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North Korea's Nuclear Weapons: Technical Issues

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Summary

This report summarizes what is known from open sources about the North Korean nuclear weapons program—including weapons-usable fissile material and warhead estimates—and assesses current developments in achieving denuclearization. Little detailed open-source information is available about the DPRK's nuclear weapons production capabilities, warhead sophistication, the scope and success of its uranium enrichment program, or extent of its proliferation activities. In total, it is estimated that North Korea has between 30 and 50 kilograms of separated plutonium, enough for at least half a dozen nuclear weapons. North Korea's plutonium production reactor at Yongbyon has been shuttered since its cooling tower was destroyed under international agreement in June 2008. However, on April 1, 2013, North Korea said it would resume operation of its plutonium production reactor. Experts estimate it will take approximately six months to restart. This would provide North Korea with approximately one bomb's worth of plutonium per year.

While North Korea's weapons program has been plutonium-based from the start, in the past decade, intelligence emerged pointing to a second route to a bomb using highly enriched uranium. North Korea openly acknowledged a uranium enrichment program in 2009, but has said its purpose is the production of fuel for nuclear power. In November 2010, North Korea showed visiting American experts early construction of a 100 MWT light-water reactor and a newly built gas centrifuge uranium enrichment plant, both at the Yongbyon site. The North Koreans claimed the enrichment plant was operational, but this has not been independently confirmed. U.S. officials have said that it is likely other, clandestine enrichment facilities exist. Enrichment (as well as reprocessing) technology can be used to produce material for nuclear weapons or fuel for power reactors. An enrichment capability could potentially provide North Korea with a faster way of making nuclear material for weapons and therefore is of great concern to policymakers.

North Korea has made multiple policy statements in the past year asserting its nuclear weapons status: in May 2012, North Korea changed its constitution to say that it was a "nuclear-armed state." In January 2013, North Korea said that no dialogue on denuclearization "would be possible" and it would only disarm when all the other nuclear weapon states also disarm. In March 2013, North Korea stated its goal of expanding its nuclear weapons program.

Many experts believe that the prime objective of North Korea's nuclear program is to develop a nuclear warhead that could be mounted on North Korea's intermediate-range and long-range missiles. This was confirmed by North Korean official statements in late March 2013. Miniaturization of a nuclear warhead would likely require additional nuclear and missile tests. In January 2013, a North Korean statement said that it would respond with a nuclear test "of higher level." On February 12, 2013, the North Korean official news agency announced a "successful" underground nuclear detonation, and seismic monitoring systems measured a resulting earthquake that was 5.1 in magnitude. This is magnitude is slightly higher than past tests, but yield estimates are still uncertain. The South Korean Ministry of Defense estimated that the test yield was between 6 and 7 kilotons, while the U.S. Director of National Intelligence so far has said "approximately several kilotons." North Korea claimed that the February 12, 2013, nuclear test was to develop a "smaller and light" warhead. At a minimum, the test would likely contribute to North Korea's ability to develop a warhead that could be mounted on a long-range missile. To date, no open source date on test emissions is available that might show whether the North Koreans tested a uranium or plutonium device. This information could help determine the type and sophistication of the North Korean nuclear warhead design, about which little is known.

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Background

In the early 1980s, U.S. satellites tracked a growing indigenous nuclear program in North Korea. The North Korean nuclear program began in the late 1950s with cooperation agreements with the Soviet Union on a nuclear research program near Yongbyon. Its first research reactor began operation in 1967. North Korea used indigenous expertise and foreign procurements to build a small nuclear reactor at Yongbyon (5 MWe). It was capable of producing about 6 kilograms (Kg) of plutonium per year and began operating in 1986.[1] Later that year, U.S. satellites detected high explosives testing and a new plant to separate plutonium from the reactor's spent fuel. In addition, construction of two larger reactors (50 MWe at Yongbyon and 200 MWe at Taechon) added evidence of a serious clandestine effort. Although North Korea had joined the Nuclear Nonproliferation Treaty (NPT) in 1985 under Soviet pressure, safeguards inspections began only in 1992, raising questions about how much plutonium North Korea had produced covertly. In 1994, North Korea pledged, under the Agreed Framework with the United States, to freeze its plutonium programs and eventually dismantle them in return for several kinds of assistance.[2] At that time, Western intelligence agencies estimated that North Korea had separated enough plutonium for one or two bombs. North Korea complied with the Agreed Framework, allowing International Atomic Energy Agency (IAEA) seals—including the "canning" of spent fuel rods at the Yongbyon reactor—and permanent remote monitoring and inspectors at its nuclear facilities.

When in 2002, U.S. negotiators reportedly presented North Korean officials with evidence of a clandestine uranium enrichment program, the North Korean officials reportedly at first confirmed this, then denied it publicly. The conflict quickly led to the breakdown of the Agreed Framework. The Bush Administration argued that North Korea was in "material breach" of its obligations and, after agreement with South Korea, Japan, and the EU (the other members of the Korean Economic Development Organization, or KEDO), stopped the next shipment of heavy fuel oil.[3] In response, North Korea kicked out international monitors, broke the seals at the Yongbyon nuclear complex, and restarted its reactor and reprocessing plant after an eight-year freeze.

Members of the Six-Party Talks—the United States, South Korea, Japan, China, Russia, and North Korea—began meeting in August 2003 to try and resolve the crisis. In September 2005, the Six Parties issued a Joint Statement on how to achieve verifiable denuclearization of the Korean Peninsula, which formed the basis for future agreements.[4] Negotiations broke down, and North Korea tested a nuclear device in October 2006.

On February 13, 2007, North Korea reached an agreement with other members of the Six-Party Talks to begin the initial phase (60 days) of implementing the Joint Statement from September 2005 on denuclearization. Phase 1 of this agreement included the shut-down of plutonium production at the Yongbyon nuclear complex in exchange for an initial heavy fuel oil shipment to

[1] 5 MWe is a power rating for the reactor, indicating that it produces 5 million watts of electricity per day (very small). Reactors are also described in terms of million watts of heat (MW thermal).

[2] See CRS Report RL33590, *North Korea's Nuclear Weapons Development and Diplomacy*, by Larry A. Niksch and CRS Report R40095, *Foreign Assistance to North Korea*, by Mark E. Manyin and Mary Beth Nikitin.

[3] "Adherence To and Compliance With Arms Control, Nonproliferation and Disarmament Agreements and Commitments," U.S. Department of State, August 2005.

[4] "Joint Statement of the Fourth Round of the Six-Party Talks, Beijing," September 19, 2005, at http://www.state.gov/r/pa/prs/ps/2005/53490.htm.

North Korea. Phase 2 steps include the disablement of facilities at Yongbyon and a "complete and correct" declaration of DPRK nuclear activities, in exchange for delivery of heavy fuel oil and equivalent, and removal of the Trading with the Enemy Act (TWEA) and State Sponsors of Terrorism (SST) designations. The United States provided funding and technical assistance for disablement activities in North Korea until April 2009. Energy assistance was divided evenly between the Six Parties in Phase 2 of the agreement. North Korea submitted a declaration of its past plutonium production activities in June 2008 as agreed in an October 3, 2007, joint statement on "Second-Phase Actions."[5] Thereafter, President Bush removed North Korea from the TWEA list and notified Congress of his intent to lift the SST designation after North Korea agreed to verification provisions. North Korea did not accept initial U.S. verification proposals, and in September 2008, threatened to restart reprocessing plutonium. U.S. officials announced a bilateral agreement on verification in October 2008, and the Bush Administration removed North Korea from the SST List. The agreement was verbal, and North Korea then said that it had not agreed to sampling at nuclear sites, a key element in verifying past plutonium production. The Six Parties met in December 2008, but did not reach agreement on verification measures. Disablement activities at Yongbyon continued through April 2009, when North Korea expelled international monitors. North Korea then announced it would restart its reprocessing plant and boasted progress in uranium enrichment technology development and soon after tested as nuclear device (see detailed discussions below).

The February 2007 Denuclearization Action Plan did not address uranium enrichment-related activities or the dismantlement of warheads and instead focused on shutting down and disabling the key plutonium production facilities at Yongbyon. A third phase, to have begun after disablement was complete and a declaration accepted by the Six Parties, was expected to deal with all aspects of North Korea's nuclear program, including weapons, using North Korea's declaration as a basis for future action. Understanding the scope of the program and the weapons capability would require transparency and careful verification for the pledged "complete, verifiable, irreversible" disarmament to be achieved.

Six Party Talks have not been held since spring 2009, but the United States and other countries have held bilateral talks with the North since then. North Korea openly acknowledged a uranium enrichment program in 2009, but has said its purpose is the production of fuel for nuclear power. In November 2010, North Korea showed visiting American experts early construction of a 100 MWT light-water reactor and a newly built gas centrifuge uranium enrichment plant, both at the Yongbyon site. The North Koreans claimed the enrichment plant was operational, but this has not been independently confirmed. U.S. officials have said that it is likely other, clandestine enrichment facilities exist. A February 2012 announcement committed North Korea to moratoria on nuclear and long-range missile testing as well as uranium enrichment suspension at Yongbyon under IAEA monitoring. However, an April 2012 satellite launch, which violated UN Security Council resolutions as well as the February missile moratorium, caused a collapse of the February agreement. Following a December 2012 satellite launch and subsequent UN Security Council condemnation, North Korea rejected future denuclearization talks, saying it would only denuclearize when all other nuclear weapons states also did so. A third nuclear test conducted on February 12, 2013, could further complicate diplomatic efforts toward denuclearization.

[5] Second-Phase Actions for the Implementation of the September 2005 Joint Statement, October 3, 2007, http://www.state.gov/r/pa/prs/ps/2007/oct/93223.htm.

Weapons Production Milestones

North Korea is widely believed to have mastered the engineering requirements of plutonium production a decade ago and may now be focusing its efforts on mastering uranium enrichment. Acquiring fissile material—plutonium-239 or highly enriched uranium (HEU)—is the key hurdle in nuclear weapons development.[6] Producing these two materials is technically challenging; in comparison, many experts believe weaponization to be relatively easy.[7] North Korea has industrial-scale uranium mining and plants for milling, refining, and converting uranium; it also has a fuel fabrication plant, a nuclear reactor, and a reprocessing plant—in short, everything needed to produce Pu-239. It has recently been built a uranium enrichment facility at Yongbyon that could produce HEU for weapons, or LEU reactor fuel which could be irradiated for plutonium production. In its earlier 5 MWe nuclear reactor, North Korea used magnox fuel—natural uranium (>99%U-238) metal, wrapped in magnesium-alloy cladding to produce plutonium for weapons. About 8,000 fuel rods constitute a fuel core for the reactor.

When irradiated in a reactor, natural uranium fuel absorbs a neutron and then decays into plutonium (Pu-239). Fuel that remains in the reactor for a long time becomes contaminated by the isotope Pu-240, which can "poison" the functioning of a nuclear weapon.[8] Spent or irradiated fuel, which poses radiological hazards, must cool after removal from the reactor. The cooling phase, estimated by some at five months, is proportional to the fuel burn-up. Reprocessing to separate plutonium from waste products and uranium is the next step. North Korea used a PUREX separation process, like the United States. After shearing off the fuel cladding, the fuel is dissolved in nitric acid. Components (plutonium, uranium, waste) of the fuel are separated into different streams using organic solvents. In small quantities, separation can be done in hot cells, but larger quantities require significant shielding to prevent deadly exposure to radiation.[9]

It operated its 5 MWe nuclear reactor, is believed to have separated Pu from the spent fuel, and has reportedly taken steps toward weaponization. In January 2004, North Korean officials showed an unofficial U.S. delegation alloyed "scrap" from a plutonium (Pu) casting operation.[10] Dr. Siegfried Hecker, a delegation member, assessed that the stated density of the material was consistent with plutonium alloyed with gallium or aluminum. If so, this could indicate a degree of sophistication in North Korea's handling of Pu metal, necessary for weapons production. But without testing the material, Hecker could not confirm that the metal was plutonium or that it was alloyed, or when it was produced.

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[6] Highly enriched uranium (HEU) has 20% or more U-235 isotope; 90% U-235 is weapons-grade.

[7] The physical principles of weaponization are well-known, but producing a weapon with high reliability, effectiveness, and efficiency without repeated testing presents significant challenges. Delivery systems add another layer of challenge.

[8] Plutonium that stays in a reactor for a long time (reactor-grade, with high "burn-up") contains about 20% Pu-240; weapons-grade plutonium contains less than 7% Pu-240.

[9] Hot cells are heavily shielded rooms with remote handling equipment for working with irradiated materials. For background, see Jared S. Dreicer, "How Much Plutonium Could Have Been Produced in the DPRK IRT Reactor?"*Science and Global Security*, 2000, vol. 8, pp. 273-286, at http://www.princeton.edu/sgs/publications/sgs/pdf/8_3Dreicer.pdf.

[10] Alloying plutonium with other materials is "common in plutonium metallurgy to retain the delta-phase of plutonium, which makes it easier to cast and shape" (two steps in weapons production). Hecker, January 21, 2004, testimony before SFRC.

Estimating Nuclear Warheads and Plutonium Stocks

Secretary of State Colin Powell in December 2002 stated, "We now believe [the North Koreans] have a couple of nuclear weapons and have had them for years."[11] In February 2005, North Korea officially announced that it had "manufactured nukes for self-defense."[12] Vice Foreign Minister Kim Gye Gwan has previously said that North Korea possesses multiple bombs and was building more.[13]

A key factor in assessing how many weapons North Korea can produce is whether North Korea needs to use more or less material than the IAEA standards of 8 kg of Pu and 25 kg for HEU per weapon.[14] The amount of fissile material used in each weapon is determined by the design sophistication. There is no reliable public information on North Korean nuclear weapons design.

In all, estimates of North Korea's separated plutonium range between 30 kg and 50 kg, with an approximate 5 kg to 6 kg of this figure having been used for the October 2006 test and an additional amount probably used in the May 2009 test.[15] This amounts to enough plutonium for approximately five to eight nuclear weapons, assuming 6 kg per weapon. Taking the nuclear tests into account, North Korean could possess plutonium for four to seven nuclear weapons. A 2007 unclassified intelligence report to Congress says that "prior to the test North Korea could have produced up to 50 kg of plutonium, enough for at least a half dozen nuclear weapons" and points out that additional plutonium is in the fuel of the Yongbyon reactor.[16] North Korea claimed to have reprocessed that fuel in the summer of 2009 (see below).

Questions arise in determining how much plutonium North Korea produced between 2003, when the IAEA monitors were kicked out of the country and the seals were broken at Yongbyon, and 2007, when international monitoring resumed. A South Korean Defense Ministry white paper from December 2006 estimated that North Korea had made 30 kg of weapons-grade plutonium in the previous three years, potentially enough for five nuclear bombs. The white paper also concurred with U.S. estimates that North Korea's total stockpile of weapons-grade plutonium was 50 kg.[17]

The accounting issue was further complicated when North Korea reportedly declared a lower number of 37 kg of separated plutonium in its declaration under the Six-Party Talks.[18] No

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[11] Transcript of December 29, 2002, *Meet the Press*.

[12] James Brooke, "North Korea says it has atom arms It will boycott talks on ending program; arsenal called self-defense against Bush," *The New York Times*, February 11, 2005.

[13] "We have enough nuclear bombs to defend against a U.S. attack. As for specifically how many we have, that is a secret." "North Korea Admits Building More Nuclear Bombs," *ABC News*, June 8, 2005, at http://abcnews.go.com/WNT/story?id=831078&page=1.

[14] IAEA Safeguards Glossary: http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_scr.pdf.

[15] Siegfried Hecker estimates 40-50 kg of separated plutonium and 6 kg for the 2006 test; David Albright and Paul Brannan's study says 33-55 kg of separated plutonium and roughly 5 kg for the 2006 test. U.S. Assistant Secretary of State Christopher Hill cites 50 kg in his comments. Hecker, ibid. David Albright and Paul Brannan, "The North Korean Plutonium Stock February 2007," Institute for Science and International Security, February 20, 2007. Christopher Hill, "Interview on PBS NewsHour," October 3, 2007, at http://www.state.gov/p/eap/rls/rm/2007/93274.htm.

[16] Unclassified Report to Congress on Nuclear and Missile Programs of North Korea, Office of the Director of National Intelligence, August 8, 2007.

[17] "North Korea 'serious threat' to South," *BBC News*, http://news.bbc.co.uk/2/hi/asia-pacific/6216385.stm.

[18] Warren Strobel, "North Korean nuclear documents challenge CIA assertions," *McClatchyNewspapers*, May 28, (continued...)

agreement has been reached on verifying the amount of plutonium stocks through inspections (see discussions on declaration, verification below). In January 2009, an American scholar who had visited Pyongyang said the North Koreans told him that 30.8 kg amount had been "weaponized," possibly meaning that the separated plutonium might now be in warheads. The DPRK officials also told him that they would not allow for warheads to be inspected.[19]

An August 2012 report published by the Institute for Science and International Security (ISIS) lays out three possible scenarios for fissile material production for the North Korean nuclear weapons program based on available open-source information.[20]

Plutonium Production and Reactors

Estimates of plutonium production depend on a variety of technical factors, including the average power level of the reactor, days of operation, how much of the fuel is reprocessed and how quickly, and how much plutonium is lost in production processes. North Korean officials claimed to have separated plutonium in hot cells as early as 1975 and tested the reprocessing plant in 1990. North Korea's 5 MWe nuclear reactor at Yongbyon operated from 1986 to 1994. It is estimated that North Korea produced and separated no more than 10 kg of plutonium prior to 1994.[21] Its plutonium production program was then frozen between 1994 and 2003 under the Agreed Framework. When this agreement was abandoned, North Korea restarted plutonium production at Yongbyon.

On February 6, 2003, North Korean officials announced that the 5 MWe reactor was operating, and commercial satellite photography confirmed activity in March. In January 2004, North Korean officials told an unofficial U.S. delegation that the reactor was operating smoothly at 100% of its rated power. The U.S. visitors noted that the display in the reactor control room and steam plumes from the cooling towers confirmed operation, but that there was no way of knowing how it had operated over the last year.[22]

The same delegation reported that the reprocessing "facility appeared in good repair," in contrast to a 1992 IAEA assessment of the reprocessing plant as "extremely primitive." According to North Korean officials in January 2004, the reprocessing plant's annual throughput is 110 tons of spent fuel, about twice the fuel load of the 5 MWe reactor. Officials claimed to have reprocessed all 8,000 fuel rods from the 5 MWe reactor between January and June 2003.[23] Reprocessing the 8,000 fuel rods at that time would have yielded between 25 kg and 30 kg of plutonium, perhaps for four to six weapons, but the exact amount of plutonium that might have been reprocessed is unknown. In 2004, North Korean officials stated that the reprocessing campaign was conducted continuously (in four six-hour shifts).

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2008.

[19] "N.K. says plutonium 'weaponized' and off-limits," *The Korea Herald*, January 19, 2009.

[20] David Albright and Christina Walrond, "North Korea's Estimated Stocks of Plutonium and Weapon-Greade Uranium," Institute for Science and International Security (ISIS), August 16, 2012.

[21] David Albright and Paul Brannan, "The North Korean Plutonium Stock February 2007."

[22] Siegfried Hecker, January 21, 2004, testimony before Senate Foreign Relations Committee.

[23] "North Korea Says It Has Made Fuel For Atom Bombs," *New York Times*, July 15, 2003.

In April 2005, the 5 MWe reactor was shut down, this time to harvest fuel rods for weapons.[24] The reactor resumed operations in June 2005.[25] One estimate is that the reactor held between 10 kg and 15 kg of Pu in April 2005, and that North Korea could have reprocessed all the fuel rods by mid-2006. From August 2005 to 2006, the reactor could have produced another 6 kg of Pu. In total, North Korea could have reprocessed enough separated plutonium for another three weapons (in addition to the estimated 4-6 bomb-worth from reprocessing the 8,000 fuel rods).[26] The 5 MWe reactor was again shut down in July 2007, when the IAEA installed containment and surveillance measures and radiation monitoring devices.[27] Its cooling tower was destroyed in June 2008, and it has not been restarted. The IAEA was asked to remove its monitoring equipment and leave the site in April 2009. In early November 2009, the North Korean news agency announced that all 8,000 spent fuel rods in its possession had been reprocessed by the end of August. Reprocessing at that time is estimated to have produced 7-8 kg of separated plutonium or approximately enough for one nuclear warhead.[28] However, even while the reprocessing facility was shut down, North Korea could have built additional warheads with existing separated plutonium because North Korea's plutonium stocks were not under IAEA safeguards.

No construction has occurred at the 50 MWe reactor at Yongbyon or at the 200 MWe Taechon reactor since 2002.[29] They were years from completion when construction was halted.[30] The 50 MWe reactor site at Yongbyon is currently being dismantled.[31] The CIA estimated that the two reactors could generate about 275 kg of plutonium per year if they were operating.[32] Dr. Hecker estimated that if the 50 MWe reactor was functioning, it would mean a tenfold increase in North Korea's plutonium production.[33] North Korea agreed to halt work on reactors as part of the Six-Party Talks. From July 2007 to April 2009, when inspectors were asked to leave, the IAEA was monitoring to ensure that no further construction took place at these sites. Significant future growth in North Korea's plutonium-based arsenal would be possible only if the two larger reactors were completed and operating, and would also depend on progress in the reported uranium enrichment program.

In December 2010, Governor Bill Richardson went to North Korea on an unofficial visit. Press reports and the governor's website at that time said that North Korea was willing to negotiate the sale of the 12,000 fresh fuel rods in storage at Yongbyon to a third party, such as South Korea.

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[24] "North Koreans Claim to Extract Fuel for Nuclear Weapons," *New York Times*, May 12, 2005.

[25] David Albright and Paul Brannan, "The North Korean Plutonium Stock February 2007," Institute for Science and International Security, February 20, 2007.

[26] Technical difficulties associated with the fuel fabrication facility may have slowed how often the fuel was unloaded from the reactor, limiting production to at most one bomb per year. Siegfried Hecker, "Report on North Korean Nuclear Program," Center for International Security and Cooperation, Stanford University, November 15, 2006.

[27] IAEA Team Confirms Shut Down of DPRK Nuclear Facilities, http://www.iaea.org/NewsCenter/PressReleases/2007/prn200712.html.

[28] Siegfried Hecker, "The Risks of North Korea's Nuclear Restart," *Bulletin of the Atomic Scientists*, May 12, 2009, http://www.thebulletin.org/web-edition/features/the-risks-of-north-koreas-nuclear-restart

[29] Report by the Director General to the IAEA Board of Governors, "Applications of Safeguards in the Democratic People's Republic of Korea (DPRK)," GOV/2007/45-GC(51)/19, August 17, 2007.

[30] Siegfried Hecker, "Report on North Korean Nuclear Program," Center for International Security and Cooperation, Stanford University, November 15, 2006.

[31] Hecker January 21, 2004, testimony before SRFC.

[32] CIA unclassified point paper distributed to congressional staff on November 19, 2002.

[33] Siegfried Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," Center for International Security and Cooperation, Stanford University, November 20, 2010. http://iis-db.stanford.edu/pubs/23035/HeckerYongbyon.pdf

These fuel rods were manufactured for the 50 MWe reactor that was never built, but could be re-clad to be used in the 5 MWe reactor if North Korea chose to restart it. North Korea announced on in April 2013 that it plans to restart the 5 MWe reactor, which experts estimate would take approximately six months.

Table 1. North Korean Nuclear Power Reactor Projects

Location	Type/Power Capacity	Status	Purpose
Yongbyon	Graphite-moderated Heavy Water Experimental Reactor/5 MWe	Currently shut-down; cooling tower destroyed in June 2009 as part of Six-Party Talks; estimated restart time would be 6 months; Re-start announced April 2013	Weapons-grade plutonium production
Yongbyon	Graphite-moderated Heavy Water Power Reactor /50 MWe	Never built; Basic construction begun; project halted since 1994	Stated purpose was electricity production; could have been used for weapons-grade plutonium production
Yongbyon	Experimental Light-Water Reactor/100 MWT (25-30 MWe)	U.S. observers saw basic construction begun in November 2010; Reactor dome emplaced on top of containment structure summer 2012	Stated purpose is electricity production; could be used for weapons-grade plutonium production
Taechon	Graphite-moderated Heavy Water Power Reactor/200 MWe	Never built; Basic construction begun; project halted since 1994	Stated purpose was electricity production; could have been used for weapons-grade plutonium production
Kumho District, Sinp'o	4 Light-water reactors/440 MW	Never built; part of 1985 deal with Soviet Union when North Korea signed the NPT; canceled by Russian Federation in 1992	Stated purpose is electricity production; could have been used for weapons-grade plutonium production
Kumho District, Sinp'o [KEDO Project]	2 Light-water reactors (turn-key)/1000 MWe	Never built; part of 1994 Agreed Framework, reactor agreement concluded in 1999; Project terminated in 2006 after North Korea pulled out of Agreed Framework	Electricity production

Uranium Enrichment

In November 2010, North Korean officials showed a visiting unofficial U.S. delegation—led by former Los Alamos National Laboratory Director Dr. Siegfried Hecker—what they claimed was an operating gas centrifuge uranium enrichment plant at the Yongbyon nuclear complex. In his

trip report, Dr. Hecker estimated that the plant had 2,000 centrifuges (most likely P-2 centrifuges)[34] in six cascades, with a capacity of 8,000 kg SWU/year.[35]

North Korea at that time claimed the uranium enrichment facility was built to produce enriched uranium for power reactor fuel. In more recent statements, it has confirmed what the international community suspected, that it could also be used for weapons material production. The North does not have any functioning nuclear power reactors, but said it is in the process of building a 100 megawatt-thermal (25-30 megawatt-electric) experimental light-water reactor.[36] Satellite images, as well as visitors to the site, confirm initial construction.[37] The reported size of the enrichment plant would match the annual fuel needs for the proposed 100 MWT reactor, which would require 3.5% low-enriched uranium fuel. However, the plant could be altered to produce 40 kg of 90% highly enriched uranium per year.[38] Highly enriched uranium can be used for weapons, while low-enriched uranium cannot.[39]

While it was known prior to Dr. Hecker's visit that North Korea was pursuing a uranium enrichment capacity, many analysts were surprised at the size and sophistication of the plant.[40] Although North Korea's weapons program has been plutonium-based from the start, in the past decade, intelligence had emerged pointing to it pursuing a second route to a nuclear bomb using highly enriched uranium. Even before North Korea unveiled the facility in November 2010, there was some certainty that North Korea had parts and plans for such a program, but far less certainty over how far this program had developed.

In particular, this revelation raises questions about North Korea's domestic capability to manufacture components, as well as how and when Pyonyang obtained any equipment or materials for the facility. Analysts point to a history of cooperation with Pakistan, particularly

[34] Hecker's assumption is based on the chief process engineer's comment that the rotors were made of "iron". P-2 centrifuges use rotors made of maraging steel (vs. high-strength aluminum for the P-1 centrifuges). See Siegfried Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," Center for International Security and Cooperation, Stanford University, November 20, 2010. http://iis-db.stanford.edu/pubs/23035/HeckerYongbyon.pdf

[35] Ibid. A SWU is a "separative work unit", and refers to the thermodynamic work needed to produce nuclear fuel. For a description of SWU and comparison chart for SWU capacities at enrichment facilities worldwide, see page 13 of CRS Report RL34234, *Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power*, coordinated by Mary Beth Nikitin.

[36] Preliminary construction was shown to an earlier unofficial U.S. delegation from the Korea Economic Institute, led by Amb. Charles "Jack" Pritchard.

[37] ISIS Imagery Brief, "New Satellite Imagery of Yongbyon Shows Construction Progress on Experimental Reactor," Institute for Science and International Security web-site, November 18, 2010. http://isis-online.org/uploads/isis-reports/documents/Yongbyon_Light_Water_Reactor_Construction_18November2010_200PM.pdf

[38] Siegfried Hecker, Comments at the Korean Economic Institute, November 23, 2010. The International Atomic Energy Agency estimates the amount of HEU needed to make a nuclear explosive device ("significant quantity") is 25kg of uranium enriched at 20% or more. http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_prn.pdf

[39] North Korean representatives reportedly told New Mexican Governor Bill Richardson during an unofficial visit to Pyongyang in December 2010 that they would be willing to invite International Atomic Energy Agency (IAEA) inspectors back into the country to monitor the enrichment plant at Yongbyon, and presumably verify that it was not producing highly enriched uranium. Chris Buckley, "North Korea to allow in IAEA inspectors—Richardson," *Reuters*, December 21, 2010.

[40] David Albright and Paul Brannan, *Taking Stock: North Korea's Uranium Enrichment Program*, The Institute for Science and International Security, October 8, 2010. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_DPRK_UEP.pdf

through the A. Q. Khan network, and multiple reports of transshipments through China.[41] The scale of the plant at Yongbyon could suggest North Korea possesses research level facilities elsewhere in the country. Another concern is that a clandestine facility might exist that is configured to produce HEU for the North Korean nuclear weapons program. U.S. Ambassador to the IAEA Glyn Davies told the IAEA Board of Governors in December 2010 that the United States believes it is likely that other, clandestine uranium enrichment facilities exist in locations other than Yongbyon.[42] A pilot-scale centrifuge plant would likely be needed to serve as a test-bed for the larger plants, perhaps consisting of a few hundred centrifuges.

Pakistani President Musharraf revealed in his September 2006 memoir, *In the Line of Fire*, that Abdul Qadeer Khan—chief scientist in Pakistan's nuclear weapons program who proliferated nuclear weapons technology for profit—"transferred nearly two dozen P-1 and P-2 centrifuges to North Korea. He also provided North Korea with a flow meter, some special oils for centrifuges, and coaching on centrifuge technology, including visits to top-secret centrifuge plants."[43] According to press reports, North Korea said it had imported 150 tons of high-strength aluminum tubes from Russia that could be used in a uranium enrichment program in the 2002-2003 period.[44]

It is not known where North Korea develops or manufactures centrifuges itself. As described in the United Nations Panel of Experts on North Korea report of June 2012, there is some debate whether North Korea has the capacity to manufacture the specialized equipment required for centrifuges, such as maraging steel or high-strength aluminum, or whether it could have imported the components. Some experts posit that North Korea could have built a centrifuge based on a less sophisticated design with less stringent quality requirements. Based on what has been reported on procurements of relevant equipment, Former IAEA Safeguards Director Olli Heinonen in an April 2012 article estimated that North Korea was likely developing a 5,000 centrifuge enrichment capacity, plus spares.[45]

North Korean Statements on Its Enrichment Program

Until May 2009, North Korea denied the existence of a highly enriched uranium program for weapons. North Korea had threatened in April 2009 that it would build a light-water reactor if the U.N. Security Council did not apologize for its condemnation of the North's missile test. Following the June 12 U.N. Security Council Resolution condemning North Korea's nuclear test, Pyongyang issued a statement: "The process of uranium enrichment will be commenced." The statement also said that "pursuant to the decision to build its own light-water reactor, enough success has been made in developing uranium enrichment technology to provide nuclear fuel to

[41] David Albright and Paul Brannan, *Taking Stock: North Korea's Uranium Enrichment Program*, The Institute for Science and International Security, October 8, 2010. http://www.isis-online.org/uploads/isis-reports/documents/ISIS_DPRK_UEP.pdf

[42] Amb. Glyn Davies, "U.S. Statement to the IAEA: DPRK," IAEA Board of Governors Meeting, December 2-3, 2010, http://vienna.usmission.gov/101202dprk.html

[43] Pervez Musharraf, *In the Line of Fire: A Memoir*, (New York: Free Press, September 2006), p. 296.

[44] "NK Admits to Buying Aluminum Tubes," KBS World News, September 27, 2007, and Takashi Sakamoto, "DPRK Admits To Importing Aluminum Tubes From Russia for Uranium Enrichment," *Yomiuri Shimbun,* in Japanese, Translated by *BBC Monitoring Asia Pacific*, October 26, 2007.

[45] Olli Heinonen, "The North Korean Nuclear Program in Transition," *38North.org*, April 26, 2012, http://38north.org/2012/04/oheinonen042612/.

allow the experimental procedure."[46] In the June statement, North Korea was apparently saying it would, at a minimum, start the experimental enrichment of uranium for fuel.[47] Pyongyang offered a further statement in September 2009: "experimental uranium enrichment has successfully been conducted to enter the completion phase." However, it was unclear what a "completion phase" meant in technical terms. After showing the plant at Yongbyon to visiting American scientists in November 2010, North Korea issued a statement saying that "a modern factory for uranium enrichment equipped with thousands of centrifuges is operating to supply fuel" [to the light-water reactor].[48]

U.S. Intelligence Assessments

A 2002 CIA report to Congress said, "In 2001, North Korea began seeking centrifuge-related materials in large quantities. It also obtained equipment suitable for use in uranium feed and withdrawal systems. North Korea's goal appears to be a plant that could produce enough weapons-grade uranium for two or more nuclear weapons per year when fully operational."[49] A 2002 unclassified CIA working paper on North Korea's nuclear weapons and uranium enrichment estimated that North Korea "is constructing a plant that could produce enough weapons-grade uranium for two or more nuclear weapons per year when fully operational—which could be as soon as mid-decade."[50] Such a plant would need to produce more than 50 kg of HEU per year, requiring cascades of thousands of centrifuges.[51]

Questions have been raised about whether the 2002 estimates were accurate.[52] In a hearing before the Senate Armed Services Committee on February 27, 2007, Joseph DeTrani, the mission manager for North Korea from the Office of the Director of National Intelligence and former chief negotiator for the Six-Party Talks, was asked by Senator Jack Reed whether he had "any further indication of whether that program has progressed in the last six years, one; or two, the evidence—the credibility of the evidence that we had initially, suggesting they had a program rather than aspirations?" DeTrani responded that "the assessment was with high confidence that, indeed, they were making acquisitions necessary for, if you will, a production-scale program. And we still have confidence that the program is in existence—at the mid-confidence level." In a clarification of his response, DeTrani issued a DNI press release that said there was a high level of confidence in 2002 that North Korea had a uranium enrichment program, and "at least moderate confidence that North Korea's past efforts to acquire a uranium enrichment capability

[46] http://www.kcna.co.jp/item/2009/200906/news13/20090613-10ee.html.

[47] Hui Zhang, "Assessing North Korea's Uranium Enrichment Capabilities," *Bulletin of the Atomic Scientists*, June 28, 2009.

[48] "North Korean paper reports plans for uranium enrichment," *BBC Monitoring Asia-Pacific*, November 30, 2010.

[49] *Unclassified Report to Congress January-June 2002*, Central Intelligence Agency, https://www.cia.gov/library/reports/archived-reports-1/jan_jun2002.html#5

[50] http://www.fas.org/nuke/guide/dprk/nuke/cia111902.html.

[51] North Korea would first have to convert uranium "yellowcake" into uranium hexafluoride to feed into the centrifuges. The centrifuges would "enrich" the uranium, or increase the portion of U-235. Weapons-grade enriched uranium according to the IAEA needs to have an enrichment level of at least 20%. See CRS Report RL34234, *Managing the Nuclear Fuel Cycle: Policy Implications of Expanding Global Access to Nuclear Power*, coordinated by Mary Beth Nikitin.

[52] Paul Kerr, "News Analysis: Doubts Rise on North Korea's Uranium-Enrichment Program," *Arms Control Today*, April 2007, at http://www.armscontrol.org/act/2007_04/NewsAnalysis.asp.

continue today."[53] Assistant Secretary of State Christopher Hill said in February 2007 that the United States is not sure if North Korea has mastered "some considerable production techniques," although they have acquired some technology for an enrichment program.[54]

A DNI unclassified report of August 2007 stated,

> We continue to assess with high confidence that North Korea has pursued efforts to acquire a uranium enrichment capability, which we assess is intended for nuclear weapons. All Intelligence Community agencies judge with at least moderate confidence that this past effort continues. The degree of progress towards producing enriched uranium remains unknown, however.[55]

In testimony to Congress on February 2008, Director of National Intelligence Michael McConnell confirmed this assessment. The confidence level of these assessments may have changed because of a decrease in international procurement by North Korea. Uranium enrichment-related imports would be more easily detected by intelligence agencies than activities inside North Korea itself. Uranium enrichment facilities can be hidden from aerial surveillance more easily than plutonium facilities, making it more difficult for intelligence agencies to even detect—thus, "degree of progress" in turning the equipment into a working enrichment program is "unknown." Furthermore, there are significant differences between assembling a small-scale centrifuge enrichment program and operating a large-scale production plant, and reportedly little evidence of procurement for a large-scale plant has emerged.[56] Dr. Siegfried Hecker has assessed that it is "highly likely that North Korea had a research and development uranium enrichment effort, but there is little indication that they were able to bring it to industrial scale."[57]

In 2007, North Korea gave the United States a sample of the aluminum tubing in an effort to prove that it never intended to produce highly enriched uranium for weapons, and that the imported materials were for conventional weapons or dual-use projects. However, when U.S. scientists analyzed the aluminum tubing provided as sample "evidence," they found traces of enriched uranium on the tubing. Analysts argue that in addition to the possibility that this is proof of a North Korean uranium enrichment program, it is also possible that the uranium traces could have been on the tubing when North Korea received it.[58]

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[53] "There has been considerable misinterpretation of the Intelligence Community's view of North Korean efforts to pursue a uranium enrichment capability. The intelligence in 2002 was high quality information that made possible a high confidence judgment about North Korea's efforts to acquire a uranium enrichment capability. The Intelligence Community had then, and continues to have, high confidence in its assessment that North Korea has pursued that capability. We have continued to assess efforts by North Korea since 2002. All Intelligence Community agencies have at least moderate confidence that North Korea's past efforts to acquire a uranium enrichment capability continue today." ODNI News Release 04-07, March 4, 2007, at http://www.dni.gov/press_releases/20070304_release.pdf.

[54] "Update on the Six Party Talks," *Brookings Institution*, February 22, 2007, at http://www.brookings.edu/events/2007/0222south-korea.aspx.

[55] Unclassified Report to Congress on Nuclear and Missile Programs of North Korea, Office of the Director of National Intelligence, August 8, 2007.

[56] See David Albright, "North Korea's Alleged Large-Scale Enrichment Plant: Yet Another Questionable Extrapolation Based on Aluminum Tubes," The Institute for Science and Security, February 23, 2007, at http://www.isis-online.org/publications/dprk/DPRKenrichment22Feb.pdf.

[57] Siegfried Hecker, "Denuclearizing North Korea," *Bulletin of the Atomic Scientists*, May/June 2008.

[58] Glenn Kessler, "Uranium Traces Found on N. Korean Aluminum Tubes," *Washington Post*, December 21, 2007, at http://www.washingtonpost.com/wp-dyn/content/article/2007/12/20/AR2007122002196_pf.html.

In 2008, U.S. personnel found traces of highly-enriched uranium on the documents submitted as part of North Korea's nuclear declaration, raising new doubts about the extent of North Korea's uranium enrichment program.[59] Ambassador Hill told Congress that North Korea included as part of its June 2008 "declaration package" a letter that says that "they do not now and will not in the future have a highly enriched uranium program."[60] However, the Section 721 Unclassified Report to Congress covering the period January 1 to December 31, 2008, said that the IC had "increasing concerns that North Korea has an ongoing covert uranium enrichment program."

The Director of National Intelligence's annual threat assessment to Congress in 2011 discussed North Korea's November 2010 unveiling of its uranium enrichment program:

> We judge it is not possible the DPRK could have constructed the Yongbyon enrichment facility and begun its operation, as North Korean officials claim, in such a short period of time—less than 20 months—without having previously conducted extensive research, development, testing, fabrication, and assembly or without receiving outside assistance.
>
> Based on the scale of the facility and the progress the DPRK has made in construction, it is likely that North Korea has been pursuing enrichment for an extended period of time. If so, there is clear prospect that DPRK has built other uranium enrichment related facilities in its territory, including likely R&D and centrifuge fabrication facilities, and other enrichment facilities. Analysts differ on the likelihood that other production-scale facilities may exist elsewhere in North Korea.[61]

The DNI's 2012 threat assessment stated that North Korea's announcement of a uranium enrichment program in November 2010 confirmed long-standing intelligence assessments.[62] The intelligence community has not discussed detailed assessments of the uranium enrichment program in open hearings.

Uranium Enrichment and Nuclear Negotiations

The uranium enrichment issue was central to denuclearization negotiations since October 2002, when the Bush Administration accused North Korea of having a clandestine uranium enrichment program. U.S. lead negotiator James Kelly told North Korean First Deputy Foreign Minister Kang Sok-chu that the United States had evidence of a uranium enrichment program for nuclear weapons in violation of the Agreed Framework and other agreements. James Kelly said that Kang acknowledged the existence of such a program at that meeting. However, Kang later denied this, and Foreign Minister Paek Nam Sun said that Kang had told Kelly that North Korea is "entitled" to have such a program or "an even more powerful one" to deter a preemptive U.S. attack.[63]

After the November 2010 revelations of a small-scale centrifuge uranium enrichment facility, negotiators have been faced with decisions over how to address this plant, which the North

[59] Glenn Kessler, "New Data Found On North Korea's Nuclear Capacity; Intelligence on Enriched Uranium Revives Questions About Weapons," The Washington Post, June 21, 2008.

[60] Senate Armed Services Hearing on the North Korean Six-Party Talks and Implementation Activities, July 31, 2008.

[61] James R. Clapper, Director of National Intelligence, Statement for the Record on the Worldwide Threat Assessment of the U.S. Intelligence Community for the House Permanent Select Committee on Intelligence, February 10, 2011.

[62] James R. Clapper, Director of National Intelligence, Unclassified Statement for the Record on the Worldwide Threat Assessment of the US Intelligence Community for the Senate Select Committee on Intelligence, January 31, 2012.

[63] Selig Harrison, "Did North Korea Cheat?" *Foreign Affairs*, vol. 84, no. 1, January/February 2005.

Koreans say is for the peaceful production of power plant fuel, and how to verify the dismantlement of any other plants as part of any future denuclearization process.

U.S. official reactions downplayed North Korea's new enrichment facility and related offers, saying they are not surprising, and are not sufficient for a return to talks. For example, State Department Spokesman P. J. Crowley said in late December 2010, "If they meet their international obligations, take affirmative steps to reduce tensions in the region and take affirmative steps to denuclearize, we will respond accordingly."[64] Neither the offer to sell the fresh fuel or to invite international monitors to the uranium enrichment plant would have demonstrated a commitment to denuclearization steps by North Korea, demanded by the U.S. and South Korean governments as a condition for reconvening the Six-Party Talks. Officials from both governments have said they want to avoid falling into the diplomatic "trap" of being drawn into a lengthy negotiating process in which Pyongyang does not take concrete steps to denuclearize. However, North Korea's offers may have some intrinsic value on technical grounds: removal of the fresh fuel could reduce the amount of ready material to produce plutonium if the 5 MWe reactor was restarted (it would take only six months to do so); the presence of international inspectors at the newly built uranium enrichment site, depending on the degree of access given, could shed light on the extent and type of technical capability of the North Korean enrichment program. State Department spokesman Victoria Nuland announced on February 29, 2012, that North Korea had agreed to a moratorium on enrichment activities at the Yongbyon site and a return of international (IAEA) inspectors to verify the pause. North Korea had set up initial meetings with IAEA officials. However, the February agreements collapsed after the North's attempted satellite launch in April 2012.

Nuclear Testing[65]

North Korea has technical and military reasons for testing an additional device or devices if it has enough fissile material to do so. Analysts would look for two main indicators after a nuclear test that could reveal information about North Korea's nuclear weapons program. First, the yield of the device, and secondly, the type of fissile material used. There are many uncertainties over whether North Korea would test a plutonium device and deplete its shrinking plutonium stockpile but advance the knowledge learned in earlier tests, whether it might pair a plutonium and HEU device together in a test, or whether North Korea has enough HEU to test. Furthermore, it is not guaranteed that the international community could discern the type of material used in a nuclear test. The ability to do so would depend on what is vented from the test site and what is detected through air sampling.[66]

[64] "North Korea to Allow Nuclear Inspectors as Tension Eases, Richardson Says," Bloomberg News, December 21, 2010.

[65] See also CRS Report RL33548, *Comprehensive Nuclear-Test-Ban Treaty: Background and Current Developments*, by Jonathan Medalia.

[66] James Acton, "North Korea's Latest Threat," April 2012, http://carnegieendowment.org/2012/04/10/north-korea-s-latest-threat/a7fk#6 and Hui Zhang, "Off Site Air Sampling Analysis and North Korean Nuclear Test," Belfer Center, http://belfercenter.ksg.harvard.edu/files/NKSampling_INMM07_Hui.pdf.

The February 12, 2013, Nuclear Test

Observable test site activity at the Punggye-ri nuclear test site since mid-2012 led analysts to believe North Korea was preparing the site for a third nuclear test. A nuclear test was carried out on February 12, 2013. The North Korean official news agency announced a "successful" underground nuclear detonation, and seismic monitoring systems measured a resulting earthquake that was 5.1M in magnitude.[67] Seismic waves were similar to the tests in 2006 and 2009. The U.S. Director of National Intelligence issued a statement:

> The U.S. Intelligence Community assesses that North Korea probably conducted an underground nuclear explosion in the vicinity of P'unggye on February 12, 2013. The explosion yield was approximately several kilotons. Analysis of the event continues.[68]

The South Korean Ministry of Defense estimated that the test yield was between 6 and 7 kilotons.[69] North Korea claimed that the February 12, 2013, nuclear test was to develop a "smaller and light" warhead. At a minimum, the test would likely contribute to North Korea's ability to develop a warhead that could be mounted on a long-range missile. It is unclear what impact a third nuclear test would have on future negotiations, but it would make their success far less likely, and the UN Security Council was discussing additional sanctions measures.

Observers are also waiting for evidence from test emissions that might show whether the North Koreans tested a uranium or plutonium device. This information could help determine the type and sophistication of the North Korean nuclear warhead design about which little is known. Two U.S. experts, Hecker and Pabian, have assessed that North Korea used plutonium in both the 2006 and 2009 tests, and that without at least one additional successful plutonium test, the North would not have confidence in its miniaturized plutonium design.[70] Other experts believe North Korea may choose to test highly enriched uranium-based devices. Testing of a uranium device might indicate a clandestine supply of highly enriched uranium, potentially from an enrichment facility in North Korea. If venting of the nuclear test site has occurred, air samples could indicate what kind of material was used.

The May 25, 2009, Nuclear Test

The DPRK announced on May 25, 2009 that it had successfully conducted another underground nuclear test. An official North Korean news release said that this test was "on a new higher level in terms of its explosive power and technology of its control and the results of the test helped satisfactorily settle the scientific and technological problems arising in further increasing the power of nuclear weapons." This may be a reference to design problems associated with the low

[67] United States Geological Survey, http://earthquake.usgs.gov/earthquakes/eventpage/usc000f5t0#summary.

[68] Statement by the Office of the Director of National Intelligence on North Korea's Declared Nuclear Test on February 12, 2013, http://www.dni.gov/index.php/newsroom/press-releases/191-press-releases-2013/809-statement-by-the-office-of-the-director-of-national-intelligence-on-north-korea's

[69] "ROK Defense Ministry Estimates DPRK's Nuclear Device Yield of 6-7 Kilotons," *Yonhap News Agency*, February 12, 2013.

[70] Frank J. Pabian and Siegfried Hecker, "Contemplating a third nuclear test in North Korea," *Bulletin of the Atomic Scientists*, August 6, 2012.

yield of the 2006 test. A North Korean official statement had threatened on April 29, 2009, that it would conduct "nuclear tests" to bolster its deterrent.[71]

The U.S. Geologic Survey registered an underground blast on May 25 with a seismic magnitude of the event as 4.7 on the Richter scale.[72] The Directorate of National Intelligence released a statement on June 15 saying, "The U.S. Intelligence Community assesses that North Korea probably conducted an underground nuclear explosion in the vicinity of P'unggye on May 25, 2009."[73] The explosion yield was first estimated to be approximately a "few" kilotons. In his February 2012 annual threat to Congress, DNI Clapper said, "The North's probable nuclear test in May 2009 had a yield of roughly two kilotons TNT equivalent and was apparently more successful than the 2006 test. These tests strengthen our assessment that North Korea has produced nuclear weapons."[74]

Open-source information is not available on the device's design and how much nuclear material was used. In contrast to 2006, no radioactive noble gases were detected by international monitoring stations and no national governments have announced such data.[75] It is possible that North Korea may have been able to contain the release of these gases and particles from the test site. This data can provide not only evidence of a test, but potentially also information on the type of weapon detonated.[76]

The October 9, 2006, Nuclear Test[77]

The U.S. Director of National Intelligence confirmed that North Korea conducted an underground nuclear explosion on October 9, 2006, in the vicinity of P'unggye.[78] However, the sub-kiloton yield of the test suggests that the weapon design or manufacturing process likely needs improvement.[79] North Korea reportedly told China before the test that it expected a yield of 4 kilotons (KT), but seismic data confirmed that the yield was less than 1 KT.[80] Radioactive debris indicates that the explosion was a nuclear test, and that a plutonium device was used.[81] It is

[71] "UNSC Urged to Retract Anti-DPRK Steps," KCNA, April 29, 2009, http://www.kcna.co.jp/item/2009/200904/news29/20090429-14ee.html.

[72] http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/us2009hbaf.php.

[73] Statement by the Office of the Director of National Intelligence on North Korea's Declared Nuclear Test on May 25, 2009, http://www.dni.gov/press_releases/20090615_release.pdf.

[74] Annual Threat Assessment of the Director of National Intelligence for the Senate Select Committee on Intelligence, January 31, 2012, at http://www.dni.gov/testimonies/20120131_testimony_ata.pdf.

[75] http://www.ctbto.org/press-centre/highlights/2009/experts-sure-about-nature-of-the-dprk-event/.

[76] See also "Factfile: underground nuclear testing," *BBC News*, May 26, 2009, http://news.bbc.co.uk/2/hi/asia-pacific/6033893.stm.

[77] See also CRS Report RL33709, *North Korea's Nuclear Test: Motivations, Implications, and U.S. Options*, by Emma Chanlett-Avery and Sharon Squassoni, December 12, 2006.

[78] "Analysis of air samples collected on October 11, 2006, detected radioactive debris which confirms that North Korea conducted an underground nuclear explosion in the vicinity of P.unggye on October 9, 2006. The explosion yield was less than a kiloton." ODNI News Release No. 19-06, at http://www.dni.gov/announcements/20061016_release.pdf.

[79] By comparison, a simple plutonium implosion device normally would produce a larger blast, perhaps 5 to 20 kilotons (KT). The first nuclear tests conducted by other states range from 9 KT (Pakistan) to 60 KT (France), but tests by the United States, China, Britain, and Russia were in the 20 KT range.

[80] Mark Mazzetti, "Preliminary Samples Hint at North Korean Nuclear Test," *New York Times*, October 14, 2006, at http://www.nytimes.com/2006/10/14/world/asia/14nuke.html.

[81] Thom Shanker and David Sanger, "North Korean fuel identified as plutonium," *New York Times,* October 17, 2006, (continued...)

widely believed that the warhead design was an implosion device.[82] Uncertainties remain about when the plutonium used for the test was produced and how much plutonium was in the device, although a prominent U.S. nuclear scientist has estimated that North Korea likely used approximately 6 kg of plutonium for the test.[83]

The test's low yield may not have been a complete failure. Another possibility is that the test's low yield was intentional—a sophisticated device designed for a Nodong medium-range missile. Alternatively, a low yield could have been intended to avoid radioactive leakage from the test site or to limit the amount of plutonium used.[84] DNI Director Clapper in his 2012 annual threat assessment to Congress called the 2006 test a "partial failure."

Delivery Systems

Although former Defense Intelligence Agency (DIA) Director Lowell Jacoby told the Senate Armed Services Committee in April 2005 that North Korea had the capability to arm a missile with a nuclear device, Pentagon officials later backtracked from that assessment. A DNI report to Congress says that "North Korea has short and medium range missiles that could be fitted with nuclear weapons, but we do not know whether it has in fact done so."[85] North Korea has several hundred short-range Scud-class and medium range No Dong-class ballistic missiles, and is developing an intermediate range ballistic missile. The Taepo-Dong-2 that was tested unsuccessfully in July 2006 would be able to reach the continental United States if it becomes operational. DNI assessed in 2008 that the Taepo-Dong-2 has the potential capability to deliver a nuclear-weapon-sized payload to the United States, but that absent successful testing the likelihood of this is low.[86] A launch of a Taepo-Dong 2 missile as part of a failed satellite launch in April 2009 traveled further than earlier unsuccessful launches but still did not achieve a complete test. An April 2012 launch of a Taepo-Dong 2 (called the Unha-3 by North Korea) also failed in the first stage.[87] The December 2012 launch of a Taepo-Dong 2 (Unha-3) was North Korea's first successful launch of a satellite into space. However, putting a satellite into orbit,

(...continued)

at http://www.nytimes.com/2006/10/17/world/asia/17diplo.html. A debate on this issue can be found in the November 2006 issue of *Arms Control Today*, at http://armscontrol.org/act/2006_11/tech.asp#Sidebar1.

[82] Implosion devices, which use sophisticated lenses of high explosives to compress fissile material, are generally thought to require testing, although the CIA suggested in 2003 that North Korea could validate a simple fission nuclear weapons design using extensive high explosives testing. CIA response to questions for the record, August 18, 2003, submitted by the Senate Select Committee on Intelligence, at http://www.fas.org/irp/congress/2003_hr/021103qfr-cia.pdf.

[83] Siegfried Hecker, "Report on North Korean Nuclear Program," Center for International Security and Cooperation, Stanford University, November 15, 2006.

[84] Ibid. Also see Peter Hayes, Jungmin Kang, "Technical Analysis of the DPRK Nuclear Test," *Nautilus* Institute, October 22, 2006, http://www.nautilus.org/fora/security/0689HayesKang.html.

[85] Unclassified Report to Congress on Nuclear and Missile Programs of North Korea, Office of the Director of National Intelligence, August 8, 2007. Also see CRS Report RS21473, *North Korean Ballistic Missile Threat to the United States*, by Steven A. Hildreth.

[86] Annual Threat Assessment of the Director of National Intelligence for the Senate Select Committee on Intelligence, February 5, 2008, at http://www.dni.gov/testimonies/20080205_testimony.pdf.

[87] "NORAD and USNORTHCOM Acknowledge Missile Launch," *NORAD News*, April 12, 2012, Peterson Air Force Base, Colorado.

while moving North Korea technically to its goal, does not translate into a reliable missile. Further testing would be required.

It is possible that Pakistani scientist A.Q. Khan may have provided North Korea the same Chinese-origin nuclear weapon design he provided to Libya and Iran. Even though that design was for an HEU-based device, it would still help North Korea develop a reliable warhead for ballistic missiles—small, light, and robust enough to tolerate the extreme conditions encountered through a ballistic trajectory. Learning more about what is needed for miniaturization of warheads for ballistic missiles could have been the goal of North Korea's testing smaller nuclear devices.[88]

Doctrine and Intent

U.S. officials in their threat assessments have described the North Korean nuclear capabilities as being more for deterrence, international prestige, and coercive diplomacy than for war fighting, and assess that Pyongyang most likely "would consider using nuclear weapons only under narrow circumstances." The Director of National Intelligence said in early 2012 that "we also assess, albeit with low confidence, Pyongyang probably would not attempt to use nuclear weapons against US forces or territory, unless it perceived its regime to be on the verge of military defeat and risked an irretrievable loss of control."[89]

Statements by North Korean officials emphasize that moves to expand their nuclear arsenal are in response to perceived threats by the United States against the North Korean regime.[90] Nuclear weapons also give North Korea leverage in diplomatic negotiations, and threatening rhetoric often coincides with times of crisis or transitions in negotiations. In January 2008, a North Korean media report stated that the country "will further strengthen our war deterrent capabilities in response to U.S. attempts to initiate nuclear war," to express its displeasure that it had not yet been removed from the U.S. terrorism list.[91] Statements from Pyongyang in January 2009 may also be part of a strategy to increase leverage in nuclear talks,[92] or could indicate an increasing role for the North Korean military in nuclear policy making.[93] A spokesman for North Korea's General Staff said on April 18, 2009, that the revolutionary armed forces "will opt for increasing the nation's defense capability including nuclear deterrent in every way."[94] At the same time, the DPRK issues periodic statements, such as its 2010 New Year's address stating its dedication to achieving a nuclear-free Korean Peninsula through negotiations.

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[88] "Technical Perspective on North Korea's Nuclear Test: A Conversation between Dr. Siegfried Hecker and Dr. Gi-Wook Shin," Stanford University website, October 10, 2006, at http://aparc.stanford.edu/news/technical_perspective_on_north_koreas_nuclear_test_a_conversation_between_dr_siegfried_hecker_and_dr_giwook_shin_20061010//.

[89] Annual Threat Assessment of the Director of National Intelligence for the Senate Select Committee on Intelligence, January 31, 2012, at http://www.dni.gov/testimonies/20120131_testimony_ata.pdf.

[90] See, for example, North Korea's statement of February 10, 2005, at http://news.bbc.co.uk/2/hi/asia-pacific/4252515.stm.

[91] "North Korea says nuclear declaration submitted," *Reuters*, January 4, 2008.

[92] Blaine Harden, "With Obama in the White House, North Korea Steps Up Big Talk," *Washington Post*, February 3, 2009.

[93] See "North Korea" section of CRS Report R40439, *Nuclear Weapons R&D Organizations in Nine Nations*, coordinated by Jonathan Medalia.

[94] "DPRK military warns against sanctions for rocket launch," *Xinhua*, April 18, 2008.

In May 2012, North Korea changed its constitution to say that it was a "nuclear-armed state."[95] On April 1, 2013, its party congress adopted the "Law on Consolidating Position of Nuclear Weapons State." The official media (KCNA) summarized the law as saying that nuclear weapons "serve the purpose of deterring and repelling the aggression and attack of the enemy against the DPRK and dealing deadly retaliatory blows at the strongholds of aggression until the world is denuclearized." The statement also said that the "nuclear weapons of the DPRK can be used only by a final order of the Supreme Commander of the Korean People's Army to repel invasion or attack from a hostile nuclear weapons state and make retaliatory strikes. The DPRK shall neither use nukes against the non-nuclear states nor threaten them with those weapons unless they join a hostile nuclear weapons state in its invasion and attack on the DPRK." This is the most detailed statement on North Korean nuclear use policies to date.

Steps Toward Denuclearization Under the Six-Party Talks (2005-2009)

In September 2005, North Korea agreed to abandon "all nuclear weapons and existing nuclear programs," but implementation of this goal was stalled.[96] The October 9, 2006, nuclear test is seen as a catalyst in uniting the other members of the Six-Party Talks to toughen their stance towards North Korea, and as a turning point in Pyongyang's attitude. U.N. Security Council Resolution 1718 calls on North Korea to abandon its nuclear weapons in a "complete, verifiable, and irreversible manner."[97] In February 2007, as part of implementation of the September 2005 Joint Statement, North Korea committed to disable all nuclear facilities and provide a "complete and correct" declaration of all its nuclear programs.[98]

Disablement

The October 2007 Six-Party joint statement said the United States would lead disablement activities and provide the initial funding for those activities.[99] Disablement indicates a physical measure to make it difficult to restart operation of a facility while terms are being worked out for its eventual dismantlement. U.S. officials said that their aim was a disablement process that would require a 12-month time period to start up the facility again.[100] The Six Parties agreed to 11 discrete steps to disable the three main Yongbyon facilities related to North Korea's plutonium program (nuclear fuel fabrication plant, plutonium reprocessing plant, and 5-megawatt experimental nuclear power reactor).[101] The disablement process began in early November 2007

[95] "New N. Korea constitution proclaims nuclear status," *Agence France Presse*, May 31, 2012.

[96] Joint Statement of the Fourth Round of Six Party Talks, Beijing, September 19, 2005, at http://www.state.gov/r/pa/prs/ps/2005/53490.htm.

[97] United Nations Security Council Resolution 1718, October 14, 2006, at http://daccessdds.un.org/doc/UNDOC/GEN/N06/572/07/PDF/N0657207.pdf?OpenElement.

[98] "Denuclearization Action Plan," February 13, 2007, at http://merln.ndu.edu/archivepdf/northkorea/state/80479.pdf.

[99] Second Phase Actions for the Implementation of the September 2005 Joint Statement, October 3, 2007, at http://www.state.gov/r/pa/prs/ps/2007/oct/93223.htm.

[100] On-the-Record-Briefing, U.S. Assistant Secretary of State Christopher Hill, October 3, 2007, at http://www.state.gov/p/eap/rls/rm/2007/93234.htm.

[101] "North Korea 'Agrees to Nuclear Disablement Procedure,'" *Chosun Ilbo*, October 27, 2007.

and continued through April 2009. The most time-consuming step was the removal of the irradiated fuel from the reactor to storage in an adjacent cooling pond.[102] A reported 8 out of 11 steps were completed (see **Table 2**).[103]

Table 2. Disablement Steps at Yongbyon, DPRK

Step	Facility	Status
Discharge of 8000 spent fuel rods to the spent fuel pool	5-megawatt reactor	6,400 completed as of April 2009
Removal of control rod drive mechanisms	5-megawatt reactor	To be done after spent fuel removal completed
Removal of reactor cooling loop and wooden cooling tower interior structure	5-megawatt reactor	Tower demolished June 26, 2008
Disablement of fresh fuel rods	Fuel fabrication facility	Not agreed to by North Korea; consultations held Jan. 2009 with South Korea on possibility of purchase
Removal and storage of three uranium ore concentrate dissolver tanks	Fuel fabrication facility	Completed
Removal and storage of seven uranium conversion furnaces, including storage of refractory bricks and mortar sand	Fuel fabrication facility	Completed
Removal and storage of both metal casting furnaces and vacuum system, and removal and storage of eight machining lathes	Fuel fabrication facility	Completed
Cut cable and remove drive mechanism associated with the receiving hot cell door	Reprocessing facility	Completed
Cut two of four steam lines into reprocessing facility	Reprocessing facility	Completed
Removal of drive mechanisms for the fuel cladding shearing and slitting machines	Reprocessing facility	Completed
Removal of crane and door actuators that permit spent fuel rods to enter the reprocessing facility	Reprocessing facility	Completed

Source: "North Korean Disablement Actions," *Arms Control Today*, October 2008; "Disablement Actions," National Committee on North Korea website; Siegfried Hecker, "Denuclearizing North Korea," Bulletin of the Atomic Scientists, May/June 2008.

[102] David Albright and Paul Brannan, "Disabling DPRK Nuclear Facilities," United States Institute of Peace Working Paper, October 23, 2007.

[103] See charts at "North Korean Disablement Actions," *Arms Control Today*, October 2008; "Disablement Actions," National Committee on North Korea website.

North Korea periodically slowed the pace of spent fuel rod removal at Yongbyon to show its displeasure over other aspects of the Six-Party agreements.[104] For example, in June 2008, Pyongyang said that while 80% of the disablement steps had been completed, only 36% of energy aid had been delivered.[105] North Korea again delayed disablement work in August, September, and October 2008, and those instances appear to have been linked to disputes over when the United States would remove the DPRK from its State Sponsors of Terrorism List and negotiations over verification measures. After the United States removed the SST designation, disablement work resumed in October 2008, and continued until North Korea halted the process in April 2009.

The steps that were not completed in disabling the Yongbyon facilities as part of phase 2 of the Six-Party Talks are completing the removal of the spent fuel rods from the 5 megawatt reactor; removing the control rod drive mechanism (after all rods are removed); and disabling or removing from the country the fresh fuel rods at the site. As of early April 2009, approximately 80% or 6,400 of the 8,000 spent fuel rods had been moved from the reactor to the cooling pond.[106] Pyongyang subsequently issued statements saying it had itself removed the remaining fuel rods from the reactor and completed reprocessing all 8,000 spent fuel rods by August 2009.[107]

In addition, North Korea possesses 2,400 5-MWt fresh fuel rods and 12,000 50-MWt fresh fuel rods in storage at Yongbyon. A technical delegation from South Korea visited the facility in January 2009 to consider possibilities for removing the fuel rods. Another option discussed was to bend them so they could not be readily used in the reactor.[108] It is not clear whether North Korea had agreed to disablement or removal of the fresh fuel, and then balked, or whether it never had agreed to this measure. North Korea told visiting unofficial American delegations in late 2010 that the North would consider shipping out (and selling) the 12,000 fresh fuel rods, most likely to South Korea, if the United States reaffirmed a 2000 Joint Statement which said the United States held no hostile intent toward the North.[109]

Reversing Disablement

The North Korean Foreign Ministry said on April 25, 2009, that it had restarted its reprocessing facility, but there has been no way to independently verify this. North Korea said in November 2009 that it had reprocessed the 8,000 spent fuel rods in its possession by the end of August.

The extent to which the Yongbyon facilities had been disabled was first tested in September 2008 when North Korea halted international monitoring at the reprocessing facility, moved some equipment out of storage, and threatened to begin reprocessing again.[110] This temporary reversal was corrected and equipment moved back to storage by November 2008. Taking into account the

[104] "N. Korea 'Slowing Disablement of Nuclear Facilities," *Chosun Ilbo*, January 29, 2008.

[105] Lee Chi-dong, "N Korea Complains About Slow Provision of Energy Aid," Yonhap News, June 5, 2008.

[106] "N. Korea can produce plutonium for 1.5 bombs in 6 months: expert," *Kyodo News*, April 25, 2009.

[107] Kim So-hyun, "N.K. says it reprocessed 8,000 spent fuel rods," *The Korea Herald*, November 4, 2009.

[108] "MOFAT Reveals North Korean Fuel Rod Images," *Daily North Korea*, February 4, 2009. http://www.dailynk.com/english/read.php?cataId=nk03100&num=4516.

[109] John Pomfret, "North Korea suggests discarding one of its nuclear arms programs in deal," *The Washington Post*, November 22, 2010.

[110] IAEA Press Release, "IAEA Removes Seals at Yongbyon," September 24, 2008.

need to test the facility (e.g., for leaks and cracks in the piping) and introduce chemicals, experts estimated that restarting the reprocessing plant could take approximately six to eight weeks, although this timeline might be shorter since some initial work may have been done in September 2008. It would then take approximately three to four months to reprocess the spent fuel rods now in storage at Yongbyon, resulting in 7 kg to 8 kg of plutonium. This would be enough for at least one nuclear weapon.[111] According to reports, disablement was limited to the "front-end," where spent fuel is loaded, at the reprocessing facility for technical reasons related to the safe disposal of the high-level waste in the facility.[112]

In order to produce additional plutonium, the North Koreans would need to restore their 5-MWt reactor or build a new reactor. Timelines for restoring the 5-MWt reactor are uncertain, although experts estimate between six months and one year. Rebuilding the cooling tower, which was destroyed in June 2008, could take approximately six months, but other venting solutions for the reactor could be possible. Additionally, this aging reactor may be in need of additional parts or repair. The fuel fabrication facility would have to be restored to produce additional fuel. Former Director of the Los Alamos National Laboratories Siegfried Hecker has said that while significant work is needed to do so, North Korea could restore operations at the 5 megawatt reactor and fuel fabrication facility without foreign equipment or materials, and could do so in approximately six months. After the facilities were operating, they could produce approximately 6 kg of plutonium per year.[113] Dr. Hecker confirmed this estimate again after his visit to North Korea in November 2010.[114] Significant future growth in North Korea's arsenal would be possible only if larger reactors were completed and operating, and would also depend on any progress in the reported uranium enrichment program.

Declaration

The required content of a "complete and correct" declaration as promised under the Six-Party negotiations evolved over time. Bush Administration officials in fall 2007 said they expected the declaration to include a full declaration of the separated weapons-grade plutonium that has already been produced, as well as full disclosure of uranium enrichment activities.[115] The North Korean Foreign Ministry said on January 4, 2008, that it had notified the United States of the content of its declaration in November 2007. However, Assistant Secretary Hill said that the two sides had discussed what was expected to be in a declaration, and "it was clearly not a complete and correct declaration."[116] At that time, North Korea reportedly suggested it would declare 30 kg of separated plutonium in its declaration, a lower number than U.S. officials have alluded to (see

[111] Peter Crail, "North Korea Moves to Restart Key Nuclear Plant," *Arms Control Today*, October 2008.

[112] For a discussion of the pro's and con's see sidebar "A Diplomatic and Technological Cocktail," *Bulletin of the Atomic Scientists*, May/June 2008, p.49.

[113] "North Korea can produce plutonium for 1.5 bombs in 6 months," *Japan Economic Newswire*, April 25, 2009.

[114] Siegfried Hecker, "A Return Trip to North Korea's Yongbyon Nuclear Complex," Center for International Security and Cooperation, Stanford University, November 20, 2010. http://iis-db.stanford.edu/pubs/23035/HeckerYongbyon.pdf.

[115] On-The-Record Briefing: Assistant Secretary of State for East Asian and Pacific Affairs and Head of the U.S. Delegation to the Six-Party Talks Christopher R. Hill, October 3, 2007, at http://www.state.gov/p/eap/rls/rm/2007/93234.htm.

[116] Joint Press Availability, Assistant Secretary of State Christopher R. Hill, January 7, 2008. http://www.state.gov/p/eap/rls/rm/2008/01/98756.htm.

above) but in the range of some analyses.[117] The United States has said that "materials, facilities and programs" need to be included in a declaration. In addition to plutonium stocks, North Korea agreed to "address concerns about a uranium enrichment program but denies that it has one" (see below). Other outstanding issues are nuclear proliferation activities and warhead information. North Korea has said it would not include warhead information at this stage. Once the original December 31 deadline for submission of the declaration had passed, U.S. officials emphasized that the completeness of the document was more important than its timing. U.S. officials also made statements in early 2008 that removal from sanctions lists would only happen after a complete declaration was submitted to the six parties.

According to press reports,[118] at a bilateral meeting in Singapore in April 2008, the United States and North Korea agreed to a formulation in which North Korea would include its plutonium production activities in a formal declaration, and the enrichment and proliferation issues would be dealt with separately in a secret side agreement in which North Korea would "acknowledge" the U.S. concerns over North Korean proliferation to Syria without confirming or denying them. This agreement is also supposed to have included a pledge by North Korea that it would not engage in any future nuclear proliferation. Administration officials in spring 2008 emphasized that ending plutonium production and tallying the plutonium stockpile were the highest priorities. However, concerns were raised in the Congress and elsewhere by those skeptical of this approach, with some observers wanting assurance that the North Korean declaration of its plutonium stockpile would be adequately verified before the United States removed them from the State Sponsors of Terrorism List.

On May 8, 2008, North Korean officials gave State Department Korean Affairs Director Sung Kim approximately 19,000 pages of documentation related to its nuclear program. According to a State Department fact sheet, the documents consist of operating records for the five-megawatt reactor [5-MW(e)] and fuel reprocessing plant at the Yongbyon nuclear complex, dating back to 1986. They reportedly include reactor operations and information on all three reprocessing campaigns undertaken by North Korea.[119] As referenced above, press reports indicated that U.S. personnel had found traces of highly-enriched uranium on these documents, raising new doubts about the extent of North Korea's uranium enrichment program at a sensitive juncture in the negotiations.[120]

On June 26, 2008, North Korea submitted a declaration of its nuclear programs to China, the chair of the Denuclearization Working Group. Ambassador Christopher Hill said in testimony to Congress that the "declaration package" addresses "its plutonium program, and acknowledged our concerns about the DPRK's uranium enrichment and nuclear proliferation activities,

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[117] David Albright, Paul Brannan, and Jacqueline Shire, "North Korea's Plutonium Declaration: A Starting Point for an Initial Verification Process," The Institute for Science and International Security, January 10, 2008. http://www.isis-online.org/publications/dprk/NorthKoreaDeclaration10Jan2008.pdf.

[118] See, for example, Helene Cooper, "Past Deals by N. Korea May Face Less Study," The New York Times, April 18, 2008. http://www.nytimes.com/2008/04/18/washington/18diplo.html?_r=2&adxnnl=1&oref=slogin&ref=world&adxnnlx=1208545358-9gpsLj35wtiPmoT8RHM6mQ and Glenn Kessler, "U.S. Ready to Lift Sanctions on North Korea," The Washington Post, April 11, 2008. http://www.washingtonpost.com/wp-dyn/content/article/2008/04/10/AR2008041004082.html?nav=emailpage.

[119] "Update on the Six-Party Talks," State Department Fact Sheet, May 10, 2008. http://www.state.gov/r/pa/prs/ps/2008/may/104558.htm.

[120] Glenn Kessler, "New Data Found On North Korea's Nuclear Capacity; Intelligence on Enriched Uranium Revives Questions About Weapons," The Washington Post, June 21, 2008.

specifically with regard to Syria."[121] Press reports have said that North Korea submitted a list of nuclear sites and declared 37 kg of plutonium in the 60-page document. The confidential message acknowledging U.S. concerns about uranium enrichment and proliferation activities was received days earlier.[122] In response, also on June 26, 2008, President Bush announced that the Trading with the Enemy Act (TWEA) would no longer apply to North Korea and notified Congress of his intent to remove North Korea's designation as a State Sponsor of Terrorism (SST) after the required 45-day wait period.[123] The day after the declaration was submitted the U.S. assisted North Korea in destroying the cooling tower at the 5-megawatt reactor at Yongbyon. Subsequent verification issues are discussed below.

Verification

IAEA inspectors returned to North Korea in July 2007 to monitor and verify the shut-down, install seals, and monitor facilities at the Yongbyon nuclear complex, and had a continuous presence there until mid-April 2009.[124] In his September 10, 2007, statement to the IAEA Board of Governors, Director General Mohamed ElBaradei stated that the IAEA was able to verify the shutdown of nuclear facilities, including the nuclear fuel fabrication plant, radio-chemical laboratory (reprocessing plant), and the 5 MWe experimental nuclear power reactor. Inspectors were also monitoring the halt in construction of the 50-megawatt nuclear power plant at Yongbyon and the 200-megawatt nuclear power plant in Taechon.[125] The United States has contributed $1.8 million as the U.S. voluntary contribution and Japan has contributed $500,000 to the IAEA for their work in North Korea.[126] In the future, the IAEA may be called on to investigate North Korea's past nuclear program in addition to monitoring activities; however, to date, its role was limited to monitoring the shut-down of Yongbyon facilities. The IAEA's role in disablement and future dismantlement efforts was not clearly determined. Some analysts recommended an observer role for the IAEA during disablement steps and continued IAEA monitoring to boost international confidence in the process.[127] The United States and North Korea reportedly agreed on an "consultative and support" role for the IAEA in future verification in October 2008.[128]

After IAEA inspectors were expelled from North Korea in 2002, information about North Korea's nuclear weapons production depended on remote monitoring and defector information, with

[121] Statement of Christopher R. Hill, Assistant Secretary of State, Bureau of East Asian and Pacific Affairs, U.S. Department of State, to the Senate Committee on Armed Services, July 31, 2008.

[122] Glenn Kessler, "Message to US Preceded North Korean Nuclear Declaration," The Washington Post, July 2, 2008.

[123] http://www.whitehouse.gov/news/releases/2008/06/20080626-4.html; http://www.state.gov/r/pa/prs/ps/2008/jun/106281.htm.

[124] "IAEA Team Confirms Shut Down of DPRK Nuclear Facilities," IAEA press release, July 18, 2007, at http://www.iaea.org/NewsCenter/PressReleases/2007/prn200712.html.

[125] GOV/2007/45-GC(51)/19, August 17, 2007.

[126] Statement of Christopher R. Hill Assistant Secretary, Bureau of East Asian and Pacific Affairs, Department of State before the House Committee on Foreign Affairs, Subcommittee on Asia, the Pacific and the Global Environment and Subcommittee on Terrorism, Nonproliferation and Trade, Joint Hearing on the North Korea Six-Party Process, October 25, 2007.

[127] North Korea reportedly did not want the IAEA involved and wanted the United States to do the disabling. Albright and Brannan, ibid.

[128] "U.S.-North Korea Understandings on Verification," October 11, 2008. http://2001-2009.state.gov/r/pa/prs/ps/2008/oct/110924.htm.

mixed results. Satellite images correctly indicated the start-up of the 5 MWe reactor, but gave no details about its operations. Satellites also detected trucks at Yongbyon in late January 2003, but could not confirm the movement of spent fuel to the reprocessing plant;[129] imagery reportedly detected activity at the reprocessing plant in April 2003, but could not confirm large-scale reprocessing;[130] and satellite imagery could not peer into an empty spent fuel pond, which was shown to U.S. visitors in January 2004. North Korean officials stated in 2004 that the reprocessing campaign was conducted continuously (four six-hour shifts). U.S. efforts to detect Krypton-85 (a by-product of reprocessing) reportedly suggested that some reprocessing had taken place, but were largely inconclusive. Even U.S. scientists visiting Pyongyang in January 2004 could not confirm North Korean claims of having reprocessed the spent fuel or that the material shown was in fact plutonium. These are some of the uncertainties verification measures will seek to answer.

Verification received increased attention in the Six-Party process beginning in spring 2008. Statements made by President Bush and Secretary of State Rice in June 2008 further demonstrated that the U.S. Administration was linking SST removal with progress on verification issues.[131] U.S. officials have said there have been spoken agreements with the North Koreans saying that the only way the declaration can be deemed "complete and correct" is if it verifiable.

The State Department said in a June 26 fact sheet that by submitting the declaration, North Korea had "begun to fulfill its declaration commitment." The fact sheet also stated that a comprehensive verification regime would include "short notice access to declared or suspect sites related to the North Korean nuclear program, access to nuclear materials, environmental and bulk sampling of materials and equipment, interviews with personnel in North Korea, as well as access to additional documentation and records for all nuclear related facilities and operations." It also said that the actual rescission of North Korea's designation as a State Sponsor of Terrorism will occur only after "the Six Parties reach agreement on acceptable verification principles and an acceptable verification protocol; the Six Parties have established an acceptable monitoring mechanism; and verification activities have begun."[132]

On July 12, 2008, the Six Parties agreed unanimously to principles for a "verification mechanism" for the denuclearization of the Korean Peninsula, to be detailed by the denuclearization working group.[133] Thereafter, U.S. negotiators submitted a proposed verification protocol to North Korea called the "Verification Measures Discussion Paper" which outlined extensive measures to verify all aspects of North Korea's nuclear programs, including plutonium production, uranium enrichment, weapons, weapons production and testing, and proliferation activities.[134] North Korea reportedly submitted a counter-proposal that objected to provisions related to inspections at undeclared facilities and the taking of samples.

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[129] "Reactor Restarted, North Korea Says," *Washington Post*, February 6, 2003.

[130] "US Suspects North Korea Moved Ahead on Weapons," *New York Times*, May 6, 2003.

[131] "President Bush Discusses North Korea," White House press release, June 26, 2008; Condoleezza Rice, "U.S. Policy Toward Asia," Heritage Foundation speech, June 18, 2008.

[132] "North Korea: Presidential Action on State Sponsor of Terrorism (SST) and the Trading with the Enemy Act (TWEA)," State Department Fact Sheet, June 26, 2008. http://www.state.gov/r/pa/prs/ps/2008/jun/106281.htm.

[133] Press Communique of the Heads of Delegation Meeting of the Sixth Round of the Six-Party Talks, Beijing, July 12, 2008. http://www.mofa.go.jp/region/asia-paci/n_korea/6party/press0807.html.

[134] This paper was made public by the Washington Post. Glenn Kessler, "Far-Reaching U.S. Plan Impaired North Korea Deal," The Washington Post, September 26, 2008.

The 45-day wait period for the SST List removal ended on August 11, 2008, but the Administration did not take action. On August 26, the North Korean news agency announced it had suspended disablement activities at Yongbyon as of August 14 since the United States had not removed it from the terrorism list. The North Korean Foreign Ministry statement said that the agreement had been to delist North Korea once it had submitted a declaration of its nuclear programs, not once verification measures had been agreed upon. It said, "As far as the verification is concerned, it is a commitment to be fulfilled by the six parties at the final phase of the denuclearization of the whole Korean Peninsula according to the September 19 joint statement.... All that was agreed upon at the present phase was to set up verification and monitoring mechanisms within the framework of the six parties."[135] The statement also threatened to restore facilities at Yongbyon.

On Monday, September 22, 2008, North Korea asked the International Atomic Energy Agency (IAEA) personnel monitoring the shut-down of facilities at the Yongbyon nuclear complex to remove the seals and surveillance equipment from the plutonium reprocessing plant. North Korea informed the IAEA that inspectors would no longer have access to that facility. IAEA inspectors and U.S. Department of Energy personnel located at Yongbyon were not expelled from the Yongbyon site, and other monitoring and inspection activities related to disablement continued. However, North Korea told the IAEA that it planned to "introduce nuclear material to the reprocessing plant in one week's time."[136]

These actions were reversed when, in early October, the United States and North Korea agreed on a "verification mechanism" to determine the accuracy of the DPRK's declaration of its plutonium production. Ambassador Hill traveled to Pyongyang October 2-3 for further bilateral talks on the verification agreement. As a result of these talks, the United States and DPRK reached agreement on verification measures. Although the document has not yet been made public, according to State Department officials North Korea has agreed to the United States taking samples out of country for review; visits to all declared sites and to undeclared sites by mutual consent; participation of South Korea and Japan in verification; and a consultative role for the IAEA.[137] They also agreed that "all measures contained in the Verification Protocol will apply to the plutonium-based program and any uranium enrichment and proliferation activities." According to the State Department's fact sheet on the agreement, the measures are "codified in a joint document between the United States and North Korea and certain other understandings." Many observers interpret "other understandings" as referring to verbal agreements or separate documents, but neither the United States nor North Korea has made this clear. The United States removed North Korea from the State Sponsors of Terrorism List on October 11.

Then-presidential candidate Barack Obama issued a statement after the October 11, 2008, SST list removal that emphasized strong verification measures:

> If North Korea refuses to permit robust verification, we should lead all members of the Six Party talks in suspending energy assistance, re-imposing sanctions that have recently been waived, and considering new restrictions. Our objective remains the complete and verifiable

[135] "Foreign Ministry's Spokesman on DPRK's Decision to Suspend Activities to Disable Nuclear Facilities," KCNA, August 27, 2008. http://www.kcna.co.jp/index-e.htm.

[136] http://www.iaea.org/NewsCenter/PressReleases/2008/prn200813.html.

[137] See October 11, 2008, State Department Press Statement http://2001-2009.state.gov/r/pa/prs/ps/2008/oct/110924.htm and Fact Sheet http://2001-2009.state.gov/r/pa/prs/ps/2008/oct/110924.htm.

> elimination of North Korea's nuclear weapons programs. This must include getting clarity on North Korea's efforts to enrich uranium and its proliferation of nuclear technology abroad.[138]

Key concerns about the details of the tentative verification agreement as well as whether North Korea had actually agreed to the provisions surfaced soon after the announcement. For example, while State Department officials said that North Korea agreed to removal of samples from the country for analysis, North Korean statements in press reports contradicted this.[139] The Six Parties were unable to reach agreement on a codified version of the verification measures in their December 2008 meeting, as North Korea appeared to reject inclusion of sampling provisions.

As described above, verification and monitoring activities in North Korea ended when Pyongyang asked U.S. and international inspectors to leave the country on April 14, 2009.[140] North Korea reportedly told Bill Richardson in December 2010 that it would allow IAEA inspectors into the country to verify that the uranium enrichment plant built at Yongbyon was for peaceful purposes and was not producing highly enriched uranium (which could be used for weapons).[141]

Future Considerations

The DPRK committed in 2005 to abandoning "all nuclear weapons and existing nuclear programs" and to returning to the Non-Proliferation Treaty and IAEA safeguards at an early date.[142] If the DPRK decides to return to the Six-Party Talks and uphold these commitments, there will be a number of issues that have not yet been resolved.

The next stage, after disablement, was to have been the decommissioning and dismantlement of the weapons production facilities. The terms for this work still need to be negotiated. This stage may include a return of IAEA monitoring of nuclear material stocks (including weapons-usable separated plutonium) and verification of actual weapons dismantlement. The question of dismantling North Korea's nuclear warheads has not yet been addressed directly, although the September 2005 joint statement commits North Korea to abandon all nuclear weapons. Critics have raised concerns about the lack of clear verification provisions for these steps and the omission of specific references to key issues such as fissile materials, warheads, the reported uranium enrichment program, the nuclear test site, and nuclear proliferation activities and history (such as possible nuclear transfers to Syria).

Some analysts have proposed that the United States should be ready to implement cooperative threat reduction (CTR)-style programs in North Korea, as were created for the former Soviet Union.[143] These might include the redirection of North Korean nuclear weapon scientists to

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[138] Statement of Senator Barack Obama on the Agreement with North Korea, October 11, 2008.

[139] "SKorea to press for sampling at NKorean nuke plants," Agence France Presse, November 14, 2008. http://news.yahoo.com/s/afp/20081113/wl_asia_afp/nkoreanuclearweaponsskoreaus.

[140] "IAEA Inspectors Asked to Leave the Democratic People's Republic of Korea," IAEA Press Release, April 14, 2009, http://www.iaea.org/NewsCenter/PressReleases/2009/prn200903.html.

[141] Chris Buckley, "North Korea to allow in IAEA inspectors—Richardson," *Reuters*, December 21, 2010.

[142] http://2001-2009.state.gov/r/pa/prs/ps/2005/53490.htm.

[143] Joel Wit, Jon Wolfsthal, Choong-suk Oh, "The Six Party Talks and Beyond: Cooperative Threat Reduction in North Korea," CSIS Press, December 2005. http://www.csis.org/media/csis/pubs/051216_ctr.pdf.

peaceful work.[144] North Korean officials have said that they are interested in eventually reorienting the Yongbyon workforce to the peaceful use of nuclear energy.[145] This could include research, medical and industrial applications, and not necessarily a nuclear power program.

An agreement reached in February 2012 (described below) gave priority to moratoria on key weapons development activities—nuclear testing, long-range missile testing, uranium enrichment—in an effort to slow North Korea's progress and gather information (through inspections), and as a precondition to returning to the negotiating table. That agreement collapsed, but future talks could explore similar measures as well as more permanent solutions, which would most likely include opening up to verification any additional uranium enrichment facilities, dismantlement of weapons material production facilities, and verification of past plutonium production and stocks at a minimum. North Korea has been reluctant to agree to this level of transparency in the past.

The Leap Day Agreement

A set of February 2012 agreements collapsed after North Korea violated its missile moratorium with a failed satellite launch in April. The United States and North Korea on February 29, 2012, had separately announced agreement on a number of steps that could have paved the way for a return to denuclearization under the Six-Party Talks process.[146] Efforts toward dismantling North Korea's nuclear weapons program under the Six-Party Talks had been stalled since the spring of 2009 when North Korea conducted a second nuclear test. [147]

In the February 29, 2012, announcements, North Korea committed to

- a long-range missile testing moratorium,
- a nuclear testing moratorium,
- a moratorium on enrichment activities at Yongbyon, and
- a return of IAEA inspectors to the Yongbyon nuclear facilities.

The United States announced that the two countries would hold further talks to finalize details on a "targeted U.S. program consisting of an initial 240,000 metric tons of nutritional assistance with the prospect of additional assistance based on continued need."[148] The U.S. statement also emphasized several wider security issues, such as its continued commitment to the 1953 armistice agreement and desire to increase people-to-people contacts with the DPRK.

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[144] David Albright, "Phased International Cooperation with North Korea's Civil Nuclear Programs," *Institute for Science and International Security,* March 19, 2007. http://www.isis-online.org/publications/dprk/CivilNuclearNK.pdf.

[145] "North Korea and Its Nuclear Program—A Reality Check," A Report to Members of the Committee on Foreign Relations, United States Senate, October 2008, S. Prt. 110-50.

[146] "U.S.-DPRK Bilateral Discussions," State Department Press Statement, February 29, 2012. http://www.state.gov/r/pa/prs/ps/2012/02/184869.htm.

[147] See CRS Report R41259, *North Korea: U.S. Relations, Nuclear Diplomacy, and Internal Situation*, by Emma Chanlett-Avery and Ian E. Rinehart.

[148] For details see CRS Report R40095, *Foreign Assistance to North Korea*, by Mark E. Manyin and Mary Beth Nikitin.

The DPRK statement included a reference to a "discussion of issues concerning the lifting of sanctions on the DPRK and provision of light water reactors" as priorities once the Six-Party Talks have resumed. The United States did not include those issues in its statement, and they are likely areas of continued disagreement between the parties. In the past, U.S. officials have not supported the lifting of sanctions until after full denuclearization and a determination by the U.N. Security Council, and have supported only "discussion" of light-water reactors in the 2005 Six-Party statement.

The February 29 announcement was the culmination of several rounds of bilateral talks since summer 2011. After the death of Kim Jong Il in December 2011, U.S. officials were uncertain whether the new leader of North Korea, Kim Jong-Un, would agree to terms that were being discussed. Several questions were still to be resolved even before the agreement's collapse—including to what extent North Koreans would grant the IAEA inspectors access to the Yongbyon facilities, and whether the North Koreans would have agreed to U.S. requirements for monitoring of food aid.

Additional questions surrounded the potential impact missile and nuclear testing moratoria would have had on North Korea's weapons programs. Some prominent analysts of North Korea's nuclear and missile programs emphasize that halting progress on North Korea's ability to develop a warhead on a long-range missile should be the United States' top priority, and further missile and nuclear testing would be necessary for North Korea to accomplish this.[149] Others point out that weaponization activities and a clandestine uranium enrichment facility or facilities could continue even if a moratorium of testing and activities at Yongbyon was in place.

Proliferation Issues[150]

Concerns persist that North Korea will continue its proliferation of missile and nuclear technology for a variety of motivations, including financial profit, joint exchange of data to develop its own systems, and as part of the general provocative trend. According to DNI Admiral Dennis Blair's testimony to Congress in 2009, North Korea is known to have sold in the past ballistic missiles and associated materials to "several Middle Eastern countries, including Iran, and, in our assessment, assisted Syria with the construction of a nuclear reactor."[151] On the likelihood of nuclear proliferation from the DPRK, the DNI assessed that

> Pyongyang is less likely to risk selling nuclear weapons or weapons-quantities of fissile material than nuclear technology or less sensitive equipment to other countries or non-state actors, in part because it needs its limited fissile material for its own deterrent. Pyongyang probably also perceives that it would risk a regime-ending military confrontation with the United States if the nuclear material was used by another country or group in a nuclear strike or terrorist attacks and the United States could trace the material back to North Korea. It is possible, however, that the North might find a nuclear weapons or fissile material transfer

[149] Siegfried S. Hecker, Robert Carlin, "North Korea in 2011: Countdown to Kim il-Sung's Centenary," *Bulletin of the Atomic Scientists*, Vol. 68 (50), 2012.

[150] Also see "Nuclear Collaboration with Iran and Syria" in CRS Report RL33590, *North Korea's Nuclear Weapons Development and Diplomacy*, by Larry A. Niksch, and "Clandestine Nuclear Program and the IAEA Investigation" in CRS Report RL33487, *Armed Conflict in Syria: U.S. and International Response*, by Jeremy M. Sharp and Christopher M. Blanchard.

[151] http://intelligence.senate.gov/090212/blair.pdf.

> more appealing if its own stockpile grows larger and/or it faces an extreme economic crisis where the potentially huge revenue from such a sale could help the country survive.

Due to concerns of proliferation and North Korea's past track record, the Security Council deliberations on a resolution condemning the May 2009 North Korean test focused on ways to interdict North Korean shipments of missile and WMD-related technologies and prevent their financing. U.N. Security Council Resolution 1874 calls on all states to "inspect, in accordance with their national legal authorities and consistent with international law, all cargo to and from the DPRK, in their territory, including seaports and airports," if that state has information that the cargo is prohibited by U.N. Security Council Resolutions. This would include cargo related to heavy arms (see UNSCR 1718 (8)(a)) and nuclear-related, ballistic missile-related, or other WMD-related programs. The resolution also calls on states to inspect suspect vessels on the high seas, with the consent of the flag state, and prohibits "bunkering services" for such shipments such as refueling or servicing. This is significant because North Korea reportedly ships most goods under its own flag, and typically uses small vessels that would need refueling. Reportedly due to objections by Russia and China, the resolution does not authorize the use of force if a North Korean vessel resists inspection.[152] The resolution also has strict provisions regarding financial services and transfer of funds through third parties, measures that may also help prevent proliferation-related transfers. Resolution 1874 bans all arms transfers from North Korea, and all arms transfers to North Korea except for small arms and light weapons (which require notification).

In addition, the Proliferation Security Initiative is a U.S.-led coordinating mechanism that is meant to guide international cooperation in carrying out interdictions of proscribed WMD and missile-related goods, including to or from North Korea.[153] China does not participate in PSI. Therefore, a key question for implementation of the Security Council resolution will be China's commitment to actual interdiction measures and willingness of others to share sensitive information, particularly if Chinese firms are implicated, as has been the case in the past. Also, there is little emphasis on airspace interdictions, which would be relevant, for example, in the case of North Korean shipments passing over Chinese airspace on their way to the Middle East. However, questions remain about the true commitment of China and others to preventing WMD and missile-related transfers to and from North Korea, in particular because North Korea has stated it views any interdiction as an "act of war."

Issues for Congress

Funding[154]

Congress will have a clear role in considering U.S. funding for any future dismantlement of North Korea's nuclear facilities, as well as other inducements for cooperation as agreed in the Six-Party Talks. U.S. assistance to nuclear disablement activities at Yongbyon was funded through the State Department's Nonproliferation and Disarmament Fund (NDF). The State Department paid the

[152] Blaine Harden, "North Korea Says It Will Start Enriching Uranium," *Washington Post*, June 14, 2009.

[153] For background on PSI, see CRS Report RL34327, *Proliferation Security Initiative (PSI)*, by Mary Beth Nikitin.

[154] For a detailed discussion, see CRS Report R40095, *Foreign Assistance to North Korea*, by Mark E. Manyin and Mary Beth Nikitin.

North Korean government for the labor costs of disablement activities, and also paying for related equipment and fuel. Approximately $20 million was approved for this purpose. NDF funds may be used "notwithstanding any other provision of law" and therefore may be used to pay North Korea. DOE's National Nuclear Security Administration (NNSA) has been contributing its personnel as technical advisors to the U.S. Six-Party delegation and as technical teams on the ground at Yongbyon overseeing disablement measures. NNSA has estimated it spent approximately $15 million in support of Phase Two (Yongbyon disablement) implementation.[155] Congress has also provided funding for energy assistance to North Korea under the Six-Party Talks through the State Department's Economic Support Fund.

Authority

Congress also plays a role in establishing legal authority for assistance to nuclear disablement and dismantlement in North Korea. Section 102 (b) (the "Glenn Amendment" *U.S.C. 2799aa-1*) of the Arms Export Control Act prohibits assistance to a non-nuclear weapon state under the NPT that has detonated a nuclear explosive device. Due to this restriction, DOE funds cannot be spent in North Korea without a waiver. Congress passed language in the FY2008 Supplemental Appropriations Act (P.L. 110-252) that would allow the President to waive the Glenn Amendment restrictions and that stipulates that funds may only be used for the purpose of eliminating North Korea's WMD and missile-related programs.[156] If the President had exercised the Glenn Amendment waiver authority, then DOE "will be able to procure, ship to North Korea, and use equipment required to support the full range of disablement, dismantlement, verification, and material packaging and removal activities that Phase Three will likely entail."[157] NNSA estimated that this would cost over $360 million in FY2009 if verification proceeded and North Korea agreed to the packaging and disposition of separated plutonium and spent fuel at Yongbyon. Because North Korea conducted an underground nuclear test on May 25, 2009, the waiver may no longer be issued under P.L. 110-252. The law stipulated that a nuclear test after the date of enactment would nullify the waiver authority.[158]

Congress had expressed concern that the Department of Energy have enough funds available to support the disablement of North Korea's nuclear weapons arsenal and production capability. In the FY2008 Consolidated Appropriations Act, the Committees on Appropriations provided DOE's NNSA with funding discretion to provide up to $10 million towards its activities in North Korea. It also directs the department to submit a supplemental budget request if additional resources are required during FY2008.[159] However, due to North Korean withdrawal from the Six-Party Talks, Congress did not fund Administration requests in the FY2009 Supplemental Appropriations or the

[155] Statement of William H. Tobey, National Nuclear Security Administration, U.S. Department of Energy, to the Senate Committee on Armed Services, July 31, 2008.

[156] Similar language appeared in the Senate version of the FY2009 Duncan Hunter National Defense Authorization Act (P.L. 110-417), but was not included in the House version. The final act includes it under "legislative provisions not adopted" under Title XII, since the waiver authority was passed earlier in the FY2008 Supplemental. See joint explanatory note: http://armedservices.house.gov/pdfs/fy09ndaa/FY09conf/ FY2009NDAAJointExplanatoryStatement.pdf.

[157] Tobey testimony, ibid.

[158] In P.L. 110-252 Section 1405 (b)(3), there is an exception for activities described in Subparas A or B of section102(b)1 of AECA. This includes "transfers to a non-nuclear weapon state a nuclear explosive device," and "is a non-nuclear-weapon state and either (i) receives a nuclear explosive device, or (ii) detonates a nuclear explosive device."

[159] See p. 50 of http://www.rules.house.gov/110/text/omni/jes/jesdivc.pdf.

FY2010 Consolidated Appropriations Act. The State Department's NDF, which did receive funding, could be used for denuclearization assistance in the case of a breakthrough in the talks.

Beyond the Glenn amendment restrictions, Department of Defense funds must be specifically appropriated for use in North Korea. Section 8045 of the FY2008 Defense Appropriations Act says that "None of the funds appropriated or otherwise made available in this Act may be obligated or expended for assistance to the Democratic People's Republic of Korea unless specifically appropriated for that purpose." Section 8044 of the FY2009 Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009 (P.L. 110-329) also contains this language. However, authorization was given for CTR funds to be used globally. The FY2008 Defense Authorization Act specifically encourages "activities relating to the denuclearization of the Democratic People's Republic of Korea" as a potential new initiative for CTR work. Senator Richard Lugar has proposed that the CTR program be granted "notwithstanding authority"[160] for this work since the Defense Department's experience in the former Soviet Union, expertise and resources could make it well-positioned to conduct threat reduction work in North Korea and elsewhere. The Department of Defense did not work on recent disablement efforts, but there may be a future role for DOD if North Korea in the future agrees to dismantlement work.

Policy Guidance

Congress may choose to influence the course of negotiations with North Korea through legislation that limits or places requirements on U.S. diplomatic actions. For example, the North Korean Counter-Terrorism and Non-Proliferation Act (H.R. 3650) introduced in the 110th Congress called for certification by the President that North Korea has met a range of nonproliferation and political benchmarks before the Administration could lift any U.S. sanctions.[161] Congress could establish reporting requirements on progress, or condition appropriations or disbursement to North Korea upon verification measures.[162] Congress could also be involved in other aspects of potential changes in U.S. relations with Pyongyang, such as the monitoring of human rights issues, funding for further denuclearization steps including verification provisions, and establishment of normalized ties once nuclear dismantlement has been achieved. Congress also plays a role in setting sanctions policies, as in the bill Security through Termination of Proliferation Act of 2009 (H.R. 485).

Congress also sometimes gives its sense of what actions North Korea should take. House Resolution 1735, passed by the House on December 1, 2010, called on North Korea to

> immediately cease any and all uranium enrichment activities and take concrete steps to dismantle, under international verification and assistance, all sensitive nuclear facilities, in accordance with United Nations Security Council Resolutions 1695 (2006), 1718 (2006), and 1874 (2009);

This resolution was passed following North Korea's unveiling of a uranium enrichment plant at Yongbyon in November 2010 and its attack on Yeonpyeong Island.

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[160] So that funds may be used "notwithstanding any other provision of law." Senator Richard Lugar, Remarks to National Defense University, October 2, 2008. http://lugar.senate.gov/record.cfm?id=304026&&.

[161] This bill was introduced and referred to the House Committee on Foreign Affairs. H.R. 3650, September 25, 2007.

[162] For example, see S.Res. 399.

Congress may also wish to examine the implementations of multilateral sanctions on North Korea. The United Nations Security Council (UNSC) has passed resolutions condemning North Korean missile and nuclear tests and imposing increasingly strict sanctions on the already-isolated regime. The resolutions have condemned the tests, and called for North Korea to abandon its ballistic missile and nuclear programs. UNSC sanctions on North Korea primarily ban all trade in military goods and WMD-related and missile technologies, as well as forms of financial support that could contribute to prohibited DPRK weapons programs. However, the UNSC sanctions are not an embargo, and explicit exclusions are made for humanitarian and denuclearization aid. Several problems arise in implementation especially related to Chinese companies' trade in dual-use goods to North Korea. A UN sanctions committee and Panel of Experts monitor implementation of international sanctions on North Korea.

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