The North Korean rocket launch failed – what’s next?

Siegfried S. Hecker
Center for International Security and Cooperation
Stanford University

Center for Energy and Security Studies
Moscow, Russia
April 27, 2012
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
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
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 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
Cascade Hall, Yongbyon, DPRK
3-D SketchUp Model

Rough sketch of interior with roof off for illustration purpose

Image © 2012 DigitalGlobe
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
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

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”
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.
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
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

**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.
So, what do we do now?

• Pyongyang appears in control again

• 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