What I saw in North Korea and why it matters

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Outline

- What they showed me and why?
- Brief history of nuclear program and LWRs
- How does it change the nuclear threat?
- Where do we go from here?

It was not a discovery of a secret facility - not a shot in the dark

Jan. 2004 Yongbyon

Aug. 2005 Pyongyang

Nov. 2006 Pyongyang

August 9, 2007, Yongbyon

Feb. 14, 2008, Yongbyon

Feb. 27, 2009, Pyongyang

Six previous visits prepared the way

DPRK positions on uranium enrichment (UE)

- **Apparently admits UE to U.S. in Oct. 2002**
  - This leads Bush administration to kill Agreed Framework
- **Subsequently denies have any UE**
- **Repeated denials during my six visits**
- **In 2009 - after rocket launch and UN condemnation**
  - We will build our own LWR
  - We will make our own fuel
  - Sept. 2009 - we have success in experimental procedure

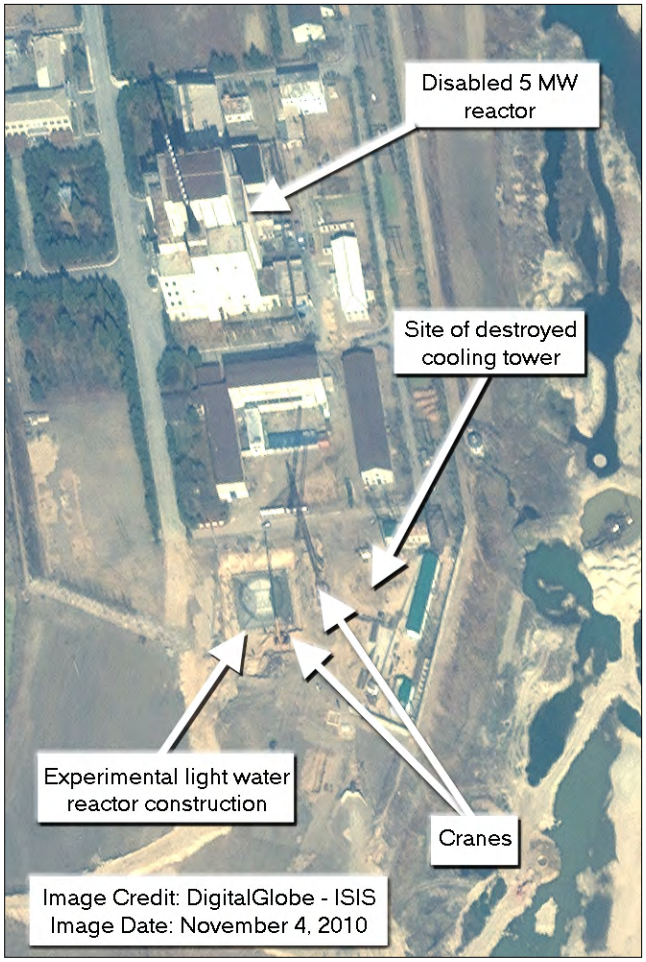
My previous assessment of uranium enrichment

Of course, DPRK has a program… …
but only at the R&D level

- **2004 visit - Yongbyon official tells J.W. Lewis of early UE**
  - But subsequently denies statements
- **1990s - connections to Pakistan's A.Q. Khan and KRL**
- **Late 1990s - global procurement attempts**
- **2002 CIA analysis is plausible**
- **Remarkably quiet since then - until Nov. 12, 2010**

Visit # 7: Yongbyon - Nov. 12, 2010

"We will convert our center to an LWR and pilot enrichment facility"



"No one believed us when we announced this in 2009 - including you, Dr. Hecker," North Korean Official

Experimental light-water reactor (LWR) construction

- **25 to 30 MWe (100 MW-thermal)**
  - We will start small, learn, then build a larger power reactor
- **Reinforced concrete containment shell started**
  - 22 m diam by 40 m high (excavation 7.1 m deep)
- **Steel pressure vessel**
  - To be manufactured indigenously
- **Two electrical generators for electricity**
  - Local communities and linked to national grid
- **Uranium dioxide (UO_2) fuel pellets in cladding**
  - Not yet decided (either zircaloy or stainless steel)
- **Fuel to be enriched (LEU) to 3.5% U-235**
- **Target completion date - 2012 (I believe, unrealistic)**

Their claim that Yongbyon is being converted to LWR and uranium enrichment is credible

Experimental light-water reactor (LWR) concerns

- **Safety -** can it be constructed and operated safely?
  - Nuclear regulatory approval and oversight is imperative
  - Claim to have a National Nuclear Safety Commission
  - LWR is a new design - entirely new design team at work
  - INPO and WANO - lessons learned?

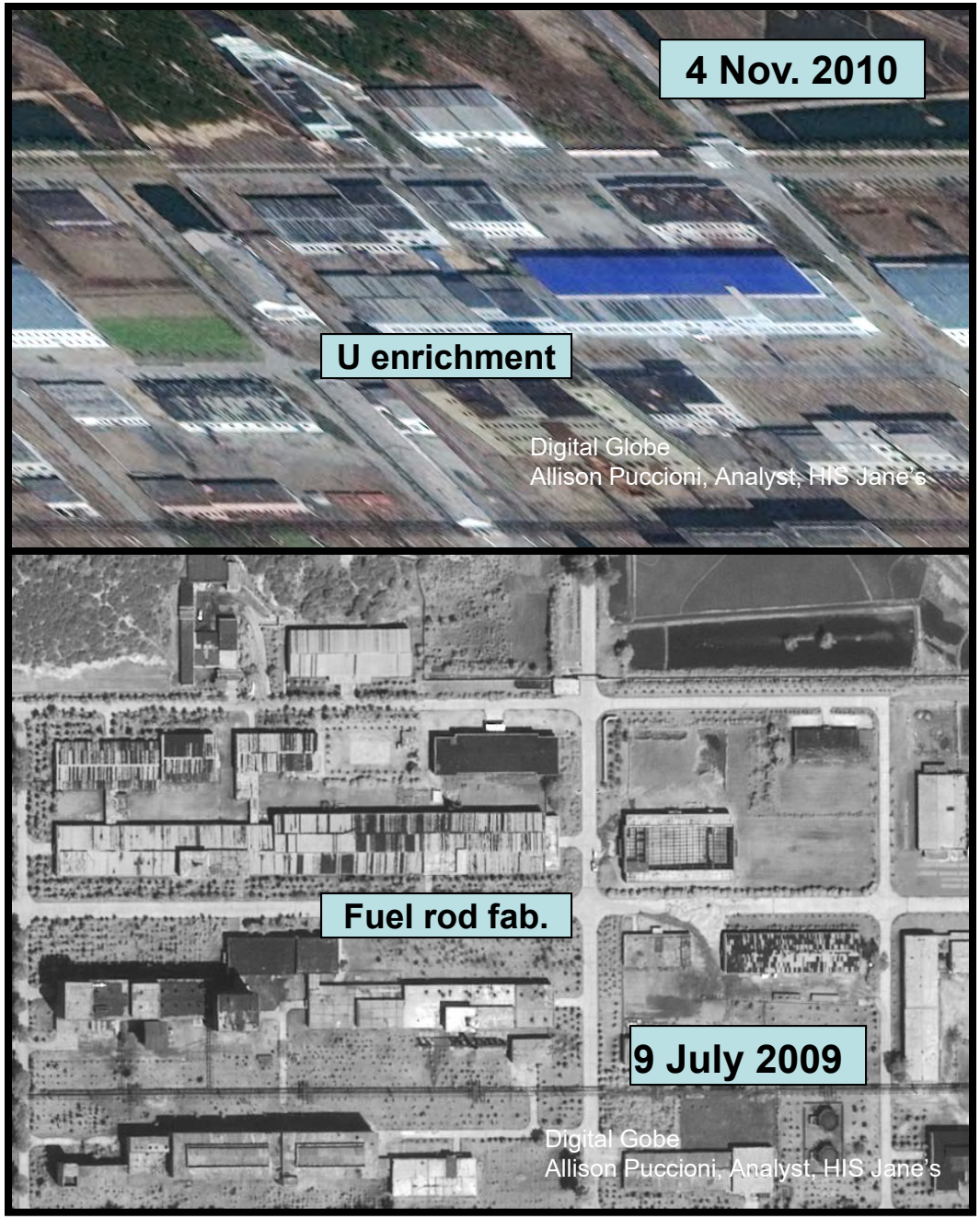
- **Plutonium production**
  - Like all uranium fueled reactors, this LWR will produce plutonium
  - Annual plutonium production estimated at 10 to 15 kg
  - Typical LWR plutonium is not very suitable for bombs
  - The existing 5 MWe reactor can produce 6 kg/year of super-bomb grade plutonium
  - Diversion to bomb plutonium production readily detected

- **LWR requires uranium enrichment**
  - Centrifuge facilities that produce LEU (3.5% U-235) can readily be reconfigured to make bomb-grade HEU (~90% U-235)

Uranium enrichment facility

- **Started construction in April 2009**
  - Claimed to have completed a few days before our visit (11/12/10)
- **Reconstruction and renovation of Bldg. 4**
  - U.S. technical team and IAEA on site until mid-April 2009
  - 120 meters by 18 meters
  - Fresh exterior stucco
  - Blue roof entire length of building (from overheads)
- **Several other new buildings visible at the FFF site**


Fuel Fabrication Facility Site
Nov. 4, 2010, Digital Globe
Allison Puccioni, Analyst, HIS Jane'


4 Nov. 2010
U enrichment
Digital Globe
Allison Puccioni, Analyst, HIS Jane's
Fuel rod fab.
9 July 2009
Digital Gobe
Allison Puccioni, Analyst, HIS Jane's

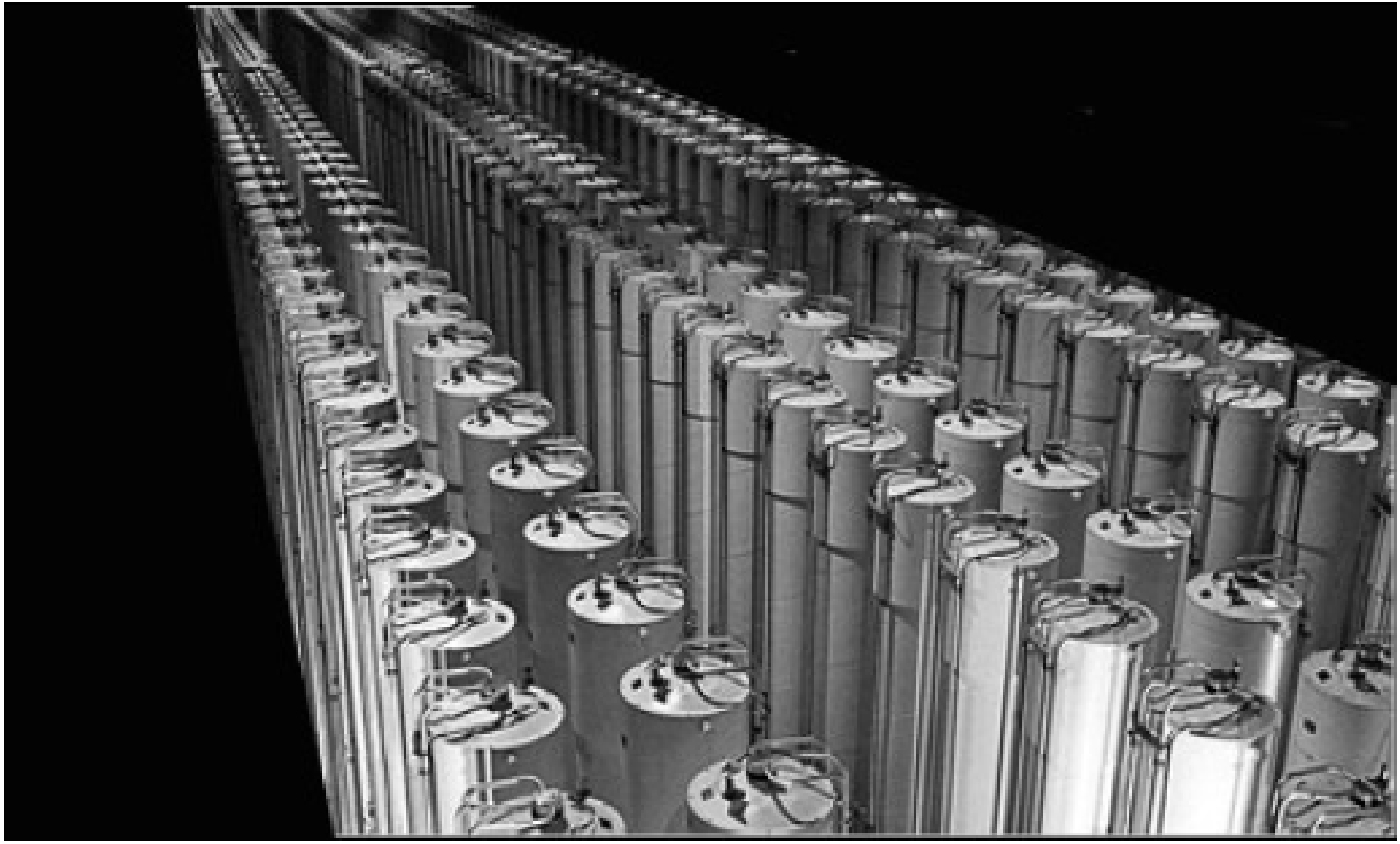
Bldg. 4 during disablement - Feb. 2008 visit

Bldg. 4 after disablement
of a casting furnace

Bldg. 4 after removal of lathes

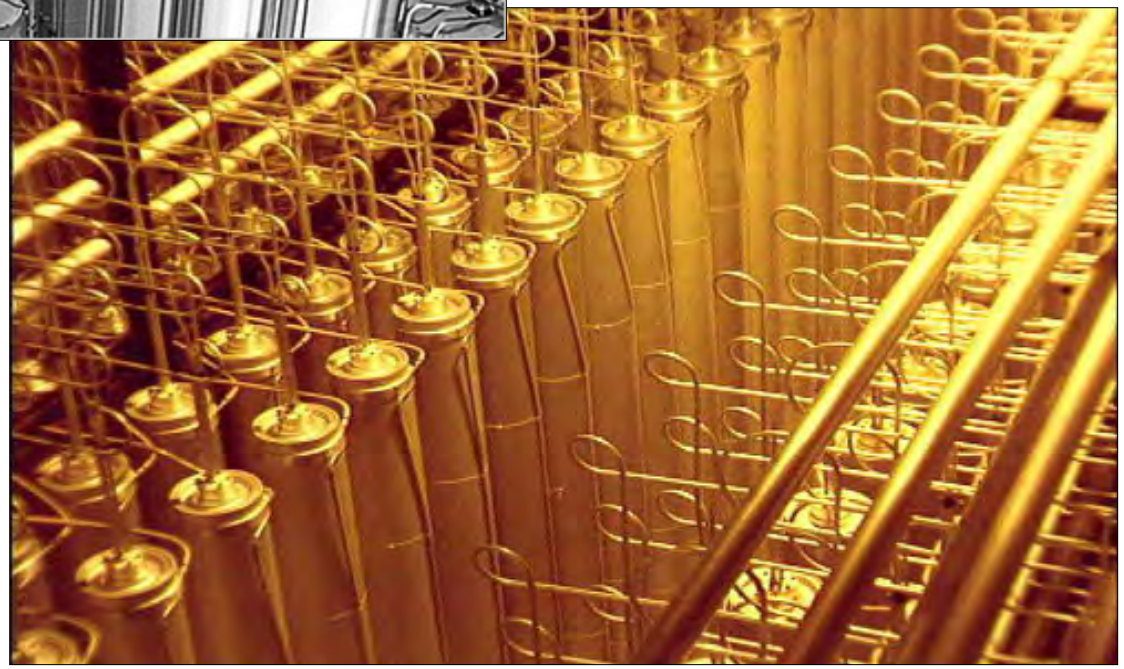
U.S. technical team had access until April 2009 - a lot has happened since

Purely illustrative - this is not Yongbyon, but close to what we saw.



Piketon, Ohio Centrifuge plant, 1984 (Department of Energy)
Several additional centrifuge lines were removed graphically to try to get this as close as possible to the centrifuge cascades we saw in Bldg. 4 at Yongbyon

U.S. Piketon, Ohio plant (1984)



URENCO Centrifuge cascades

The new Yongbyon centrifuge facility

- **2,000 centrifuges in a divided 100-meter cascade hall**
- **Centrifuges ~ 6 ft high by 8 in diameter**
- **Claimed to have steel rotors**
  - Likely maraging steel, hence P-2 (G-2) centrifuges
- **Through-put claimed at 8,000 kg SWU/year**
  - Capable of producing 2 tonnes LEU/yr (adequate for small LWR)
- **Claimed to be operating, producing LEU now**
  - We cannot confirm, but not inconsistent with what we saw
- **Modern control room**

Facility and capacity is consistent with fuel requirements for experimental LWR


Kim Il-sung University e-Lab


5 MWe reactor control room

Why?

- **Why did they show the facilities?**
  - LWR construction difficult to hide
  - Finally admit uranium enrichment with a cover story
- **Why to us?**
  - Trusted interlocutors - good track record
  - Plus, I asked to see the enrichment facility in January
- **Why now?**
  - Looks to have been well planned in early 2009
  - LWR would become visible soon and enrichment facility was ready

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- **But, why the blue roof?**
  - The Yongbyon enrichment facility is likely for LEU

Motivation and history of LWRs for North Korea

- **North Korea chose gas-graphite reactor design in '70s**
  - Poor for electricity, good for bombs (like early UK and France)
- **By 1980s realized difficulty of nuclear electricity supply**
  - 1985 agreement to get two Soviet LWRs - dashed by end of SU
- **1994 Agreed Framework**
  - U.S., ROK, Japan to provide two modern LWRs - unfulfilled
- **Aug. 2005 meeting with Vice Minister Kim Kye-gwan**
  - No LWR, no deal - referring to Joint Statement (signed 9/19/05)
- **Aug. 2007 meeting with VM Kim Kye-gwan**
  - U.S. can run the LWR, we won't enrich, won't reprocess
- **2009 decision after rocket and nuclear test and sanctions**
  - We'll do it alone - begin experimental LWR and enrichment

The LWR has economic and symbolic importance

Vice Minister Kim Kye-gwan (Feb. 2007)

What's the threat?

- **Enriched uranium is required for LWRs**
  - If in good international standing, easy to obtain from suppliers
- **Same equipment, same technologies permit HEU**
  - The Iran problem - LEU can serve as cover for HEU
  - Breakout or parallel covert facilities allow HEU production
- **2,000 centrifuge cascades**
  - Can produce 2 tonnes/year of 3.5% LEU reactor fuel **or**
  - 40 kg of 90% bomb-grade HEU/year (enough for ~ 1 or 2 bombs)

It's the dual use problem

How did North Korea get enrichment and when?

- **What we saw requires many years of development, manufacture and testing**
- **Most likely decades of R&D, procurement and training**
- **HEU particles in North Korea and UF_6 to Libya questions**
- **Current system likely built and tested outside Yongbyon**
- **Unlike the original reactors, centrifuges require help***
  - Cooperation with Pakistan's A.Q. Khan since 1993
  - Included training of their technical specialist at Khan Research Lab
  - Supply of two dozen centrifuges by Khan around 2000
  - Complex web of procurement - i.e. aluminum from Russia & Germany
- **Possible cooperation with Iran**

* See D. Albright and P. Brannan, "Taking Stock: North Korea's Uranium Enrichment Program, ISIS, Oct. 8, 2010

Status of Yongbyon plutonium program

- **5 MWe reactor - shut down, in standby**
  - No new plutonium being produced
  - No cooling tower, fresh fuel not ready
- **Reprocessing facility in standby**
  - All spent fuel reprocessed
  - No plutonium in the pipeline
- **Fuel fabrication facility**
  - Construction to convert to LWR fuel
- **50 MWe reactor being torn down**
  - 200 MWe at Taechon also not salvageable
- **Estimated plutonium inventory**
  - 24 to 42 kg (enough for 4 to 8 bombs)
  - Claimed that all of it is weaponized

If North Korea really wants to enhance and improve its nuclear arsenal, I would expect it to restart and rebuild these facilities

DPRK nuclear status: 9/30/10

- Plutonium: 24 to 42 kg (~4 to 8 bomb's worth)
- Nuclear weapons (~4 to 8 primitive bombs)
  - Limited by plutonium and sophistication (lack of testing)
- No plutonium in the pipeline – reactor not restarted
  - Fuel for one more load – but requires 6 months
  - Reactor needs cooling tower – requires ~ 6 months
  - Reprocessing facility – ready to operate
- Potential nuclear test – needed for miniaturization for missiles
  - Plutonium scarcity; may look for another confrontation
- Uranium enrichment
  - Likely long-standing R&D effort but denied by DPRK
  - Announced success in summer 2009 – but still likely only R&D

DPRK nuclear status: Current assessment

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  - Plutonium scarcity; may look for another confrontation
  - HEU as back-up?
- Uranium enrichment
  - Likely long-standing R&D effort but denied by DPRK
  - Announced success in summer 2009 – but still likely only R&D
  - Small industrial scale apparently operational - others possible

What are the nuclear security threats? (9/30/10)

- **Nuclear bombs – currently, a low threat**
  - Concerns in event of instability
- **Miscalculations or accidents – possible**
- **Uranium enrichment (HEU) – low**
- **Export – materials or technologies – very serious**

What are the nuclear security threats? Post 11/12/10

- **Nuclear bombs – currently, a low threat**
  - Concerns in event of instability
  - Greater threat if many more bombs
- **Miscalculations or accidents – possible**
- **Uranium enrichment (HEU) – low** unless lots of HEU
- **Export – materials or technologies – very serious**
  - Centrifuge technologies may be attractive
  - HEU export bigger threat than plutonium

Summary of threat and why it matters now?

- **Not much for the current enrichment capacity**
  - Better off continuing to produce plutonium if they want more bombs
  - Modern nuclear arsenals use plutonium
- **But, once demonstrated, could duplicate anywhere**
  - Small footprint and signature, difficult to detect
- **Number of facilities limited by materials and components**
  - High-strength steel, high-strength aluminum, etc.
  - Components - ring magnets, frequency converters, bearings, vacuum valves, molecular pumps, etc.
  - Indigenous manufacturing capability unknown, but questioned
- **Large HEU capability could lead to increased arsenal size**
  - Could become more like Pakistan arsenal
  - More sophisticated bombs require testing, but plutonium is superior

So, what to do now?

- **Take threat seriously, but don't hype it**

- **Remember Perry process recommendation in 2000**
- Deal with North Korea as it is, not the way we'd like it to be

- **Do policy review to see what's changed since 2000**

- **Stay the course on denuclearization, but contain threat**

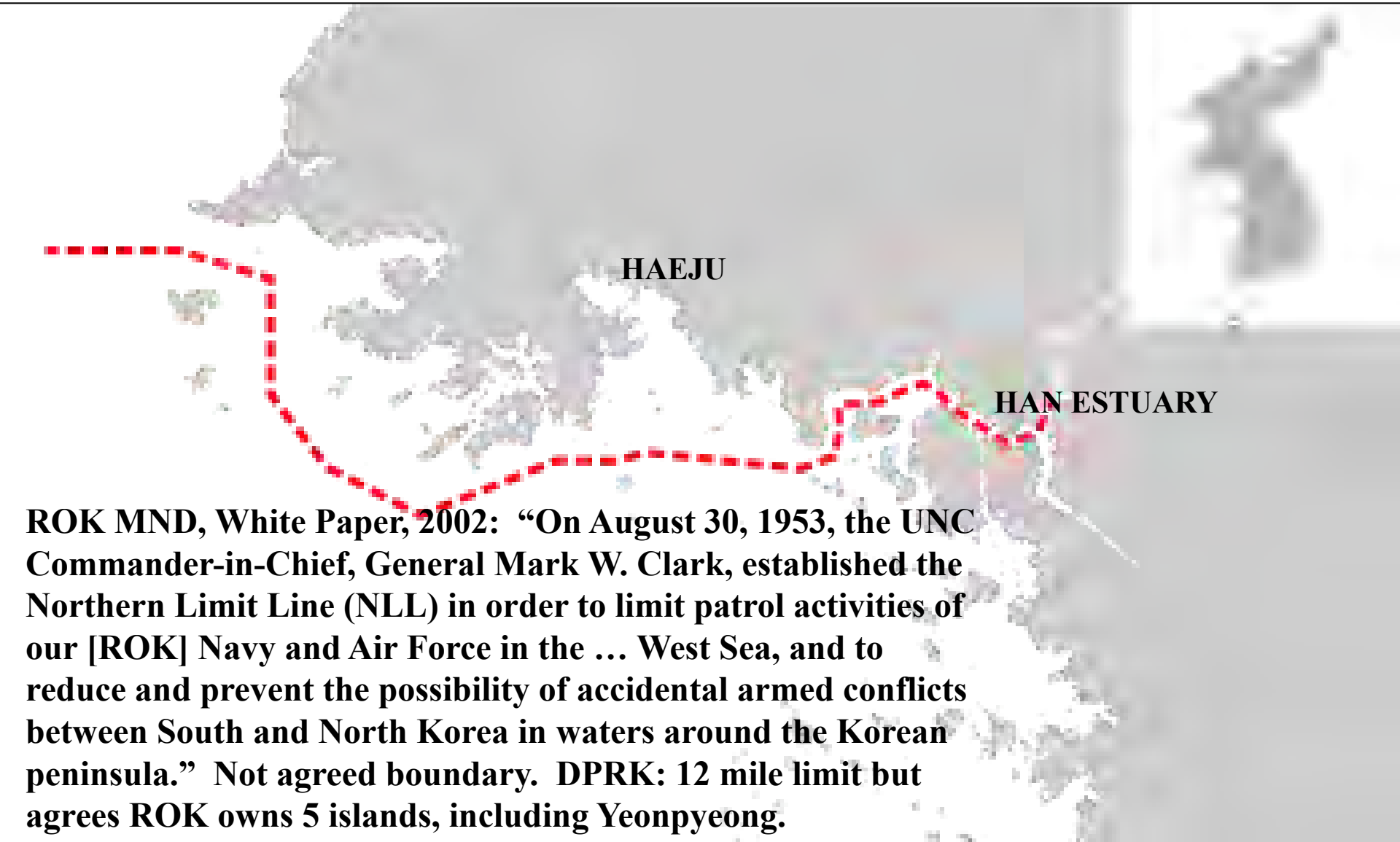
- **For now - three no's in return for one yes**
  - **No more bombs**
  - **No better bombs**
  - **No export**

- **Yes - address fundamentals of North Korea's insecurity**

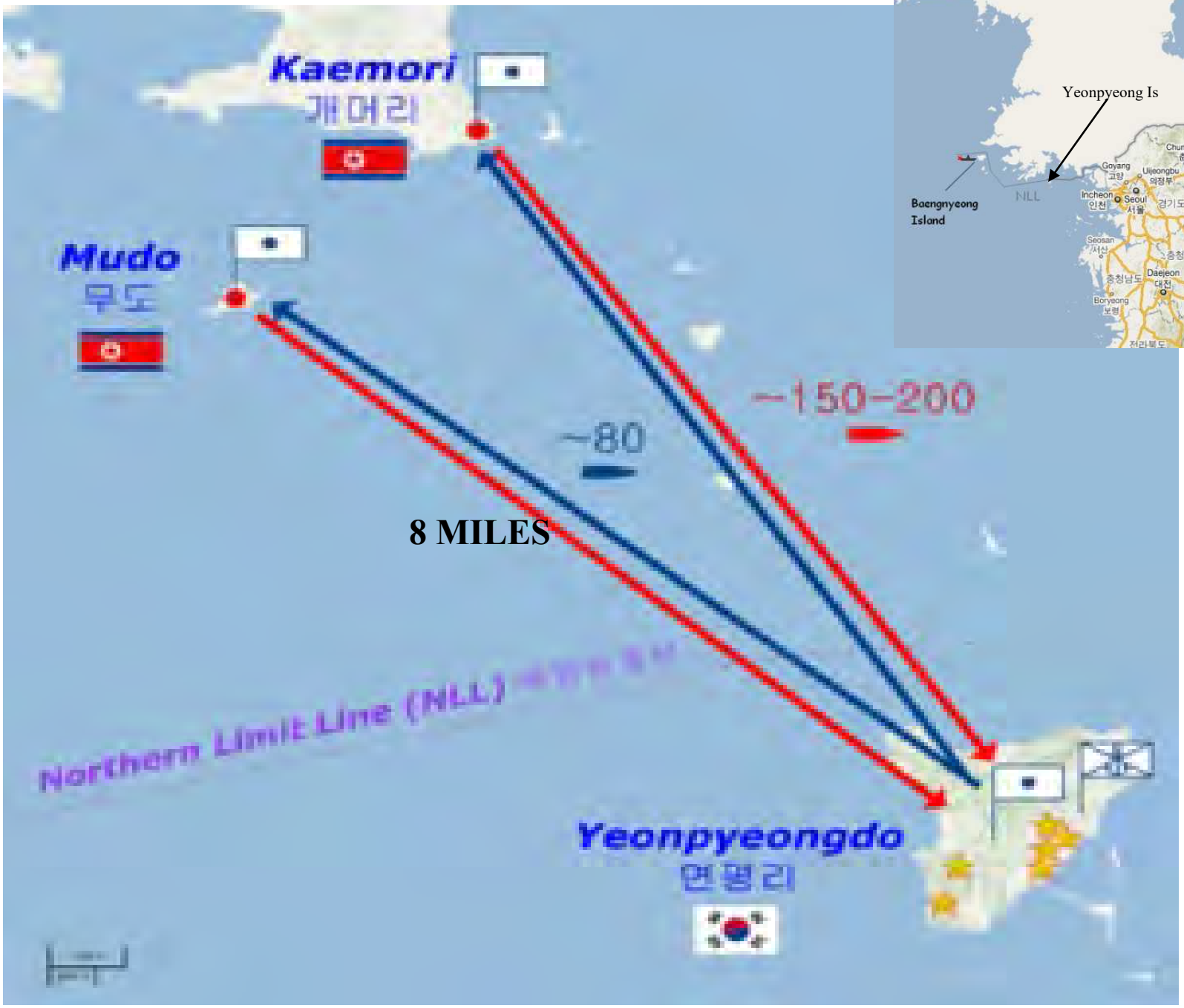
Northern Limit Line

Major Clashes: 1999, 2002, NOV 2009, January 2010, March 2010

Repeated Unofficial and Official Proposals including Oct 4, 2007 N-S



ROK MND, White Paper, 2002: "On August 30, 1953, the UNC Commander-in-Chief, General Mark W. Clark, established the Northern Limit Line (NLL) in order to limit patrol activities of our [ROK] Navy and Air Force in the … West Sea, and to reduce and prevent the possibility of accidental armed conflicts between South and North Korea in waters around the Korean peninsula." Not agreed boundary. DPRK: 12 mile limit but agrees ROK owns 5 islands, including Yeonpyeong.


Kaemori
개머리
Mudo
무도
~150-200
~80
8 MILES
Northern Limit Line (NLL)
Yeonpyeongdo
연평리
Yeonpyeong Is
Baengnyeong Island
NLL
Incheon
Seoul
Chuncheon
Goyang
Ujeongbu
Daejeon
Daegu

"The revolutionary armed forces of the DPRK (North Korea) are getting fully prepared to launch a sacred war of justice of Korean style based on the nuclear deterrent at any time necessary to cope with the enemies' actions deliberately pushing the situation to the brink of a war," General Kim Yong-chun was quoted by the KCNA as saying in the report.

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That's what we need to avoid

The 3-26 Wire Factory


Textile Factory

Pyongyang University of Music

Kim Il-sung University


Nov. 2006


조선을위하여배우자
Feb. 2009


Nov. 2010


Phone booths in Feb. 2009
공중전화
공중전화
공중전화