How did North Korea get the bomb and will it give it up?

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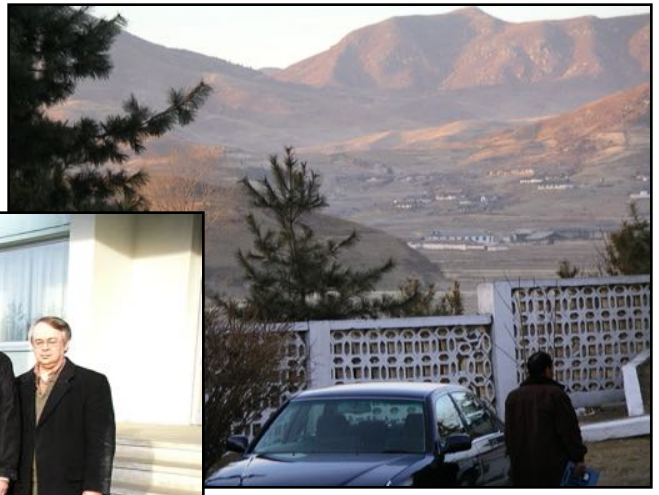
Presentation at the
Lawrence Livermore National Laboratory
Oct. 26, 2007

North Korea has the raw material, facilities, and people for power and bombs

Lewis delegation visit to Yongbyon – 8 January 2004



5 MWe reactor restarted and operating smoothly

Reactor is providing heat and electricity for town …

Lewis delegation in reactor control room

… and producing 6 kg of plutonium annually.

But, the 50MWe reactor will not be completed any time soon

DPRK officials stated all fuel rods were reprocessed between mid-January and end of June, 2003

Lewis delegation at pool observation platform

Radiochemical Laboratory

8000 spent fuel rods were reprocessed. They contained an estimated 25 – 30 kg of plutonium

Why did they let us in?

Vice Minister Kim Gye Gwan
"This visit can have great symbolic significance."

"We view the delegation's visit to Yongbyon as a way to help contribute to breaking the stalemate and opening up a bright future."

"We will not play games with you. We have invited you to go to Yongbyon. The primary reason for this is to ensure transparency. This will reduce the assumptions and errors."

"Hecker's presence will allow us to tell you everything. This is an extraordinary approval by us."

North Korea has the bomb

- **Weapons-grade plutonium (bomb fuel)**
  - Estimated at 40 to 50 kilograms
  - Sufficient for ~ 6 to 8 bombs
- **Nuclear weapons**
  - One nuclear test with limited success
  - Most likely have a few simple bombs
  - Unlikely to have confidence to mount on missiles
- **Uranium enrichment**
  - DPRK denies program in spite of strong evidence
  - DPRK says it is ready to address U.S. concerns

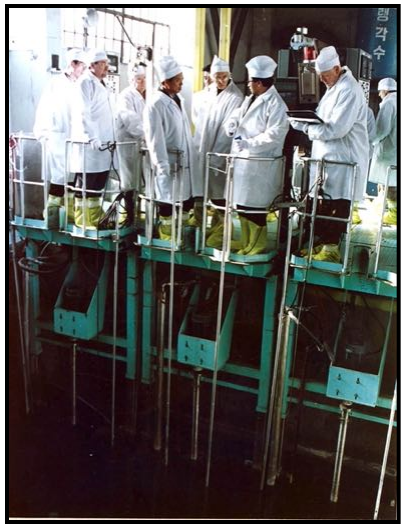
Fifty years in the making.
Many years under cover of civilian nuclear power.
Followed by breakout and dialogue.

How North Korea got the bomb

- **Soviet "Atoms for Peace" – 1950s & 1960s**
- **Going solo, but under civilian cover – 1970s to 1992**
- **Break out, retreat, and freeze – 1994 to 2003**
  - Possibly built one untested bomb
- **Break out, withdraw, and arm – 2003 to 2007**
  - Now has a few bombs, and fuel for 6 to 8

U.S. actions triggered 2003 break-out.
North Korean actions built the bombs.
U.S. inaction contributed to where we are today.

Track II visits to DPRK, plus DRPK visit to U.S.



Jan. 2004 Yongbyon

Aug. 2005 Pyongyang

Nov. 2006 Pyongyang

March 1, 2007 Saratoga

August 10, 2007, Yongbyon

Steps to "denuclearize" the Korean Peninsula

- **Joint Statement of Sept. 19, 2005**
  - First significant progress of six-party talks
- **Initial Actions Agreement of Feb. 13, 2007**
- **Shut down and seal nuclear production complex**
  - Yongbyon shut down, July 15, 2007
  - IAEA seals concluded and confirmed, Aug. 9
  - Three-country experts inspection, Sept. 11-15
- **Oct. 3 agreement of second phase actions**
  - Roadmap for declarations and disablement
  - DPRK committed not to transfer nuclear materials, technology or know-how
- **Next phase - dismantlement**

How to achieve "denuclearization"

- **Elimination of nuclear weapons and bomb fuel (plutonium) will be the hard part**

- **North Korea wants compensating measures**
  - Remove from state sponsoring terrorism list
  - Remove from trading with the enemy act
  - Remove U.S. and UN sanctions
  - Provide energy assistance
    - Fuel oil and a Light-Water Nuclear Reactor
  - Normalize relations with U.S.
    - Peace treaty
    - International commerce
    - Science, technology and educational exchanges

Yongbyon Nuclear Complex: A closer look

August 9, 2007 Visit to Yongbyon

What is the DPRK nuclear program?

Yongbyon nuclear complex

- Fuel fabrication facility – uranium metal fuel
- 5 MWe reactor – Magnox (gas – graphite)
- Reprocessing facility – plutonium extraction (PUREX)
- 50 MWe and 200 MWe reactors – bigger reactors
- IRT-2000 research reactor – medical isotopes

What is the DPRK nuclear program?

Likely outside Yongbyon

- Weaponization facilities – plutonium casting, machining, other components, and assembly
- Nuclear weapons – bombs and delivery vehicles
- Uranium enrichment effort – a potential alternative to plutonium for weapons (highly enriched uranium)

Status of DPRK nuclear reactors

5 MWe reactor
Shut down & sealed.
In stand-by mode
(6 kg Pu per year)

50 MWe reactor
Construction site. Most likely not salvageable

200 MWe reactor Taechon
Construction site. Not salvageable

Three options for the fuel rods

- **Dry transfer and storage** (DPRK not prepared)
- **1994 process – into the pool and recan** (will take years)
- **Reprocess and deal with 10-12 kg Pu**

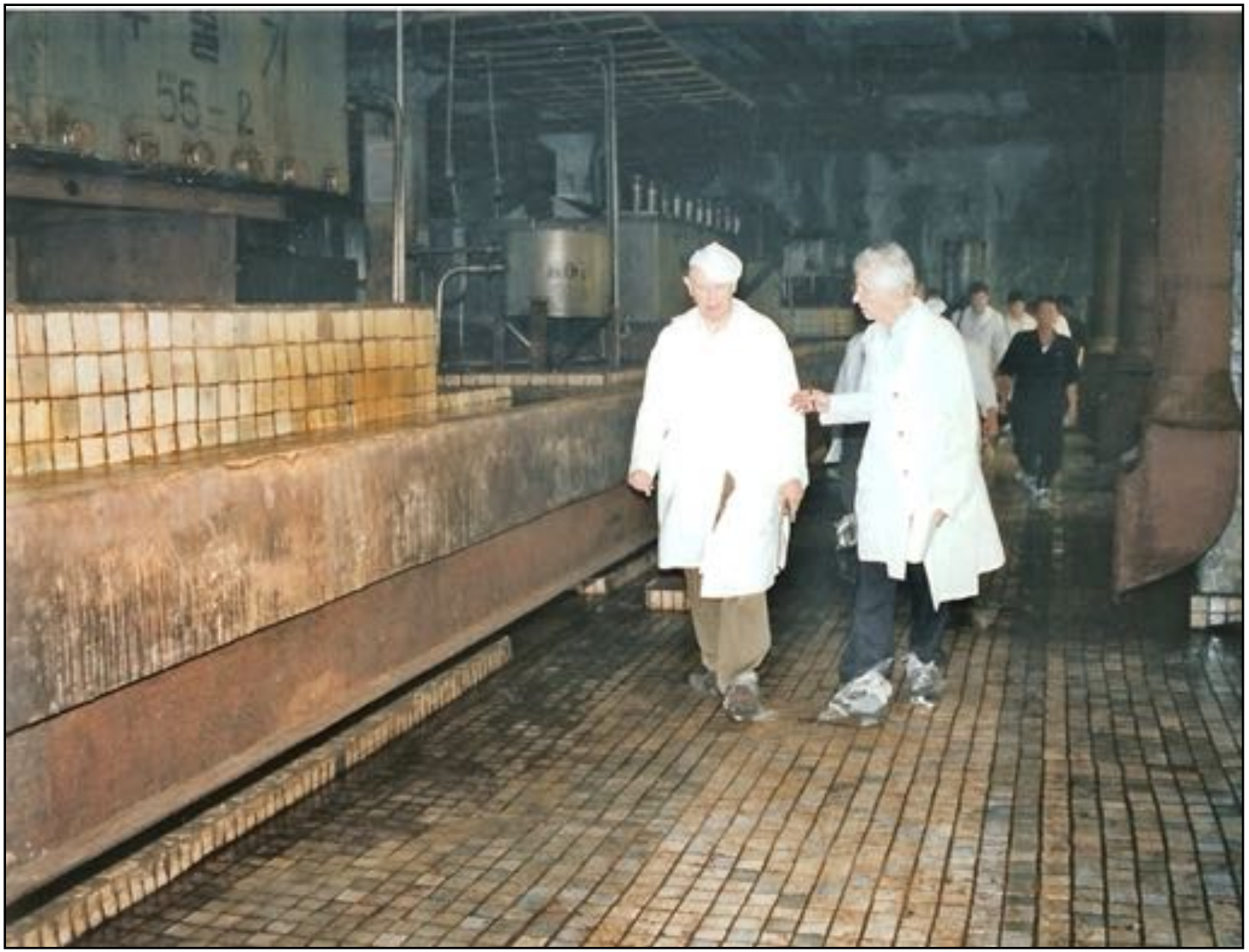
Technically, the preferred option is to have DRPK reprocess this load of spent fuel

Fuel fabrication facility

Shut down and sealed. Has not made new uranium fuel for reactors since 1994

- But was making UO2 from 2003 till shut down.
- Dry UF4 line work-around
- Casting and machining OK

Lewis and Hecker at Fuel Fabrication Plant



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Radiochemical Laboratory (Reprocessing Facility)

In stand-by mode with IAEA seals, detectors & cameras. Still contains high-level waste

Reprocessing facility

Jan. 8, 2004 – very cold

Hot cell by flashlight

Aug. 9, 2007 – hot and power out


Pu laboratories
Image © 2007 DigitalGlobe
Google

The Yongbyon plutonium labs – small and primitive

August 9, 2007

Status and prospects (technical perspective)

- **Operations**
  - Could continue at 1 bomb/yr for some time
  - Does not have capacity to ramp up
- **Disable**
  - Render unusable (U.S.) vs. temporarily suspend (DPRK)
  - Question of time and effort to restart
  - Question of verification and forensics
- **Dismantle**
  - Decontaminate & Decommission
  - Entomb?
- **Eliminate (abandon)**
  - Monitoring and Verification

So, where are we now ?

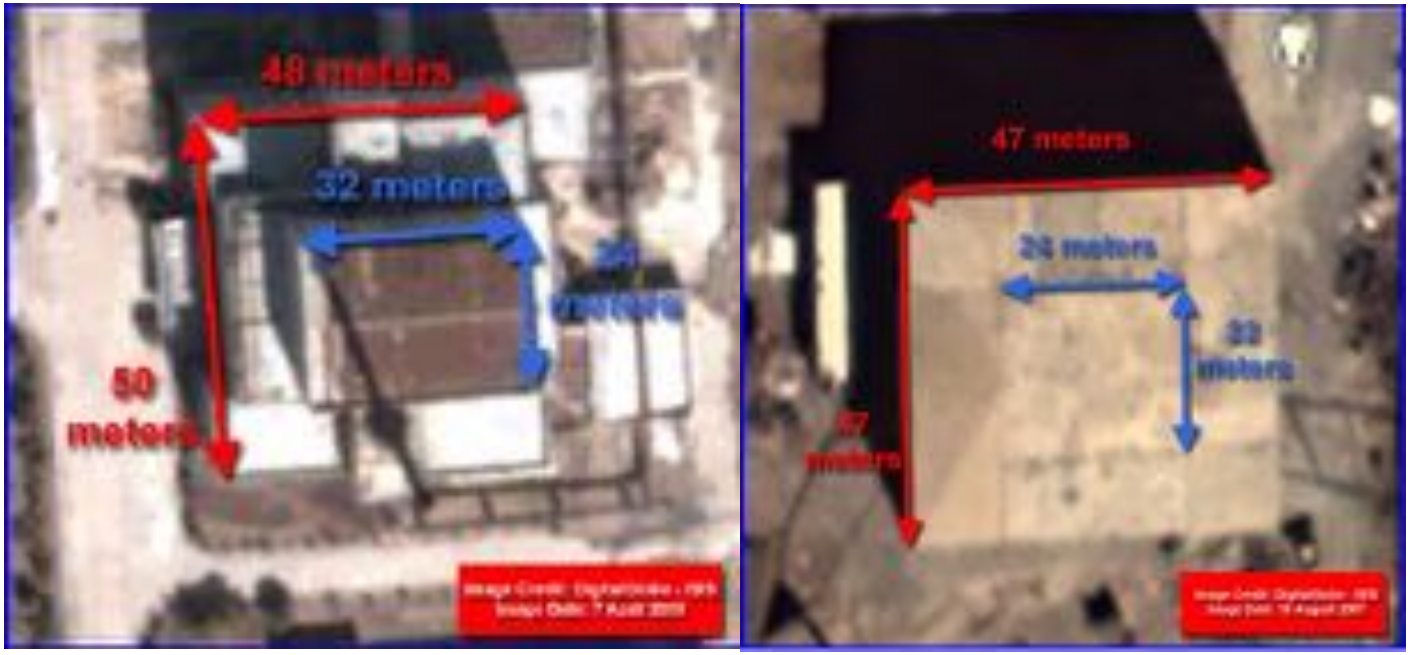
With current state of "shut and seal" –

- No more bombs
  - With Yongbyon shut down
- No better bombs
  - Without more testing
- Must assure no nuclear export
  - Iran remains the biggest concern
- Nuclear facilities on hold and deteriorating

Positive steps have been taken, but Syria situation is of great concern

Is there a potential Syria – North Korea nuclear link?

North Korea – Syria nuclear link possible



Yongbyon 5 MWe reactor Syrian site bombed by Israel

Satellite Photos Show Cleansing of Syrian Site

By WILLIAM J. BROAD and MARK MAZZETTI

Published: October 26, 2007, New York Times

Where do we need to go?

- Disable facilities (Yongbyon first)
- Declaration
- Dismantle facilities
- Eliminate nuclear weapons and plutonium
- Remediation of nuclear sites

And, stop all nuclear exports

The current situation – my view

- North Korea has made the decision to dismantle Yongbyon – if corresponding measures are taken

- Declaration will be piecemeal – some by 12/31/07. Will include uranium enrichment. Initial step will most likely not include weaponization outside Yongbyon

- North Korea has not yet made decision to give up its plutonium and its bombs – this will require a transformation in our relationship.
  - Normalization and LWR

Are these gains worth the price?
Yes, if it means no more bombs, no better bombs, and no transfers and DPRK back in NPT

Estimate of DPRK nuclear materials and weapons

- **Plutonium**
  - < 1994 (IRT & 5 MWe) ~ 8.6 kg (1 + weapons)
  - 2003 (5 MWe) ~ 25 kg (4-6 weapons)
  - 2005 (5 MWe) ~10-14 kg (~ 2 weapons)
  - In reactor (Oct. 2007) ~ 10-12 kg (not separated)

  - Estimated separated plutonium for ~ 6 to 8 bombs

- **Nuclear weapons**
  - One nuclear test – some success. Must assume DPRK has a few rudimentary nuclear weapons.
  - Unlikely to have confidence that devices are missile capable without more tests.
  - Plutonium itself represents a major threat, regardless of test and of sophistication and number of weapons

- **Uranium enrichment**
  - DPRK denies program in spite of strong evidence
  - DPRK says it is ready to address U.S. concerns

DPRK is diplomatic and Iran defiant – Both remain a great challenge

Ahmadinejad: "Today, the Iranian nation fully possesses the nuclear fuel cycle. If all of you gather and also invite your ancestors from hell, you will not be able to stop the Iranian nation."

Kim: "The NPT is brittle; it's under stress. It was not the intent of the DPRK to undermine the NPT. It is not too late for the NPT regime."

Hill and Kim in Berlin

Greatest nuclear threats today: Driven by nuclear terrorism concerns

1) Pakistan

2) HEU-fueled research reactors around the world

3) North Korea

4) Nuclear materials security in Russia

5) What's left in Kazakhstan

6) Iran

Iran's nuclear program

- **1960s U.S. Atoms for Peace**
  - 5 MWth research reactor & facilities
  - Signed NPT in 1968
- **1974 Contract for Bushehr to Siemans**
  - German and French activities
- **1979 Revolution and stop to nuclear program**
- **Mid-1980s Iraq bombs Bushehr – Iran reconsiders nuclear option**
  - Around 1987 begins clandestine uranium enrichment
- **1990s – Iran makes many nuclear acquisitions (Russia, China)**
  - A.Q. Khan network
- **2003 – Iran covert uranium enrichment facilities discovered**
- **2003 – 2007: Cat & mouse game with Europeans**
  - Iran remains defiant about its right to nuclear energy

What a difference the regime makes

The Shah < 1979

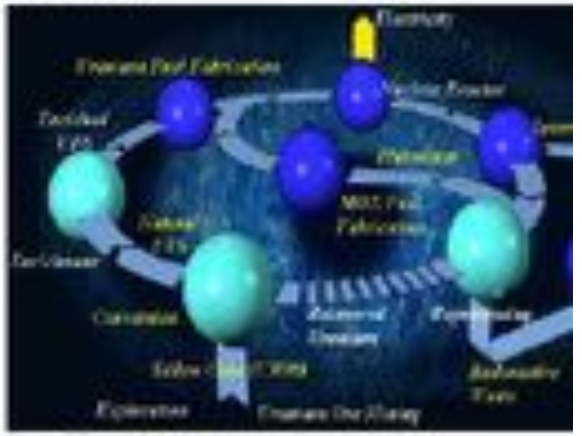
Ahmadinejad - now

Known Iran Nuclear Installations

- Bushehr reactor: 915 MWe, ready to fuel
- Natanz enrichment plant
- Esfahan: Uranium conversion
- Arak: 40 MW heavy water reactor (2009?)
- Laser enrichment experiments – milligrams
- Esfahan Nuclear Fuel Research & Production Center: 3 research reactors, other facilities
- Tehran nuclear facilities
- Parchin military complex – high explosives and other work

Iran's Nuclear Fuel Cycle Facilities

- *Uranium Exploration: (1/3 of the country is under airborne exploration)*
- *Mining: (2 anomalies are under operation in Saghand)*
- *Yellow Cake Production: (YCP in Yazd and Bandar Abbas)*
- *Uranium Conversion: (UCF in Esfahan)*
- *Enrichment: (FEP in Natanz)*
- *Fuel Fabrication: (FMP& ZPP in Esfahan)*
- *Nuclear Reactors: (VVER-1000 in Bushehr, TRR in Tehran, Zero Power-Sub critical-MNSR in Esfahan and IR-40 in Arak)*
- *Reprocessing: None*
- *Waste Management: (Development of Generic Conceptual Design for a Near Surface Repository in the Country, and Incinerator, and Online Activities)*



Source: Mohammad Saeidi, Vice President for Planning & International Affairs, Atomic Energy Organization of Iran

Geoff Forden and Sir John Thomson

Buhsher Commercial Reactor

Iran centrifuges

Iran is still several years away from making the nuclear bomb fuel – but they are developing the nuclear option

Getting around in Pyongyang - 2006

Signs of market activity: Pyongyang 2006

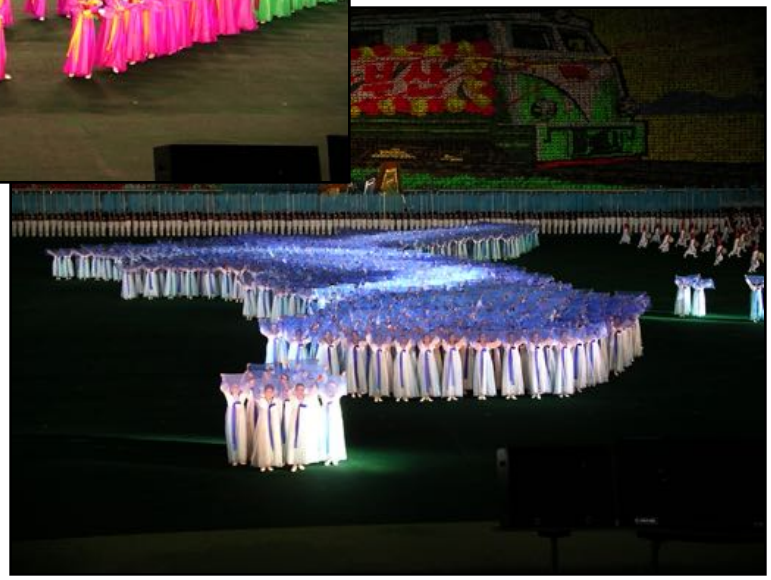
Tong il Street Market – signs of commerce

Instructions, discipline and friendship in Middle School #1

Pyongyang subway – artistic and functional

A touching performance at Children's Palace (Aug. 2005)

A masterful performance of "Arirang" (Aug. 2005)



Arirang
Pyongyang, Aug. 9, 2007

Pyongyang

August 9, 2007

Pyongyang
August 10, 2007

North-South Unification
Pyongyang, Aug. 7-11, 2007

The South is patient –
don't rush the collapse or
unification


Aug. 9, 2007


Aug. 9, 2007


Aug. 9, 2007

Heavy flood damage in North Korea – Aug. 7-11, 2007

(AP Photo/APTN)

- > 50 cm of rain
- > 600 people dead
- 200,000 – 300,000 homeless

- 450,000 tons crops lost
- > 10% of corn and rice fields washed away or buried

S.S. Hecker – Aug. 9, 2007

The winds of change

Pyongyang subway – Nov. 2006

Nuclear timeline for North Korea

- 1960s Soviet Union supplies IRT research reactor (HEU metal fuel) and isotope production lab (IAEA safeguards in 1977)
- Dec. 12, 1985 North Korea accedes to the NPT
- Sept. 27, 1991 President Bush announces unilateral withdrawal of all naval and land-based nuclear weapons from abroad (leads to withdrawal of U.S. nukes from ROK)
- Dec. 31, 1991 Two Koreas sign South-North Joint Declaration on Denuclearization of Korean Peninsula
- April 9, 1992 DPRK ratifies the safeguards pact with IAEA
- May 4, 1992 DPRK submits nuclear material declaration to IAEA. Hans Blix and IAEA inspectors at Yongbyon

Nuclear timeline: The first nuclear crisis

- Feb. 9, 1993 IAEA demands special inspection after finding discrepancies in DRPK declarations
- March 12, 1993 DPRK announces intention to withdraw from NPT
- June 1993 U.S. – DPRK talks defuse nuclear crisis
- January 1994 CIA director estimates DPRK may have produced one or two nuclear weapons
- June 13, 1994 DPRK announces withdrawal from NPT
- June 15, 1994 Pres. Carter negotiates nuclear "freeze"
- Oct. 21, 1994 U.S. and DPRK adopt "Agreed Framework" and IAEA inspectors return to Yongbyon