its national security interests.
- North Korea needs to demonstrate full cooperation with the verification organization(s)
- It needs to permit access to sites, personnel, and documents. Access to military sites will be necessary.
- North Korea needs to understand that sanctions are not traded for negotiations but concrete actions.

# Brief comments on what to look for at the upcoming summits and subsequent negotiations

- One lesson of past negotiations with North Korea is that the United States should seek initially a clear, written (public) commitment from North Korea on eliminating its nuclear weapons and the means to make, test, and maintain them.
- The United States should also seek an agreement with North Korea on all necessary verification measures, in particular it should achieve such an agreement prior to starting any verification.
- The alternative, namely a piecemeal approach to negotiating verification measures, was used in the past but did not succeed and can require on-going, difficult negotiations over the basic principles and ground rules of verification, with little certainty of succeeding in a satisfactory manner.
- The entirety of North Korea's nuclear weapons programs need to be included in any verification effort. In the past, for example, plutonium was singled out and enrichment put off until later.
- Is there a focus on a historical nuclear material balance and flow chart for all uranium in North Korea? Such an approach would cover the plutonium, enriched uranium, and nuclear weapons program. In the case of enriched uranium, a reconstruction of the daily separative work output and enriched uranium production may be necessary. Other approaches will be needed as well.

# Quick Overview of Major Verification Arrangements in a Potential Agreement

- Provision of more clarity on nuclear sites; a tour of major sites should be obtained as an early outcome of negotiations
- Declarations of all of the nuclear weapons program
- Verification of the declarations
- Verification Organization
- Ensuring absence of undeclared materials and facilities
- Irreversible dismantlement
- On-going monitoring

# Example: Overview of Verification of Dismantlement of Uranium Enrichment Program

- Phase 1:
  - Listing and describing the UEP facilities subject to abandonment;
  - Visiting these facilities;
  - Halting operations at these facilities and establishing at least partial IAEA monitoring.
- Phase 2:
  - Disabling these facilities;
  - Producing a declaration
- Phase 3:
  - Verifying the declaration and ensuring the absence of undeclared nuclear materials or facilities;
  - Dismantlement and disposal of the UEP

# Thank You

For a description of a successful denuclearization process, please see *Revisiting South Africa's Nuclear Weapons Program*, available as an ebook at Nook, Kindle, and Smashwords, as a pdf on the Institute website (http://isis-online.org/uploads/isis-reports/documents/RevisitingSouthAfricasNuclearWeaponsProgram.pdf), and as a paperback in black and white at Amazon.