

**North Korea's nuclear program:  
Status and Prospects**

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# How did North Korea get the bomb?

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- **Soviet “Atoms for Peace” – 1950s & 1960s**
- **Proceeding alone, but under civilian cover – 1970s to 1992**
- **Freeze: Agreed Framework 1994 – 2002**
- **Bomb production: Jan. 2003 – Present**
- **Nuclear tests: October 2006; May 2009; February 2013**
- **Successful missile test Dec.2012**

**North Korean bomb – 50 years in the making.  
Civilian and military programs side by side.**

# 10-year comparison of DPRK nuclear program

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Nuclear Capability	January 2003	January 2014
Plutonium	0 to 10 kg	
HEU (Highly enriched U)	Likely none	
Nuclear tests	None	
Nuclear weapons	Likely no plutonium bombs No highly enriched uranium bombs	
Long-range rockets	One failed Taepodong-1 launch (1998)	

# 10-year comparison of DPRK nuclear program

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Nuclear Capability	January 2003	January 2014
Nuclear reactors	5 MWe – standby 50 MWe – standby 200 MWe - abandoned	
Fuel fabrication	Standby – corroding U conversion - operating	
Uranium enrichment	DPRK – denied US – 2002 accusation	
Nuclear export	UF6 to Libya Reactor to Syria	
Political	Kim Jong-il No mention of nukes	

Plutonium production halted. Uranium enrichment – building capacity.  
No nuclear weapons, no long-range rockets.

# January 2004 visit to Yongbyon

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## What was known in 2003?

- Oct. 2002 Pyongyang Confrontation
- IAEA inspectors expelled
- DPRK withdrew from NPT
- 5 MWe reactor restarted
- Uncertainty about spent fuel

## Our visit established:

- Reactor operating well
- Spent fuel removed
- Spent fuel reprocessed  
(possibly separated 25 kg Pu)
- Plutonium fabrication demonstrated
- Nuclear weapons likely fabricated



# Agreed Framework limited plutonium production



**5 MWe reactor**  
(6 kg Pu per year)  
Restarted in 2003



**50 MWe reactor**  
~ 10 bombs/yr  
Expected compl. 1995



**200 MWe reactor Taechon**  
~40 bombs/yr, Exp. ~2000

50 MWe and 200 MWe reactors had to  
be abandoned

# Visits to North Korea provided valuable insight

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July 2005 – 6-Party Talks



- No visit to Yongbyon because of reprocessing spent fuel (possibly separated ~ 10 kg Pu)
- Banco Delta Asia Sanctions
- Pyongyang leaves 6-party talks

Sept. 19 2005 – 6-Party Talks  
Joint Denuclearization Statement



# Visits to North Korea provided valuable insight

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July 5, 2006 Failed rocket launch

Oct. 9, 2006 First nuclear test



Oct. 14: UN sanctions 1718

Defense Secretary Rumsfeld  
leaves office

Christopher Hill begins to talk  
to North Koreans

Nov. 2006 visit to Pyongyang

“It worked and we are filled with pride”

# Visits to North Korea provided valuable insight

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## Feb. 13: Initial Actions for the Implementation of the Joint Statement



DPRK stops 5 MWe reactor operation

U.S. takes DPRK off terror list

Oct. 3: **Second-Phase Actions for the Implementation of the Joint Statement**

Visit to Yongbyon demonstrates serious disablement – but DPRK retains hedge to restart plutonium facilities

# Visits to North Korea provided valuable insight

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Feb. 2008 Visit to Yongbyon



June 27, 2008

Disablement continues

DPRK blows up cooling tower

DPRK provides US with nuclear  
Declaration

US presses for deal

DPRK shows little interest as  
Bush Administration comes to end

# Visits to North Korea provided valuable insight

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Feb. 2009 visit – DPRK shows no interest in dialogue. Appears to prepare for nuclear test.



April 5 2009 – failed Taepodong-2 rocket launch

6-party talks end. IAEA inspectors out

May 25, 2009 Second nuclear test

June 12: UN sanctions 1874

DPRK announces decision to build LWR and start uranium enrichment

US has no desire to negotiate

# 2010: Time of danger on Korean peninsula

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March 26: Cheonan sinking



Oct. 10: Musudan road-mobile  
Intermediate-range rocket at  
Pyongyang parade



Nov. 23: Attack on Yeonpyeong Island

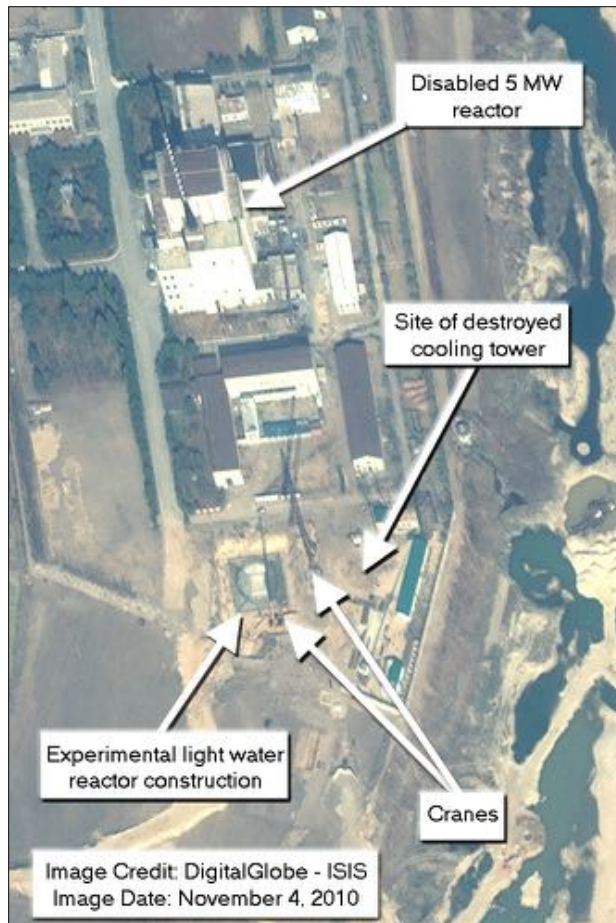


# November 2010 visit to Yongbyon presented us with a new reality

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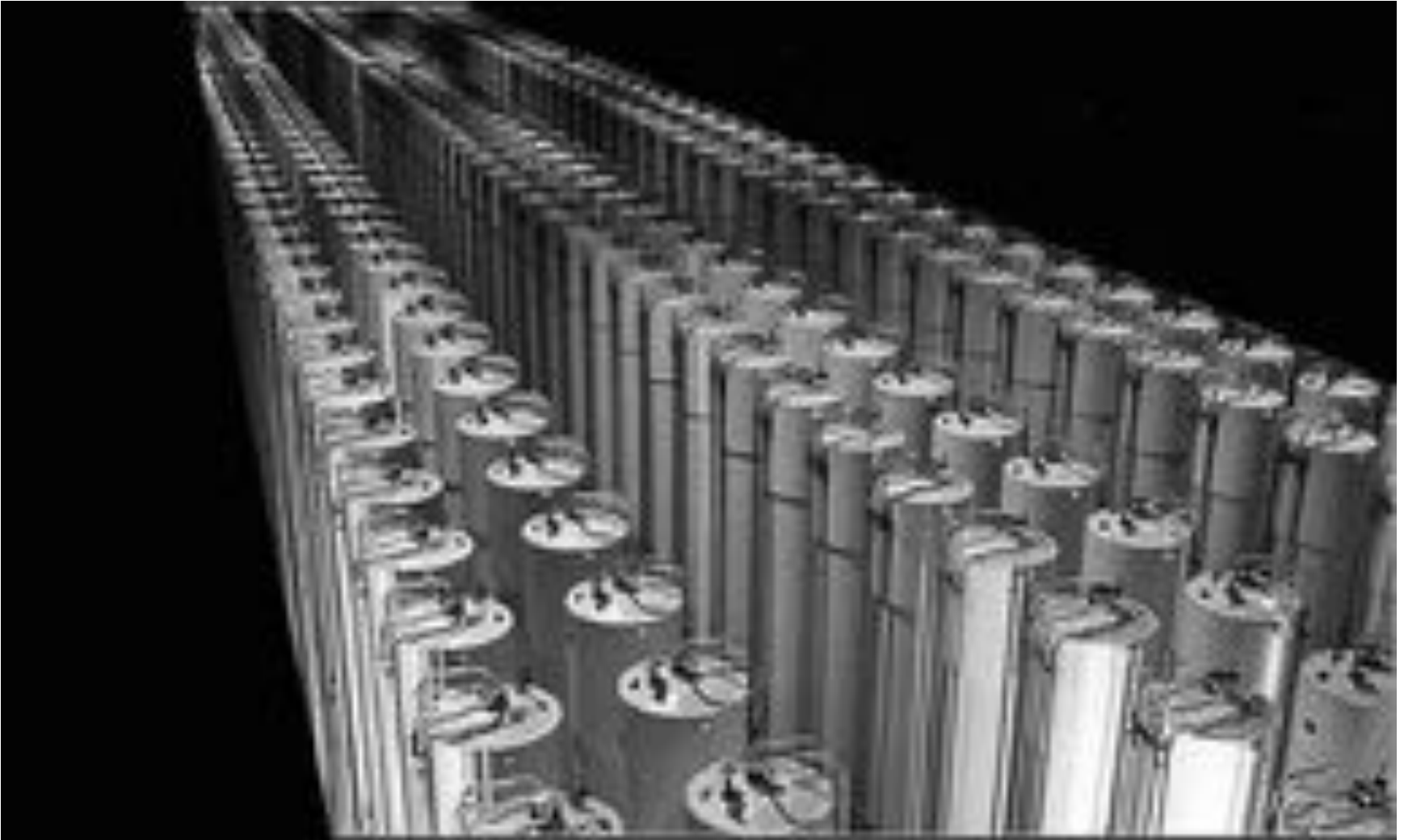
**“We will convert our center to an LWR and pilot enrichment facility.”**

DPRK Official, Nov. 2010



**No foreigners have been at Yongbyon since Nov. 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

# Uranium Enrichment Centrifuge Facility

Building Exterior 1  
3-D Model



Blue Roof  
Centrifuge Hall

Main Gate to Fuel  
Fabrication Facility

2nd Floor:  
Control Room

2nd Floor:  
Recovery Room

1st Floor  
Feed Room

Main Entrance  
with granite steps

Road to Building 4

© 2011 Google  
© 2011 Mapbox.com  
© 2011 Europa Technologies  
Image © 2011 DigitalGlobe

Google earth

36.451713° N, 125.450239° E, elev: 154 ft

Open 100%

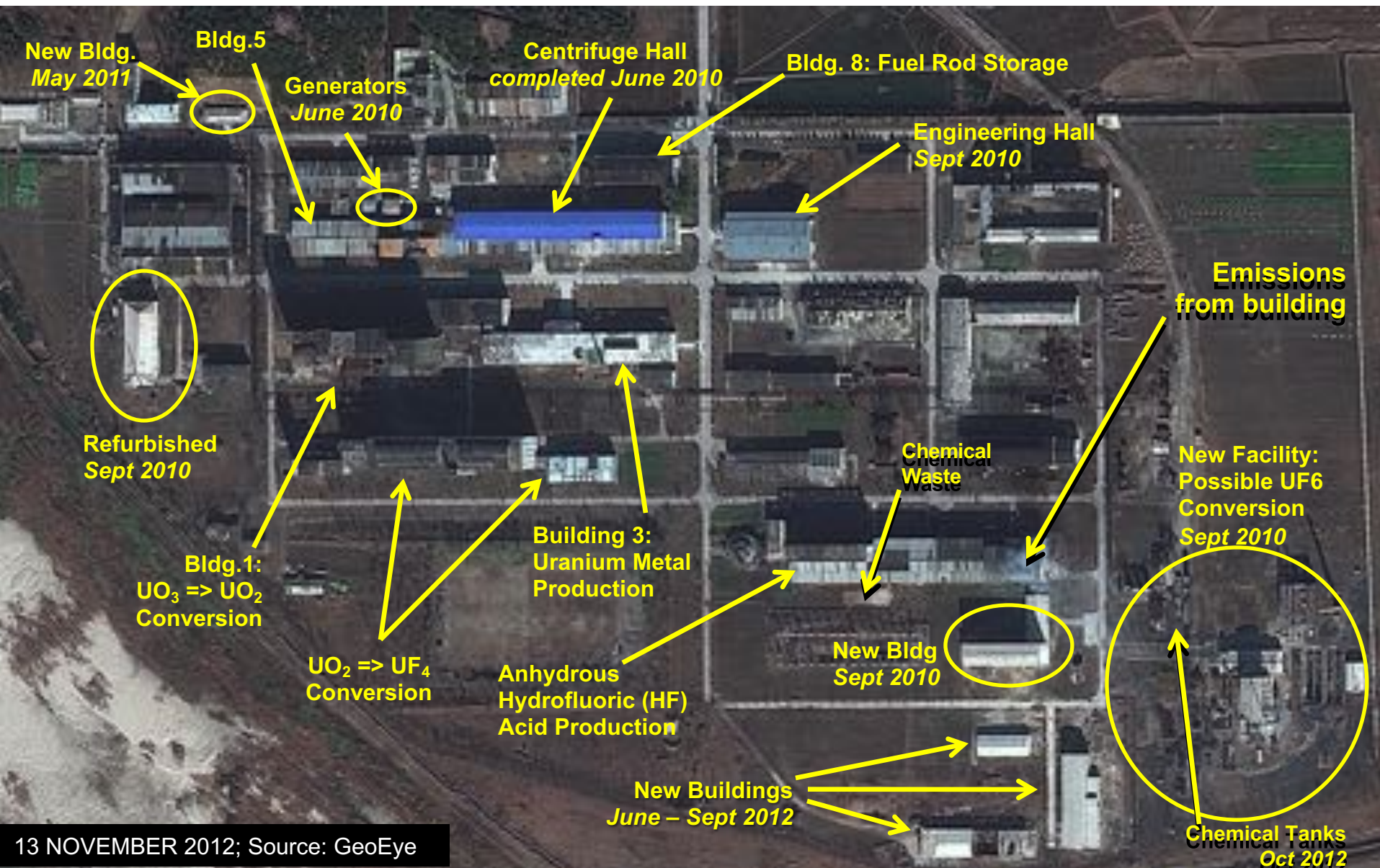


Yongbyon Centrifuge Facility





# Yongbyon Fuel Fabrication Plant, North Korea



2011: Year of political rapprochement, but nuclear buildup



26 SEP 2010



Source: DigitalGlobe

4 NOV 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

DigitalGlobe - 38 North  
March 27, 2013







Sentry and the news media  
Sohae launch complex



Associated Press



The planned April 15 launch is

# The case of North Korea

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- < 2006 Only mention of a nuclear deterrent  
But many attempts to send message to US
- > Oct. 2006 DPRK claims test in response to  
hostile U.S. policy
- > May 2009 "The test will contribute to defending the  
sovereignty of the country and the nation  
and socialism and ensuring peace and  
security on the Korean Peninsula..."
- > Feb. 2013 Smaller and lighter warheads and a  
threat to launch pre-emptive nuclear  
strikes against the United States and Seoul



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National security drivers remain paramount, but once they tested the domestic and international drivers increased

# North Korean nuclear test: #1 – Oct. 9, 2006

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## **Results:**

- Predicted 4 kt yield; actual seismic ~ 4; yield < 1 kt
- Likely Pu; likely rudimentary (Nagasaki like)

## **Motivation:**

- Technical and military drivers
- Convince Kim Jong-il and military leaders
- Political - reinforce deterrence message to U.S.
- Response to sanctions

## **Consequences:**

- China's displeasure, UNSCR sanctions
- No major impact of sanctions
- Bush administration came to negotiating table
- 2007 & 2008 – Restraint, hedge and regroup



# North Korean nuclear test: #2 – May 25, 2009

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## **Results:**

- Seismic ~ 4.5; yield 2 to 7 kt
- Likely Pu; likely rudimentary (Nagasaki like)

## **Motivation:**

- Strong technical drivers to improve on 2006 performance
- Convince Kim Jong-il, military leaders after 2006 attempt
- Convince U.S. and world
- Develop more credible deterrent (followed LR missile launch)

## **Consequences:**

- China's displeasure, UNSCR sanctions
- No major impact of sanctions
- Killed six-party talks
- Stopped Obama administration from negotiating
- Facilitated expansion of nuclear weapons program

# North Korean nuclear test: #3 – Feb. 12, 2013

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## **Results:**

- Seismic ~ 4.9; yield 8 to 16 kt; No info on Pu vs. HEU
- Likely achieved some miniaturization (so claimed by DPRK)

## **Motivation:**

- Technical and military drivers for miniaturization
- Demonstrate more threatening nuclear weapon capability
- Preceded by successful LR missile launch
- Domestic - shore up Kim Jong-un's regime

## **Consequences:**

- China's strong displeasure; sanctions may have more impact
- DPRK threatened pre-emptive nuclear strike followed by offer to talk
- Terminated Obama administration negotiation attempts
- Demonstrated expansion of nuclear weapons program

# 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

# Dec. 12, 2012 Successful Unha-3 Rocket Launch



# What next?

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- **Why test again?**

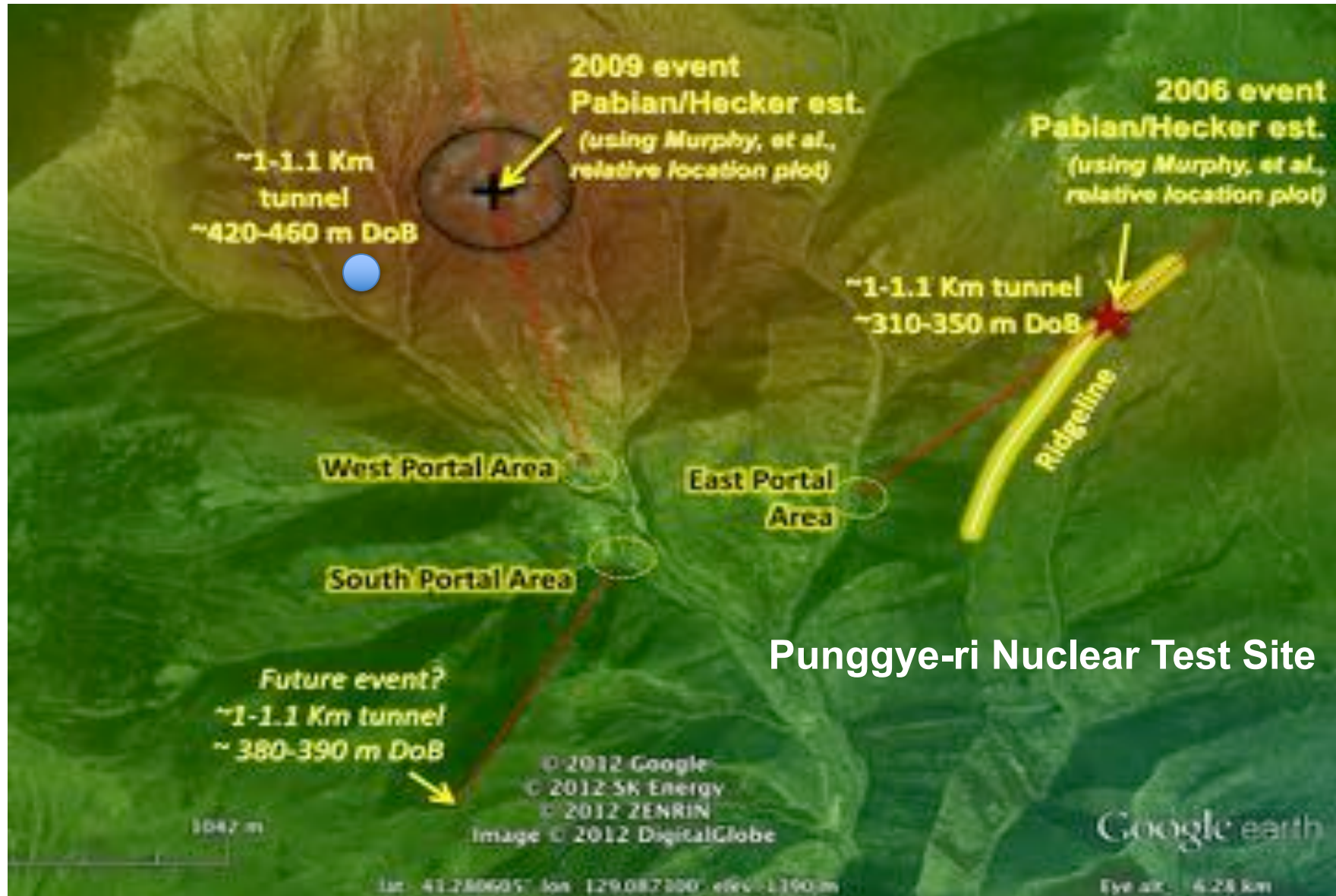
- Strong technical reasons
- Strong military and political reasons
- Domestic support

- **Why not test?**

- China's displeasure and potential actions
- Unlikely to be influenced by international constraints
- Fissile materials constraints



# Will DPRK test again – and if so, what will it be?



South tunnel is prepared

# So, what to do now?

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- Deal with DPRK as it is, not the way we'd like it to be
  - Time is not on their side
- Stay the course on denuclearization, but limit threat
- For now - three no's and a yes
  - No more bombs (no Pu or HEU)
  - No better bombs (no missile tests)
  - No export
- Yes - address fundamentals of North Korea's insecurity to create conditions favorable to disarmament and provide energy and economic assistance

# **Current DPRK nuclear weapons assessment**

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- **Nuclear weapons (~4 to 8 primitive bombs)**
  - Limited by plutonium and sophistication (lack of testing)
  - Some progress to miniaturization – Pu or HEU
- **Plutonium production complex restarted**
- **Uranium enrichment**
  - Small industrial scale apparently operational – others likely
  - Some HEU likely but do not know how much or production capacity
- **Missile program**
- **Concern about nuclear imports, exports and cooperation**

# Construction at Sohae Satellite Launch Site

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- Recent imagery reported by 38 North (Oct. 9) shows significant construction at Sohae
- Work ongoing to upgrade Unha launch pad and possibly build a second mobile missile launch pad
- Activities in line with North Korean desire to field mobile missile capability and launch larger rockets than the Unha-3 launched last December 2012



North Korea continues to prepare for future space launches, increasing the likelihood of rocket tests that improve its missile program



# 10-year comparison of DPRK nuclear program

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Nuclear Capability	January 2003	January 2014
Plutonium	0 to 10 kg	24 to 42 kg
HEU (Highly enriched U)	Likely 0	???
Nuclear tests	0	3
Nuclear weapons	Likely 0 Pu 0 HEU	4 to 8 Pu ??? HEU
Long-range rockets	One failed Taepodong-1 launch (1998)	Successful Unha-3 launch (Dec. 2012)

# 10-year comparison of DPRK nuclear program

---

Nuclear Capability	January 2003	January 2014
Nuclear reactors	5 MWe – standby 50 MWe – standby 200 MWe - abandoned	5 MWe restarted ELWR under construction
Fuel fabrication	Standby – corroding U conversion - operating	Reactivated Fuel for ELWR
Uranium enrichment	DPRK – denied US – 2002 accusation	Centrifuge facility Covert facilities ?
Nuclear export	UF6 to Libya Reactor to Syria	Cooperation with Iran?
Political	Kim Jong-il No mention of nukes	Kim Jong-un New constitution declares DPRK nuclear state

# Winds of change are blowing in DPRK



Cell phones in Nov. 2010





# Nuclear testing program

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- **Previous nuclear tests**

- Oct. 2006 – East tunnel, close to 1 kiloton
- Oct. 2009 – West tunnel, between 2 and 7 kilotons
- Feb. 2013 – Likely West tunnel, ~ 7 to 10 kilotons

- **South tunnel**

- Excavation apparently started in 2009
- Tunnel appeared ready for test by April 2012
- Continued activity through floods and snow

- **Other activities**

- West portal showed greatest activity in 2013
- Cold tests or experiments at either tunnel

- **Nuclear testing issues**

- Why test again? Needed to miniaturize;
- Possibly test both Pu and HEU

# Developments in Spring 2013

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- Dec. 12, 2012 – DPRK conducts “successful” space launch
- Feb. 12 – DPRK conducts third nuclear test



U.N. Approves China-Backed Sanctions on North Korea, March 7, 2013

## Pyongyang responds:

“Now that the U.S. is set to light a fuse for a nuclear war, the revolutionary armed forces of the **DPRK will exercise the right to a pre-emptive nuclear attack to destroy the strongholds of the aggressors** and to defend the supreme interests of the country.”

# Korean Peninsula on the Brink?

**The New York Times**

March 11, 2013

**North Korea Declares 1953 War Truce Nullified**

**The Daily Telegraph**  
March 11, 2013  
**North Korea cuts  
off hotline to South**

March 26, 2013 **Yonhap, Seoul**

**N. Korean Military Enters Highest  
Combat Ready Posture, Fueling  
Tension**

**The New York Times**

March 5, 2013

**North Korea Threatens to Attack U.S.  
With 'Lighter and Smaller Nukes'**

**THE WALL STREET JOURNAL.**  
March 8, 2013  
**Iran-North Korea Pact  
Draws Concern**

**The New York Times**  
March 8, 2013  
**After U.N. Vote on Sanctions, 2  
Koreas Ratchet Up Threats**

**U.S. official: North Korea could test fire  
missiles at any time**  
CNN, April 10, 2013

**Should we be concerned?**



# Then, things got worse

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- **March plenary of Central Committee: Push forward economic construction (includes nuclear electricity) and nuclear armed forces**
- **April 2: General Department of Atomic Energy announced “readjustment and restarting all nuclear facilities at Yongbyon”**
- **Early April : Pyongyang moved road-mobile missiles to East Coast, apparently for flight testing**

# Then, things got worse

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- **March plenary of Central Committee: Push forward economic construction (includes nuclear electricity) and nuclear armed forces**
- **April 2: General Department of Atomic Energy announced “readjustment and restarting all nuclear facilities at Yongbyon”**
- **Week of April 8: Pyongyang moved road-mobile missiles to East Coast, apparently for flight testing**

**What does this mean?**  
**How does it change the security threat?**

# Six visits to North Korea helped us assess the program

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Jan. 2004 Yongbyon



Aug. 2005 Pyongyang



Nov. 2006 Pyongyang



August 9, 2007, Yongbyon



Feb. 14, 2008, Yongbyon



Feb. 27, 2009, Pyongyang

The seventh brought the centrifuge facility surprise



# Uranium Enrichment Program

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- **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
  - It likely was 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 size

# Why uranium enrichment?

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- **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

# So, what do recent developments mean?

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- **DPRK warned to strengthen its deterrent both in quantity and sophistication**
- **Now pursuing both plutonium and highly enriched uranium – alleviate shortage of fissile materials**
- **Road-mobile missile tests would boost its deterrent**
- **Demonstrates that it is pursuing a nuclear missile threat capability**

# DPRK nuclear facilities

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## Yongbyon nuclear complex

- Fuel fabrication facility – **uranium metal fuel**
- 5 MWe reactor – **Magnox (gas – graphite)**
- Reprocessing facility – **plutonium separation**
- 50 MWe and 200 MWe reactors – **not salvageable**
- IRT-2000 research reactor – **very little fuel remains**
  - Good for medical isotope production
- Uranium centrifuge facility

## Other facilities outside Yongbyon

- Covert uranium facilities and weaponization facilities



# DPRK nuclear facilities

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## Yongbyon nuclear complex

- **Fuel fabrication facility – uranium metal fuel**
  - Fuel for reactor and feed for uranium centrifuges
- **5 MWe reactor – Magnox (gas – graphite)**
  - 6 kg plutonium/year
- **Reprocessing facility – plutonium separation**
  - Large scale capability, small plutonium laboratory
- **50 MWe and 200 MWe reactors – not salvageable**
  - Would represent major threat (~ 300 kg Pu/year)
- **IRT-2000 research reactor – very little fuel remains**
  - Good for medical isotope production
- **Uranium centrifuge facility**

## Other facilities outside Yongbyon

- Covert uranium facilities and weaponization facilities

# What Yongbyon facilities would be restarted?

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- IRT-2000 research reactor – very little fuel remains
  - Good for medical isotope production
- **Uranium centrifuge facility “readjusted” to HEU?**

## Other facilities outside Yongbyon

- Covert uranium facilities and weaponization facilities

# **Current DPRK nuclear weapons assessment**

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- **Plutonium (Pu): 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)
  - Some progress to miniaturization – Pu or HEU
- **No plutonium in the pipeline**
  - Recent announcement that it will restart 5 MWe reactor
- **Additional nuclear test – needed for miniaturization for missiles**
- **Uranium enrichment**
  - Small industrial scale apparently operational – others likely
  - Some HEU likely but do not know how much or production capacity
- **Concern about nuclear imports, exports and cooperation**

# How will assessment change?

---

- Plutonium (Pu): 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)
  - Some progress to miniaturization – Pu or HEU
- In roughly 3 years, produce 12 kg of Pu (2 bomb's worth)
  - Maximum capacity will be 6 kg/year (one bomb's worth)
- Additional nuclear tests – needed for miniaturization for missiles
- Uranium enrichment
  - Could produce ~ 40 kg/year of HEU – roughly two bomb's worth
  - Capacity of covert facility for HEU is unknown
- Greater concern about imports, exports and cooperation



# Nuclear testing program

---

- **Previous nuclear tests**

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- **Nuclear testing issues**

- Why test again? Needed to miniaturize;
- Possibly test both Pu and HEU

# DPRK Missile Program



**April 13, 2012 Space launch**



**Combination of nuclear weapons and missiles increases the threat**

# Unha-3 Rocket Launch Preparation





# Unha-3 recovered debris



**Oxidizer container for first-stage propellant.**



**Engine connection rod**



**Possible Engine of rocket**



**Fuel Tank with "3" inscribed**

# Unha-3 rocket and Kwangmyonsong-3 satellite

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- 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 but no signals
  - Orbits globe at 7.6km/sec (every 95.4min)
- Unha-3 long-range rocket characteristics
  - Liquid fueled, three-stage rocket (not good for ICBM)
  - Estimate range of ~4,000 to 6,000km. Could be as much as 10,000km (capable of reaching the continental U.S.)

# Images of DPRK's “Musudan” IRBM and KN-08

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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 North Korean vehicle carries a missile.  
(AP Photo/Vincent Yu, File)





# 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



# Experimental LWR Program

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- **Steady progress on EWLR (25 to 30 MWe)**
  - KEDO abandoned in 2006
  - No apparent plans in 2008
  - Site preparation 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

# **We should be concerned about nuclear exports**

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- **Missile exports - definitely**
- **Libya – Uranium hexafluoride (UF<sub>6</sub>) - yes**
- **Syria – plutonium-producing reactor - yes**
- **Iran and Burma ???**

**These are big money makers for the DPRK and pose a serious threat – very difficult to stop**

# **Syrian reactor site at Dayr az Zawr region bombed by Israel on Sept. 6, 2007**

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**Before bombing**

**After bombing**



# Satellite Photos Show Cleansing of Syrian Site

By [WILLIAM J. BROAD](#) and MARK MAZZETTI

Published: October 26, 2007, New York Times



Suspected reactor site in Dayr az Zawr region bombed by Israel on September 6, 2007

Same site in Dayr az Zawr region in October after Syrian cleanup



# **Will DPRK give up the bomb?**

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- **Not in the near future - not voluntarily**
- **Must make it more attractive to give them up and more costly to keep them**
- **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](http://cisac.stanford.edu/publications/can_north_korea_nuclear_crisis_be_resolved)

# Why did North Korea get the bomb?

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- **Security** - Most powerful deterrent against aggression
  - Best assurance to keep the regime in power
- **Domestic reasons**
  - Increase tensions and distract people's attention from daily grievances.
  - External threat justifies the bomb; bomb justifies sacrifices people continue to make
- **International statement** – International prestige, bring U.S. to bargaining table, use as a bargaining chip

Security was and remains the main driver.  
Domestic and international reasons followed.

# What are the nuclear security threats?

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



# So, what to do now?

---

- Deal with DPRK as it is, not the way we'd like it to be
  - Time is not on their side
- Stay the course on denuclearization, but limit threat
- For now - three no's in return for one yes
  - No more bombs (no Pu or HEU)
  - No better bombs (no missile tests)
  - No export
- Yes - address fundamentals of North Korea's insecurity to create conditions favorable to disarmament

# Why countries build and keep nuclear weapons

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- **National security**
- **International norms, statement, prestige**
- **Domestic statement and politics**

# What about North Korea?

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- **National security**
  - Primary reason, since 1950s
  - Remains primary reason today
- **International norms, statement, prestige**
  - Post 1994 with Agreed Framework
  - Increased importance post 2003
- **Domestic statement and politics**
  - Important only after 2006 test
  - Increasing importance today

# Symbolic destruction of 5 MWe cooling tower

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