Problems, Prospects, and Recommendations for North Korean Denuclearization

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Status (and Problems) of DPRK Nuclear Program

- **Nuclear reactors**
  - Plutonium production reactor
  - Experimental Light-water Reactor (LWR)
- **Uranium enrichment**
  - Centrifuge facility
  - Fuel fabrication facility
  - Covert centrifuge facilities?
- **Nuclear testing**
  - Test site activities and readiness
- **Missile program**

Yongbyon
Nuclear Reactor Facilities

Plutonium complex in stand-by mode

5 MWe Gas-Graphite reactor

- In stand-by, no cooling tower,
- Could potentially be restarted to make 6 kg Pu/year

Fuel fabrication facility

- Some fresh fuel available but needs work
- Some facilities in stand-by, some converted for uranium enrichment enterprise

Plutonium reprocessing facility

- In stand-by mode
- Needed to process old spent-fuel waste
- Would need work to convert to LWR spent fuel

No plutonium in the pipeline

Steady progress with Experimental LWR

2 JAN 2013


Excavated holes for reactor make-up tanks
5MWe Reactor
Newly constructed fence
Fuel Building
Tanks/Equipment
New support building
Oct 2010
Possible Access Control Building
Ventilation stack
Spent fuel pool storage
Reactor Containment Structure
Auxiliary building
Turbine Generator Hall
Heavy Manufacturing
Removal of Crane
Transformer Park
Trench for waste water
Cooling water Pumphouse
2 JAN 2013
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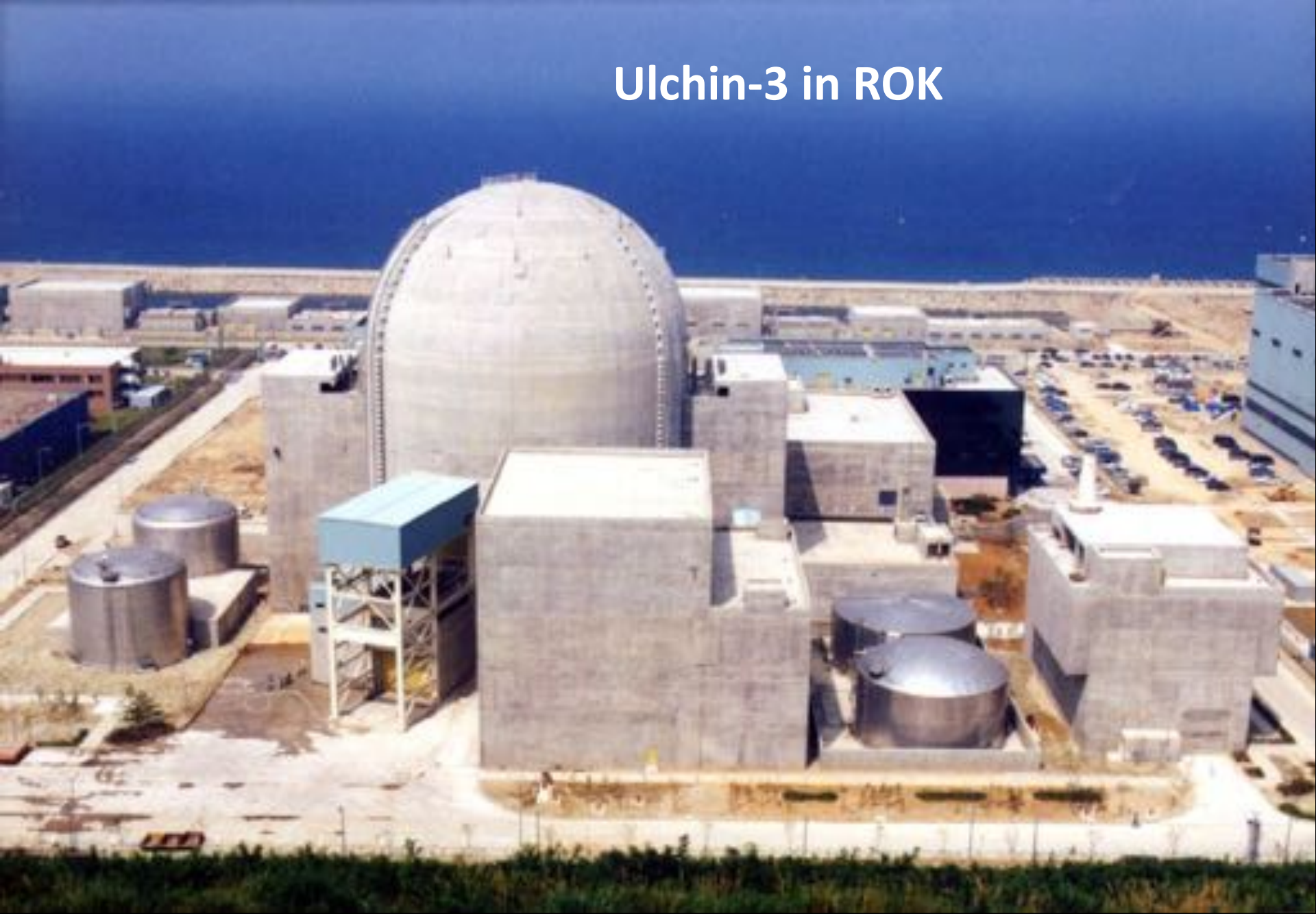
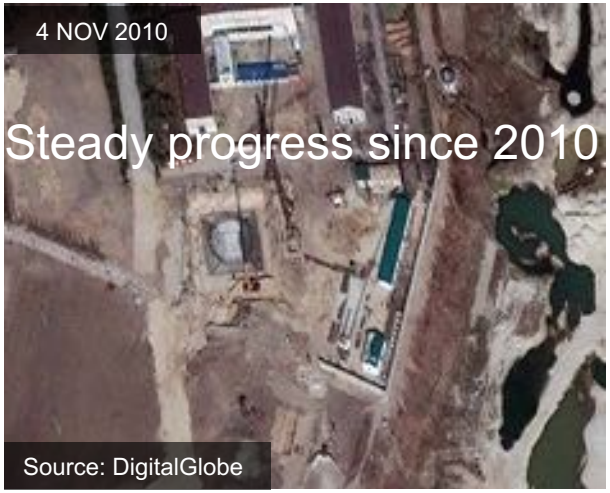
Ulchin-3 in ROK



Ulchin-3 and KSNP were prototypes for KEDO reactors


26 SEP 2010
Source: DigitalGlobe


4 NOV 2010
Steady progress since 2010
Source: DigitalGlobe


28 MAY 2011
Source: GeoEye


4 NOV 2011
Source: DigitalGlobe, 38 North


26 JAN 2012
Source: DigitalGlobe


20 MAR 2012
Source: DigitalGlobe


24 JUN 2012
Source: GeoEye


6 AUG 2012
Source: GeoEye


2 JAN 2013
Source: DigitalGlobe

Experimental LWR Program

- **Steady progress on EWLR (25 to 30 MWe)**
  - KEDO officially terminated in Jan. 2006
  - No apparent indigenous LWR plans in 2008
  - Site preparation for ELWR in September 2010
  - Stanford visit in November 2010
  - Steady progress – possible operation by 2014/2015
- **First step toward full power reactor (like KSNP)**
  - KEDO and KSNP – 1000 MWe
- **Concerns**
  - Regulatory system, safety and emergency response
  - Low proliferation concern

Significant electricity production is at least 10 years off.
ELWR is not the answer to DPRK's electricity problem.

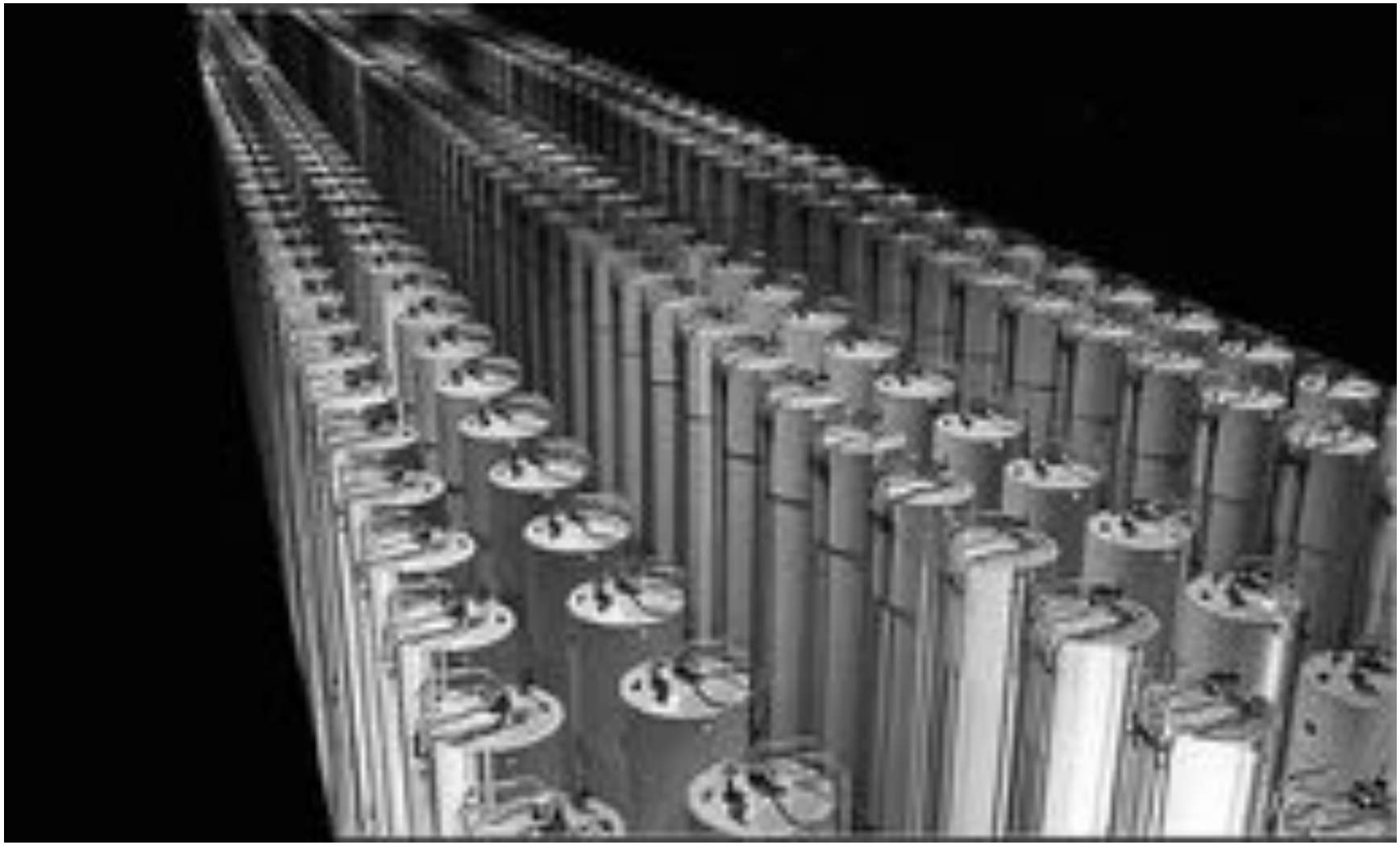
Yongbyon
Uranium Enrichment Facility

Uranium Enrichment Centrifuge Facility

Building Exterior 1

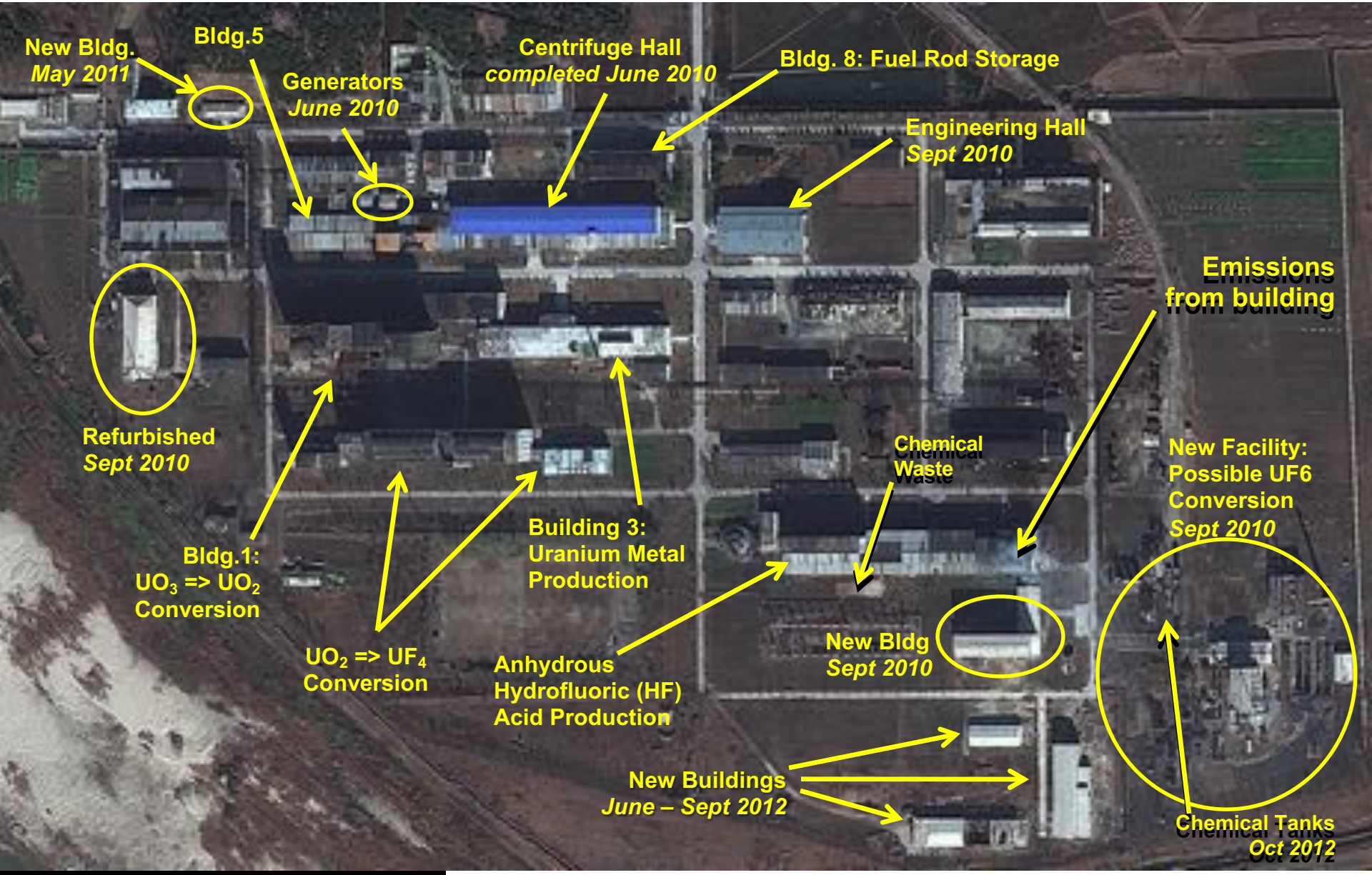
3-D Model of facility we visited in November 2010

Purely illustrative - this is not Yongbyon, but close to what we saw (Nov. 12, 2010).



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

Yongbyon Fuel Fabrication Plant, North Korea



13 NOVEMBER 2012; Source: GeoEye

Uranium Enrichment Program

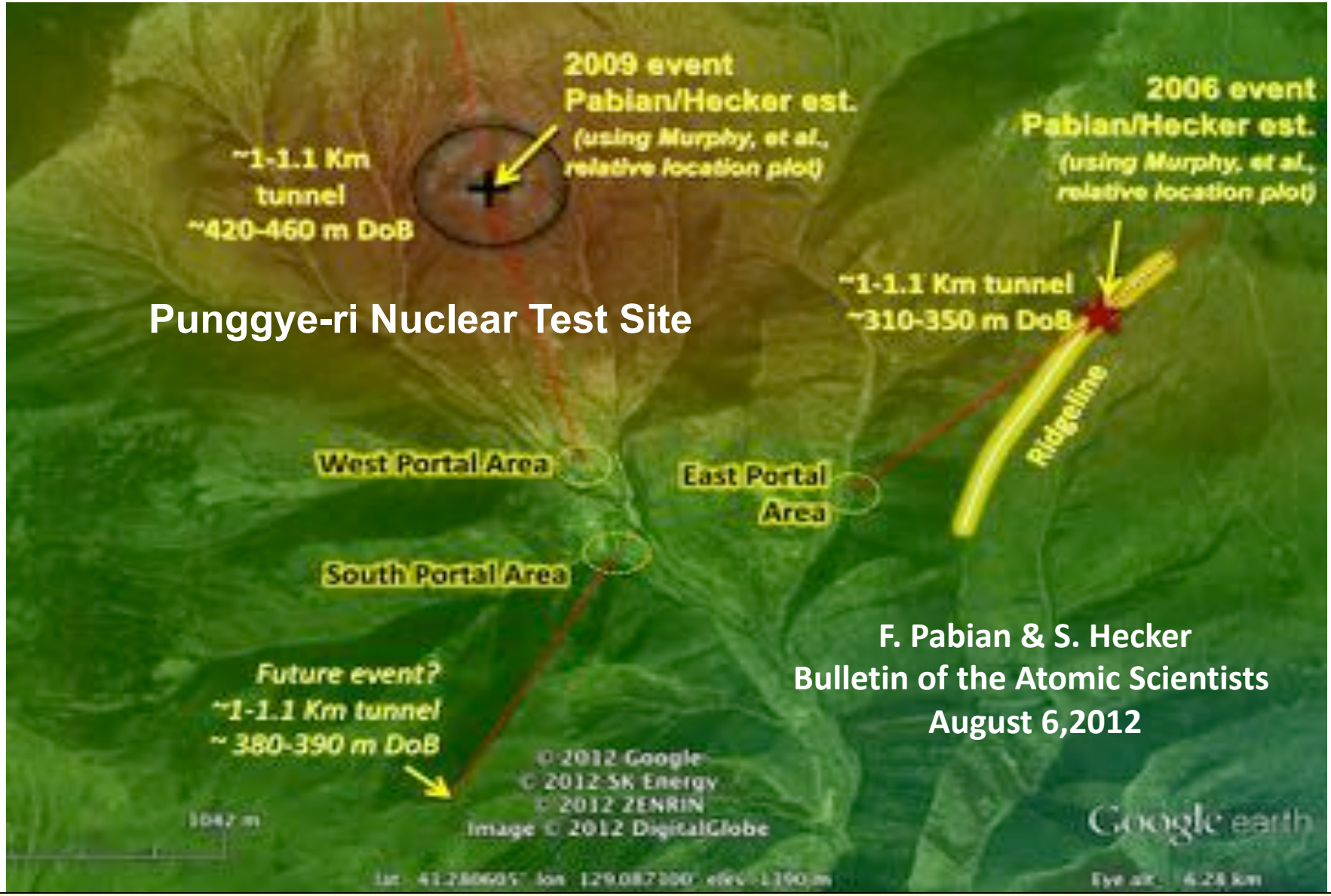
- **Yongbyon centrifuge facility**
  - No information since Nov. 2010 visit
  - Likely 2000 P-2 centrifuges – 8000 SWU/yr
  - Potential for 2 tonnes LEU fuel/yr or 40 kg HEU/yr
  - Likely still dedicated to LEU production for ELWR

- **Support facilities at Fuel Fabrication Plant**
  - Enormous amount of construction at FFP since 2010
  - Required to support ELWR and ceramic fuel fabrication

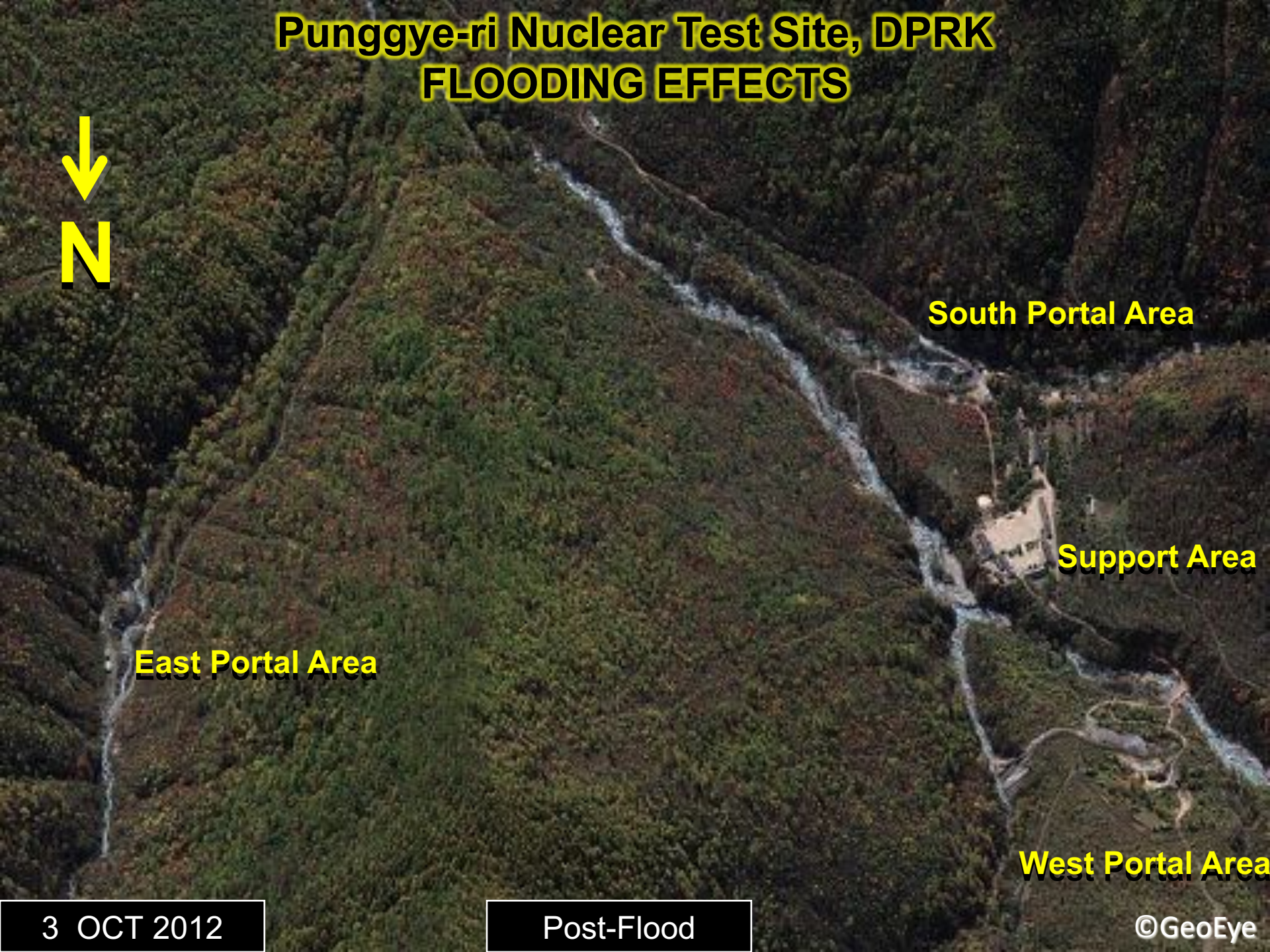
- **Concerns**
  - Must have covert facility because of size and timing of Yongbyon facilities
  - Very likely can produce HEU, but no estimate of capacity

Punggye-ri Nuclear Test Site

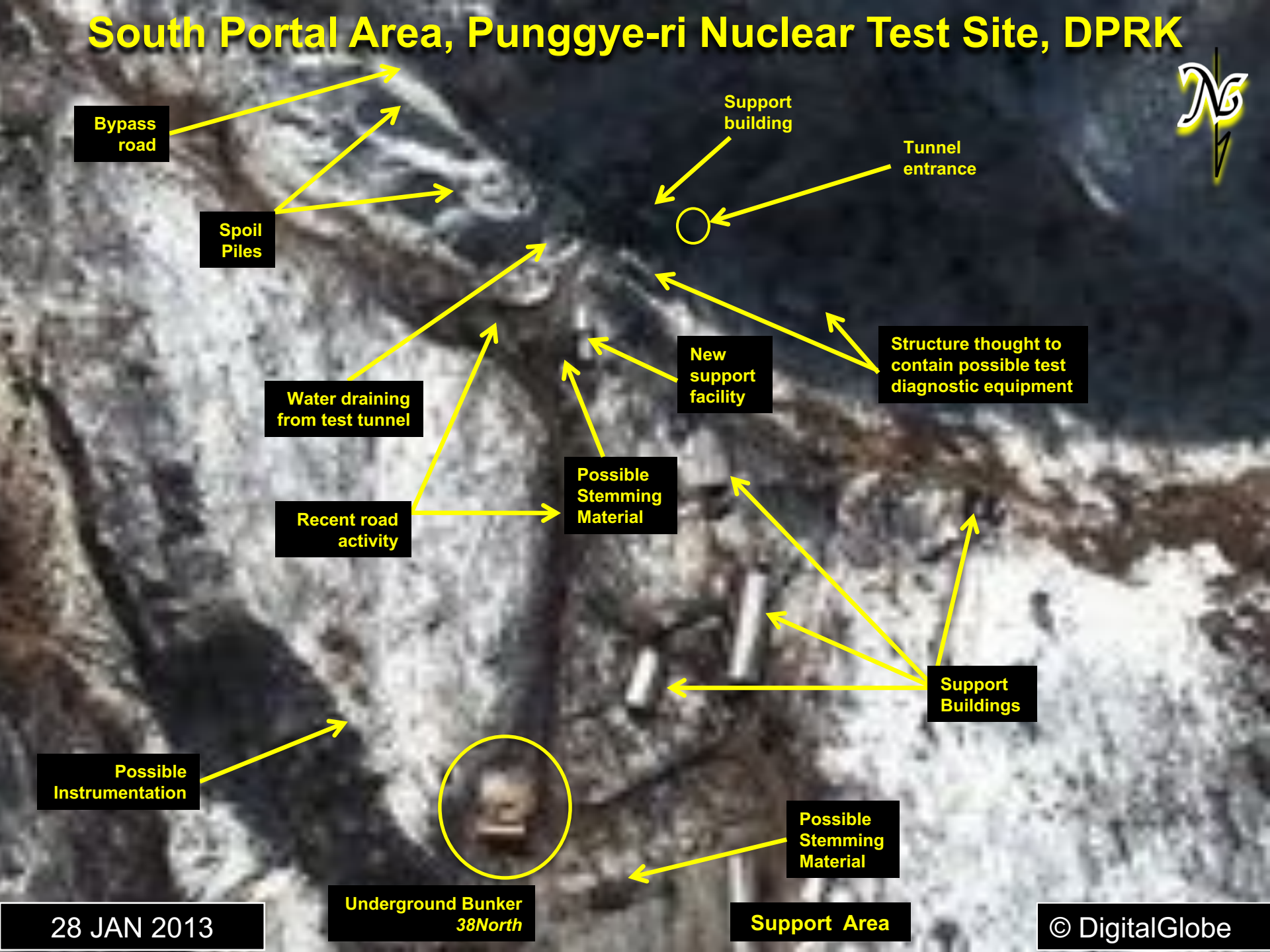
Better bombs? North Korea would require another test

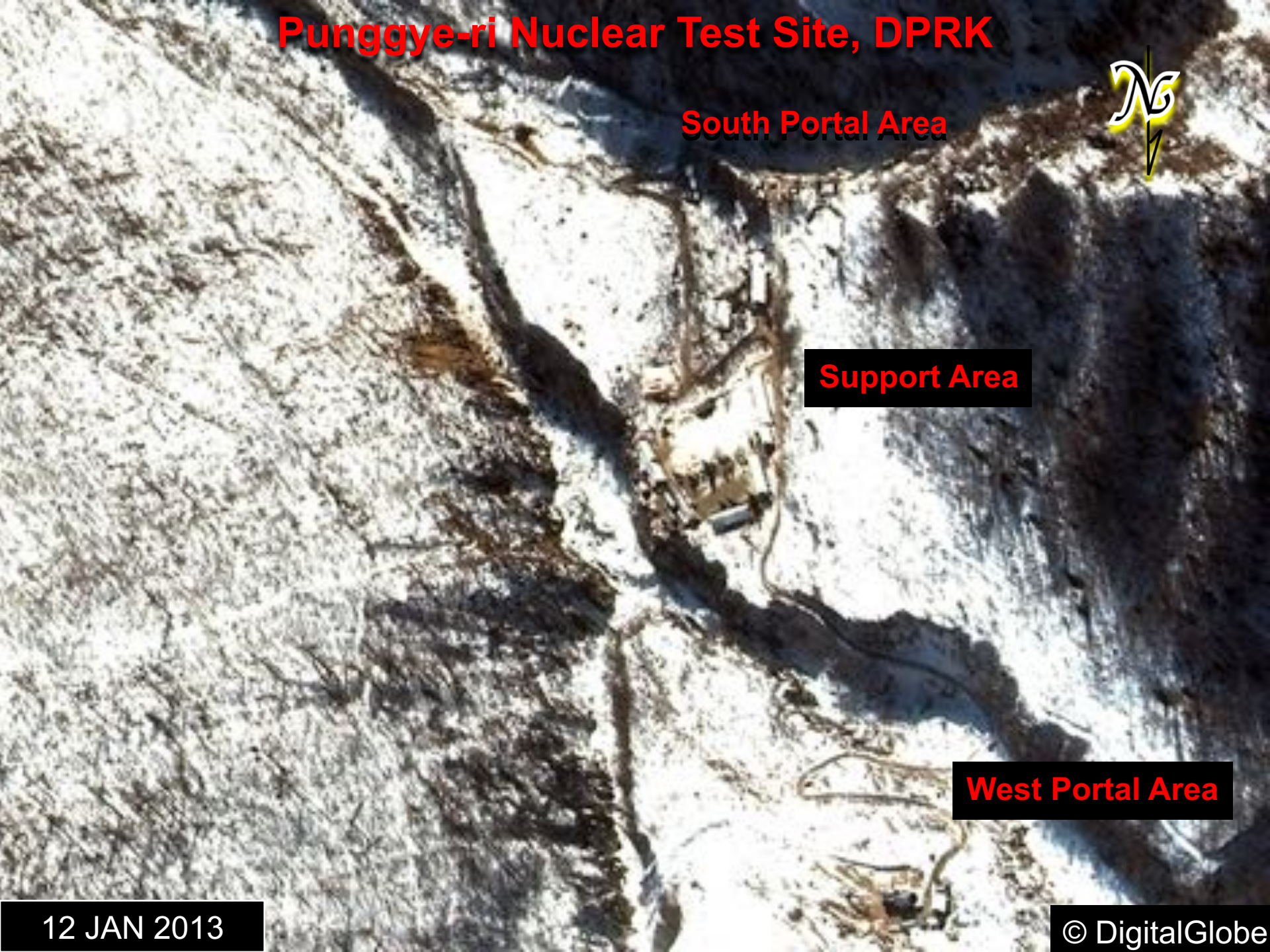


If DPRK tests, what will it be and when?


Punggye-ri Nuclear Test Site, DPRK
FLOODING EFFECTS
N
South Portal Area
Support Area
East Portal Area
West Portal Area
3 OCT 2012
Post-Flood
©GeoEye

South Portal Area, Punggye-ri Nuclear Test Site, DPRK




Punggye-ri Nuclear Test Site, DPRK
South Portal Area
Support Area
West Portal Area
12 JAN 2013
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DPRK's Nuclear Test Site

28 JAN 2013

Instrumentation Bunker?

Water drainage from the tunnel

Support Area

150 meters

Tunnel portal

Pakistan's Nuclear Test Site

Instrumentation Bunker

Support Area

120 meters

Water drainage from the tunnel

Image © 2013 DigitalGlobe

Google earth

25 MAY 2011

Nuclear testing program

- **Previous nuclear tests**
  - Oct. 2006 – East tunnel, close to1kiloton
  - Oct. 2009 – West tunnel, between 2 and 7 kilotons
- **South tunnel**
  - Excavation apparently started in 2009
  - Tunnel appeared ready for test by April 2012
  - Continued activity through floods and snow
  - Could test in less than two weeks – possibly multiple tests
- **Other activities**
  - West portal activity – possible test or staging area
  - Cold tests or experiments at either West or South tunnel
- **Nuclear testing issues**
  - Why test? Needed to miniaturize; possibly also for HEU
  - What could stop them? Only hope is Chinese pressure

Threatening response to Jan. 22, 2013 UNSCR-2087

- Jan. 24 – Ministry of Foreign Affairs: take steps for physical counteraction to bolster the military capabilities for self defense, including the nuclear deterrence, both qualitatively and quantitatively

- Jan. 24 – National Defense Commission: Long-range rockets will be targeted against the U.S., the sworn enemy of the Korean people.
  A nuclear test of higher level will be carried out in all-out action

- Jan. 25 – KCNA warning to ROK: DPRK will take strong physical counter-measures against it. It will never be able to escape deadly retaliatory blows.

- Jan. 26 – editorial in *Rodong Sinmun* (Korean Workers' Party):
  "A nuclear test is the demand of the people; no other choice can be made. Peoples' demand for something even greater than a nuclear test."

- Jan. 26 – DPRK State Media – warning of substantial and high-profile important state measures. Specific tasks assigned.

What is a nuclear test at a “higher level?”

- **Plutonium bomb with ~ 20 kiloton yield**
- **HEU bomb with ~ 15 kt yield**
- **Miniaturized (smaller, lighter) at moderate yield**
  - Most likely case
- **Both plutonium and HEU simultaneously**
  - Possible – two for the price of one
- **Highly sophisticated – fusion boosted or hydrogen bomb**
  - Unlikely, unless they conduct campaign of multiple test
  - Announcing the test puts premium on being successful

Containment is a serious challenge – especially for test at a “higher level”

U.S. nuclear test containment failures

"Des Moines" June 1962 – 2.9 kilotons

"Baneberry" Dec. 1970- 10 kilotons

DPRK Missile Program

April 13, 2012 Space launch

Combination of nuclear weapons and missiles increases the threat

Unha-3 Rocket Launch Preparation

Control Room at
The General Satellite Control and Command Center

Unha-3 recovered debris

Unha-3 rocket and Kwangmyonsong-3 satellite

- Unha-3 launched on Dec. 12, 2012 from Sohae Launch Site
  - First Stage fell in Yellow Sea
  - Second Stage near Philippines
- Kwangmyonsong-3 satellite in orbit
  - In elliptical path, tumbling – no signals detected
  - Orbits globe at 7.6km/sec (every 95.4min)
- Unha-3 long-range rocket characteristics
  - Liquid fueled, three-stage rocket.
  - Estimate range of ~4,000 to 6,000km. Could be as much as 10,000km (capable of reaching the continental U.S.)

But DPRK is still a very long way from being able to launch a nuclear warhead to reach the U.S.

Images of DPRK's "Musudan" IRBM and KN-08 ICBM

Side View of the Musudan IRBM missile and MAZ-547A TEL as featured in the 10 Oct 2010 military parade in Pyongyang. Source: AP/Wide World

In this April 15, 2012 file photo, a Chinese TEL carries the North Korean KN-08 missile.
(AP Photo/Vincent Yu, File)

Neither has been flight tested
as far as we know

Prospects?

- **Nuclear weapons**
  - Plutonium: 24 to 42 kg (~4 to 8 bomb's worth)
  - No plutonium in the pipeline; uncertain HEU inventory
  - Most likely simple, not confident to mount on missiles

- **Uranium enrichment**
  - Appear to have all requisite technologies
  - Likely to have HEU, possibly use for HEU bombs

- **Missile program**
  - Last of five long-range missile tests successful
  - Musudan and KN-08 road-mobile missiles – not tested
  - Lots of short-range capabilities

We know little about weapons progress since Nov. 2010.
They may have both plutonium and HEU – and need to test.

What will another nuclear test do?

- **Nuclear weapons**
  - Plutonium: 24 to 42 kg (~4 to 8 bomb's worth)
  - No plutonium in the pipeline; uncertain HEU inventory
  - Most likely simple, not confident to mount on missiles
  - Possibly certify a miniaturized, missile-capable device
- **Uranium enrichment**
  - Appear to have all requisite technologies
  - Likely to have HEU, possibly use for HEU bombs
  - Potentially greatly expand size of nuclear arsenal
- **Missile program**
  - Last of five long-range missile tests successful
  - Musudan and KN-08 road-mobile missiles – not tested
  - Lots of short-range capabilities
  - Flight testing may provide missile with warhead

Recommendations: Two possible options

- **If DPRK tests – it's bombs over electricity**
  - Constrain, contain and be prepared

- **If no test – still hope for electricity over bombs**
  - Create conditions favorable for nuclear disarmament
  - Phased denuclearization with three No's
    - No more bombs, no better bombs, no exports
  - Address DPRK security fears, energy & economic concerns
  - Focus on rolling back DPRK nuclear infrastructure

Recommendations: Two possible options

- **If DPRK tests – it's bombs over electricity**
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Two failed options

- **Do nothing, wait for Kim regime collapse**
  - Not very attractive

- **Dual track, sanctions with limited diplomacy**
  - Conditioned on denuclearization first – a failed history

If DPRK tests – Constrain, contain, be prepared

- **Constrain imports to limit HEU capacity**
  - Must have cooperation from China
  - Work cooperatively to limit DPRK – Iran collaboration

- **Contain the DPRK missile and nuclear threat**
  - Develop more extensive BMD with ROK and Japan
  - Increase ROK missile capabilities
  - Readiness for DPRK provocations – be prepared to retaliate

A test will make it difficult, if not impossible for, new Park Administration and second Obama administration to look beyond the nuclear issues to resolve long-standing enmities

If no test - phased denuclearization

- **Energy & economic development in return for substantial roll-back on nuclear infrastructure**
  - 3 No's
  - DPRK holds on temporarily to nuclear weapon hedge
  - U.S. reiterates security guarantees to ROK and Japan

- **Work toward normalization of relations and implementation of Sept. 19, 2005 Joint Statement**
  - Leading to denuclearized Korean Peninsula

Full implementation will require long-term commitment and cooperation

Back-up slides

Concrete steps to roll back weapons infrastructure

- **Plutonium complex - dismantle**
  - Poison or entomb 5-MWe reactor core
  - Disable front (receiving) end of reprocessing facility
  - Sell 12,000 fresh uranium metal fuel rods
- **Nuclear testing infrastructure**
  - Permanently close Punggye-ri test tunnels
  - Dismantle diagnostic equipment and instrumentation
- **Uranium enrichment**
  - Halt EWLR construction – work deal for energy & LWR
  - Inspect and freeze Yongbyon centrifuge facility and work enrichment deal
  - Help to convert IRT-2000 or support building a new medical isotope production reactor
- **Missile program**
  - Missile launch moratorium; offer satellite launch services (Russia, China) in return

Disclaimer: Ideas of S.S. Hecker, not USG

Denuclearization through sanctions – a failed history

- 2000 – U.S. and DPRK close to a deal
- 2002 – 03 – Confrontation, NPT withdrawal, plutonium processing, and nuclear weapons
- 2005 – 06 – Sept. 19 Joint Statement, BDA sanctions, failed missile launch and first nuclear test
- 2007 – Year of rapprochement (Feb. & Oct. disablements)
- 2009 – Failed missile launch and second nuclear test
- 2010 – Conversion of Yongbyon: U enrichment and ELWR
- 2012 – Steady progress on Yongbyon and test readiness

2013 – Why should we expect sanctions to work now?