# A Comprehensive History of North Korea's Nuclear Program and Lessons Learned

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A comprehensive technical and political history of North Korea's nuclear program over the past 26 years

- This history is based on an extensive literature review combined with expert analysis of diplomatic and political developments by R.L. Carlin and technical developments by S.S. Hecker. It was also informed by numerous interviews and inputs from other subject-matter experts.

- The objective is to present an overarching comprehensive picture of the evolution of North Korea's nuclear program to help understand the relationship among politics, diplomacy and technical developments during the entire time frame.

- The analysis helps to illuminate how critical decisions, either technical or political, affected the directions of the nuclear program. It points to numerous "hinge points" that proved critical in the evolution of the program and relations between North Korea and the United States.

- The history is presented in color charts to provide easy-to-follow visual interpretations year-by-year of technical and political developments and their relationships. We use three shades of red denoting negative effects (for example, nuclear buildup or lack of diplomacy – the darker the more negative) and three shades of green denoting positive effects (serious diplomacy, for example, or lesser nuclear concerns – the darker the more positive). We have defined rigorous coding criteria for each color shade in each category.

- The charts are supplemented in a separate written narrative that provides detailed explanations of the key developments on an annual basis.

## Fielding a nuclear arsenal requires three components:

1) Bomb fuel, 2) Weaponize (design, build, test), and 3) Delivery systems



The individual requirements for the three components will constitute the columns in the technical parts of the charts.

## North Korea Nuclear Program– Technical Focus 3 shades of green (dark best), 3 shades of red (dark worst)

| Year | US Diplomacy | DPRK<br>Diplomacy | US/IAEA YB<br>Presence | Plutonium | U enrichment | Tritium/Li-6<br>H-bomb fuel | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|------------------------|-----------|--------------|-----------------------------|--------------------------------|--------------------|----------|
| 1992 |              |                   |                        |           |              |                             |                                |                    |          |
| 1993 |              |                   |                        |           |              |                             |                                |                    |          |
| 1994 |              |                   |                        |           |              |                             |                                |                    |          |
| 1995 |              |                   |                        |           |              |                             |                                |                    |          |
| 1996 |              |                   |                        |           |              |                             |                                |                    |          |
| 1997 |              |                   |                        |           |              |                             |                                |                    |          |
| 1998 |              |                   |                        |           |              |                             |                                |                    |          |
| 1999 |              |                   |                        |           |              |                             |                                |                    |          |
| 2000 |              |                   |                        |           |              |                             |                                |                    |          |
| 2001 |              |                   |                        |           |              |                             |                                |                    |          |
| 2002 |              |                   |                        |           |              |                             |                                |                    |          |
| 2003 |              |                   |                        |           |              |                             |                                |                    |          |
| 2004 |              |                   |                        |           |              |                             |                                |                    |          |
| 2005 |              |                   |                        |           |              |                             |                                |                    |          |
| 2006 |              |                   |                        |           |              |                             |                                |                    |          |
| 2007 |              |                   |                        |           |              |                             |                                |                    |          |
| 2008 |              |                   |                        |           |              |                             |                                |                    |          |
| 2009 |              |                   |                        |           |              |                             |                                |                    |          |
| 2010 |              |                   |                        |           |              |                             |                                |                    |          |
| 2011 |              |                   |                        |           |              |                             |                                |                    |          |
| 2012 |              |                   |                        |           |              |                             |                                |                    |          |
| 2013 |              |                   |                        |           |              |                             |                                |                    |          |
| 2014 |              |                   |                        |           |              |                             |                                |                    |          |
| 2015 |              |                   |                        |           |              |                             |                                |                    |          |
| 2016 |              |                   |                        |           |              |                             |                                |                    |          |
| 2017 |              |                   |                        |           |              |                             |                                |                    |          |

### Explanation of column headings

#### **US Diplomacy**

A measure of US initiatives and efforts to support diplomatic engagement with North Korea. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korea nuclear and ballistic missile programs.

### North Korea Diplomacy

A measure of North Korean initiatives and efforts to support diplomatic engagement with the United States, though not necessarily in support of common goals. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korean nuclear and ballistic missile programs.

### **US/IAEA Presence at Yongbyon Nuclear Center**

A measurement of the presence of US and/or IAEA personnel at Yongbyon.

#### Plutonium

A measurement of the state of plutonium production facilities and the current stockpile of weapon-grade plutonium.

#### Uranium Enrichment

A measurement of the state of uranium enrichment program and facilities and the current stockpile of highly enriched uranium.

#### Tritium/Lithium-6

A measurement of the state of fusion (hydrogen bomb) fuels, encompassing tritium/Li-6D production facilities and the current stockpile of tritium and lithium-6.

### Weaponization

A measurement of the level of nuclear weapons development achieved and in progress, including nuclear tests.

#### **Nuclear Weapons Summary**

A measurement of the level of nuclear weapons development achieved and in progress, encompassing fissile material production and weaponization, including nuclear tests.

### **Missiles Summary**

A measurement of the level of missile development and deployment achieved and in progress, encompassing all aspects of delivery system development.

Examples of color shade coding criteria:

### **US Diplomacy**

## A measure of US initiatives and efforts to support diplomatic engagement with North Korea.

**G3:** Sustained and serious US engagement at every level with the DPRK intended to conclude and implement agreements. **G2**: Continued engagement and efforts to implement agreements reached with the DPRK, but without serious, demonstrated intent to push beyond the current levels.

**G1**: Limited engagement, no new initiatives, difficulties dealing with implementation of existing agreements for reasons of internal political or bureaucratic opposition.

**R1:** Episodic engagement for forms sake but no serious overtures; some actions that reverse or undermine existing agreements.

**R2:** Rare, sporadic pro forma contact, limited communication, no realistic proposals. Failure to explore DPRK initiatives. Failure to implement or abrogation of existing agreements.

R3: Minimal or no engagement. Overt expressions of hostility.

### Missiles

# A measurement of the level of missile development and deployment achieved and in progress (encompassing all aspects of delivery system development).

G3: No missile development or significant rollback of missile capabilities.

G2: Complete missile and space launch rocket testing moratorium or roll back of missile deployment.

**G1:** Ongoing rocket/missile R&D and component testing. In case of previous missile deployments, observing a long and intermediate missile or space-launch testing moratorium.

R1: Short and medium (SCUD and Nodong) missile component procurement, manufacturing and deployment with flight tests. Possible development of space-launch rockets, IRBMs or ICBMs but no flight tests. Space launch possible.
R2: Significant increase in missile tests. In addition to SCUD and Nodong deployment and testing, also test IRBMs and continued vigorous development of long-range missiles and technologies.

R3: In addition to R2, also test ICBM and continue vigorous development and testing of advanced IRBM and ICBMs.

## Each box in the charts has a separate historical narrative.

| Year | US Diplomacy | DPRK<br>Diplomacy | Yongbyon<br>Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|----------------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |

A sampling of the narratives for 1992:

#### US Diplomacy:1992: G1

Year begins on a positive note, with a January meeting in New York between Undersecretary of State for Political Affairs Arnold Kanter and Korean Worker's Party Secretary for International Affairs Kim Yong Sun. The year ends with tensions rising as the IAEA moves toward demanding special inspections in the North.

#### DPRK Diplomacy: 1992: G1

At the January meeting in New York between Arnold Kanter and Kim Yong Sun, Kim hints that the North is willing to accept long term presence of US troops on the Korean Peninsula. North ratifies IAEA safeguards agreement, leading to IAEA inspections. These produce evidence of cheating, and tensions rise with IAEA moves toward demanding special inspections. By then Kim Jong-il has already decided to have the North withdraw from the NPT in 1993.

#### Uranium enrichment: 1992: G1

DPRK has industrial scale uranium processing and fabrication facilities at Yongbyon for the uranium metal alloy fuel elements for the 5 MWe Gas-Graphite reactor. It has abundant uranium ore supply from two mines. DPRK likely has some centrifuge R&D activity based on small number of Urenco centrifuges, but slows down that effort in favor of plutonium production. It has requisite uranium chemical facilities and processes to make UF4 (in large quantities because of its use for reactor fuel manufacture) and some experimental UF6 production (a step required only for enrichment activities).

#### Weaponization: 1992: R1

DPRK most likely had an active nuclear weapons R&D program in the 1980s. This effort is believed to have included weapon physics design and engineering, including explosive cold tests for implosion (Nagasaki-style) nuclear fission devices. It also likely included materials R&D on special nuclear materials such as plutonium and uranium, and high explosives. Initial efforts on nuclear device fabrication and preparations for possible underground nuclear tests at Punggye-ri also appear to have been underway.

#### Missiles: 1992: R1

DPRK missile efforts date back to 1960s and 1970s in conjunction with Soviet Union and to some extent China. Extensive DPRK missile program prior to 1992 focused primarily on SCUD short-range missiles (SCUD-B with 300 km range) and components imported from Soviet Union.

During a 5-year period (1987-92), DPRK began developing the *Hwasŏng-6* (a North Korean version of the Soviet SCUD-C), the "*Nodong*," the *Taepodong-1*, the *Taepodong-2*, and the "*Musudan*" (a North Korean road-mobile version of the Soviet R-27/SS-N-6 submarine-launched ballistic missile). In May 1992, Igor Velichko, general designer of the V.P. Makeyev Engineering Design Office, signed a \$3 million contract with the Korea Yŏn'gwang Trading Company in Pyongyang.

In 1992, DPRK likely attempted a launch of SCUD-C (Hwasong-6) with 500 km range.

In March, US sanctions North Korean companies for missile proliferation, with evidence of major missile sales to Iran in late 1980s. Reports of Russian nuclear missile specialists working in large numbers in North Korea. Suspected imports of missiles, rocket technologies, components, materials and know-how from Russia – most likely by Russian individuals and institutes, rather than the Russian government. Also reports of DPRK missile specialists being trained in China.

| Year | US Diplomacy | DPRK<br>Diplomacy | Yongbyon<br>Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|----------------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1                   | G2        | G1           | G1          | R1                             | R1                 | R1       |

A sampling of the narratives for 1993 and 1994:

### DPRK Diplomacy: 1993: G2

March: North Korea gives notice of intent to withdraw from NPT in 90 days (as per NPT provisions). The clock is stopped in June at the last minute with US-DPRK joint statement. In second round of talks in July in Geneva, DPRK announces a "bold decision" to give up graphite moderated reactor technology in return for light water reactors. For remainder of year, there are frequent meetings with the US but no progress in the face of suspicions of North Korean efforts to evade IAEA monitoring.

## US Diplomacy: 1994: G3

Tensions build as the North threatens to unload its 5 MWe reactor without IAEA monitoring. When it does so, Washington reviews options for a possible military response. Full-scale diplomacy resumes in July, is interrupted by the death of Kim II Sung, then resumes again for meetings in August and September, culminating in Agreed Framework signing in October. US midterm elections in November bring a wave of conservative lawmakers into Congress, impeding Administration efforts at AF implementation.

## 1994 Crisis resolved by diplomacy: The Agreed Framework



- Replace graphite-moderated reactors with light water reactors for 2000 MWe
- DPRK will freeze its GMR and related facilities, allow IAEA inspection and dismantle as progress is made on LWRs. Two sides move toward full normalization of economic and political relations
- Both sides will work toward peace and security of a nuclear-free peninsula
- DPRK will consistently take steps to implement the 1992 N/S Declaration
- And other conditions

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |

A sampling of the narratives for 1998 and 1999:

DPRK Diplomacy: 1998: G2

North Korea participates in working and ambassadorial level meetings on Agreed Framework implementation, but these are increasingly difficult because of complaints by both sides on implementation. Agreed Framework appears moribund by August when North Korea launches a satellite, shrugging off US warnings. Missile and Four Party talks in the autumn make no progress. November: US-NK talks in Pyongyang discuss US concerns about a suspected nuclear site at Kumchang-ri.

#### DPRK Diplomacy: 1999: G3

North continues to engage in multiple meetings on Agreed Framework implementation and KEDO affairs. Four party talks held in April—no progress but the US and DPRK delegations use the opportunity to deal with details for a US "visit" to the Kumchang-ri site. May: Inspection of Kumchang-ri completed with North Korean cooperation. Pyongyang accepts a visit by US presidential envoy Perry. The North Korean reaction to the trip is positive. September: At talks in Berlin, North Korea agrees to a long-range missile launch moratorium in return for US commitment to lift some economic sanctions.

#### Missiles: 1998: R1

On August 31, DPRK launched a Taepodong-1 rocket with a range of 1,500-2,000 kilometers that flies over Japan. Foreign assistance, primarily from Russia and Ukraine, but also Iran, was instrumental in Taepodong development. Earlier in April, the US imposes sanctions on DPRK and Pakistan in response to Pyongyang's transfer of missile technology and components to Pakistan's Khan Research Laboratory. US and DPRK hold first missile talks in Berlin in April. Evidence of continued transfer of Nodong missile technologies to Iran, possibly the sale of as many as 150 Nodongs.

#### Uranium Enrichment: 1998: R1

Centrifuge interest continues to increase. DPRK has covert procurement efforts for centrifuge technologies, materials and equipment. Likely scale-up of equipment for production of UF6 – the feed material for centrifuges. Around this time, DPRK reportedly receives a centrifuge starter kit from A.Q. Khan comprised of twenty P-1 centrifuges and four P-2 centrifuges, along with flow meters and control devices. Also around this time, North Korean engineers visit Khan Research Laboratories to help Pakistan with missile technology and manufacture. Former President of Pakistan, Pervez Musharraf, confirmed in his memoirs that the North Koreans were regular guests at KRL and that Khan supplied them centrifuges so that they may gain experience in the operation of centrifuges, as well as with computer software.

# 1998 – Missiles and the Perry Process

North Korean medium and long-range missile programs raise concerns in Washington.

Former Secretary of Defense William Perry undertakes a North Korean Policy Review at the behest of President Clinton after North Korean space launch attempt.

UNITED STATES



Taepodong-1 launch (August 31, 1998) Space launch attempt



# Almost there with diplomacy in Oct. 2000?





Vice Marshal Jo Myong-rok and President Bill Clinton at the White House

2000 US-DPRK Joint Communiqué pledges fundamental improvement in bilateral relations.

- to "fundamentally improve their bilateral relations" and "build a relationship free from past enmity."
- Missile issue is important



Kim Jong-il and Secretary of State Madeleine Albright in Pyongyang.

## Examples of narratives for 2000

## DPRK Diplomacy: 2000: G3

Progress in US-North Korea talks slows as the two Koreas work behind the scenes for their first summit. In June, at talks in Rome, North Korea agrees to repeat its commitment to a missile launch moratorium as a condition for the US fulfilling its commitment to lift some sanctions. In September, the North informs the US that it will send Vice Marshal Jo Myong Rok to Washington, reciprocating the Perry visit of May 1999. Jo arrives in October, meets with President Clinton and other US officials. The two sides release a joint communiqué, discussed at meetings since the beginning of the year, pledging to "fundamentally improve their bilateral relations," not to have "hostile intent toward the other and...build a relationship free from past enmity." Weeks later Secretary of State travels to Pyongyang for several hours of meeting with Kim Jong II. Kim Jong II proposes ideas during the Albright visit for limiting the North's missile program, but talks to flesh this out in November make no progress.

### US Diplomacy: 2000: G3

A key year. In January, US passes to the North a draft of a document that eventually becomes a joint communiqué. June—US-DPRK talks in Rome, US asks the North to reiterate its missile moratorium in return for US lifting some sanctions. October 6: US-DPRK joint statement on terrorism issue; October 10, First Vice Chairman of the National Defense Commission Jo Myong Rok visits Washington DC, communiqué issued in which the two governments pledge to "fundamentally improve their bilateral relations… the two sides stated that neither government would have hostile intent towards the other and continued the commitment of both governments… to build a relationship free from past enmity;" October 25, Secretary of State Madeleine Albright travels to Pyongyang, meets with Kim Jong II, discussions focus on missile issue. Visit by President Clinton raised as a possibility if progress on the latter.

# Late 1990s - Uranium enrichment





- Covert global procurement network centrifuge technologies, materials and equipment.
- Centrifuge starter kit from A.Q. Khan comprised of twenty P-1 centrifuges and four P-2 centrifuges and possibly an implosion nuclear device design.
- North Korean engineers visit Khan Research Laboratories and receive hands-on training in centrifuge facilities.
- Likely scale-up of equipment for production of UF6 the feed material for centrifuges later exported to Libya.

## Examples of narratives for 1998-2000

## Uranium Enrichment: 1998: R1

Centrifuge interest continues to increase. DPRK has covert procurement efforts for centrifuge technologies, materials and equipment. Likely scale-up of equipment for production of UF6 – the feed material for centrifuges. Around this time, DPRK reportedly receives a centrifuge starter kit from A.Q. Khan comprised of twenty P-1 centrifuges and four P-2 centrifuges, along with flow meters and control devices. Also around this time, North Korean engineers visit Khan Research Laboratories to help Pakistan with missile technology and manufacture. Former President of Pakistan, Pervez Musharraf, confirmed in his memoirs that the North Koreans were regular guests at KRL and that Khan supplied them centrifuges so that they may gain experience in the operation of centrifuges, as well as with computer software.

## 1999: R1

Covert procurement efforts increase. DPRK likely receives additional help from Khan including blueprints for centrifuge equipment and processes. Facilities for UF6 production likely increase as it is preparing to sell tons of natural (un-enriched) UF6 to Libya for its clandestine centrifuge program. This activity is most likely done outside of Yongbyon complex since IAEA and US technical teams have access to Yongbyon. It is also likely that A.Q. Khan supplied DPRK with an HEU implosion bomb design similar to what he sold to Libya. Such a design could also have increased DPRK's interest in developing centrifuge capabilities.

## 2000: R1

Covert centrifuge procurement efforts continue to increase. Shipments of small canisters of UF6 made to Libya in September (per information received when M. Gaddafi gave up his clandestine centrifuge program). DPRK has technical team at Pakistan's KRL to learn how to operate centrifuge cascades.

## Plutonium production scaled back dramatically during AF



Operations halted. (~6 kg/yr Pu potential) - not operated 1995 to 2003)

**50 MWe reactor** Construction halted – never Completed. (Pu forfeit ~ 56 kg/yr)



200 MWe reactor Taechon Construction never completed. (Pu forfeit ~ 220 kg/yr)

## Examples of narratives for 2000

## Plutonium: 1998: G3

No plutonium produced in reactor or reprocessed. Yongbyon facilities frozen and monitored by IAEA inspectors. Construction of two larger reactors halted. Continued presence of US technical team. US suspects DPRK has built a nuclear reactor complex inside Kumchang-ri mountain and requests inspection.

## 1999: G3

Same conditions at the Yongbyon nuclear complex. Access is granted to US team to inspect Kumchang-ri mountain tunnel, which finds no indication of nuclear facilities.

## 2000: G3

Yongbyon nuclear complex remains frozen and under IAEA inspection with presence of US technical team. DPRK believed to have signed contract to build a clandestine gas-graphite plutonium production reactor for Syria. Construction on 50 and 200 MWe reactors has been halted since 1994. Yongbyon freeze greatly limits plutonium production capacity for the present and future. In fact, several years later, North Korea decides the reactors are not salvageable and their construction is permanently abandoned. Consequently, North Korea forfeits the ability to produce nearly 300 kg of plutonium per year and settles for the less than 6 kg per year potential of the 5 MWe reactor – a serious setback for the North Korean weapon program.

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|------|--------------|-------------------|-------------|-----------------------|--------------|-------------|--------------------------------|--------------------|----------|
| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium             | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
| 1992 | G1           | G1                | G1          | G2                    | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2                    | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2                    | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3                    | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3                    | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3                    | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3                    | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3                    | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3                    | R1           | G1          | R1                             | G3                 | G1       |

By the end of 2000, both sides had high hopes for diplomacy. North Korea had sacrificed significant plutonium production potential, but it was covertly pursuing a hedging strategy through uranium enrichment activities with an assist from Pakistan's A.Q. Khan. It is also likely that North Korea continued some nuclear weapon design, research and development activities during the 1990s.

The Clinton administration was aware of the covert enrichment efforts but considered them sufficiently nascent that it decided not to derail the benefits of the Agreed Framework at that time.

The missile program was also kept in check with a missile testing moratorium resulting from the 1999 Perry Process.

| North Korea Nuclear Program– Technical Focus (Stanford University CISAC)          |  |
|---|--|
| 3 shades of green (dark best), 3 shades of red (dark worst) -Hecker/Carlin/Serbir |  |

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
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| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |

Transition from 2000 to 2001, represents a major hinge point.

US Diplomacy: 2001: R2. Progress stops abruptly. The George W. Bush administration assumes power with a contingent of hardline officials highly critical of the Agreed Framework and intent on ending it. Diplomatic contacts severely cut back but not ended completely.

## 2002: R3

President Bush includes North Korea in the "axis of evil" in his State of the Union address. US begins cutback of support for KEDO. In October, US delegation led by A/S Kelly to Pyongyang confronts the North with issue of uranium enrichment. Kelly under instructions to lay out the US position and then leave. No negotiations and limited exchange of ideas. In November, Kim Jong II sends oral message to US signaling effort to put things back on track. WH rejects immediately. Under US pressure, KEDO suspends HFO deliveries. North Korea warns that will end the freeze of facilities at Yongbyon. In December, the North asks IAEA inspectors to leave.

# Yongbyon facilities become operational in 2003

At end of 2002, North Korea expels IAEA inspectors from Yongbyon. In 2003, it withdraws from the NPT and restarts Yongbyon facilities. October: Pyongyang states it "is making a switchover in the use" of its reprocessing facilities to produce a nuclear deterrent.



North Korea's 5 MWe reactor

## Pyongyang likely built its first nuclear device in 2003

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| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |

North Korea diplomacy: 2003: R2.

January: North Korea announces its withdrawal from the NPT. In March, DPRK jets intercept a US reconnaissance plane over the East Sea. PRC arranges trilateral meeting (PRC-US-DPRK) that produces no results. June: the North announces intention to build a "nuclear deterrent" unless US changes its position. August: First round of Six Party talks, no progress. The North sends a lower ranking official to head its delegation. October: North Korea engages in a slow public acknowledgment of its nuclear intentions, with the Foreign Ministry stating that the North is "making a switchover in the use" of its reprocessing facilities to produce a nuclear deterrent and that it will display the deterrent at "the appropriate time."

US Diplomacy: 2003: R2.

Six Party talks begin. US ends funding for KEDO. KEDO board suspends LWR project.

## John Lewis Stanford delegation visit to Yongbyon, Jan. 2004



## My bottom line: They can build the bomb

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |

### Plutonium: 2003: R3

January – DPRK announces withdrawal from NPT and restarts 5 MWe reactor and re-activates rest of Yongbyon nuclear facilities. Reprocessing of 8,000 fuel elements complete by end of June. Plutonium metal processing line re-installed in Yongbyon. DPRK now has roughly 20 to 30 kg of weapon-grade plutonium metal available and is producing nearly 6 kg more annually. No access for US or IAEA inspectors.

### 2004: R3

January – DPRK shows Hecker and Stanford University delegation it has reprocessed and fabricated plutonium metal and that rest of Yongbyon facilities are operating. Hecker is convinced that DPRK has ability to make plutonium weapon components based on the piece he was shown and discussions with Yongbyon technical team. Devices most likely of Nagasaki-type fission bomb design with approximately 6 kg plutonium. Increased preparation of nuclear test site, including mining, stemming and test diagnostics. Design and engineering team likely explores advanced fission design concepts beyond Nagasaki-style. North Korea also likely begins to explore tritium production with the possibility of eventually being able to produce a hydrogen bomb.

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrich | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|----------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1       | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1       | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1       | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1       | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1       | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1       | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1       | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1       | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1       | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1       | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1       | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1       | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1       | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1       | R1          | R2                             | R2                 | R1       |

US Diplomacy: 2005: R1.

Six Party joint statement released September 19. Within hours, Washington reneges on a key section (possibility of LWRs for North Korea) and announces Treasury sanctions against a Macau-based Banco Delta Asia bank that, in effect, threaten any bank dealing with the DPRK. US announces that KEDO will be dismantled by year's end.

North Korea Diplomacy: 2005: R1

February: In a high-level Foreign Ministry statement, Pyongyang declares that it has manufactured nuclear weapons. Six Party talks resume in an extended 4th session; by September agreement reached on a joint statement. DPRK Foreign Ministry issues statement rebutting position taken in Ambassador Hill's closing remarks and criticizing US Treasury sanctions against Banco Delta Asia that result in freezing North Korean accounts in the bank. A 5th round in November ends with no results.

# Sept. 19, 2005 Six-Party Joint Statement

Could have opened door to return of IAEA.

- DPRK agrees to abandon all nuclear weapons and existing nuclear programs
- Normalization of US-DPRK relations
- Promoting economic relations and energy assistance – and permanent peace regime
- Consideration of LWR at an appropriate time

Agreement derailed by US Treasury sanctions and walk-back on LWR by the U.S.



The fourth round of the Six Party Talks in Beijing.



| Year | US Diplomcay | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🍸               | R1       |

US Diplomacy: 2006: R1

January: KEDO withdraws from site. The North participates in trilateral talks with US and China in Beijing to work toward a resumption of the Six Party Talks. March: Working level meeting in New York to discuss the Banco Delta Asia sanctions. June--the North Invites Ambassador Hill to Pyongyang. Washington turns it down. October – first North Korean nuclear test. Soon after, Amb. Chris Hill and VFM Kim Kye Gwan meet in Beijing.

Plutonium: 2006: R3

5 MWe reactor operating. DPRK conducts first nuclear test in October, which utilizes between 2 and 6 kg plutonium. Lower figure claimed by DPRK, but unrealistic. No access for US or IAEA inspectors. Hecker is told that construction of both 50 MWe and 200 MWe reactors construction is abandoned. No access for US or IAEA inspectors.

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |

## DPRK Diplomacy: 2007: G1.

When Bush Administration decides to resume diplomatic activity, North Korea attends multiple meetings with US to discuss implementation of the 2005 Joint Statement. First phase agreement on implementing Joint Statement—shutting down Yongbyon facilities and providing declaration of nuclear activities while the US agrees to provide energy aid remove the North from the list of state sponsors of terrorism. Implementation delayed until June, when the North receives its BDA funds. North Korea begins to disable Yongbyon nuclear facilities.

## Disablement efforts in 2007-2008: Serious, but reversible.

IAEA inspectors & US technical team allowed back into Yongbyon

- 5 MWe reactor is not operating. No plutonium being produced.
- Disablement efforts are verified but are reversible.
- Likely increase in clandestine effort to build uranium enrichment facility.







## Pyongyang heads into 2009 determined to enhance nuclear program



August 2008



Time runs out for Amb. Chris Hill - 2008

- In Feb./March visit, Stanford delegation is told of upcoming space launch.
- Amb. Ri Gun told delegation and you have no idea of how bad it's going to get.
- April 5 failed space launch followed by UNSC sanctions. Inspectors expelled.
- May 25 Second nuclear test successful at 4 to 7 kilotons.

| Year | US Diplomcay | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2          | R1        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2010 | G1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |

In 2008 time ran out on the Bush administration as North Korea appeared determined to proceed building a nuclear arsenal, potentially related to Kim Jong-il's stroke in August and the realization that another nuclear test was necessary since the 2006 test was largely a failure.

North Korea proceeded with a controversial space launch attempt in April 2009, which as they likely anticipated was met with UNSC sanctions. That provided an excuse to conduct the second nuclear test, which was successful.

## 2009 - 2010:

In April 2009 expels IAEA inspectors. After the second nuclear test in May, North Korea announces that it would pursue building its own light water reactor and begin uranium enrichment efforts.

In 2010, diplomatic efforts by Amb. Steve Bosworth come close to more talks with the North but that is derailed as tensions flare between North and South Korea.

In November, DPRK shows Lewis/Hecker/Carlin Stanford delegation a modern centrifuge facility housing 2000 P-2 type centrifuges, which apparently had just become operational. Hecker concluded that covert facilities must exist, which allowed DPRK to demonstrate working cascades and form the basis for the Yongbyon facility. With this revelation, Pyongyang sent a message to the US government and the world that it now has both paths to the bomb – plutonium and highly enriched uranium. The additional twist was to also send the message that the outside will never know how much they have since unlike plutonium production, uranium centrifuges are not observable from afar.

## Yongbyon visit by Stanford team on Nov. 12, 2010

"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," Ri Yong-ho (VM MFA) **Pyongyang reveals modern uranium centrifuge facility to Lewis/Hecker/Carlin in Nov. 2010** DPRK demonstrates second path to the bomb – makes assessment difficult

Piketon, Ohio Centrifuge plant, 1984 (Department of Energy) Purely illustrative - this is not Yongbyon, but close to what we saw



## No outsiders have been in Yongbyon since Nov. 2010

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2010 | G1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |

# 2012 Leap Day Agreement – classic case of different views and opportunity missed



US Special Representative for North Korean Affairs Glyn Davies briefs reporters after a meeting with Kim Kye Gwan in February.

Opportunity for:

- Missile and nuclear test moratorium
- Solve uranium enrichment issue
- Freeze nuclear work and allow inspectors back in Yongbyon

- No joint statement or agreement each side makes its own announcement
- U.S. claims moratorium for long-range missiles
- DPRK only ban long-range missiles, not space launches (claims priority of Space Treaty over UNSC)

As a result of April 13 satellite launch, US walks away from deal and North Korea nuclear buildup continues unabated

## 2011: G1

Talks held in July in New York between Amb. Steve Bosworth and VFM Kim Kye Gwan. A second meeting talks place in Geneva in October as two sides make progress on key issues. Talks set for December are cancelled with death of Kim Jong II. Bosworth replaced by Ambassador Glyn Davies.

## 2012: R1

The US and North Korea in separate and slightly different press statements announce agreement (the "Leap Day Agreement") in which North Korea would suspend activity at Yongbyon with IAEA verification and institute a moratorium on nuclear and missile tests, though it does not itself pledge to halt space launches. US will provide the North with 240,000 metric tons of food. Within weeks, the North announces it will launch a satellite in April. US sends secret mission to Pyongyang in a failed effort to dissuade the North from launching. US announces cancellation of the Leap Day deal as a result of April 13 launch attempt.

Lost in the Leap Day Deal withdrawal by the U.S.:

In retrospect, passing up instituting a nuclear and missile testing moratorium and getting access to Yongbyon facilities (including the centrifuge facility at that site) was a great opportunity lost. North Korea likely possessed only a few tens of kilograms of plutonium and a like amount of highly enriched uranium. Its reactor was not operating. The Yongybon centrifuge facility would have been opened for inspection and prevented HEU production there (although a limited level of enrichment could have continued at the covert site(s)). North Korea had no successful long-range missile tests and no successful space launch. As the follow-on charts show, North Korea made rapid progress in subsequent years because they were not impeded by agreements or an international presence in Yongbyon.

The 5 MWe reactor is restarted in August 2013. The size of the Yongbyon centrifuge facility is likely doubled that year. Construction consistent with the potential production and extraction of tritium (fuel necessary for fusion bombs) is observed.
### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🕎               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2010 | G1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |

### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2          | R1        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2010 | G1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2013 | R2           | R1                | R3          | R2        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2014 | R2           | R1                | R3          | R2        | R3           | R3          | R2                             | R2                 | R1       |
| 2015 | R1           | G1                | R3          | R3        | R3           | R3          | R2                             | R2                 | R2       |

Not much diplomatic activity in 2013 to 2015 while nuclear and missile capabilities increase.

Another possible opportunity lost in January 2015 when Obama administration rejects a Kim Jong-un nuclear testing halt.

# North Korean diplomatic overtures in 2015

January: North Korea announces formal suspension for suspension proposal - Nuclear test suspension for U.S.-South Korea joint military exercises suspension

Later in the year, engages in talks with Washington on linkage between peace agreement and nuclear issue.





ASIA PACIFIC

## North Korea Offers U.S. Deal to Halt Nuclear Test

By CHOE SANG-HUN JAN. 10, 2015

### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | DPRK<br>Diplomacy | YB Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1          | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3          | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3          | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3          | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3          | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3          | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2010 | G1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3          | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2013 | R2           | R1                | R3          | R2        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2014 | R2           | R1                | R3          | R2        | R3           | R3          | R2                             | R2                 | R1       |
| 2015 | R1           | G1                | R3          | R3        | R3           | R3          | R2                             | R2                 | R2       |
| 2016 | R1           | R3                | R3          | R3        | R3           | R3          | R3                             | R3                 | R2       |

2016 was a very bad year.

US reevaluates its North Korea policy, but with no resulting progress or steps toward engagement. Two North Korean tests result in tougher UN Security Council and US sanctions, including sanctions on Kim Jong Un. The North reacts by closing the New York channel.

On Jan. 6, DPRK conducts its fourth nuclear test with explosive yield of 7 to 14 kt. It claims to have detonated a hydrogen bomb, but the yield is not consistent with a hydrogen device. However, it is possible that DPRK achieved some fusion yield by testing a boosted fission device (most likely with plutonium). The test may have been a proof-of-principle hydrogen bomb. On Sept. 9, DPRK conducts its fifth nuclear test with explosive yield of 15 to 25 kt (fully contained), makes no mention of hydrogen bombs, but rather claims miniaturization, which likely was the primary intent of the test.

By this time, DPRK likely produced all the components of perhaps as many as a dozen nuclear devices based on its nuclear test results. Five nuclear tests over 10 years likely enables DPRK to mount a nuclear warhead in its SCUD and Nodong missiles capable of reaching all of South Korea and Japan. At this point, North Korea should have been viewed as having an effective deterrent to U.S. aggression since it had the capability to inflict unacceptable damage on US assets and its allies (although not be able to reach the US mainland with a nuclear tipped missile).

| Nuclear Capability                       | December 2016<br>(Hecker-rough estimates) |
|--|---|
| Plutonium                                | 20 – 40 kg                                |
| HEU<br>(highly uncertain)                | 300 – 450 kg                              |
| Tritium                                  | Very limited<br>(Multi-grams)             |
| Nuclear devices<br>(sufficient material) | ~25                                       |
| Fit and robust for: SCUD & Nodong        | Yes                                       |
| IRBM & ICBM                              | Only space launch.<br>No IRBM or ICBM     |
| Fit on long-range missiles               | No  |

## **Nuclear tests history**

- Oct. 9, 2006: Close to1 kiloton
- May 25, 2009: ~ 2 to 7 kilotons
- Feb. 12, 2013: ~ 7 to 14 kilotons
- Jan. 6, 2016: ~ 7 to 14 kilotons
  - Claim of H bomb not likely.
  - Possible proof-of-principle H-bomb?
- Sept. 9, 2016: ~ 15 to 25 kilotons ⊮
  - Likely made progress in miniaturization





### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | DPRK<br>Diplomacy | Yongbyong<br>Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-----------------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3                    | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3                    | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3                    | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3                    | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3                    | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3                    | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3                    | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3                    | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2                    | R1        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2010 | G1           | R1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2013 | R2           | R1                | R3                    | R2        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2014 | R2           | R1                | R3                    | R2        | R3           | R3          | R2                             | R2                 | R1       |
| 2015 | R1           | G1                | R3                    | R3        | R3           | R3          | R2                             | R2                 | R2       |
| 2016 | R1           | R3                | R3                    | R3        | R3           | R3          | R3                             | R3 22              | R2       |
| 2017 | R3           | R3                | R3                    | R3        | R3           | R3          | R3                             | R3                 | R3       |

2017 was another very bad year.

It began with Kim Jong-un announcing that North Korea will achieve nuclear-tipped ICBMs that can reach the US and President-elect Trump tweeting "It won't happen."

There was no serious US-DPRK diplomatic engagement. After a policy review in the spring, the new US administration announced a policy of "maximum pressure and engagement." The administration was able to significantly strengthen sanctions and pressure on North Korea, but there was little engagement although the New York channel was opened and low level exchanges were restart between the two sides, but there are no serious initiatives resulted. Tensions rise with the North's successful launch of longer-range missiles in the summer and threats traded between the two leaders. In September, the situation deteriorates further with the President's UN General Assembly speech, which contains what the North considers threats and insults to Kim Jong Un. In November, the US puts the North back on the list of state sponsors of terrorism.

In spite of maximum US pressure and increased sanctions, North Korea made rapid progress with all of its missile capabilities trying to demonstrate Kim Jong-un's promise that they will be able to launch missiles from anywhere at any time. By the end of the year, he had demonstrated the ability to launch rockets of intermediate range (IRBMs capable of 4,500 km range) and intercontinental range (ICBMs up to 13,000 km) although these were all launched on a lofted trajectory achieving great altitudes but not normal range. In addition, on September 3, North Korea detonated a nuclear device with an explosive yield in the range of 200 to 250 kilotons, which may have been a two-stage thermonuclear (hydrogen) bomb. That was followed by the Hwasong-15 missile on Nov. 29.

By the end of 2017, North Korea still had only modest plutonium and tritium inventories, but growing HEU inventories. It demonstrated the ability to develop ICBMs, but would require more missile tests and nuclear tests to mount a nuclear warhead on a missile to reach the US mainland.

## Nov. 29, 2017 Hwasong-15 ICBM-capable



Launch date and time—Nov 29, at 2:47a.m. (North Korean) local time. Range and altitude---950km and 4,475km on a 'lofted' trajectory. On a standard trajectory it could cover the entire US, (over 13,000km). Launch site---Pyongsong. Flight time---53min 49sec.



## **Nuclear tests history**

- Oct. 9, 2006: Close to1 kiloton
   Likely Pu
- May 25, 2009: ~ 2 to 7 kilotons
  Likely Pu
- Feb. 12, 2013: ~ 7 to 14 kilotons
   Either Pu or HEU
- Jan. 6, 2016: ~ 7 to 14 kilotons
  - Claim of H bomb not likely. Possible proof-of-principle H-bomb?
- Sept. 9, 2016: ~ 15 to 25 kilotons
  Likely made progress in miniaturization
- Sept. 3, 2017: 200 to 250 kilotons
  - Two-stage thermonuclear possible



| Nuclear Capability                       | December 2016<br>(Hecker-rough estimates) | December 2017<br>(Hecker-rough estimates) |
|--|---|---|
| Plutonium                                | 20 – 40 kg                                | 20 – 40 kg                                |
| HEU<br>(highly uncertain)                | 300 – 450 kg                              | 250 - 500 kg                              |
| Tritium                                  | Very limited<br>(Multi-grams)             | Very limited<br>(Multi-grams)             |
| Nuclear devices<br>(sufficient material) | ~25                                       | ~25-30                                    |
| Fit and robust for: SCUD & Nodong        | Yes                                       | Yes                                       |
| IRBM & ICBM                              | Only space launch.<br>No IRBM or ICBM.    | Hwasong-12<br>Hwasong-14<br>Hwasong-15    |
| Fit on missiles                          | No  | No - need more tests                      |



Yet, in his 2018 New Year's speech on state TV, Kim stated "We achieved the goal of completing our state nuclear force in 2017. The entire United States is within range of our nuclear weapons, a nuclear button is always on my desk. This is reality, not a threat." With that announcement Kim signaled that he was prepared to talk.

Before looking at 2018, we provide additional analysis of political developments. For this purpose we collapse the technical analysis into two columns, and expand other columns as explained below.

#### **US Diplomacy**

A measure of US initiatives and efforts to support diplomatic engagement with North Korea. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korea nuclear and ballistic missile programs.

### North Korea Diplomacy

A measure of North Korean initiatives and efforts to support diplomatic engagement with the United States, though not necessarily in support of common goals. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korean nuclear and ballistic missile programs.

### **US/IAEA Presence at Yongbyon Nuclear Center**

A measurement of the presence of US and/or IAEA personnel at Yongbyon.

#### **Nuclear Weapons Summary**

A measurement of the level of nuclear weapons development achieved and in progress, encompassing fissile material production and weaponization, including nuclear tests.

### **Missiles Summary**

A measurement of the level of missile development and deployment achieved and in progress, encompassing all aspects of delivery system development.

### North Korea/South Korea Relations

A measurement of the state of relations between North Korea and South Korea.

#### North Korea/China Relations

A measurement of the state of relations between North Korea and China.

### Sanctions

A measurement of the level of combined U.S. and U.N. sanctions levied against North Korea.

### North Korean Economy

A measurement of the level of economic output and general status of North Korea's economy. Observations based on official statistic, but mostly on assessments of foreign visitors to North Korea. This measure is more about relative change in economy than absolute measure of the economy.

### **US Financial Aid to North Korea**

A measurement of U.S. dollar amounts going to North Korea in the form of food, fuel, and KEDO contributions.

## North Korea Nuclear Program– Policy Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Dipl. | DPRK Dipl. | YB Presence | Nukes | Missiles | N/S Relation | N/Sino Rel. | Sanctions | NK Economy | US Fin. Aid |
|------|----------|------------|-------------|-------|----------|--------------|-------------|-----------|------------|-------------|
| 1992 | G1       | G1         | G1          | R1    | R1       | G3           | R2          | R1        | R2         | \$0         |
| 1993 | G2       | G2         | G1          | R1    | R1       | G2           | R1          | R1        | R2         | \$0         |
| 1994 | G3       | G3         | G1          | R1    | R1       | R2           | R1          | R1        | R3         | \$0         |
| 1995 | G3       | G3         | G3          | G3    | R1       | R1           | R1          | R1        | R3         | \$9.7M      |
| 1996 | G3       | G3         | G3          | G3    | R1       | R1           | R1          | R1        | R3         | \$30.3M     |
| 1997 | G2       | G2         | G3          | G3    | R1       | G1           | R1          | R1        | R3         | \$82.4M     |
| 1998 | G2       | G2         | G3          | G3    | R1       | G1           | R1          | R1        | R3         | \$122.9M    |
| 1999 | G3       | G3         | G3          | G3    | G1       | G3           | G1          | R1        | R3         | \$287.2M    |
| 2000 | G3       | G3         | G3          | G3    | G1       | G3           | G2          | R1        | R2         | \$138.7M    |
| 2001 | R2       | G2         | G3          | G3    | G1       | G1           | G2          | R1        | R2         | \$132.97M   |
| 2002 | R3       | G2         | G3          | G3    | G1       | G2           | G2          | R1        | R2         | \$140.9M    |
| 2003 | R2       | R2         | R3          | R2    | G1       | G1           | G2          | R1        | R1         | \$27.78M    |
| 2004 | R2       | R1         | R3          | R2    | G1       | R1           | G1          | R1        | R1         | \$36.4M     |
| 2005 | R1       | R1         | R3          | R2    | R1       | G1           | G1          | R1        | R1         | \$5.7M      |
| 2006 | R1       | R2         | R3          | R2    | R1       | G1           | R1          | R1        | R1         | \$0         |
| 2007 | G2       | G1         | G3          | R1    | R1       | G3           | R1          | R1        | R1         | \$45.1M     |
| 2008 | G2       | G1         | G3          | R1    | R1       | R1           | G1          | R1        | R1         | \$224.7M    |
| 2009 | R1       | R1         | R2          | R2    | R1       | R2           | G1          | R1        | R2         | \$24.6M     |
| 2010 | G1       | R1         | R3          | R2    | R1       | R3           | G2          | R1        | R1         | \$3.5M      |
| 2011 | G1       | G1         | R3          | R2    | R1       | R3           | G2          | R1        | R1         | \$0.9M      |
| 2012 | R1       | R1         | R3          | R2    | R1       | R3           | G2          | R1        | G1         | \$0         |
| 2013 | R2       | R1         | R3          | R2    | R1       | R2           | R2          | R2        | G1         | \$0         |
| 2014 | R2       | R1         | R3          | R2    | R2       | R2           | R2          | R2        | G1         | \$0         |
| 2015 | R1       | G1         | R3          | R2    | R2       | R2           | R2          | R2        | G2         | \$0         |
| 2016 | R1       | R3         | R3          | R3    | R3       | R3           | R2          | R2        | G2         | 0           |
| 2017 | R3       | R3         | R3          | R3    | R3       | R2           | R2          | R3        | G2         | \$0.9M      |

### North Korea Nuclear Program– Policy Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | Nukes | Missiles | Sanctions |
|------|-------|----------|-----------|
| 1992 | R1    | R1       | R1        |
| 1993 | R1    | R1       | R1        |
| 1994 | R1    | R1       | R1        |
| 1995 | G3    | R1       | R1        |
| 1996 | G3    | R1       | R1        |
| 1997 | G3    | R1       | R1        |
| 1998 | G3    | R1       | R1        |
| 1999 | G3    | G1       | R1        |
| 2000 | G3    | G1       | R1        |
| 2001 | G3    | G1       | R1        |
| 2002 | G3    | G1       | R1        |
| 2003 | R2    | G1       | R1        |
| 2004 | R2    | G1       | R1        |
| 2005 | R2    | R1       | R1        |
| 2006 | R2    | R1       | R1        |
| 2007 | R1    | R1       | R1        |
| 2008 | R1    | R1       | R1        |
| 2009 | R2    | R1       | R1        |
| 2010 | R2    | R1       | R1        |
| 2011 | R2    | R1       | R1        |
| 2012 | R2    | R1       | R1        |
| 2013 | R2    | R1       | R2        |
| 2014 | R2    | R2       | R2        |
| 2015 | R2    | R2       | R2        |
| 2016 | R3    | R3       | R2        |
| 2017 | R3    | R3       | R3        |

We track the severity of sanctions over the years and examine their effects on the nuclear and missile programs.

No green coding since all sanctions try to impose a penalty on the DPRK. DPRK had been under US bilateral sanctions since 1950. Sanctions in the 1990s and early 2000s were primarily aimed at the DPRK missile trade and cooperation. Severity of sanctions is indicated by shades of red. In September 2005, the US Treasury Department imposes Banco Delta Asia sanctions.

In July 2006, the UNSC adopts Resolution 1695 in response to North Korea's missile launches on July 4. Resolutions 1718 (2006) and 1874 (2009) place special emphasis on inhibiting the ability of the Democratic People's Republic of Korea to acquire, and to provide to others, materials, equipment, goods, technology and technical knowhow with regard to nuclear weapons and other weapons of mass destruction as well as ballistic missiles.

In November 2016, the UN Security Council passes UNSCR 2321, expanding sanctions following North Korea's fifth nuclear test in September. The sanctions include an export ban on minerals and other items.

In June 2017, the United States imposes unilateral sanctions on North Korean entities and individuals.

### North Korea Nuclear Program– Policy Focus (Stanford University CISAC)

3 shades of green (dark best), 3 shades of red (dark worst) -Hecker/Carlin/Serbin

| Year | Nukes | Missiles | Sanctions | NK Economy | US Fin. Aid |
|------|-------|----------|-----------|------------|-------------|
| 1992 | R1    | R1       | R1        | R2         | \$0         |
| 1993 | R1    | R1       | R1        | R2         | \$0         |
| 1994 | R1    | R1       | R1        | R3         | \$0         |
| 1995 | G3    | R1       | R1        | R3         | \$9.7M      |
| 1996 | G3    | R1       | R1        | R3         | \$30.3M     |
| 1997 | G3    | R1       | R1        | R3         | \$82.4M     |
| 1998 | G3    | R1       | R1        | R3         | \$122.9M    |
| 1999 | G3    | G1       | R1        | R3         | \$287.2M    |
| 2000 | G3    | G1       | R1        | R2         | \$138.7M    |
| 2001 | G3    | G1       | R1        | R2         | \$132.97M   |
| 2002 | G3    | G1       | R1        | R2         | \$140.9M    |
| 2003 | R2    | G1       | R1        | R1         | \$27.78M    |
| 2004 | R2    | G1       | R1        | R1         | \$36.4M     |
| 2005 | R2    | R1       | R1        | R1         | \$5.7M      |
| 2006 | R2    | R1       | R1        | R1         | \$0         |
| 2007 | R1    | R1       | R1        | R1         | \$45.1M     |
| 2008 | R1    | R1       | R1        | R1         | \$224.7M    |
| 2009 | R2    | R1       | R1        | R2         | \$24.6M     |
| 2010 | R2    | R1       | R1        | R1         | \$3.5M      |
| 2011 | R2    | R1       | R1        | R1         | \$0.9M      |
| 2012 | R2    | R1       | R1        | G1         | \$0         |
| 2013 | R2    | R1       | R2        | G1         | \$0         |
| 2014 | R2    | R2       | R2        | G1         | \$0         |
| 2015 | R2    | R2       | R2        | G2         | \$0         |
| 2016 | R3    | R3       | R2        | G2         | 0           |
| 2017 | R3    | R3       | R3        | G2         | \$0.9M      |

We examine the relationship between sanctions and the state of the North Korean economy, which we assess from numerous literature sources and several frequent foreign visitors to North Korea.

The dire state of North Korea's economy in the 1990s had little to do with sanctions, but rather resulted from the difficult times it suffered after the dissolution of the Soviet Union and the distancing of its relationship with China. These difficulties were exacerbated by intense periods of drought with intermittent devastating floods.

As the economy recovered, there appears to be little effect of sanctions on North Korea's economy.

It is quite possible, that the significant tightening of the sanctions, particularly the more stringent enforcement of sanctions by China may have some effect on the economy in 2018.

We also provide a listing of U.S. financial assistance in the form of food and energy over the years. The figures show that the total aid was sufficiently small as to have played little or no role in the nuclear program.

## North Korea Nuclear Program– Policy Focus (Stanford University CISAC)

3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | N/S Relations | DPRK Diplomacy | Nukes | Missiles |
|------|--------------|---------------|----------------|-------|----------|
| 1992 | G1           | G3            | G1             | R1    | R1       |
| 1993 | G2           | G2            | G2             | R1    | R1       |
| 1994 | G3           | R2            | G3             | R1    | R1       |
| 1995 | G3           | R1            | G3             | G3    | R1       |
| 1996 | G3           | R1            | G3             | G3    | R1       |
| 1997 | G2           | G1            | G2             | G3    | R1       |
| 1998 | G2           | G1            | G2             | G3    | R1       |
| 1999 | G3           | G3            | G3             | G3    | G1       |
| 2000 | G3           | G3            | G3             | G3    | G1       |
| 2001 | R2           | G1            | G2             | G3    | G1       |
| 2002 | R3           | G2            | G2             | G3    | G1       |
| 2003 | R2           | G1            | R2             | R2    | G1       |
| 2004 | R2           | R1            | R1             | R2    | G1       |
| 2005 | R1           | G1            | R1             | R2    | R1       |
| 2006 | R1           | G1            | R2             | R2    | R1       |
| 2007 | G2           | G3            | G1             | R1    | R1       |
| 2008 | G2           | R1            | G1             | R1    | R1       |
| 2009 | R1           | R2            | R1             | R2    | R1       |
| 2010 | G1           | R3            | R1             | R2    | R1       |
| 2011 | G1           | R3            | G1             | R2    | R1       |
| 2012 | R1           | R3            | R1             | R2    | R1       |
| 2013 | R2           | R2            | R1             | R2    | R1       |
| 2014 | R2           | R2            | R1             | R2    | R2       |
| 2015 | R1           | R2            | G1             | R2    | R2       |
| 2016 | R1           | R3            | R3             | R3    | R3       |
| 2017 | R3           | R2            | R3             | R3    | R3       |

We find no clear pattern between North/South relations and the progress of the North's nuclear program. It appears that for the most part US/DPRK relations and North/South relations were for the most part uncoordinated, thereby impeding a common front.

### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US<br>Diplomacy | DPRK<br>Diplomacy | Yongbyon<br>Presence | Plutonium | U enrich. | <b>Tritium/Li-6</b><br>(H-bomb fuel) | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles | Imports | Exports |
|------|-----------------|-------------------|----------------------|-----------|-----------|--------------------------------------|--------------------------------|--------------------|----------|---------|---------|
| 1992 | G1              | G1                | G1                   | G2        | G1        | G1                                   | R1                             | R1                 | R1       | R1      | R1      |
| 1993 | G2              | G2                | G1                   | G2        | G1        | G1                                   | R1                             | R1                 | R1       | R1      | R1      |
| 1994 | G3              | G3                | G1                   | G2        | G1        | G1                                   | R1                             | R1                 | R1       | R1      | R1      |
| 1995 | G3              | G3                | G3                   | G3        | G1        | G1                                   | R1                             | G3                 | R1       | R1      | R1      |
| 1996 | G3              | G3                | G3                   | G3        | G1        | G1                                   | R1                             | G3                 | R1       | R1      | R1      |
| 1997 | G2              | G2                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | R1       | R2      | R1      |
| 1998 | G2              | G2                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | R1       | R2      | R1      |
| 1999 | G3              | G3                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | G1       | R2      | R3      |
| 2000 | G3              | G3                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | G1       | R2      | R3      |
| 2001 | R2              | G2                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | G1       | R2      | R3      |
| 2002 | R3              | G2                | G3                   | G3        | R1        | G1                                   | R1                             | G3                 | G1       | R2      | R3      |
| 2003 | R2              | R2                | R3                   | R3        | R1        | R1                                   | R2                             | R2                 | G1       | R2      | R3      |
| 2004 | R2              | R1                | R3                   | R3        | R1        | R1                                   | R2                             | R2                 | G1       | R2      | R3      |
| 2005 | R1              | R1                | R3                   | R3        | R1        | R1                                   | R2                             | R2                 | R1       | R2      | R3      |
| 2006 | R1              | R2                | R3                   | R3        | R1        | R1                                   | R2                             | R2                 | R1       | R2      | R3      |
| 2007 | G2              | G1                | G3                   | G1        | R1        | R1                                   | R1                             | R1                 | R1       | R1      | R3      |
| 2008 | G2              | G1                | G3                   | G1        | R1        | R1                                   | R1                             | R1                 | R1       | R1      | R2      |
| 2009 | R1              | R1                | R2                   | R1        | R2        | R2                                   | R2                             | R2                 | R1       | R2      | R2      |
| 2010 | G1              | R1                | R3                   | R1        | R2        | R2                                   | R2                             | R2                 | R1       | R2      | R2      |
| 2011 | G1              | G1                | R3                   | R1        | R2        | R2                                   | R2                             | R2                 | R1       | R2      | R2      |
| 2012 | R1              | R1                | R3                   | R1        | R2        | R2                                   | R2                             | R2                 | R1       | R2      | R2      |
| 2013 | R2              | R1                | R3                   | R2        | R2        | R2                                   | R2                             | R2                 | R1       | R2      | R1      |
| 2014 | R2              | R1                | R3                   | R2        | R3        | R3                                   | R2                             | R2                 | R1       | R2      | R1      |
| 2015 | R1              | G1                | R3                   | R3        | R3        | R3                                   | R2                             | R2                 | R2       | R2      | R1      |
| 2016 | R1              | R3                | R3                   | R3        | R3        | R3                                   | R3                             | R3                 | R2       | R2      | R1      |
| 2017 | R3              | R3                | R3                   | R3        | R3        | R3                                   | R3                             | R3                 | R3       | R2      | R1      |

We also examined North Korea's import and export record as shown in this chart. Imports have continued to be important to North Korea's nuclear and missile programs, particularly its uranium enrichment and missile programs.

Imports for the centrifuge program began to increase substantially after 1997 and North Korea's ties to Pakistan's A.Q. Khan.

Imports for the missile programs played a critical role throughout the entire period, with strong ties to Russian entities as well as cooperation with Chinese entities and Iran.

Exports have been an important part of North Korea missile and nuclear programs. The 1990s saw primarily significant missile exports to countries such as Iraq, Iran, Pakistan, Libya and others.

In the nuclear technology arena, North Korea's most egregious exports were the sale of uranium hexafluoride to Libya's centrifuge program and the construction of a plutonium production reactor to Syria. Both of these were mean to be long-term business opportunities for North Korea that could have amassed billions of dollars income.

Both imports and exports have become more difficult in recent years because of UN sanctions and measures such as the Proliferation Security Initiative. However, North Korea has become more adapt at circumventing the santions as the severity increased.









EAST ASIA

## Trump accepts invitation to meet North Korea's Kim Jongun, will do so by May, Seoul's envoy announces

South Korean security chief Chung Euiyong praises Trump for his 'maximum pressure' strategy as he makes stunning announcement outside White House, adding that Kim had agreed to halt nuclear and missile testing

## **Reuters, Associated Press**

### North Korea Nuclear Program– Technical Focus (Stanford University CISAC) 3 shades of green (dark best), 3 shades of red (dark worst) –Hecker/Carlin/Serbin

| Year | US Diplomacy | DPRK<br>Diplomacy | Yongbyong<br>Presence | Plutonium | U enrichment | Tritium/Li6 | Weaponize<br>Design/build/test | Nukes<br>(Summary) | Missiles |
|------|--------------|-------------------|-----------------------|-----------|--------------|-------------|--------------------------------|--------------------|----------|
| 1992 | G1           | G1                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1993 | G2           | G2                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1994 | G3           | G3                | G1                    | G2        | G1           | G1          | R1                             | R1                 | R1       |
| 1995 | G3           | G3                | G3                    | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1996 | G3           | G3                | G3                    | G3        | G1           | G1          | R1                             | G3                 | R1       |
| 1997 | G2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1998 | G2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | R1       |
| 1999 | G3           | G3                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2000 | G3           | G3                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2001 | R2           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2002 | R3           | G2                | G3                    | G3        | R1           | G1          | R1                             | G3                 | G1       |
| 2003 | R2           | R2                | R3                    | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2004 | R2           | R1                | R3                    | R3        | R1           | R1          | R2                             | R2                 | G1       |
| 2005 | R1           | R1                | R3                    | R3        | R1           | R1          | R2                             | R2                 | R1       |
| 2006 | R1           | R2                | R3                    | R3        | R1           | R1          | R2                             | R2 🏆               | R1       |
| 2007 | G2           | G1                | G3                    | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2008 | G2           | G1                | G3                    | G1        | R1           | R1          | R1                             | R1                 | R1       |
| 2009 | R1           | R1                | R2                    | R1        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2010 | G1           | R1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2011 | G1           | G1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2012 | R1           | R1                | R3                    | R1        | R2           | R2          | R2                             | R2                 | R1       |
| 2013 | R2           | R1                | R3                    | R2        | R2           | R2          | R2                             | R2 🏆               | R1       |
| 2014 | R2           | R1                | R3                    | R2        | R3           | R3          | R2                             | R2                 | R1       |
| 2015 | R1           | G1                | R3                    | R3        | R3           | R3          | R2                             | R2                 | R2       |
| 2016 | R1           | R3                | R3                    | R3        | R3           | R3          | R3                             | R3 22              | R2       |
| 2017 | R3           | R3                | R3                    | R3        | R3           | R3          | R3                             | R3                 | R3       |

## Lessons learned

- Pursuit of weapons deliberate and determined not responsive/reactive or triggered by provocations. Patient, not a surprise, not the most secretive.
- Program slowed, sometimes reversed, but never abandoned during diplomacy.
   Most important element was a US/IAEA presence in Yongbyon.
- US diplomacy since 2000 has been sporadic and reactive. Resulted in avoiding risk instead of managing risk.
- Nuclearization was a massive enterprise took 25 years to go to dark red, going to dark green (denuclearization) will take time.
- Besides what does denuclearization mean? No weapons, no deployed weapons, no fissile materials, no missiles, no people, no civilian nuclear program...?
- As bad as it was in 2017, stop it from getting worse. Several opportunities missed in the past by not managing the incremental risks.
- The narrative that North Korea "has cheated on every agreement" is neither accurate nor useful. Need to better understand history so as not to repeat mistakes.

## **Opportunity / Challenge – Denuclearization**

## Is North Korea serious <u>this</u> time?

## **Opportunity / Challenge – Denuclearization**

## Is North Korea serious <u>this</u> time?

Is Washington prepared this time?

## North Korea nuclear program



Most difficult part
Reactors (Pu) or enrichment (HEU)

## Hydrogen bombs

- Tritium
- Deuterium
- Li**-6D**

- •Physics, computers
- •High explosives
- Detonators
- Initiators
- Machining
- Assembly
- Explosives tests
- •Arming, fuzing, firing
- Nuclear testing

- •Plane
- •Boat
- •Van
- •Missile

## DPRK Risk Color Charts (Hecker) – Current U.S. view of DPRK risk management Risk posed by nuclear assets/activities

|                       | Specific facilities or<br>activities |
|-----------------------|--------------------------------------|
| Nuclear weapons       | Nuclear arsenal                      |
| Nuclear tests         | Nuclear tests                        |
|                       | Tunnels                              |
|                       | Test infrastructure                  |
|                       |                                      |
| Missile Tests         | IRBM &ICBM                           |
|                       | SLBM & Solid                         |
|                       | New engine tests                     |
|                       | SR & MR Missiles                     |
|                       | Space Launch Vehicles                |
|                       |                                      |
| Plutonium             | Inventory                            |
|                       | 5MWe reactor                         |
|                       | ELWR                                 |
|                       | IRT-2000                             |
|                       | Reprocessing Facility                |
|                       | Metal fuel fab facilities            |
|                       |                                      |
| Fusion (H-bomb) fuels | Tritium                              |
|                       | Lithium-6                            |
|                       |                                      |
| Uranium Enrichment    | HEU inventory                        |
|                       | YB centrifuge facility               |
|                       | Covert centrifuge facilities         |

### DPRK Risk Color Charts – A common U.S. view of how to manage DPRK risks

Risk posed by nuclear assets/activities – red (very high)

|                       | Specific facilities or<br>activities | ELIMINATE |
|-----------------------|--------------------------------------|-----------|
| Nuclear weapons       | Nuclear arsenal                      |           |
| Nuclear tests         | Nuclear tests                        |           |
|                       | Tunnels                              |           |
|                       | Test infrastructure                  |           |
|                       |                                      |           |
| Missile Tests         | IRBM &ICBM                           |           |
|                       | SLBM & Solid                         |           |
|                       | New engine tests                     |           |
|                       | SR & MR Missiles                     |           |
|                       | Space Launch Vehicles                |           |
|                       |                                      |           |
| Plutonium             | Inventory                            |           |
|                       | 5MWe reactor                         |           |
|                       | ELWR                                 |           |
|                       | IRT-2000                             |           |
|                       | Reprocessing Facility                |           |
|                       | Metal fuel fab facilities            |           |
|                       |                                      |           |
| Fusion (H-bomb) fuels | Tritium                              |           |
|                       | Lithium-6                            |           |
|                       |                                      |           |
| Uranium Enrichment    | HEU inventory                        |           |
|                       | YB centrifuge facility               |           |
|                       | Covert centrifuge facilities         |           |

## **DPRK Risk Color Charts – A longer-term U.S. view of managing DPRK risks** Risk posed by nuclear assets/activities – red (very high, must be eliminated)

|                       | Specific facilities or<br>activities | Short term<br>< 1 year | Medium term<br>2 to 5 years | Longer term – 6 to 10 years<br>CVID |
|-----------------------|--------------------------------------|------------------------|-----------------------------|-------------------------------------|
| Nuclear weapons       | Nuclear arsenal                      |                        |                             |                                     |
| Nuclear tests         | Nuclear tests                        |                        |                             |                                     |
|                       | Tunnels                              |                        |                             |                                     |
|                       | Test infrastructure                  |                        |                             |                                     |
|                       |                                      |                        |                             |                                     |
| Missile Tests         | IRBM &ICBM                           |                        |                             |                                     |
|                       | SLBM & Solid                         |                        |                             |                                     |
|                       | New engine tests                     |                        |                             |                                     |
|                       | SR & MR Missiles                     |                        |                             |                                     |
|                       | Space Launch Vehicles                |                        |                             |                                     |
|                       |                                      |                        |                             |                                     |
| Plutonium             | Inventory                            |                        |                             |                                     |
|                       | 5MWe reactor                         |                        |                             |                                     |
|                       | ELWR                                 |                        |                             |                                     |
|                       | IRT-2000                             |                        |                             |                                     |
|                       | Reprocessing Facility                |                        |                             |                                     |
|                       | Metal fuel fab facilities            |                        |                             |                                     |
|                       |                                      |                        |                             |                                     |
| Fusion (H-bomb) fuels | Tritium                              |                        |                             |                                     |
|                       | Lithium-6                            |                        |                             |                                     |
|                       |                                      |                        |                             |                                     |
| Uranium Enrichment    | HEU inventory                        |                        |                             |                                     |
|                       | YB centrifuge facility               |                        |                             |                                     |
|                       | Covert centrifuge facilities         |                        |                             |                                     |
|                       |                                      |                        |                             |                                     |

### DPRK Risk Color Charts – More sensible approach to risk management (Hecker/Carlin/Serbin)

Risk posed by nuclear assets/activities – red (very high, must be eliminated), yellow (moderate – can be managed)

|                       | Specific facilities or<br>activities | HALT - short term<br>< 1 year | ROLL BACK- medium term<br>2 to 5 years | ELIMINATE or SET LIMITS -<br>long term – 6 to 10 years |
|-----------------------|--------------------------------------|-------------------------------|--|--|
| Nuclear weapons       | Nuclear arsenal                      |                               |  |  |
| Nuclear tests         | Nuclear tests                        |                               |  |  |
|                       | Tunnels                              |                               |  |  |
|                       | Test infrastructure                  |                               |  |  |
|                       |                                      |                               |  |  |
| Missile Tests         | IRBM &ICBM                           |                               |  |  |
|                       | SLBM & Solid                         |                               |  |  |
|                       | New engine tests                     |                               |  |  |
|                       | SR & MR Missiles                     |                               |  |  |
|                       | Space Launch Vehicles                |                               |  |  |
|                       |                                      |                               |  |  |
| Plutonium             | Inventory                            |                               |  |  |
|                       | 5MWe reactor                         |                               |  |  |
|                       | ELWR                                 |                               |  |  |
|                       | IRT-2000                             |                               |  |  |
|                       | Reprocessing Facility                |                               |  |  |
|                       | Metal fuel fab facilities            |                               |  |  |
|                       |                                      |                               |  |  |
| Fusion (H-bomb) fuels | Tritium                              |                               |  |  |
|                       | Lithium-6                            |                               |  |  |
|                       |                                      |                               |  |  |
| Uranium Enrichment    | HEU inventory                        |                               |  |  |
|                       | YB centrifuge facility               |                               |  |  |
|                       | Covert centrifuge facilities         |                               |  |  |
|                       |                                      |                               |  |  |

DPRK Risk Color Charts with detail – Hecker/Carlin/Serbin Risk posed by nuclear assets/activities – red (very high, must be addressed), yellow (moderate – can be managed)

|                       | Specific facilities or<br>activities | HALT - short term<br>< 1 year   | ROLL BACK- medium term<br>2 to 5 years | ELIMINATE or SET LIMITS -<br>long term – 6 to 10 years |
|-----------------------|--------------------------------------|---------------------------------|--|--|
| Nuclear weapons       | Nuclear arsenal                      | Сар                             | Declare & reduce                       | Eliminate & verify                                     |
| Nuclear tests         | Nuclear tests                        | Moratorium/suspend              | Ban                                    | Ban (Join CTBT)  |
|                       | Tunnels                              | Suspend activity                | Close                                  | Destroy  |
|                       | Test infrastructure                  | Suspend activity                | Dismantle                              | Dismantle & verify                                     |
|                       |                                      |                                 |  |  |
| Missile tests         | IRBM &ICBM                           | Moratorium/suspend              | Halt, declare & monitor                | Ban tests, missiles & developm.                        |
|                       | SLBM & Solid rocket motors           | Moratorium/suspend              | Halt, declare & monitor                | Ban tests, missiles & developm.                        |
|                       | New engine tests                     | Suspend                         | Halt & monitor                         | Ban tests and development                              |
|                       | SR & MR Missiles                     | Short term suspension           | TBD – set allowable limits             | TBD – set allowable limits                             |
|                       | Space Launch Vehicles                | Short term suspension           | TBD – establish protocol               | TBD – establish acceptable limits                      |
|                       |                                      |                                 |  |  |
| Plutonium             | Inventory                            | Сар                             | Cap, declare & monitor                 | Eliminate  |
|                       | 5MWe reactor                         | Halt                            | Dismantle                              | Decommission   |
|                       | ELWR                                 | Halt or don't start             | Inspect & future TBD                   | TBD  |
|                       | IRT-2000                             | Halt                            | Dismantle                              | Decommission, possibly replace                         |
|                       | Reprocessing facility                | Don't operate                   | Dismantle front end (no new fuel)      | Dismantle & decommission                               |
|                       | Metal fuel fab facilities            | Don't operate                   | Dismantle                              | Decommission   |
|                       |                                      |                                 |  |  |
| Fusion (H-bomb) fuels | Tritium                              | Halt reactors ( as above)       | Dismantle reactors & hot cells         | Eliminate  |
|                       | Lithium-6                            | Halt production                 | Dismantle production facilities        | Eliminate  |
|                       |                                      |                                 |  |  |
| Uranium enrichment    | HEU inventory                        | Limit (halt support facilities) | Cap, declare & monitor                 | Eliminate  |
|                       | YB centrifuge facility               | Halt & inspect                  | Inspect & future TBD                   | TBD  |
|                       | Covert centrifuge facilities         | Limit (halt support facilities) | Declare & inspect                      | Eliminate  |
|                       |                                      |                                 |  |  |

## **Backup Slides**

## **Rapidly evolving political landscape**



- Director Pompeo's secret visit to Pyongyang
- Pres. Moon's comments on North Korean terms
- Upcoming April 27 Inter-Korean Summit
- Kim's April 21 statement of closing nuclear test site

North Korea "has cheated on every agreement" narrative is neither accurate nor helpful. Need to better understand history so as not to repeat the mistakes.

- 1992 North/South Joint Denuclearization Declaration – North did not comply, but superseded by Agreed Framework.

- 1994 AF – cheating is technically not correct because it was not an agreement. Certainly UE was not in the spirit of the AF and contrary to 1992 N/S Joint Declaration.

- 2000 Joint US-DPRK Communiqué – voided by the Bush administration

- Sept. 19, 2005 Joint Statement – never really got off the ground because of US back peddling on LWR and applying BDA sanctions. Not cheating, but terminated.

- Feb. and Oct. 2007 agreements on disablement followed by dismantlement. North claimed US was moving goal posts on verification. However, the North appeared to be determined to terminate –not really an issue of cheating.

- Leap Day 2012 deal – very poorly consummated deal with actions not clearly spelled out. Two sides had different interpretations of what was permitted.

More important is what risk was US willing to take as North Korea kept a hedge. And what actions did US take as deals fell apart.
## Explanation of column headings: Technical Focus [Extended]

## **US Diplomacy**

A measure of US initiatives and efforts to support diplomatic engagement with North Korea. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korea nuclear and ballistic missile programs.

## North Korea Diplomacy

A measure of North Korean initiatives and efforts to support diplomatic engagement with the United States, though not necessarily in support of common goals. The metric does not depend on definite progress toward US goals of limiting or terminating the North Korean nuclear and ballistic missile programs.

## **US/IAEA Presence at Yongbyon Nuclear Center**

A measurement of the presence of US and/or IAEA personnel at Yongbyon.

#### Plutonium

A measurement of the state of plutonium production facilities and the current stockpile of weapon-grade plutonium.

#### Uranium Enrichment

A measurement of the state of uranium enrichment program and facilities and the current stockpile of highly enriched uranium.

#### Tritium/Lithium-6

A measurement of the state of fusion (hydrogen bomb) fuels, encompassing tritium/Li-6D production facilities and the current stockpile of tritium and lithium-6.

#### Weaponization

A measurement of the level of nuclear weapons development achieved and in progress, including nuclear tests.

## **Nuclear Weapons Summary**

A measurement of the level of nuclear weapons development achieved and in progress, encompassing fissile material production and weaponization, including nuclear tests.

#### **Missiles Summary**

A measurement of the level of missile development and deployment achieved and in progress, encompassing all aspects of delivery system development.

## Imports

A measurement of the import of technologies, materials, and equipment for all nuclear- and missile-related programs.

## Exports

A measurement of the technologies, materials, and equipment of all nuclear- and missile-related exports.

## **Cheating Narrative**

- Can never trust the other side. Focus is on inspection.
- Why do they cheat? To buy time to gain the upper hand.
- It becomes a moral judgment gives U.S. the moral high ground.

# **Hedging Narrative**

- Considered a strategic imperative to survive.
- Must address what makes the other side hedge.
- Why do they hedge? Insurance against the other side not keeping its commitment.