

North Korea – what's next?

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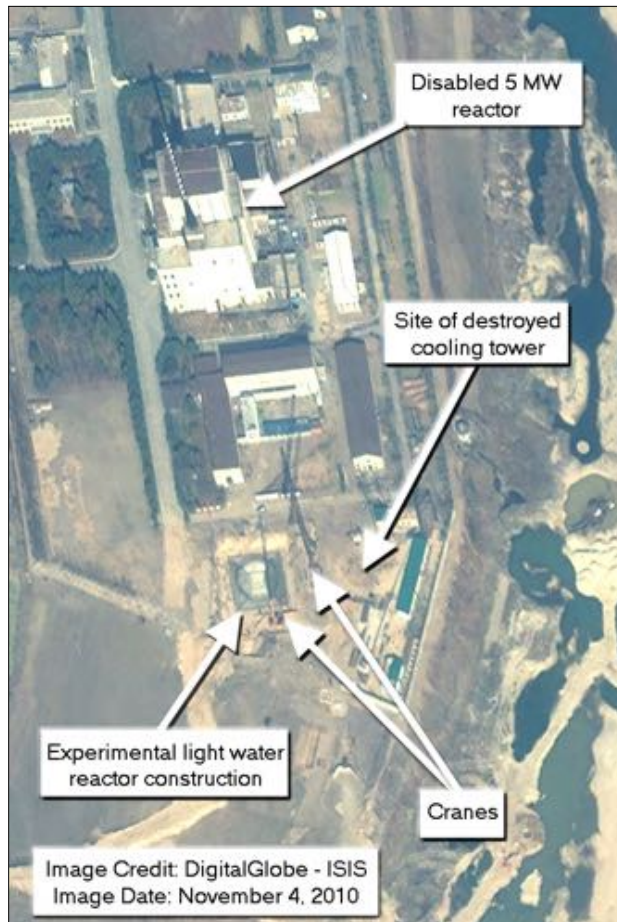
OUTLINE

- **November 2010 visit to Yongbyon**
- **Status of DPRK nuclear program**
- **Nuclear advances in 2011**
- **Recent activities**
- **Future outlook – pessimistic in short term...
but optimistic in the long term**

Dr. Hecker, you will have very big news

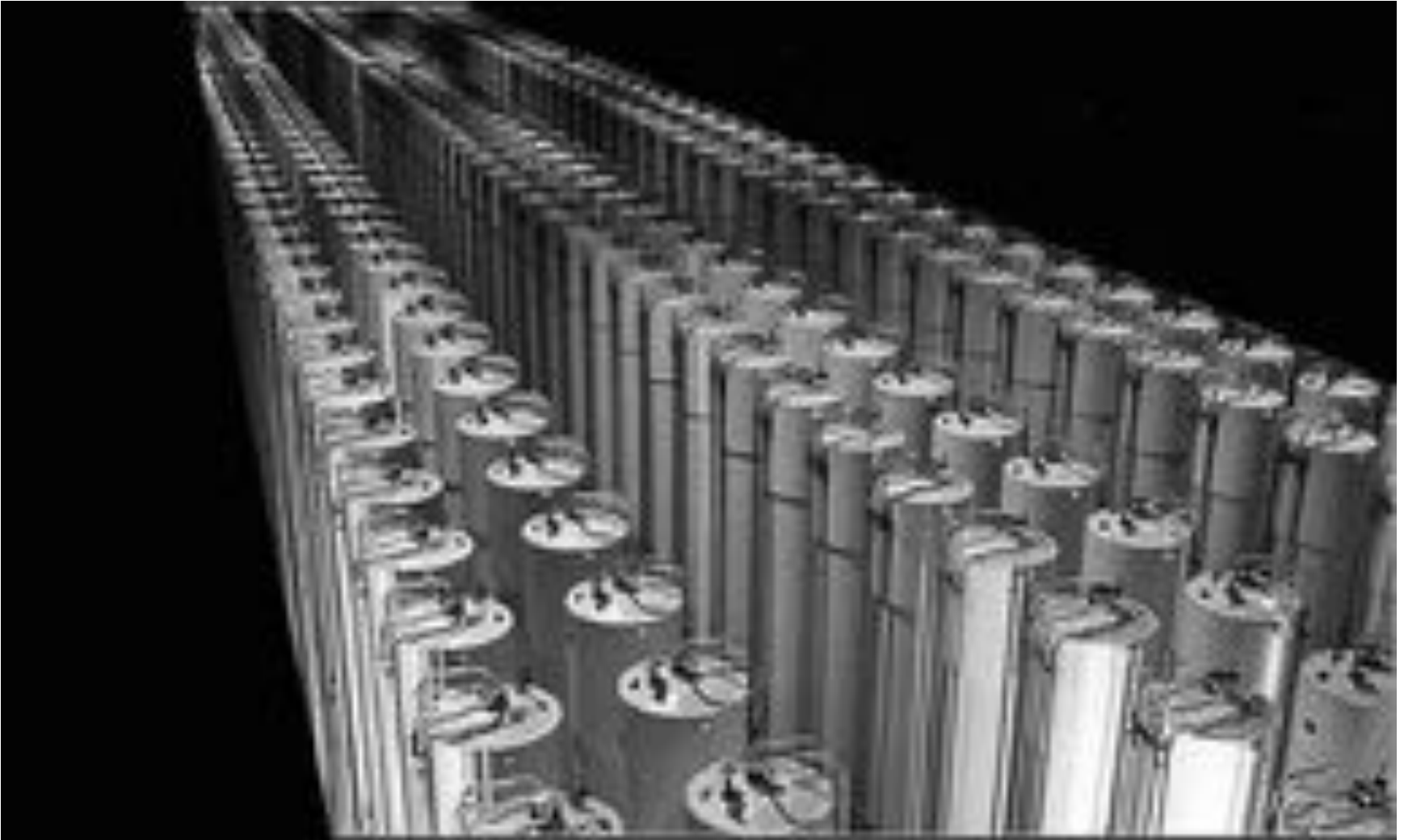


November 2010 visit to Yongbyon presented us with a new reality



**“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,” DPRK Official, Nov. 2010**

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

We did not discover a secret facility – they showed it to us



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

North Korea mastered the full plutonium fuel cycle

Front end of fuel cycle (reactor fuel)

- Mining to fabrication of natural uranium fuel
- No enrichment required

Reactors (produce Pu, electricity & heat)

- 5 MWe gas-graphite reactor (currently shut down)
 - Capable of ~ 6 kg Pu/year (one bomb's worth)
- 50 MWe construction - not finished
- 200 MWe construction halted in 1994 – not finished

Back end of fuel cycle (extract Pu, manage waste)

- Reprocessing facility using Purex process

**After initial nuclear training by Soviets,
DPRK built these indigenously**



Fuel fabrication



5 MWe reactor



Reprocessing Facility

Here is what DPRK gave up



5 MWe reactor

Shut down in 2007
In stand-by mode
(6 kg Pu per year)



50 MWe reactor

~ 10 bombs/yr
Not completed because of
Agreed Framework in
1994



200 MWe reactor Taechon

~40 bombs/yr, Not completed

What does North Korea have?

- **Nuclear weapons**

- Plutonium: 24 to 42 kg (~4 to 8 bomb's worth)
- Most likely simple, not confident to mount on missiles
- 2006 test - partial success; 2009 - likely successful

- **Missile program**

- Three long-range missile tests – one a total failure, two partially successful. **Likely a fourth - 2012.4.15**
- Musudan road-mobile missile – Oct. 2010 parade

- **Uranium enrichment**

- Showed me a small industrial scale enrichment facility
- Likely to have HEU, not sure of extent of program

North Korea has the bomb, but not much of a nuclear arsenal – yet.

DPRK nuclear advances in 2011

- Experimental Light-water reactor (LWR)
- Uranium enrichment
- Ballistic missiles



Musudan road-mobile missile



Yongbyon Exp. LWR



Yongbyon Centrifuge Facility

Sept 26 2010



Nov 04 2010



Dec 03 2010



Feb 26 2011



March 1 2011



May 28 2011



June 13 2011



Oct 18 2011



Nov 04 2011



Experimental Light Water Reactor

3-D Model

Newly roofed
Turbine
Generator Hall

Reactor
containment
structure

Port for
maintenance and
replacement of
equipment

LWR
Reactor Dome

© 2012 GeoEye Spot Image
Image © 2012 GeoEye
Image © 2012 DigitalGlobe
© 2012 Google

Google Earth

03 February 2012; Image Credit: DigitalGlobe

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)

Yongbyon Centrifuge Facility





Jun 24, 2010 Digital Globe



May 13, 2010 GeoEye



Uranium Enrichment Centrifuge Facility

Building Exterior 1
3-D SketchUp Model



Blue Roof
Centrifuge Hall

Main Gate to Fuel
Fabrication Facility

2nd Floor: Control Room
and Recovery Room?

Road to Building 4

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Image ©2011 J. J. Landis
©2011 Google
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Google earth

Cascade Hall, Yongbyon, DPRK

3-D SketchUp Model

**Rough sketch of interior with roof
off for illustration purpose**

Image © 2012 DigitalGlobe

Google earth

19°46'13.12" N 125°44'58.42" E elev 18 m

Eye alt 137 m

Cascade Hall, Yongbyon NRC, DPRK

3-D SketchUp Model

Showing layout of control room



Cascade Hall, Yongbyon NRC, DPRK

3-D SketchUp Model

West Observation Window



Image © 2012 Digital Globe
© 2012 Google Earth
Image © 2012 GeoEye
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

Eye alt 44 m

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

How did North Korea get enrichment and when?

- **What we saw requires many years of development, manufacture and testing** – not started in April 2009 as claimed
- **Most likely decades of R&D, procurement and training**
- **HEU particles in North Korea and UF₆ to Libya questions**
- **Current configuration likely tested outside Yongbyon**
 - Another centrifuge facility dedicated to HEU likely
- **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

Why uranium enrichment?

- **Fuel for LWR**
- **HEU for bombs or warheads**
 - HEU provides the most certain route to simple bomb
 - May be viewed as quicker route to miniaturized warhead
 - But, only with outside help (A.Q. Khan, Tinner family, Iran ?)
 - Uranium enrichment is easier to hide
 - May be able to scale up more easily
- **Uranium enrichment offers better export potential**

Uranium enrichment is dual use – the “Iran problem”

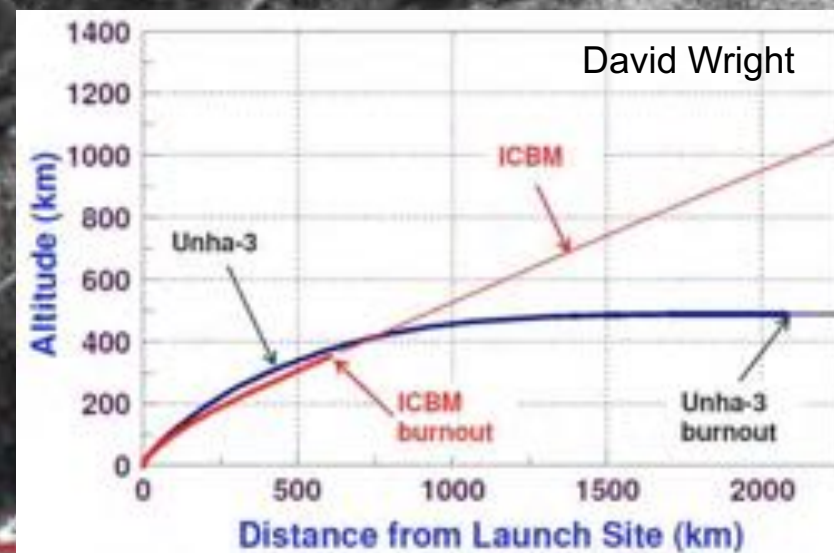


Musudan Missile and TEL

Pyongyang Parade: 10 October 2010

AP Wide World

- **Miniaturization combined with missiles is dangerous**
- **Especially road-mobile Musudan (aka Soviet SS-N-6)**
- **Strengthens Pyongyang's case for a deterrent**



The planned April 15 launch looks like a space launch
It will be easy to tell once they launch.



Check out the trails in the snow leading directly from the road to the launch tower and the fuel facilities

Nuclear arsenal plus missile development is aimed to put U.S. at greater risk – strengthen Pyongyang's deterrent

What are the nuclear security threats?

- **Nuclear attack – currently, a low threat**
 - Concerns in event of miscalculation or instability
 - Greater threat if many more bombs
- **Miscalculations, instability 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

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Threat reduction – stop the nuclear program
from becoming worse

The near-term dilemma

- **Re-engage to stop nuclear threat escalation**
 - Feb. 29 deal a small, but necessary step
 - Missile and nuclear test and Yongbyon enrichment moratorium
- **Possible trouble on the horizon – two statements, different language**
 - Question of monitoring – access to centrifuge facility not clear
 - Does not deal with Yongbyon experimental LWR
 - Does not deal with undeclared enrichment facilities
 - Nuclear exports not addressed
 - DPRK language on sanctions and provision of LWR
- **DPRK “space launch” announcement makes mockery of agreement**
 - but what to do now?

I am pessimistic in the short term that suitable agreements can be reached

Steps to reduce nuclear risks

- **Moratorium on nuclear & missile tests and enrichment**
 - Must include all long-range rockets
 - Full access to Yongbyon centrifuge facility
 - Monitoring of all LEU produced to date
- **Steps to roll back nuclear weapons program**
 - Permanently disable 5 MWe gas-graphite reactor
 - Eliminate reprocessing capacity for new used fuel
 - Sell stored, fresh uranium metal fuel rods
 - Declaration of covert uranium enrichment facilities
 - Resolution of future of LWR because of safety concerns
 - Close nuclear test tunnel and abandon test site
 - Stop nuclear exports and nuclear cooperation – especially with Iran
- **What does DPRK value in return?**

Will DPRK give up the bomb?

- **Not in the near future - not voluntarily**
- **Must make the price of keeping weapons be greater than the benefits of giving them up**
- **China holds the key to the price – U.S. and ROK hold the key to benefits**
- **We must understand why DPRK wants weapons – security, domestic and international reasons**

http://cisac.stanford.edu/publications/can_north_korea_nuclear_crisis_be_resolved



Pyongyang puts on quite a show



David Guttenfelder / AP



Sentry and the news media
Sohae launch complex



Associated Press



So, what do we do now?

- Pyongyang has us over a barrel again. The news media circus has been amazing – it's like KJ-i were still alive
- Our typical response is ineffective – we should focus on what's important – missiles are worthless without a warhead.
- Focus on risk – 3 no's – no more bombs, no better bombs, no export.
- No nuclear test – close the tunnel
- Stop uranium enrichment – get into YB centrifuge facility
- Take irreversible steps to shut down plutonium production
- Work with China on stopping nuclear imports and exports

Policies are complicated by leadership transition in North,
domestic politics in South and the U.S.

Kim Jong-un: Third in the Kim family dynasty



KCNA

Lone exterior photo used to locate reported site of DPRK Strategic Rocket Forces Headquarters as blogged by Jeffrey Lewis on “Arms Control Wonk” (16 March 2012)



**Mosaic composite of two images taken at the same location
presumably at the same time
(left image courtesy of Jeffrey Lewis)**





Mosaic composite of two images compared with Google Earth imagery





Mosaic composite of two images compared with Google Earth imagery



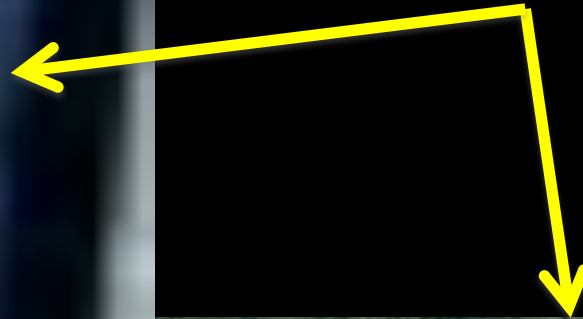


Kim Jong Un (3rd R) looks at training equipments during his visit to the KPA Strategic Rocket Force Command in the suburbs of Pyongyang. Also in attendance is Gen. Pak Jae Gyoung (R) (Photos: KCNA/Yonhap)

**Kim Jong Un being shown an historical
satellite image from ~2005
(GoogleEarth?) on large flat screen
monitor!**



**Kim Jong Un being shown an historical
satellite image of the site from ~2005
(GoogleEarth?)
on large flat screen monitor!**



Cluster of building along river listed on Wikimapia and Google Earth Community Blog as
Second Economic Committee Executive Offices

Underground Entrance



**Second Economic Committee
Executive Offices now
reportedly include Strategic
Rocket Forces headquarters**

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Image © 2012 DigitalGlobe

Google earth

19 44'32.53" N 126°09'21.28" E Elev. 74 m

156.3m 994.3m

11 NOV 2005

Reported Strategic Rocket Forces HQ's Identified from photo (Located between Kangdong and So'ngch'o'n Counties)



Time is not on DPRK's side

Over 1 million cell phones now

