

# CRS Report for Congress

## North Korea's Nuclear Weapons: Latest Developments

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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 verifying dismantlement of North Korea's nuclear facilities as agreed in the Six-Party Talks. The Six-Party Talks include the United States, South Korea, Japan, China, Russia, and North Korea, and were begun in August 2003 to attempt to resolve the current crisis over North Korean nuclear weapons.

Beginning in late 2002, North Korea ended an eight-year freeze on its plutonium production program, expelled international inspectors, and restarted facilities. North Korea may have produced enough additional plutonium for five nuclear warheads since 2002. In total, it is estimated that North Korea has up to 50 kilograms of separated plutonium, enough for at least half a dozen nuclear weapons. On February 10, 2005, North Korea announced that it had manufactured nuclear weapons for self-defense and that it would bolster its nuclear weapons arsenal. On October 9, 2006, North Korea conducted a nuclear test, with a yield of under 1 kiloton. The United States and other countries condemned the test, and the United Nations Security Council passed Resolution 1718 on October 14, 2006, that requires North Korea to (1) refrain from nuclear or missile tests, (2) rejoin the Nuclear Nonproliferation Treaty (NPT), and (3) abandon its weapons of mass destruction and ballistic missile programs.

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. Key components of the agreement include halting production at the Yongbyon nuclear complex and delivery of heavy fuel oil to North Korea. In July 2007, International Atomic Energy Agency (IAEA) inspectors verified the shutdown of the Yongbyon facilities. On October 3, 2007, the Six Parties adopted a Joint Statement in which North Korea agreed to disable the Yongbyon facilities and provide a declaration of all its nuclear programs by December 31, 2007. The October 2007 statement said the United States would lead disablement activities and provide the initial funding for those activities.

Much still remains to be confirmed regarding North Korea's nuclear weapons production capabilities and delivery systems, particularly regarding uranium enrichment. Although U.S. officials confronted the North Koreans in 2002 with intelligence that reportedly proved that Pyongyang was pursuing a uranium enrichment program, U.S. intelligence officials have said they do not know where the uranium program is based and have over time shown less confidence about what the scope of the program might be. Further, although seismographs registered the October 9, 2006, detonation and environmental sampling confirmed radioactivity, uncertainty about the weapon's design and sophistication remains. Additional transparency on fissile material stocks and programs, including the uranium enrichment program, may contribute to a better picture of North Korean nuclear weapons capabilities. This report will be updated as events warrant.

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# North Korea's Nuclear Weapons: Latest Developments

## 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 (5MWe). It was capable of producing about 6 kilograms (Kg) of plutonium per year and began operating in 1986.<sup>1</sup> Later that year, U.S. satellites detected high explosives testing and a new plant to separate plutonium. In addition, construction of two larger reactors (50MWe at Yongbyon and 200MWe 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.<sup>2</sup> At that time, western intelligence agencies estimated that North Korea had separated enough plutonium for one or two bombs; other sources estimated four to five 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.<sup>3</sup> In response, North Korea kicked out international monitors, broke

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<sup>1</sup> 5MWe 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).

<sup>2</sup> See CRS Report RL33590, *North Korea's Nuclear Weapons Development and Diplomacy*, by Larry Niksch.

<sup>3</sup> “Adherence To and Compliance With Arms Control, Nonproliferation and Disarmament (continued...)”

the seals at the Yongbyon nuclear complex, and restarted its 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.<sup>4</sup> After negotiations broke down, North Korea tested a nuclear device in October 2006. The Denuclearization Action Plan of February 2007 called for shut-down of facilities and provision of fuel oil to North Korea.<sup>5</sup> Currently in the second phase of this plan, the United States is working with North Korea to disable key facilities and expects a full declaration of North Korea's nuclear program by the end of 2007.

The Denuclearization Action Plan does not include actions that will address fissile material stocks, the uranium enrichment program, or dismantlement of warheads and instead focuses on shutting down and disabling, for at least a year's time, the key plutonium production facilities. A later stage, to begin in January 2008, is supposed to address 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 will require transparency and careful verification for "complete, verifiable, irreversible" disarmament to be achieved.

## Weapons Production Milestones

Acquiring fissile material — plutonium-239 or highly enriched uranium (HEU) — is the key hurdle in nuclear weapons development.<sup>6</sup> Producing these two materials is technically challenging; in comparison, many experts believe weaponization to be relatively easy.<sup>7</sup> 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. In its nuclear reactor, North Korea uses magnox fuel — natural uranium (>99%U-238) metal, wrapped in magnesium-alloy cladding. About 8,000 fuel rods constitute a fuel core for the reactor.

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<sup>3</sup> (...continued)

Agreements and Commitments," U.S. Department of State, August 2005.

<sup>4</sup> "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>].

<sup>5</sup> The United States authorized its first shipment of 50,000 metric tons of heavy fuel oil to North Korea in September 2007. Peter Baker, "U.S. to Ship Fuel Oil to North Korea," *The Washington Post*, September 29, 2007.

<sup>6</sup> Highly enriched uranium (HEU) has 20% or more U-235 isotope; 90% U-235 is weapons-grade.

<sup>7</sup> The physical principles of weaponization are well-known, but producing a weapon with high reliability, effectiveness, and efficiency without testing presents significant challenges.

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.<sup>8</sup> 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 uses 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.<sup>9</sup>

North Korea appears to have mastered the engineering requirements of plutonium production. It has operated its 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.<sup>10</sup> 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.

## Verification and “Disablement”

In September 2005, North Korea agreed to abandon “all nuclear weapons and existing nuclear programs,” but implementation of this goal was stalled.<sup>11</sup> 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. UN Security Council Resolution 1718 calls on North Korea to abandon its nuclear weapons in a “complete, verifiable, and irreversible manner.”<sup>12</sup> In February 2007, as part of implementation of the September 2005 Joint Statement,

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<sup>8</sup> 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.

<sup>9</sup> 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/~globsec/publications/pdf/8\\_3Dreicer.pdf](http://www.princeton.edu/~globsec/publications/pdf/8_3Dreicer.pdf)].

<sup>10</sup> 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.

<sup>11</sup> 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>].

<sup>12</sup> United Nations Security Council Resolution 1718, October 14, 2006, at [<http://daccessdds.un.org/doc/UNDOC/GEN/N06/572/07/PDF/N0657207.pdf?OpenElement>].

North Korea committed to disable all nuclear facilities and provide a “complete and correct” declaration of all its nuclear programs by December 31, 2007.<sup>13</sup> This declaration is expected 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.<sup>14</sup>

The October 2007 joint statement said the United States would lead disablement activities and provide the initial funding for those activities.<sup>15</sup> 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 have said that they would prefer a disablement process that would require a 12-month time period to start up the facility again.<sup>16</sup> A team of U.S. technical experts in mid-October 2007 continued negotiations with the North Koreans on a plan that reportedly includes 10 discrete steps to disable the three main Yongbyon facilities related to North Korea’s plutonium program (nuclear fuel fabrication plant, radio-chemical laboratory and 5-megawatt experimental nuclear power reactor).<sup>17</sup> The first step will be to remove the irradiated fuel from the reactor and store it in an adjacent cooling pond. The specifics of the other nine steps (other than that there will be three for each facility) have not yet been agreed upon.<sup>18</sup> Disablement steps will need to be carefully chosen in order to preserve information to completely verify the scope of the nuclear program. The disablement process began in early November 2007.<sup>19</sup> Japan is also interested in contributing expertise, but it is not clear if this will be agreed to by North Korea.<sup>20</sup>

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 have had a continuous presence there since then.<sup>21</sup> In his September 10, 2007,

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<sup>13</sup> “Denuclearization Action Plan,” February 13, 2007, at [<http://www.state.gov/r/pa/prs/ps/2007/february/80479.htm>].

<sup>14</sup> 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>].

<sup>15</sup> 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>].

<sup>16</sup> 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>].

<sup>17</sup> “North Korea ‘Agrees to Nuclear Disablement Procedure,’” *Chosun Ilbo*, October 27, 2007.

<sup>18</sup> David Albright and Paul Brannan, “Disabling DPRK Nuclear Facilities,” United States Institute of Peace Working Paper, October 23, 2007.

<sup>19</sup> “U.S. Team heads to N.K. to begin nuclear disablement,” *Yonhap English News*, October 31, 2007.

<sup>20</sup> “Japan Eyes Support for Disabling N. Korea Nuke Facilities,” *Jiji Press English News Service*, October 29, 2007.

<sup>21</sup> “IAEA Team Confirms Shut Down of DPRK Nuclear Facilities,” IAEA press release, July (continued...)

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 5MWe experimental nuclear power reactor. Inspectors are also monitoring the halt in construction of the 50-megawatt nuclear power plant at Yongbyon and the 200-megawatt nuclear power plant in Taechon.<sup>22</sup> 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.<sup>23</sup> In the future, the IAEA will also likely be called on to investigate North Korea's past nuclear program in addition to monitoring activities. The IAEA's role in disablement and future dismantlement efforts has yet to be determined. Some analysts recommend an observer role for the IAEA during disablement steps and continued IAEA monitoring to boost international confidence in the process.<sup>24</sup>

Since IAEA inspectors were expelled from North Korea in 2002, information about North Korea's nuclear weapons production has depended on remote monitoring and defector information, with mixed results. Satellite images correctly indicated the start-up of the 5MWe 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;<sup>25</sup> imagery reportedly detected activity at the reprocessing plant in April 2003, but could not confirm large-scale reprocessing;<sup>26</sup> 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. Verifying those claims will require greater access to the material and North Korean cooperation, and it is hoped that significant progress will be made on these issues by the December 31, 2007, deadline for a North Korean declaration detailing its nuclear program.

The next stage of verification, after disablement, will be the decommissioning and dismantlement of the weapons production facilities. The terms for this work still

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<sup>21</sup> (...continued)

18, 2007, a t [<http://www.iaea.org/NewsCenter/PressReleases/2007/prn200712.html>].

<sup>22</sup> GOV/2007/45-GC(51)/19, August 17, 2007.

<sup>23</sup> 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.

<sup>24</sup> North Korea reportedly did not want the IAEA involved and wanted the United States to do the disabling. Albright and Brannan, *ibid*.

<sup>25</sup> "Reactor Restarted, North Korea Says," *Washington Post*, February 6, 2003.

<sup>26</sup> "US Suspects North Korea Moved Ahead on Weapons," *New York Times*, May 6, 2003.



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. Assistant Secretary Christopher Hill has said that the issue of which states will participate in the verification is under discussion, but may include the nuclear-weapon states amongst the six parties: the United States, Russia, and China. 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, and the nuclear test site in the latest agreements.<sup>27</sup> In remarks to journalists, Assistant Secretary Hill has said that warhead dismantlement will be addressed in the next stage — the “endgame” or the “weapons phase” — which he hoped would start at the beginning of 2008.<sup>28</sup>

## The October 9, 2006, Nuclear Test<sup>29</sup>

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.<sup>30</sup> However, the sub-kiloton yield of the test suggests that the weapon design or manufacturing process likely needs improvement.<sup>31</sup> North Korea reportedly told China before the test that it expected a yield of 4 kilotons, but seismic data confirmed that the yield was less than 1 kt.<sup>32</sup> Radioactive debris indicates that the explosion was a nuclear test, and that a plutonium device was used.<sup>33</sup> It is widely

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<sup>27</sup> Ileana Ros-Lehtinen, “Verification Holds the Key,” *The Washington Times*, October 7, 2007; Sharon Squassoni, “Partial Progress,” *The Guardian*, October 9, 2007; Bruce Klingner, “North Korea: Worrisome Gaps in Six-Party Talks’ Joint Statement,” *Heritage Foundation WebMemo* No. 1655, October 4, 2007.

<sup>28</sup> On-the-Record Briefing by 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 On His Upcoming Trip and the Six-Party Talks, U.S. State Department, August 29, 2007, at [<http://www.state.gov/r/pa/prs/ps/2007/aug/91612.htm>].

<sup>29</sup> See also CRS Report RL33709, *North Korea's Nuclear Test: Motivations, Implications, and U.S. Options*, by Emma Chanlett-Avery and Sharon Squassoni.

<sup>30</sup> “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](http://www.dni.gov/announcements/20061016_release.pdf)].

<sup>31</sup> By comparison, a simple plutonium implosion device normally would produce a larger blast, perhaps 5 to 20 kilotons. The first nuclear tests conducted by other states range from 9 kt (Pakistan) to 60kt (France), but tests by the United States, China, Britain, and Russia were in the 20kt-range.

<sup>32</sup> 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>].

<sup>33</sup> Thom Shanker and David Sanger, “North Korean fuel identified as plutonium,” *New York Times* (continued...)

believed that the warhead design was an implosion device.<sup>34</sup> 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.<sup>35</sup>

The test's low yield may not have been a 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.<sup>36</sup>

## Estimating Nuclear Warheads and 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.”<sup>37</sup> In February 2005, North Korea officially announced that it had “manufactured nukes for self-defense.”<sup>38</sup> Although North Korea has tested one device, Vice Foreign Minister Kim Gye Gwan has previously said that North Korea possesses multiple bombs and was building more.<sup>39</sup>

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 8kg of Pu and 25kg for HEU per weapon<sup>40</sup>. The amount of fissile material used in

<sup>33</sup> (...continued)

*Times*, October 17, 2006, 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](http://armscontrol.org/act/2006_11/tech.asp#Sidebar1)].

<sup>34</sup> 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](http://www.fas.org/irp/congress/2003_hr/021103qfr-cia.pdf)].

<sup>35</sup> Siegfried Hecker, “Report on North Korean Nuclear Program,” Center for International Security and Cooperation, Stanford University, November 15, 2006.

<sup>36</sup> Siegfried Hecker, “Report on North Korean Nuclear Program,” Center for International Security and Cooperation, Stanford University, November 15, 2006.

<sup>37</sup> Transcript of December 29, 2002, *Meet the Press*.

<sup>38</sup> 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.

<sup>39</sup> “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>].

<sup>40</sup> IAEA Safeguards Glossary: [[http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3\\_scr.pdf](http://www-pub.iaea.org/MTCD/publications/PDF/nvs-3-cd/PDF/NVS3_scr.pdf)].

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 and 50 kg, with an approximate 5 to 6 kg of this figure having been used for the October 2006 test.<sup>41</sup> This amounts to enough plutonium for approximately five to eight nuclear weapons, assuming 6 kg per weapon. After the test, North Korea could possess four to seven nuclear weapons. An 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.<sup>42</sup>

Additional questions arise in determining how much plutonium North Korea has produced since 2002 when the IAEA monitors were kicked out of the country and the seals were broken at Yongbyon. 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. It also concurred with U.S. estimates that North Korea's total stockpile of weapons-grade plutonium was 50 kg.<sup>43</sup>

## Plutonium Production

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 5MWe 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.<sup>44</sup> 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.

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<sup>41</sup> Siegfried Hecker estimates 40-50 kg of separated plutonium and 6 kg for the test; David Albright and Paul Brannan's study says 33-55 kg of separated plutonium and roughly 5 kg for the 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>].

<sup>42</sup> Unclassified Report to Congress on Nuclear and Missile Programs of North Korea, Office of the Director of National Intelligence, August 8, 2007.

<sup>43</sup> "North Korea 'serious threat' to South," *BBC News*, [<http://news.bbc.co.uk/2/hi/asia-pacific/6216385.stm>].

<sup>44</sup> David Albright and Paul Brannan, "The North Korean Plutonium Stock February 2007."

On February 6, 2003, North Korean officials announced that the 5MWe 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.<sup>45</sup>

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 5MWe reactor. Officials claimed to have reprocessed all 8,000 fuel rods from the 5MWe reactor between January and June 2003.<sup>46</sup> Reprocessing the 8,000 fuel rods would yield between 25 and 30kg 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).

In April 2005, the 5MWe reactor was shut down, this time to harvest fuel rods for weapons.<sup>47</sup> The reactor resumed operations in June 2005.<sup>48</sup> One estimate is that the reactor held between 10 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).<sup>49</sup> The 5MWe reactor was again shut down in July 2007, when the IAEA installed containment and surveillance measures and radiation monitoring devices.<sup>50</sup>

The reactors at Yongbyon (50MWe) and Taechon (200MWe) are several years from completion. No construction has occurred at the 50MWe reactor or at the

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<sup>45</sup> Siegfried Hecker, January 21, 2004, testimony before Senate Foreign Relations Committee.

<sup>46</sup> “North Korea Says It Has Made Fuel For Atom Bombs,” *New York Times*, July 15, 2003.

<sup>47</sup> “North Koreans Claim to Extract Fuel for Nuclear Weapons,” *New York Times*, May 12, 2005.

<sup>48</sup> David Albright and Paul Brannan, “The North Korean Plutonium Stock February 2007,” Institute for Science and International Security, February 20, 2007.

<sup>49</sup> 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.

<sup>50</sup> IAEA Team Confirms Shut Down of DPRK Nuclear Facilities, [<http://www.iaea.org/NewsCenter/PressReleases/2007/prn200712.html>].

200MWe reactor since 2002.<sup>51</sup> U.S. visitors in January 2004 saw heavy corrosion and cracks in concrete building structures at Yongbyon, reporting that the reactor building “looks in a terrible state of repair.”<sup>52</sup> The CIA estimated that the two reactors could generate about 275kg of plutonium per year if they were operating.<sup>53</sup> Dr. Hecker estimated that if the 50MWe reactor was functioning, it would mean a tenfold increase in North Korea’s plutonium production.<sup>54</sup> North Korea agreed to halt work on reactors as part of the Six Party Talks. As of July 2007, the IAEA is monitoring to ensure that no further construction takes place at these sites.

Significant future growth in North Korea’s arsenal would be possible only if the two larger reactors were completed and operating, and would depend on progress in the reported uranium enrichment program. With construction of the 50MWe and 200MWe reactors shuttered and the Yongbyon facilities awaiting disablement and eventual dismantlement, North Korean plutonium production for the moment has stopped. The reprocessing facility is also now shut down and under IAEA monitoring. However, even with the reprocessing facility shut down, North Korea could build additional warheads with existing separated plutonium because North Korea’s plutonium stocks are not yet under IAEA safeguards.

## A Uranium Enrichment Program?

While North Korea’s weapons program has been plutonium-based from the start, in the last decade, intelligence has emerged pointing to a second route to a bomb using highly enriched uranium. There is some certainty that North Korea has parts and plans for such a program, and less certainty over how far this program has developed. The issue has been central to 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 pre-emptive U.S. attack.<sup>55</sup>

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<sup>51</sup> 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.

<sup>52</sup> Hecker January 21, 2004, testimony before SRFC.

<sup>53</sup> CIA unclassified point paper distributed to congressional staff on November 19, 2002.

<sup>54</sup> Siegfried Hecker, “Report on North Korean Nuclear Program,” Center for International Security and Cooperation, Stanford University, November 15, 2006.

<sup>55</sup> Selig Harrison, “Did North Korea Cheat?” *Foreign Affairs*, vol. 84, no. 1, January/February 2005.

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." Such a plant would need to produce more than 50kg of HEU per year, requiring cascades of thousands of centrifuges.<sup>56</sup> The paper noted that in 2001, North Korea "began seeking centrifuge-related materials in large quantities." 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."<sup>57</sup> However, the United States has not been able to get direct confirmation from Khan. 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.<sup>58</sup>

Questions have been raised about whether the 2002 estimates were accurate.<sup>59</sup> 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 continue

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<sup>56</sup> 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*, by Mary Beth Dunham Nikitin, Jill Marie Parillo, Sharon Squassoni, Anthony Andrews, and Mark Holt.

<sup>57</sup> Pervez Musharraf, *In the Line of Fire: A Memoir*, (New York: Free Press, September 2006), p. 296.

<sup>58</sup> "NK Admits to Buying Aluminum Tubes," KBS World News, September 27, 2007, and Takashi Sakamoto, "DPRK Admits To Importing Aluminium Tubes From Russia for Uranium Enrichment," *Yomiuri Shimbun*, in Japanese, Translated by *BBC Monitoring Asia Pacific*, October 26, 2007.

<sup>59</sup> 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](http://www.armscontrol.org/act/2007_04/NewsAnalysis.asp)].

today.”<sup>60</sup> Assistant Secretary 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.<sup>61</sup>

The most recent 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.<sup>62</sup>

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.<sup>63</sup>

As part of the February 2007 agreement in the Six-Party talks, North Korea agreed to provide a “complete declaration of all nuclear programs and disablement of all existing nuclear facilities,” and has pledged to do so by the end of 2007. U.S. officials have said that this will include any uranium enrichment activities. Assistant

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<sup>60</sup> “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](http://www.dni.gov/press_releases/20070304_release.pdf)].

<sup>61</sup> “Update on the Six Party Talks,” *Brookings Institution*, February 22, 2007, at [<http://www.brookings.edu/events/2007/0222south-korea.aspx>].

<sup>62</sup> Unclassified Report to Congress on Nuclear and Missile Programs of North Korea, Office of the Director of National Intelligence, August 8, 2007.

<sup>63</sup> 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/DPRK\\_enrichment22Feb.pdf](http://www.isis-online.org/publications/dprk/DPRK_enrichment22Feb.pdf)].

Secretary Christopher Hill in testimony to Congress in October 2007 said that he expects transparency on the uranium enrichment program by the end of 2007.<sup>64</sup>

North Korea reportedly continues to deny the existence of a highly enriched uranium program for weapons. A *Washington Post* report on November 10, 2007, said North Korea has given evidence to the United States 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. A senior U.S. official is quoted as saying, “They have shown us some things, and we are working it through. Some explanations make sense; some are a bit of a stretch.”<sup>65</sup> Christopher Hill on November 15 after meeting with IAEA Director General El Baradei about North Korean disablement said that their was “some progress” on the issue, but declined to discuss details.<sup>66</sup>

## 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.”<sup>67</sup> 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.

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. 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

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<sup>64</sup> 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.

<sup>65</sup> Glenn Kessler, “N. Korea Offers Evidence to Rebut Uranium Claims,” *The Washington Post*, November 10, 2007.

<sup>66</sup> “U.S. Reports Progress on North Korean Uranium Issue,” *Global Security Newswire*, November 14, 2007.

<sup>67</sup> 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.



about what is needed for miniaturization of warheads for ballistic missiles could have been the goal of North Korea's testing a smaller nuclear device.<sup>68</sup>

## Issues for Congress

Congress will have a clear role in considering U.S. funding for the disablement and decommissioning of North Korea's nuclear facilities, as well as other inducements for cooperation as agreed in the Six Party talks. For example, the President has submitted a request to Congress for \$106 million "to provide Heavy Fuel Oil or an equivalent value of other assistance to North Korea on an 'action-for-action' basis in support of the Six Party Talks in return for actions taken by North Korea on denuclearization" as part of the 2008 War Funding Request.<sup>69</sup>

In addition, Congress may influence the course of the negotiations with North Korea through legislation that limits or places requirements on U.S. diplomatic actions. For example, H.R. 3650 has been introduced and referred to the House Foreign Affairs Committee, calling for certification by the President that North Korea has met a range of nonproliferation and political benchmarks before lifting any U.S. sanctions imposed because it has been deemed a supporter of international terrorism by the Secretary of State.<sup>70</sup> Congress could also establish reporting requirements on progress, or condition appropriations or disbursement to North Korea upon verification measures. Congress will also be involved in other aspects of potential changes in U.S. relations with Pyongyang, such as removal from the state sponsors of terrorism list, monitoring of the North Korean human rights issues, funding for further denuclearization steps including verification provisions, and establishment of normalized ties once nuclear dismantlement has been achieved.

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<sup>68</sup> "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/](http://aparc.stanford.edu/news/technical_perspective_on_north_koreas_nuclear_test_a_conversation_between_dr_siegfried_hecker_and_dr_giwook_shin_20061010/)].

<sup>69</sup> 2008 War Funding Request, October 22, 2007, at [<http://www.whitehouse.gov/news/releases/2007/10/20071022-7.html>].

<sup>70</sup> H.R. 3650, September 25, 2007.