WORKING PAPERS

VERIFYING NORTH KOREAN NUCLEAR DISARMAMENT

A Technical Analysis

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FOREWORD

The nuclear crisis on the Korean peninsula continues to pose the most serious security threat to U.S. interests and friends in East Asia. North Korea's nuclear activities include both an active plutonium production capability and a still-under-construction uranium enrichment capability. This program presents a critical security challenge for the United States, countries in East Asia, and, through North Korea's potential to sell nuclear materials abroad, the entire world. All of the states engaged with North Korea agree that the goal of international efforts should be the complete elimination of North Korea's nuclear program and the firm establishment of a non-nuclear Korean peninsula. To achieve this worthy goal, both political and technical agreements will need to be negotiated and implemented to ensure that any commitments are sustainable and reliable. On the technical side of this equation, at the very least, there are viable options for verifying a complete freeze and dismantlement of North Korea's nuclear facilities and its nuclear capabilities.

Of its two programs, North Korea's plutonium infrastructure is the more advanced and may already have yielded enough separated plutonium to produce one or two nuclear weapons. In addition, enough plutonium for the production of five or six nuclear weapons also exists in (or was recently released from) spent fuel discharged from North Korea's nuclear reactor in 1994. Key to any moves to refreeze North Korea's weapons program is the reintroduction of inspectors from the International Atomic Energy Agency (IAEA) or another source to determine the current state of this spent fuel and North Korea's nuclear facilities. The facts found on the ground will determine what initial steps are required to implement a verified freeze on North Korea's plutonium program. Any agreement aimed at eliminating North Korea's nuclear potential, however, will also have to deal effectively with questions about its past production and set an established and observable timetable for the elimination of existing facilities and the removal of all plutonium or plutonium-bearing materials out of the country.

North Korea's uranium enrichment program is still under development and is thought to be at least two years from beginning the production of significant amounts of nuclear weapons–usable materials. Given the nature of North Korea's secrecy and the technical realities associated with centrifuge-based enrichment facilities, a high degree of uncertainty will surround any agreement by North Korea to abandon this technology. Even now, the location of North Korea's enrichment site is not publicly known. A negotiated agreement will require not only an intrusive nature of geographic transparency by North Korea, permitting inspectors access to highly sensitive and secret facilities, but also an unprecedented degree of programmatic transparency, including procurement efforts and financial information.

In reviewing these issues, it is clear that any agreement to ensure the end of North Korea's nuclear potential will require an unparalleled level of transparency and verification. A critical contribution to this effort would be the acceptance by North Korea of the Strengthened Safeguards

System developed and implemented by the IAEA or a system with similar rights and standards for verification and transparency. These measures—which include everything from comprehensive safeguards at declared facilities to full special inspection rights to environmental monitoring and more—would be extremely useful in developing a system within North Korea that can build confidence that all nuclear weapons–related activities have ceased. These programs can be implemented by the IAEA, another group, or in cooperation with several organizations, and they are the key to success in international efforts to ensure the full denuclearization of the Korean peninsula.

The papers included in this report are meant to spur discussion and exploration of these complex issues, and give support to efforts to negotiate an agreement that ends the potential for North Korea to directly threaten the security of its neighbors and other countries. The measures explored in these papers are not sufficient to overcome the North Korean nuclear threat. In particular, the potential for nuclear exports from North Korea during any realistic "dismantlement" period requires that North Korea not only declare its enrichment acquisition and programs but also provide considerable information about clandestine networks involving narco-criminal syndicates and transnational terrorists. Breaking any current or future link between North Korea's weapons of mass destruction and terrorists is crucial to achieving security for the United States, its allies and friends, and even some of its adversaries—all of whom are threatened by the prospect of North Korean nuclear exports.

Monitoring and verifying a nuclear freeze and phased dismantlement is the right place to begin, however. We hope that these papers help policymakers come to grips with the urgent need to achieve these measures in North Korea.

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PREFACE

On January 27, 2003, the Nautilus Institute and the Carnegie Endowment for International Peace convened a one-day workshop, "US–DPRK Next Steps," to explore North Korea's nuclear program and consider various approaches to resolving security and other issues dividing the United States and North Korea. The workshop drew together current and former U.S. government officials, representatives from governments in East Asia, and outside technical and political experts.

In its approach toward North Korea, the United States has insisted that Pyongyang freeze and dismantle its nuclear programs, including its plutonium production and uranium enrichment activities. A key consideration in the workshop, and in any negotiated settlement with North Korea, is the extent to which it might be possible to verify a freeze or dismantling of North Korea's nuclear activities and how such verification would take place. These are difficult questions, and the ability to verify any commitment by North Korea to reverse its nuclear activities is highly dependent on the situation on the ground when any freeze is to be implemented.

The initial panels at the workshop featured a detailed technical discussion of what would need to be accomplished under any arrangement to end North Korea's nuclear activities. To lead off the discussion, two technical papers were presented laying out how a program to eliminate North Korea's nuclear weapons might be implemented, including the critical questions of how such a task might be verified. One of these papers, by Jon B. Wolfsthal, dealt with North Korea's plutonium program. The other, by Fred McGoldrick, explored North Korea's uranium enrichment program. In addition, a third paper, by Seongwhun Cheon, considered various inspection arrangements. The three papers have been updated in this report.

The increasingly difficult situation on the Korean peninsula has made the issues raised in these papers more relevant, and the authors hope that their consideration of these issues will prove useful to officials and the broader public in understanding the difficult technical and political issues arising from the current nuclear situation in East Asia.

ABBREVIATIONS

AEC	Atomic Energy Commission
ARMSCOR	South African state-owned armaments corporation
CIA	U.S. Central Intelligence Agency
DOE	U.S. Department of Energy
DPRK	Democratic People's Republic of Korea
HEU	highly enriched uranium
IAEA	International Atomic Energy Agency
JDD	Joint Denuclearization Declaration
JNCC	Joint Nuclear Control Commission
KCTR	Korean Cooperative Threat Reduction program
LWR	light water, as in power plants
MWe	megawatts–electric
NGO	nongovernmental organization
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRDC	Natural Resources Defense Council
SWU	separative work unit
ROK	Republic of Korea
UNMOVIC	UN Monitoring, Verification, and Inspection Commission
WMD	weapons of mass destruction

Freezing and Reversing North Korea's Plutonium Program

Jon B. Wolfsthal

This chapter examines North Korea's plutonium infrastructure and production capabilities, as well as how a freeze over that capability might be reconstituted and verified if an agreement to do so can be reached. The chapter, which also discusses several issues related to the possible final elimination of North Korea's nuclear capability—a stated goal of U.S. policy—does not prejudge what form a freeze might take, how it might be negotiated, or by what bodies it might be implemented. This chapter is meant to provide a broad view of what hurdles anyone trying to reestablish a freeze might encounter and what uncertainties might remain under such a freeze.

North Korea has an active nuclear program capable of producing large amounts of weapons-grade nuclear materials during the next few years. The current challenge with regard to North Korea involves both its active plutonium production and extraction infrastructure and a uranium enrichment capability that is still in development. The discovery and announcement of North Korea's uranium enrichment development program in late 2002 thrust Pyongyang's nuclear ambitions back into the headlines after an eight-year hiatus, but North Korea's plutonium program is the most advanced component of its nuclear complex. If left unchecked, this program could provide Pyongyang with enough separated plutonium to produce as many as six new nuclear weapons, possibly by the end of 2003, and as many as 200 by 2010.

North Korea's current plutonium infrastructure was frozen from 1994 to 2002 under the United States–Democratic People's Republic of Korea Agreed Framework. North Korea ejected International Atomic Energy Agency (IAEA) inspectors from the country on December 31, 2002, and it has restarted at least some of its plutonium-based facilities. If all of North Korea's current facilities (completed and under construction) were completed and put into operation, by the end of the decade, the isolated country could produce enough weapons-grade plutonium for more than 50 weapons a year.

The current goal of the United States and other regional powers is to eliminate North Korea's nuclear weapons program, including any current holdings of nuclear weapons–usable materials and the ability to produce new nuclear materials. Any such elimination would need to include a verified freeze on current activities and the elimination of production and extraction facilities and equipment. Total elimination is a process that would take years to complete, although a freeze could be implemented much more quickly. Depending on the conditions that exist when a freeze is implemented, however, additional uncertainty about North Korea's current nuclear capability may persist.

U.S. officials have stated again and again that they are willing to talk with North Korea in a multilateral setting but that no "bold approach" can be taken toward new relations with North Korea until Pyongyang first dismantles its nuclear weapons program. At a minimum, North Korea would need to provide strong evidence that its plutonium-based program is not active before any significant talks could begin. In addition, any long-term solution to outstanding issues would have to resolve questions about North Korea's past nuclear activities and possible production of plutonium, which include the concern that the country already possesses enough separated plutonium for one to two nuclear weapons.

Many of the tools that *could*—under certain circumstances—be applied to refreeze the plutonium program are well understood and straightforward. The task of implementing a freeze that recreates the same situation as existed in late 2002 may prove difficult, if not impossible, depending on what steps North Korea has taken since restarting its plutonium program. Information on the exact steps North Korea has taken to date is limited, and—since the IAEA inspectors left North Korea on December 31, 2002—totally unconfirmed. Under even the best circumstances now possible, there undoubtedly will be additional uncertainties as to the full extent of North Korea's plutonium holdings.

CURRENT PLUTONIUM STOCKS

The full extent of North Korea's current plutonium holdings is not known. North Korea does possess enough plutonium (25–30 kilograms in the form of spent fuel as of December 2002) to produce five to six nuclear weapons.[1] There are reports that this spent fuel has been or is in the process of being moved from the spent fuel storage facility where it was stored during the past nine years to a reprocessing plant in Yongbyon. The exact location and condition of the fuel is not publicly known.

In addition, North Korea may have also produced an additional 5 to 10 kilograms of plutonium in the early 1990s. Although U.S. officials, including Secretary of State Colin Powell, have stated that they believe North Korea already possesses nuclear weapons, there is no public evidence to conclusively prove or disprove this possibility. The possible previous production of plutonium from North Korea's 5 megawatts-electric (MWe) research reactor forms the basis for intelligence estimates that North Korea may already possesses one to two nuclear weapons.[2] If this material was in fact produced, its whereabouts are unknown outside North Korea's leadership. Determining once and for all the history of North Korea's past nuclear activities is an additional goal of U.S. policy in North Korea, which would require more extensive access to North Korea's plutonium infrastructure than that needed to reestablish and verify a freeze over all "known" activities.

KEY ELEMENTS

Three critical components of North Korea's plutonium-based program would need to be covered by any newly implemented freeze and eventually dismantled (see table 1):

- existing spent fuel (if intact);
- three graphite-moderated, gas-cooled nuclear reactors: one of 5 MWe (completed and operational), one of 50 MWe (construction not yet completed), and one of 200 MWe (construction not yet completed); and
- reprocessing facility and associated equipment.

If any agreement to refreeze North Korea's plutonium program is reached, a top priority will be to determine the status of the spent fuel previously stored in the spent fuel building at Yongbyon. North Korea released about 8,000 irradiated, magnesium-clad, natural uranium fuel rods from the 5 MWe reactor at Yongbyon in 1994.

Table 1. Summary of North Korea's Plutonium-related Nuclear Facilities

Facility (in megawatts-electric, MWe) and Status	Plutonium Production per Year (kilograms)	Weapons per Year
5 MWe reactor, operational	6	1
50 MWe reactor, under construction	56	11
200 MWe reactor, under construction	220	44
Reprocessing facility, operational	220–250 ton throughput (as of 1994), enough for the fuel produced annually from the 5 and 50 MWe reactors	

Sources: Joseph Cirincione, with Jon B. Wolfsthal and Miriam Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington, D.C.: Carnegie Endowment for International Peace, 2002) and ISIS, *Solving the North Korean Nuclear Puzzle* (Chilton, U.K.: ISIS).

After their removal from the reactor, these rods were stored in a spent fuel pond next to the reactor building for more than two years, during which time a considerable amount of corrosion took place. As a result, much of the magnesium cladding and some of the uranium metal broke loose from the fuel rods themselves. These were the conditions U.S. government officials found when they first arrived on site in 1995 to stabilize the fuel to prevent its reprocessing, as called for in the Agreed Framework.

During the course of the next several years, under IAEA monitoring, the spent fuel rods were placed in 400 stainless steel canisters, each containing approximately 20 rods or fragments. These cans were filled and sealed by U.S. contractors on site in North Korea and then placed in underwater racks under IAEA seal. Each can has a serial number, and records of how many rods were inserted into each can were retained by the IAEA and U.S. Department of Energy (DOE) officials.[3]

The status of the spent fuel is not currently known. According to an IAEA press release, "Seals in the 5MW(e) reactor's spent fuel pond containing some 8,000 irradiated fuel rods have been removed by the [Democratic People's Republic of Korea], and the functioning of essential surveillance equipment has been impeded."[4] U.S. intelligence has reportedly witnessed activity between the spent fuel site and the reprocessing facility, located less than a quarter of a mile away. These reports have not confirmed that spent fuel is being shipped from the storage site, but it is assumed that at least some of the fuel has been moved to the reprocessing facility, or possibly to some other facility for processing or hiding.

It is also not publicly known if the reprocessing facility has begun operation. U.S. intelligence officials and technical experts are not totally confident that national technical means could reliably observe the start of reprocessing activities, and no public confirmation that reprocessing has begun has been made.[5]

The 5 MWe reactor at Yongbyon has been refueled and restarted. This reactor is capable of producing enough plutonium-bearing spent fuel for one nuclear weapon every year.

STEPS TOWARD A NEW FREEZE

Upon the completion of any agreement to refreeze North Korea's nuclear activities, whoever is tasked with verification will need to quickly establish the location and condition of the spent fuel, as well as the operational status of the 5 MWe reactor and reprocessing facility at Yongbyon. Also, any system implemented would need to confirm the cessation of construction on the two additional reactors being built by North Korea.

Existing Spent Fuel

Even under the best possible scenario, where the cans are found intact and unopened, the job of reverifying the freeze to the highest level of confidence would still require in-depth access to the spent fuel cans and could take months, if not years. The removal of tamper-indication devices from the spent fuel racks by North Korea will require either a complete reinventory of the rods in the cans or an elaborate set of technical measures to x-ray, measure, or otherwise ensure that the cans in fact contain the spent fuel rods canned by DOE in the middle to late 1990s.

Given the lack of details obtained by IAEA and DOE teams regarding the radiation signature of each fuel rod, however, it may never be possible to provide 100 percent confidence that the rods in the cans when monitoring was interrupted are the rods found in the cans upon the return of the monitoring system. As part of the canning process, North Korean officials only allowed IAEA and DOE to take basic gamma radiation readings (to verify that each rod had been irradiated in a reactor) and to weigh each rod to verify that it was made of uranium metal.

Teams were not allowed, however, to take detailed spectral analyses of individual rods during the canning process, despite IAEA officials' efforts to obtain such rights. Such information would have allowed the IAEA to help verify the length of time the rods had been in an operating reactor, and therefore, provide additional insight into North Korea's nuclear history. This lack of a detailed rod-by-rod "fingerprint" means there is no way to reverify the presence of the original spent fuel piece by piece. Any confidence that the fuel found on site is the same fuel canned in the mid-1990s will be based, in part, on circumstantial evidence and have to include elements of a subjective assessment.

If the cans are found intact and appear unopened upon the resumption of monitoring, a number of clues can be sought that might help provide a subjective assessment of whether the cans had been disturbed in the absence of IAEA monitors. If the clues point to some movement of the cans, more detailed and extensive sampling may be required to verify that the fuel rods remain in the spent fuel pond. In addition, despite the fact that the IAEA and DOE do not possess detailed radioactivity profiles of each rod, each organization possesses a large amount of information that might be used to provide confidence that cans found in the spent fuel pond had been undisturbed. These include:

- a record of the contents of each numbered can;
- a measurement of the weight of one-quarter to one-third of the cans; and
- possible physical evidence of the location of each can in the spent fuel rack.

These data sets can be used to make an initial assessment of whether the cans had been tampered with during the monitoring hiatus. Findings that suggest that the cans had been moved would necessitate a more extensive set of measures to help determine if the spent fuel rods found in the pool

are the same ones canned by DOE. These measures include visual clues, physical clues, sampling, and timing.

Visual Clues. A visual inspection could be made to judge if the cans had been moved. During storage, a fine layer of silt has formed on the cans and the bottom of the spent fuel pond. This particulate matter covers most horizontal surfaces in the spent fuel pond, including the tops of the cans. This silt may provide clues of any major activities in the spent fuel pond.

Moreover, DOE and contractor teams have routinely traveled to the spent fuel site to repair leaking cans and perform maintenance on the pool filtration system. The most recent site photographs of the spent fuel racks could be compared with the facts found upon the reentry of outside experts. Together, these visual clues could be used to provide a basic estimate of whether the cans had been disturbed. Also, each spent fuel can is tagged with an identifying number. It is possible that the IAEA or DOE has maintained a register of which can is located where on the racks. If there is such a record, comparing the existing and previous locations of the cans could help determine if they had been disturbed in the interim period.

Physical Clues. Each can is sealed with a ring of approximately 20 bolts and filled with an argon–oxygen gas mixture to help prevent further corrosion. It might be possible that a physical inspection of the cans could help determine if they have been opened in the interim. Damaged or missing bolts would suggest some tampering. Moreover, if North Korean officials have attempted to replace the fuel rods in the cans with dummies, large amounts of sediment (magnesium and uranium oxide) would be deposited into the pool, leaving a sign of such activities. If intact cans are found in the pool, additional basic tools—such as weighing each can or testing to see if the cans continue to be filled with the argon–oxygen mixture—might also provide evidence that the cans have been undisturbed.

Sampling Methods. To obtain greater confidence that sealed cans found in the spent fuel pond have not been tampered with, several options for radioactive sampling exist to help determine if the cans contain their original loading of fuel. These include sensing radiation levels from the outside of each can or a significant, and random sampling of the cans to determine the basic radiation level of separate fuel rods. In addition, a more detailed survey can be done requiring the opening of each can or a significant and random sampling of each can and a subsequent basic radioactive sampling of each rod.

Timing. Each filled, spent fuel can weighs several hundred pounds and is sealed shut with approximately 20 bolts. The cans are all filled with argon and oxygen to slow the additional corrosion of the spent fuel, and the lid of each can is equipped with valves that were used to remove water and fill the can with the argon–oxygen mixture.

Rough estimates suggest that, at most, North Korea might be able to safely open and remove the contents of eight to ten cans per day, using all four canning stations installed on-site. This would require between 40 to 50 days to completely empty the contents of the cans. However, two of the

canning stations are in poor, if not inoperable, condition, and a third was never efficiently used by the North Korean technicians. Thus, the time required for North Korea to safely empty the spent fuel cans could be up to four times longer (160–200 days). North Korean technicians, however, have been able to cut corners and accelerate their normal operations when motivated. Thus, estimates of any time frame should be considered loose. If such activities had begun the day inspectors left the facility on December 30, opening the contents of each can could take anywhere from one to six months. If an attempt was made to refill the cans to deceive IAEA or outside inspectors, that time could easily double, given the complexities of refilling and releasing each can.

Although North Korean teams could conceivably move the cans loaded with the spent fuel to the reprocessing facility, the author assumes that they would want to open and unload the cans in the spent fuel basin, where the equipment to open the cans is located. It is not known if the reprocessing facility at Yongbyon is capable of accepting the sealed stainless steel cans into the reprocessing line. The logistics of shipping the sealed cans and opening them at the processing plant, however, would appear to suggest that North Korean officials would first remove the fuel from the cans at the spent fuel pond before shipping them to the reprocessing plant.

All of this previous discussion assumes, however, that the spent fuel is found intact in spent fuel cans. If this is not the case, the process of verifying that North Korea's plutonium holdings will be greatly complicated.

The Reprocessing Plant

North Korea has constructed and previously operated a plutonium extraction or reprocessing facility at the nuclear complex at Yongbyon. The building is a quarter of a mile across the river from the 5 MWe reactor and the associated spent fuel storage pond.

Although no maintenance or operational activities took place at the reprocessing plant during the 1994–2002 freeze, before their departure from North Korea, IAEA inspectors verified that North Korea removed seals from the plant. Press reports indicate that activity has resumed at the facility, but it is not publicly known what progress has been made in making the plant fully operational. U.S. intelligence agencies reportedly suspect that North Korean technicians may be experiencing problems in resuming full operation at the plant, delaying the point at which North Korea might be able to successfully extract large amounts of weapons-grade plutonium from the spent fuel produced in the 5 MWe reactor.

If the facility has not yet resumed reprocessing when a freeze is reimplemented, it would be a fairly direct matter to verify the cessation of operations and maintenance at the facility. Seals and routine monitoring could then be installed to maintain a freeze. Any requirement for dismantlement could also proceed.

A far more complex and difficult scenario would unfold if reprocessing activities had already begun or had been completed before a freeze could be implemented. The lack of any ongoing monitoring presence at the operating reprocessing plant would require that any verification system be able to verify North Korean declarations about the extent of past operations at the plant. Though technical measures could be developed to help determine the general accuracy of North Korean statements, some level of uncertainty would remain under even the best of circumstances. This uncertainty would translate into an inability to establish that North Korea does not possess any weapons-usable plutonium or nuclear weapons.

Given what is known about how much spent fuel was in the spent fuel pond at the time the inspectors were ejected, it could be possible for the IAEA and outside experts to conduct a materials-balance assessment using:

- the spent fuel not yet de-clad or dissolved,
- the amount of spent fuel "in process,"
- the amount of material (separated plutonium, waste products, chemical, etc.) discharged from the facility, and
- waste product analysis (contents, volume).

The risk factor involved in this approach comes from the lack of safeguards on the facility before the start of operations. Under normal safeguards, inspectors can rely on both material balance (including waste streams) and perimeter monitoring to detect if all materials brought into a reprocessing plant are accounted for. In addition, safeguards on reprocessing plants require an intimate understanding of the architecture and "plumbing" of the facility. This information is needed to detect possible "diversion points" and apply monitoring mechanisms to detect any diversion of special nuclear materials.

Outside verifiers could, over time, develop a detailed knowledge of the reprocessing facility, but they would not be able to ensure—without demolition of the facility—that additional, undeclared outflow pipes did not exist. This creates some uncertainty in whatever declaration North Korea might make regarding the extent of reprocessing activities within the site.

The IAEA or outside inspectors would need to rely on extensive sampling to help verify operating records of the facility normally kept by the North Korean technicians. Given the success of this process in uncovering inconsistencies in past North Korean declarations of its nuclear activities, North Korea would presumably be more sophisticated should it undertake any attempt to deceive inspectors of their operations. At a minimum, inspectors would need to gain detailed access to any separated materials and to the waste streams produced by reprocessing operations.

If North Korea has begun reprocessing, it would also create complications for uncovering the history of North Korea's nuclear activities. One key objective of the special inspections requested by the IAEA in 1993 was to gain access to two suspected, underground waste storage facilities near the reprocessing facility. It was hoped that by gaining access to these waste storage sites, the IAEA could more fully verify how much, if any, additional plutonium North Korea had produced before the start of IAEA inspections. If, as is believed, waste from North Korea's reprocessing facility would also be shipped to the suspected waste storage sites, this would dilute the contents of those facilities and greatly complicate efforts to use those materials to reconstitute North Korea's nuclear history.

The final disposal of the reprocessing facility is something that might also be required under any agreement to eliminate North Korea's nuclear capability. Decommissioning of a reprocessing facility can be a very time-consuming, expensive, and complicated process. The extreme levels of radiation and broader contamination involved in reprocessing spent fuel suggest that any program to decommission the reprocessing plant would take several years to develop and implement.

North Korea also possesses other small-scale manual means for reprocessing spent fuel. North Korea possesses between seven and twenty hot cells, or hand-operated shielded machines, in which small amounts of plutonium can be extracted from spent fuel. It is assumed that this equipment

would need to be subject to any nuclear freeze and dismantlement. Placing seals and monitoring equipment on these pieces of equipment would not be technically challenging.

The Reactors

North Korea's plutonium production reactors fall into two categories: complete and under construction. Only one of the three facilities—the 5 MWe facility at Yongbyon—had operated previously, producing at least one fuel load of 8,000 spent fuel rods. It is also possible that this reactor, which shut down for 100 days in 1989, discharged an earlier load of spent fuel. As was stated above, the other two facilities are a 50 MWe reactor and a 200 MWe reactor, both of which are several years away from being able to operate.

The 5 MWe Reactor. North Korea has restarted operation of the 5 MWe reactor with what is believed to be a full load of 8,000 fresh fuel rods. Any effort to refreeze North Korea's plutonium program would have to verify the shutdown of activities at the 5 MWe reactor. The fuel in the reactor would need to be removed and placed in storage. The spent fuel pond at Yongbyon has enough room for an additional load of fuel, even if it still contains the spent fuel canned by the United States in the 1990s. This new fuel would also need to be stabilized in some way to prevent the need to reprocess the materials and, presumably, to facilitate its final disposition, which might include shipment out of North Korea.

If the process of removing the new batch of spent fuel and storing it can take place in the presence of inspectors (IAEA or otherwise), this process can be relatively straightforward, if somewhat time consuming (canning 8,000 new fuel rods could take at least a year, if not longer, depending on the extent of cooperation from North Korea).

One other issue that could be addressed with regard to the 5 MWe reactor has to do with accessing the reactor for the purpose of more firmly establishing an accurate history of North Korea's nuclear activities. It has been suggested that by sampling the graphite that makes up the 5 MWe reactor, some details of the operating history of the reactor could be determined. This, in sum, could provide an additional piece of evidence in determining if North Korea did produce a load of fuel previous to the fuel canned by DOE teams in the mid-1990s.

If the 5 MWe reactor is restarted, the process of deciphering the reactor's operating history would be somewhat complicated—but, according to some technical experts, not completely compromised. Any detailed analysis would require the partial, if not complete, dismantling of the reactor, something that is likely to be required in any program to eliminate North Korea's nuclear capability.

The Larger Reactors. The 50 MWe and 200 MWe reactors, located at Yongbyon and Taechon, respectively, were still under construction when the nuclear freeze took effect in 1994. These reactors were a number of years away from completion at that time, and no additional construction took place in the 1994–2002 time frame.

Just as before, the IAEA would be well qualified to verify that no new construction activities were taking place at the reactor. Given that the reactors are years away from start-up, there is not the same imperative associated with inspecting these facilities as with the 5 MWe reactor, the spent fuel, and the reprocessing facility.

NOTES

1. For nominal purposes, the Carnegie Endowment has assumed that North Korea could produce a nuclear device with 5 kilograms of weapons-grade plutonium; see Joseph Cirincione, with Jon B. Wolfsthal and Miriam Rajkumar, *Deadly Arsenals: Tracking Weapons of Mass Destruction* (Washington, D.C.: Carnegie Endowment for International Peace, 2002).
2. U.S. Central Intelligence Agency, "Foreign Missile Developments and the Ballistic Missile Threat Through 2015—Unclassified Summary of a National Intelligence Estimate," December 2001; www.cia.gov or www.ProliferationNews.org.
3. Discussion with DOE officials, January 2003.
4. IAEA Press Release PR 2002/23, December 22, 2002; www.iaea.org.
5. Conversation with U.S. government officials, January 2003.

The North Korean Uranium Enrichment Program: A Freeze and Beyond

Fred McGoldrick

This chapter attempts to identify steps that the Democratic People's Republic of Korea (DPRK) could take to reduce international concerns about the clandestine uranium enrichment program it acknowledged to the United States in early October 2002. The chapter's purpose is to identify measures first to verify that the DPRK has put a brake on, or "frozen," its uranium enrichment program and ultimately to confirm that it has dismantled that program as well as any nuclear weapons activities. The premise is that the DPRK might at some point find it in its interest to freeze its uranium enrichment program and to invite the International Atomic Energy Agency (IAEA) or some other entity to verify that North Korea is maintaining its freeze. In other words, although the DPRK may be unlikely to agree to move immediately into full compliance with all of its nonproliferation obligations, it may at some point, and as part of some negotiation process, agree to a verified freeze of its uranium enrichment program.

Following North Korea's admission of its enrichment program in October 2002, the DPRK abrogated its commitments under the 1994 the United States–Democratic People's Republic of Korea Agreed Framework to freeze the operation of the 5 megawatts-electric (MWe) reactor and the fuel fabrication and reprocessing facilities at Yongbyon as well as the construction of the 200 MWe reactor at Taechon and the 50 MWe reactor at Yongbyon. The DPRK has restarted the 5 MWe reactor at Yongbyon and announced its intention to resume construction of the other two reactors. Pyongyang has also expelled IAEA inspectors and withdrawn from the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). As a result of these actions, the IAEA is no longer in a position to verify that material from the 5 MWe reactor remains in peaceful use. The DPRK could reprocess the spent fuel rods stored at that facility (if this process has not already begun) and separate weapons-grade plutonium, perhaps within a few months.

A DPRK decision to freeze its enrichment program would, of course, be relatively meaningless unless the North Korean government also took steps to reinstitute the freeze of operations at the nuclear facilities covered by the Agreed Framework. The actions by the DPRK to restart its plutonium program make it imperative that a freeze of the North Korean plutonium and enrichment programs be examined as a whole. If a freeze on the North Korean enrichment program still represents a possible interim way forward in resolving this crisis, then it must be accompanied by a resumption of the verified freeze on the facilities covered by the Agreed Framework.

If North Korea were now prepared to freeze its enrichment program, verifying a freeze of its enrichment activities would present different issues and challenges than those involved in the IAEA's reinstitution of its monitoring procedures at the reactors and reprocessing facility covered by the Agreed Framework. The 5 MWe reactor and reprocessing plant at Yongbyon and the two reactors under construction at Yongbyon and Taechon are large, denotable facilities where the IAEA has already operated a verification regime. By contrast, on the basis of the publicly available information, there appear to be significant limitations in our knowledge of North Korean enrichment activities. For example, there are uncertainties concerning the nature, number, and location of activities associated with the enrichment program; how long the activities have been taking place; and what progress the DPRK has made in enriching uranium (see below). To initiate a verified freeze of its enrichment program, the DPRK would

need to make a detailed declaration concerning its program, and the verifying agency would need broad authority to determine the correctness and completeness of that declaration.

The first section of this chapter seeks to identify the steps that the DPRK could take to implement a freeze of its uranium enrichment activities, including acceptance of some mechanism to verify or monitor such a freeze. The second section addresses how the interim step of a freeze might transition to full implementation by the DPRK of its various nonproliferation obligations, namely, those set forth in the NPT, its NPT safeguard agreement with the IAEA, and the 1992 Joint Declaration between the DPRK and the Republic of Korea (ROK). The chapter addresses the following specific questions:

- What enrichment activities should the DPRK "freeze"?
- Because any verification or monitoring of the freeze will require that the DPRK make a declaration of its uranium enrichment program, what specifically should the DPRK declare?
- Who should verify such a freeze?
- How should such a freeze be verified?
- What level of confidence can the international community have in the accuracy and completeness of the DPRK declaration?
- How might the monitoring of the freeze facilitate North Korea's full compliance with its nonproliferation obligations, including acceptance of full-scope IAEA safeguards and verification of the dismantlement of all its sensitive nuclear activities?

STEPS THE DPRK COULD TAKE TO IMPLEMENT A FREEZE

On October 16, 2002, the United States reported that, in October 3–5, 2002, meetings with representatives of the DPRK, U.S. representatives had confronted the DPRK with intelligence information about the existence of a clandestine uranium enrichment program and that North Korean officials had acknowledged having such a program during the course of those meetings. Since this revelation, North Korea has said that it is open to discussion of international inspections of the uranium facilities and that "everything will be negotiable," including the dismantling of the enrichment program. However, it has apparently laid down certain conditions, namely, that the United States would agree to a nonaggression treaty, recognize the North Korean government, and sign a U.S.–North Korean peace treaty. The United States has taken the position that it will not negotiate about such matters until North Korea dismantles its nuclear weapons program.

What Is Known about the North Korean Enrichment Program?

On the basis of what the U.S. government has said and what has appeared in the media, the international community does not appear to have many details about the North Korean enrichment program. U.S. Undersecretary of Defense Douglas Feith, has been quoted as saying that "there is much about the program that we do not know. I cannot answer with precision exactly what they have accomplished with their uranium enrichment program to date."[1] The *Washington Post* of October 18, 2002, quoted an anonymous U.S. government official as saying that U.S. intelligence analysts were

unanimous in their readings of the intelligence reports, but he conceded that, "There is a lot we do not know."[2] Nevertheless, statements by U.S. officials and leaks to the press have suggested certain information about the North Korean program. (Statements by U.S. officials and press reports are summarized in the appendix to this chapter.) Recognizing the inherent limitations and distortions that might appear from such sources, the following picture emerges.

North Korea apparently began its efforts in earnest to establish a clandestine uranium enrichment program based on centrifuge technology in the late 1990s, although interest in such a program may have extended as far back as the late 1980s. The DPRK was seeking to obtain frequency converters from Japan in 1999. In 2000, the United States apparently obtained evidence of North Korean attempts to acquire large quantities of high-grade aluminum suitable for use in centrifuges as well as equipment for use in uranium feed and withdrawal systems.

The United States does not know for sure where the North Korean uranium enrichment activities are taking place. However, U.S. officials have been quoted as saying that the United States has received reports of significant construction activity that appears related to a uranium enrichment facility. There have also been press reports that the United States suspects that the North Korean Academy of Sciences near Pyongyang is one of three sites where the DPRK has conducted uranium enrichment tests. The other two suspected sites are the Hagap region in Chang-gang Province and the city of Yeongjeo-dong, near the Chinese border. The facilities may be underground.

It is unlikely that North Korea has produced any nuclear weapons to date or even a significant amount of highly enriched uranium (HEU), although it may have begun producing some enriched uranium in 2001. It appears that the DPRK may be in the process of constructing an enrichment facility. John Bolton, the U.S. undersecretary of state for arms control and international security, has said, "What we have said publicly and in consultations is not that North Koreans have nuclear weapons produced through the uranium enrichment program" but that the North Koreans "are seeking a production scope capability to produce weapons-grade uranium." As noted, press reports have quoted U.S. officials as saying that the United States has received reports of significant construction activity.

A few reports suggest that North Korea has actually obtained centrifuges from Pakistan. However, Pakistani assistance is not likely to have included large numbers of actual centrifuges. One report from *Nuclear Fuel* (November 25, 2002) that appears to be based on detailed discussions with officials with access to intelligence and with experts on centrifuge enrichment technology indicates that the DPRK may have acquired from Pakistan a complete design package for a proven centrifuge machine, prototype components, and manufacturing and some diagnostic assistance, which might drastically reduce the timeline for producing HEU.

The size of a North Korean enrichment plant is uncertain. The *Nuclear Fuel* report cited above states that North Korea may be constructing a facility with a capacity of some 2,000 centrifuge machines with a throughput capacity of about 1 separative work unit (SWU) per machine per year. However, there are unclassified reports that Pakistan's centrifuges have a capacity of about 5 SWU per year.[3] *Nuclear Fuel* and the *Washington Times* (November 22, 2002) quoted the U.S. Central Intelligence Agency (CIA) as saying that North Korea is constructing a plant that could produce enough weapons-grade uranium for two or more nuclear weapons per year by mid-decade.

The *Nuclear Fuel* article cited above asserts that this CIA assessment assumes, however, that the DPRK has obtained unprecedented assistance from foreign sources in building gas centrifuges,

including a complete design package for a proven centrifuge machine using aluminum. Thus it may be reasonable to conclude that North Korea is in the process of manufacturing and testing centrifuges and constructing a centrifuge enrichment facility, but that it probably has not produced significant amounts of HEU to date.

What Specifically Could or Should the DPRK "Freeze"?

Ideally, the DPRK freeze should apply to all aspects of its centrifuge program, that is, the entire range of activities and operations involved in its enrichment program. This would include:

- All procurement of all enrichment materials, equipment, and technology from abroad, as well as the purchase of so-called dual-use items.[4]
- All research, development, and testing related to the DPRK enrichment program.
- Facilities for manufacturing or assembling of enrichment equipment.
- Facilities for the conversion of uranium oxide to uranium hexafluoride.
- Any enrichment facilities.
- Preparation of any feed material for an enrichment facility.
- Testing or operation of an enrichment facility.
- Production of enriched uranium.
- Conversion of enriched uranium to metal.

If the North Korean enrichment program is still in the manufacturing and construction stage, as has been suggested by U.S. official statements and press leaks, North Korea may only be engaged in some of these activities, and so the freeze would apply only to a subset of the operations listed above. Of course, the DPRK may not be willing to freeze all aspects of the program. For example, North Korea may be prepared to stop construction of an enrichment plant but not the testing, manufacture, or assembly of centrifuge machines. (See below for a further discussion of this issue.)

For a freeze on North Korean enrichment activities to have any credibility, North Korea would need to invite an inspection agency to verify that it had indeed stopped all activities related to its enrichment program. A centrifuge facility is not difficult to conceal, because it has no obvious signatures that would be easily observable by national technical means (see below). Hence an extensive and rigorous on-site inspector presence with broad access rights and detailed information would be necessary to provide a meaningful degree of confidence that the DPRK had indeed frozen all of its enrichment activities.

Who Might Verify or Monitor the Freeze?

There are at least four possible options for verifying and monitoring a DPRK freeze. These include the IAEA alone, joint DPRK–Republic of Korea verification, the United States alone, and a nongovernmental organization (NGO) role.

The IAEA. The DPRK rejected a resolution of the IAEA Board of Governors of November 29, 2002, to accept the Director General's proposal to dispatch a senior team to the DPRK, or to receive a

DPRK team in Vienna, to clarify the DPRK's enrichment program. The DPRK has also ignored the resolutions of the Board of Governors of January 6, 2003, and February 12, 2003, that reiterated this request and called on it to cooperate fully with the IAEA to implement safeguards. The DPRK has charged the IAEA with being a "poor servant and mouthpiece" of the United States. Nevertheless, the IAEA is perhaps the most obvious candidate to undertake the job of verifying a freeze of the North Korean enrichment program, for several reasons:

- Inspecting nuclear facilities is what the IAEA does, and it possesses a great deal of experience and expertise in this field.
- It has conducted safeguard inspections pursuant to the IAEA–DPRK safeguard agreement as provided for by the NPT. It has also monitored the freeze of North Korean nuclear facilities pursuant to the 1994 Agreed Framework between the United States and the DPRK.
- The DPRK as well the United States and the various interested states in the region are familiar with the IAEA, its capabilities, and its safeguard system.
- The DPRK has been obligated by virtue of its adherence to the NPT to accept IAEA safeguards on all its peaceful nuclear activities, including any enrichment activities. Even if the DPRK has not actually begun enrichment of uranium, the DPRK–IAEA safeguard agreement provides that the DPRK should make available design information on new facilities to the IAEA as soon as possible before nuclear material is introduced into the facility and allow the IAEA to perform a design review. (For more on this point, see below.) The DPRK has also been obliged to submit to IAEA safeguards any uranium when it is of a suitable composition and purity for isotopic separation in the enrichment plant.

Any eventual resolution of this issue must involve the DPRK's fulfillment of its obligations under the NPT to accept full-scope IAEA safeguards on all its nuclear activities. The transition from a freeze to full compliance with North Korea's NPT obligations would be greatly facilitated if the IAEA were verifying the freeze.

Potential practical difficulties the IAEA could face in monitoring a freeze are the lack of adequate financial resources and the relative remoteness of the DPRK from Vienna. Since 1984, member states of the UN system have held the assessed or regular budgets of the IAEA and other international organizations in the UN system to a policy of zero real growth, which means that no increases in the annual assessment budgets of the UN agencies can exceed the increase in the inflation rate. Recently, a number of UN member states, including the United States, have strongly advocated an increase in resources for IAEA safeguards.

Joint DPRK–ROK Verification. There are options other than the IAEA for verifying a freezing of the enrichment program in the DPRK. One is the Republic of Korea. There is a precedent for ROK nuclear inspections in the DPRK, at least in principle. The 1992 Joint Declaration between the DPRK and the ROK provided for the establishment and operation of a South–North Joint Nuclear Control Commission (JNCC), which would be responsible for conducting inspections of "particular subjects chosen by the other side and agreed upon between the two sides." The JNCC was tasked with matters "related to the exchange of information for the verification of the denuclearization of the Korean peninsula," as well as organizing the composition and operation of inspection teams.

However, the JNCC meetings had a short life span. Major disagreements quickly broke out over the nature of a bilateral inspection regime. The DPRK rejected South Korean demands for short-notice inspections and tried to limit the inspections to verifying that no nuclear weapons existed on the Korean peninsula, while the ROK insisted that there be an equal number of inspections by both parties, that there be no sanctuaries, and that challenge inspections should take place on 24-hour notice. In any event, North Korea canceled the JNCC talks altogether in 1993 when the ROK refused to cancel its Team Spirit joint military exercises with the United States.

There is some logic to having the JNCC monitor a DPRK freeze on its enrichment activities. In addition to banning the possession and use of nuclear weapons on the Korean peninsula, the Joint Declaration also explicitly prohibits the possession of nuclear reprocessing and enrichment facilities on the peninsula. Using the ROK to verify a freeze on enrichment activities would be an appropriate implementation of the Joint Declaration aimed specifically at verifying the freeze on the DPRK enrichment program. In addition, some may see certain political advantages in having the ROK verify the enrichment freeze.

Yet there are some important downsides. The ROK does not presently possess the experience or expertise to carry out such a monitoring function; nor, presumably, does the DPRK. Because neither side has had any experience with bilateral nuclear inspections, both North Korean and South Korean teams would have to receive extensive and time-consuming training to be able to carry out such inspections. North Korea would probably insist that such inspections be reciprocal, and this would introduce the complication of access to military bases in South Korea, including those of the United States.

The question also arises as to whether such inspections should be limited to merely enrichment activities or should be expanded to encompass all the elements of the Joint Declaration. Finally, it would raise questions about the relationship of the ROK–DPRK bilateral inspection regime with the responsibility of the IAEA to implement inspections in the DPRK pursuant to the NPT and to the Agreed Framework. If the DPRK excluded the IAEA from the verification of the freeze on the enrichment program, it would seem to run counter to the U.S. position that North Korea needs to abide by its existing nonproliferation obligations as reflected in the NPT and the Agreed Framework.

Nonetheless, during the course of negotiations on this issue, the interested parties may find some political value in a North–South bilateral inspection regime. One option would be to model such a bilateral DPRK–ROK inspection regime on the Argentine–Brazilian Agency for the Accounting and Control of Nuclear Materials (ABACC) that was established to implement inspections of all Argentine and Brazilian nuclear facilities. ABACC is a party to a quadrilateral safeguard agreement with the governments of Argentina and Brazil and the IAEA, under which the IAEA has rights to independently verify ABACC's findings. In practice, the IAEA has been doing most of the inspection work in Argentina and Brazil. Such a DPRK–ROK–IAEA inspection regime would have the advantage of exploiting IAEA experience, minimizing the problems stemming from the lack of inspection expertise in the ROK and the DPRK, and keeping the IAEA intimately involved as the DPRK progresses—it is to be hoped—into full compliance with its NPT safeguard obligations. (The DPRK would, of course, have to consent to the IAEA conducting independent verification.)

The United States. The United States could also be a candidate for verifying a North Korean freeze of its enrichment program. The DPRK could conceivably invite the United States to verify its freeze

as a means of drawing the United States directly into the process. North Korea might view U.S. participation in the monitoring exercise as some sort of political triumph, because it would be part of a bilateral negotiation with the United States—something that the United States has thus far declined to do—and it might seek to extract a high political price for U.S. participation. Such an action would not be unprecedented, because the DPRK permitted a team of U.S. inspectors to visit an underground site at Kumchang-ri on two occasions and even proposed permanent monitoring at the site in the form of a joint venture. However, even if the interested parties saw some political value in a U.S. verification regime, they should find some way to link it to the IAEA safeguard system to bring North Korea into eventual compliance with its NPT obligations and its commitments under the DPRK–IAEA safeguard agreement.

A Possible Role for a Nongovernmental Organization. If the governments involved are unable to initiate progress toward a verified freeze, it is conceivable that an NGO could play the role of catalyst. Such a role for an NGO in the arms control area is not unheard of. In the mid-1980s, the Natural Resources Defense Council (NRDC) set up seismic measuring equipment at the Soviet Union's nuclear weapons test site in Kazakhstan to monitor the Soviet Union's nuclear testing moratorium and thereby to demonstrate the feasibility of using seismic monitoring to verify a low-threshold test ban. Soviet scientists subsequently monitored the testing at the Nevada nuclear weapons test site in the United States. In the late 1980s, the NRDC applied radiation detectors near a live warhead on a Soviet cruiser to prove that detectors could verify arms control limits. It is possible to conceive of a constructive role that an NGO could play in a freeze of the DPRK nuclear program. For example, so-called track-II discussions between an NGO and North Korea on the modalities of a freeze and its verification might pave the way for an intergovernmental dialogue.

Similarly, an NGO might take on a more ambitious role in monitoring a freeze, if the interested governments were unable to reach a formal agreement on this issue and saw some merit in using an NGO as a first step in initiating steps toward verifying a freeze. A role for an NGO might also be possible if North Korea found some political value in inviting an NGO to verify a freeze it had unilaterally undertaken and could serve as a precursor to a more formal verification by the IAEA or another government. For example, the DPRK might invite an NGO to visit one or more of its enrichment facilities to determine whether it was operating or had been shut down. NGO visits could be conducted periodically. An NGO could also install containment and surveillance devices to monitor the freeze between visits.

However, an NGO would be able to play only a very limited and short-lived role in technical verification, because it would presumably possess neither the technical capability nor the financial resources to carry out the full spectrum of inspections and monitoring actions required for a credible verification regime. The installation of an effective surveillance system is not a simple task and requires a great deal of sophistication and experience, skills not typically possessed by NGOs. An NGO would also face serious obstacles in obtaining information from the U.S. intelligence community or the intelligence agencies of other governments to carry out inspections to verify the correctness and completeness of declared activities. Any role that an NGO might play in such an endeavor would, therefore, be limited but could be useful in clearing the way for a more formal verification regime by the IAEA and/or interested governments. And the United States and other interested governments would probably be anxious to bring the IAEA into the picture as soon as possible.

What Is to Be Declared?

Any verification regime must begin with a declaration by the party whose activities are to be inspected. In the case of verifying a freeze by North Korea of its uranium enrichment program, such a declaration should encompass all aspects of its enrichment activities. These would include the following (the DPRK may already be obliged to declare some of these activities to the IAEA in accordance with its NPT safeguard agreement):

- Records, locations, and disposition of all imports of enrichment materials, equipment, and technology.[5]
- Records, locations, and disposition of all enrichment materials, equipment, and technology that have been produced or manufactured in North Korea.[6]
- Foreign sources of procurement of enrichment materials, equipment, and technology.
- All research and development (R&D) and test facilities and their operating records. (If nuclear material were present in such facilities, the DPRK would be obliged under the DPRK–IAEA NPT safeguard agreement to declare such facilities to the IAEA and to make available design information.)
- Manufacture and assembly facilities and their operating records.
- Facilities for the conversion of uranium oxide to uranium hexafluoride.[7]
- Enrichment facility (facilities)—including feed, product, and tails, as well as the operating records.[8]
- Facilities for the conversion of an HEU product to metallic uranium. (The DPRK is already obliged to declare such material to the IAEA under its NPT safeguard agreement and to provide the IAEA with design information and records for each material balance area.)

Are there steps short of a full freeze that the DPRK could take? North Korea, of course, might be resistant to accepting a verified freeze on all the activities listed above. If it had begun to operate an enrichment facility, it might be prepared to cease operations of the enrichment plant but be unwilling to reveal any information about its operating history, thereby adopting a position much like the one it took with respect to the 5 MWe reactor at Yongbyon. This would lead to the type of interim freeze that was contemplated in the Agreed Framework, whereby reactor operations were halted under an IAEA monitoring regime, but the DPRK did not permit the IAEA to verify past production. (Among other things, the DPRK did not reveal the operating records of the 5 MWe reactor, refused to allow the IAEA to determine the amount of plutonium in the spent fuel from that reactor, and did not implement safeguard measures at the liquid waste tanks at Yongbyon.)

This would leave the international community with some confidence that North Korea was not currently producing HEU for nuclear weapons but not knowing for certain how much HEU they might have produced in the past. If the DPRK had not yet begun enrichment operations, it might be willing to halt construction of the enrichment facility or installation of the centrifuge cascade but be unwilling to freeze the manufacture or assembly of centrifuges or to stop the testing of its centrifuge designs. (The DPRK did not provide the IAEA with adequate information about the amount and location of nuclear equipment that it may have manufactured for the two reactors under construction.)

The advantage of even this limited kind of freeze is that North Korea would stop short of actually producing enriched uranium for nuclear weapons and would permit an outside agency to verify that it was not producing HEU. However, it would retain a breakout capability by continuing to test and/or manufacture centrifuges. Each of these scenarios is short of a complete freeze, but each could be part of an understanding that could constitute the beginning of a step-by-step process toward a complete verified freeze of all enrichment activities and the eventual dismantlement of all of North Korea's enrichment activities.

How Is the "Freeze" to Be Monitored?

The verification of the freeze on *declared activities* should *as a technical matter* be relatively straightforward. The verifying agency should have access to all declared facilities. Such facilities would be subject to inspection to verify the correctness and completeness of the DPRK declaration. Inspectors would tag and seal all items subject to the freeze. Containment and surveillance devices (tamper-proof seals and cameras) would be situated at appropriate locations at all facilities. For facilities under construction, the inspection agency could establish an initial photographic baseline to document the status of each facility's construction. Subsequently, inspectors could visit the facilities, observe them, take updated photographs, and compare them with the initial photos to ensure that construction has not resumed.

This would be similar to the activities carried out by the IAEA at the nuclear facilities covered by the Agreed Framework. In the case of a freeze that applies to all enrichment activities, the inspecting agency should have access even to facilities where no nuclear material is present, for example, centrifuge enrichment research, development, and testing facilities, and plants for manufacturing and assembling centrifuges. The IAEA has had extensive experience inspecting and monitoring such facilities in Iraq under UN Security Council Resolution 687. For example, the IAEA tagged, sealed, or conducted surveillance of certain machine tools at Iraqi facilities to ensure that those machine tools were not being used to manufacture enrichment or other prohibited equipment.

Most important, the inspecting agency would have to verify that any North Korean enrichment facilities remained "frozen." If the enrichment facility were still under construction, the inspection would involve some seals and surveillance and periodic inspection to verify that construction had not been resumed. If the facility had actually been operating, the inspecting agency and the governments involved would face different and more complex issues. The IAEA has had experience in safeguarding operating centrifuge enrichment facilities in Japan and Western Europe.[9] The IAEA has also inspected enrichment facilities that have been shut down. Of particular note is the case of South Africa. Following South Africa's adherence to the NPT in 1991, the IAEA engaged in an extensive exercise to verify whether the declared inventory of the South African "Y" plant (the enrichment facility that had produced HEU for its nuclear weapons program and that had been shut down) was consistent with the declared production and usage data, and that the amount of HEU declared to have been produced by the Y plant was consistent with the plant's production capacity.

On the basis of exhaustive studies, the IAEA determined that it was reasonable to conclude that the uranium-235 balance of the HEU, low-enriched uranium, and depleted uranium produced by the Y plant was consistent with the natural uranium feed and that the amounts of HEU that could have been produced by the plant were consistent with the amounts declared in the initial South African report. A similar exercise was undertaken for the Z plant, the semi-commercial enrichment plant in South Africa, which continued to operate for some time.[10]

The IAEA exercise in South Africa was complicated by the fact that the Y plant had been operating for a number of years, which required an extensive reconstruction of the historical record. If North Korea has initiated the actual enrichment of uranium, it has done so presumably for a fairly short period of time. Hence a similar exercise in the DPRK would not in principle be as difficult. However, in the case of South Africa, by the time the IAEA had begun its inspections, the South African government had already decided to abandon its nuclear weapons program and to dismantle its nuclear weapons.

As a result, the South African authorities were quite open, transparent, and cooperative with the IAEA to enable effective safeguards. Given the history of the relationship of the DPRK with the IAEA at Yongbyon, it is at the very least open to question how transparent and cooperative the DRPK might be with respect to the history of its enrichment operations. If the DPRK has operated a uranium enrichment facility, it will be essential to allow the inspection of the operating records of the plant as well as the application of material accountancy to determine the quantity and isotopic composition of the feed, product, and tails. Otherwise, the international community will be confronted with the same situation it faced with respect to the history of the 5 MWe reactor at Yongbyon. (The DPRK did not make operating records of the 5 MWe reactor available to the IAEA.)

Environmental sampling may also be appropriate inside any enrichment facility and on areas within boundaries or the immediate vicinity of an enrichment plant to characterize the facility operations, both historical and current, as well as air, vegetation, soil, and water samples, and biota inside and outside the facility, and to verify the absence of the production of HEU. The IAEA has developed swipe sampling techniques and ultra-sensitive analytical techniques, such as mass-spectrometry methods, particle analysis, and low-level radiometric techniques that can reveal signatures of past and present activities in locations where nuclear material was handled. (Though the DPRK allowed the IAEA to apply safeguards at facilities not subject to the freeze, it did not permit the IAEA to take environmental swipe samples at those facilities, even though provision for environmental sampling is contained in the DPRK–IAEA NPT safeguard agreement.)

How Much Confidence Can the International Community Have in the DPRK Declaration?

Although it may be relatively straightforward to verify the activities and facilities that North Korea has declared, the real challenge will be in determining whether the North Korean declaration of its enrichment program is correct and complete, or whether the DPRK may have decided to withhold certain information from the inspecting agency and to continue to operate one or more elements of its enrichment program on a clandestine basis. This is particularly important in light of the fact that North Korea apparently decided to embark on a clandestine enrichment program in violation of its international obligations.

Detecting a centrifuge enrichment program through national technical means is much more difficult than observing reactor operations. It would not be difficult to hide facilities for manufacturing or assembling centrifuges for uranium enrichment. Centrifuge enrichment itself does not require a large facility with clear signatures. A facility could be located underground, and the national pastime of the DPRK is to dig tunnels. One South Korean publication said that the North is suspected of having numerous secret underground sites for its enrichment activities; twelve was cited by the newspaper *Joonggang Ilbo* on February 6, 1999. A small, carefully designed, constructed, and maintained centrifuge enrichment plant producing only enough HEU for one or two nuclear weapons per year

(about the estimated capacity of the North Korean enrichment facility), if equipped with a ventilation system using high-efficiency filters, would release few emissions and could be quite difficult to detect. Gaseous diffusion, aerodynamic, and electromagnetic enrichment plants are quite inefficient and release a large amount of heat. A centrifuge facility requires much less electricity.[11]

Conversely, centrifuge plants place unusual loads on the electric power system. In particular, the centrifuges operate at high speed and require conversion of the line frequency to a much higher frequency. The converters reflect a distinct signal back into the line that can be detected. Finally, under some conditions, the distinct noise generated by centrifuges might be detected and recognized.[12] Without knowing what assets and technology the U.S. intelligence community has available to detect North Korean enrichment activities, it is not clear how much confidence one can place in national technical means for determining the correctness and completeness of a DPRK declaration of its enrichment program.

In any case, an extensive and rigorous on-site (boots and eyes on the ground) inspection regime would clearly be required to achieve a reasonable level of confidence that the North Korean declaration of its enrichment program was correct and complete. The IAEA has had extensive experience in conducting operations to detect suspected nuclear activities in Iraq under the provisions of UN Security Council Resolutions 687 and 1441. These mandates gave the IAEA extensive rights to conduct inspections in Iraq. Despite Iraqi efforts to conceal and deceive, the IAEA—with the assistance of intelligence information provided by UN member states and its own inspection efforts, including the extensive use of environmental monitoring—was able over time to undercut Iraq's cover stories and expose its nuclear weapons program, including its enrichment efforts.

The DPRK is, of course, highly unlikely to accord any inspection agency the rights of inspection that the IAEA had in Iraq. (North Korea did not even allow the IAEA access to some of the technical buildings at the facilities covered by the Agreed Framework.) Monitoring imports would also be difficult, and detecting the clandestine procurement of items for an enrichment program on the international market would require close cooperation by the international community, especially key countries such as China, Pakistan, and Russia. The detection of undeclared activities in North Korea, including research, development, manufacture, and assembly of centrifuge parts and components, would present particular challenges.

Detecting the operation of an undeclared enrichment facility could also prove difficult. The inspecting agency would need broad rights of access to sites that are suspected of being associated with an enrichment program, including short-notice inspection of suspect facilities or sites. According to the former U.S. Office of Technology Assessment, the analytical techniques that are available to the IAEA are sufficiently sensitive to have a high probability of detecting covert activities to produce nuclear weapons materials if the sampling is close to the facility.

Long-distance monitoring, especially of the air, is more problematical. The more dilute the emissions become, the less likely that critical materials can be distinguished from the background or that they can be traced back to the source. A verification regime would also have to provide for the collection of environmental samples beyond declared locations when deemed necessary. This would evidently require collecting a large volume of air samples and testing the effectiveness of hydrological sampling along major waterways. However, the use of wide-area environmental monitoring sampling, the feasibility of which remains to be demonstrated, could be extremely costly and vulnerable to countermeasures deployed by the DPRK that could undermine its effectiveness.

The effectiveness of any such verification regime will depend on (1) the extent to which North Korea would allow extensive access (i.e., including short-notice inspections of suspect sites), (2) the extent to which the DPRK would permit environmental monitoring, (3) the extent to which the inspecting agency would receive quality information from national governments on the location of suspect clandestine enrichment activities, and (4) the extent to which the inspecting agency would have access to adequate financial resources. However rigorous the regime for monitoring a freeze of the North Korean enrichment program might be, it would not be able to assure with certainty the absence of clandestine enrichment activities, and the conclusions that an inspecting agency would draw would most likely be qualified but might be judged adequate.

HOW MONITORING THE FREEZE MIGHT LEAD TO FULL-SCALE INSPECTIONS AND DISMANTLEMENT

The logical next step following a verified freeze of the North Korean uranium enrichment program and the reinstitution of the freeze on the reactors and associated facilities at Yongbyon and Taechen would be a move by the DPRK toward compliance with its various nonproliferation obligations, including adherence to its full-scope NPT safeguard agreement with the IAEA and the termination and dismantlement of any program designed to acquire nuclear weapons. This could be accomplished all at once or on a gradual basis.

The NPT Safeguard Agreement and the Additional Protocol

As part of this process, it is imperative that an eventual resolution of the North Korean nuclear crisis include the DPRK's ratification of the Additional Protocol to the IAEA safeguard agreements as approved in 1997 by the IAEA Board of Governors. The Additional Protocol gives the IAEA rights to increased information and access to all aspects of a state's nuclear fuel cycle—from uranium mines to nuclear wastes and to locations where nuclear material intended for non-nuclear uses is stored.

Under the NPT safeguard agreements, inspectors' rights of access have been limited, and in practice the IAEA did not fully exercise its rights to conduct special inspections. For routine inspections, the IAEA has been limited to key measuring points in declared facilities. The Additional Protocol gives complementary access rights to the IAEA and its inspectors; for example, access is possible to any place on a "site" or to mines or to nuclear-related locations where no nuclear material is located, such as sites where related R&D or manufacturing activities are performed, to ensure the absence of undeclared activities. The Additional Protocol also permits environmental sampling with either location-specific or, under certain conditions, wide-area monitoring. (The latter may, however, require an additional Board of Governors approval and perhaps a new agreement.) In particular, the Additional Protocol provides for the following:

- Information and access to all buildings on a nuclear site.
- Information about and access to fuel cycle–related R&D.
- Information on the manufacture and export of sensitive nuclear-related technologies and inspector access to manufacturing and import locations.
- Collection of environmental samples beyond declared locations when deemed necessary by the IAEA.

- Administrative arrangements that improve the process of designating inspectors and the issuance of multi-entry visas and IAEA access to modern communications.

It is noteworthy that, if the DPRK agreed to declare all aspects of its enrichment program as part of a freeze on its existing program, it would be well on its way to accepting the added responsibilities of the Additional Protocol. For example, the Additional Protocol provides for the provision of information, among other things, on the location of nuclear fuel cycle–related R&D not involving nuclear material and specifically related to enrichment, a description of the scale of operations for each location engaged in activities related to the manufacture of centrifuge rotor tubes or the assembly of gas centrifuges, and information on the import of enrichment equipment. These rights could be crucial in helping ensure that there are not additional illicit North Korean activities (beyond enrichment facilities) that have not yet surfaced.

There are limitations on IAEA access under the Additional Protocol. For example, there are provisions for managed access to prevent the dissemination of proliferation-sensitive information, to meet safety or physical protection requirements, or to protect proprietary or commercially sensitive information. Nevertheless, if implemented effectively, the Additional Protocol, in combination with the DPRK's NPT safeguard agreement, would provide for as complete a picture as practical of the DPRK's holdings of nuclear material and its fuel cycle activities. However, there will remain some inherent, irreducible uncertainty concerning the completeness of the DPRK declaration.

North Korea's fulfillment of its NPT safeguard obligations and its adherence to the Additional Protocol would necessarily involve the verified abandonment of its nuclear weapons program (supplemented by what is available through national intelligence). This may involve the actual dismantlement of nuclear weapons and/or the declaration of plutonium or HEU that had been recovered from dismantled nuclear weapons, or had been stockpiled for a planned nuclear weapons program that the DPRK had abandoned before its implementation.

Under the NPT safeguards, the DPRK would have no obligation to explain what had been the past purpose of this material, and the role of the IAEA in implementing its NPT safeguard responsibilities would be limited to determining that all nuclear material had been declared and placed under safeguards. (The international community, however, may insist that the DPRK provide an explanation of the history of this material as part of any overall resolution of the North Korean nuclear problem.) The IAEA has had experience in this sort of exercise in connection with the adherence of South Africa to the NPT.

In 1993, the South African government openly declared that it had developed a limited nuclear weapon capability and that it had dismantled that capability before its adherence to the NPT. The IAEA, in an effort to determine the correctness and completeness of the South African declaration, carried out inspections, accompanied by nuclear weapons experts, at a number of facilities that had been declared to have been involved in the dismantled South African nuclear weapons program.

The IAEA also had extensive discussions with South African authorities and technical staff at the Atomic Energy Commission (AEC) and the state-owned armaments corporation (ARMSCOR), which had been responsible for the production of South Africa's nuclear weapons. On the basis of documentation and interviews, the IAEA was able to learn the timing and scope of the nuclear weapons program. The IAEA also carried out an audit of the records of the transfer of enriched uranium between the AEC and ARMSCOR and concluded that the enriched uranium originally supplied to ARMSCOR had been returned to the AEC and was subject to IAEA safeguards. The findings from the IAEA's examination

of the records, facilities, and remaining non-nuclear components of the dismantled or destroyed nuclear weapons, and from the IAEA's evaluation of the amount of HEU produced by the pilot enrichment plant, were consistent with the declared scope of the nuclear weapons program.[13]

The IAEA conducted these various activities under its NPT safeguard agreement with the South African government and without the benefit of the enhanced rights to information and rights of access accorded by the Additional Protocol. It should be emphasized that the IAEA was able to accomplish these verification activities because the South African authorities actively cooperated in arranging access to all facilities that the IAEA requested to visit, based on a prior decision of the South African government to abandon and dismantle its nuclear weapons program, to adhere to the NPT, and to bring all its nuclear activities under IAEA safeguards. It is unlikely that we would be dealing with a comparable situation with the DPRK, and it may prove far more difficult to verify that North Korea has abandoned its clandestine nuclear activities and declared all past production of plutonium and HEU.

Resolutions 687 and 1441—Another Model?

It is also possible, at least in theory, to consider a second model for an eventual resolution of the North Korean nuclear crisis—one that goes beyond full implementation of full-scope safeguards and the Additional Protocol, namely, an inspection regime that is comparable to that required in Iraq by UN Security Council Resolutions 687 and 1441. This inspection regime is a highly intrusive and coercive system that was imposed on a state that had initially been subject to military defeat and more recently to the threat of military force and coerced regime change.

Short of war and perhaps a draconian sanctions regime rigorously enforced by China, Japan, and other states, it is difficult to imagine the circumstances that might persuade or compel the highly secretive North Korean regime to accept the kind of inspections called for in these UN resolutions and that accord the UN Monitoring, Verification, and Inspection Commission (UNMOVIC) and the IAEA rights, among other things, of

> immediate, unimpeded, unconditional, and unrestricted access to any and all, including underground, areas, facilities, buildings, equipment, records, and means of transport which they wish to inspect, as well as immediate, unimpeded, unrestricted, and private access to all officials and other persons whom UNMOVIC or the IAEA wish to interview in the mode or location of UNMOVIC's or the IAEA's choice pursuant to any aspect of their mandates.[14]

Moreover, if the DPRK were to agree to a verified freeze of its sensitive nuclear activities (its plutonium production and uranium enrichment programs) as an interim step toward ultimate compliance with its various international nonproliferation obligations, there might be little incentive to compel North Korea to accept a Resolution 1441–type of inspection regime.

CONCLUSIONS

With sufficient access, information, and resources, it is possible to establish a regime to verify a freeze of North Korean sensitive nuclear activities (and notably its enrichment program) as an interim step toward full DPRK compliance with its nonproliferation obligations. Whether this can be translated into a reality under the present difficult circumstance is obviously an open question and will depend on variables that go beyond the scope of this chapter.

Some historical grounds exists for believing that North Korea might be prepared to take interim steps to maintain or restore some level of assurance about its nuclear program before reaching a more permanent resolution. For example, even when the DPRK threatened to withdraw from the NPT in 1993, it said it was prepared to let the IAEA monitor nuclear facilities to prevent diversion. Again, in the tension-filled weeks of the spring and summer of 1994—after the DPRK took the provocative step of unloading spent fuel from the 5 MWe reactor at Yongbyon—it allowed the IAEA to continue to monitor the spent fuel. This situation continued until the arrangements provided in the Agreed Framework went into effect.

North Korea might agree to a complete freeze of all its enrichment-related activities, or it might be prepared to accept a freeze of only some subset of such a activities as part of a step-by-step process. The effectiveness of any regime to verify a freeze of DPRK enrichment activities will depend on the degree of North Korean cooperation with inspection and monitoring activities, the information that the United States and other countries have with respect to DPRK uranium enrichment activities, their willingness to share that information with the inspecting agencies, and the resources available to the inspecting agency.

Although interested states might find some political advantage in having the ROK or the United States actually participate in verifying the freeze of North Korean enrichment activities, it will be important to maintain a material role for the IAEA in such an exercise so as to press the DPRK to meet its obligations to accept IAEA safeguards under the NPT and monitoring under the Agreed Framework and to facilitate the transition to full compliance by the DPRK with it various nonproliferation obligations. The use of an NGO might have some temporary value in catalyzing a monitored freeze, but the basic objective should be to bring the IAEA back into the business of safeguarding the North Korean nuclear program as soon as possible.

Given the erratic and unpredictable behavior of the DPRK, it is not inconceivable that the DPRK could unilaterally and voluntarily announce a freeze of its enrichment and reactor programs to convince the international community that it is not proceeding with a nuclear weapons program or as a gesture to persuade the United States that it is willing to engage in genuine negotiations leading to the dismantling of its unsafeguarded nuclear program. However, this would not be consistent with past behavior or current steps to restart the facilities at Yongbyon. The DPRK has typically ratcheted up crises to extract concessions in return for easing tensions.

It is far more likely that North Korea would move toward a freeze or any other confidence-building measure only under duress, or if it obtains some significant economic and/or political advantages in doing so. This chapter has not examined the economic, political, or security incentives—or the forms of coercion—that might lead North Korea to make such a decision. Presumably, a North Korean move to freeze its enrichment program and to reinstitute the freeze called for by the Agreed Framework would be part of some negotiation process either with the United States or some other state or group of states in the region.

This chapter has not addressed several key questions:

- How realistic is it to assume that the DPRK can be persuaded or compelled to move toward a freeze of its enrichment activities as well as those activities at Yongbyon and Taechon?
- What incentives or sanctions might be employed to induce the DPRK to accept such a freeze?
- What is North Korea really seeking to accomplish? Is it intent on acquiring and maintaining a nuclear weapons capability? Or is it prepared, as it has claimed, to forgo such weapons in exchange for security guarantees and other political and economic benefits from the United States?

- Are there any constructive approaches that could break the current impasse and put nonproliferation relationships with North Korea on a more solid basis than was achievable under the Agreed Framework?

The only way to answer these questions is through negotiations with North Korea and through the establishment of a rigorous verification regime that puts to the test its avowed willingness to forgo the possession of sensitive nuclear facilities and nuclear weapons.

APPENDIX: SUMMARY OF OFFICIAL STATEMENTS AND PRESS REPORTS ON NORTH KOREA'S NUCLEAR PROGRAM

This appendix summarizes statements by U.S. officials and press reports on North Korea's nuclear program. These materials deal with the questions of when the program began and where enrichment activities are taking place.

When Did the Program Begin?

The United States apparently obtained evidence of the uranium enrichment program in 2000.[15] This evidence was presumably based on discovery of North Korean attempts to acquire large amounts of high-strength aluminum.[16]

A CIA report to Congress on the Acquisition of Technology Related to Weapons of Mass Destruction and Advanced Conventional Munitions for the period of July 2001 to December 2001 stated: "The North has been seeking centrifuge-related materials in large quantities to support a uranium enrichment program. It also obtained equipment suitable for use in uranium feed and withdrawal systems."[17]

Daniel Pinkston of the Monterey Institute has written that there is evidence that North Korea's HEU program began in the 1980s.[18] According to German intelligence, North Korea obtained "an array of nuclear-related dual-use furnace equipment in the 1980s, including a small annealing furnace from the German firm Leybold AG in 1987." In November 1991, "one western government" concluded that uranium enrichment technology "allegedly diverted to Pakistan via Switzerland may have been exported to Iran, Iraq and North Korea." The report also added that uranium melting technology may also have been shipped to North Korea. U.S. and German intelligence officials also believe that Leybold personnel were in North Korea in 1989 and 1990. Assistant Secretary of State James Kelly said the United States had information on the North Korean efforts to establish a uranium enrichment capability that "is already several years old."

On television, U.S. Secretary of State Colin Powell said on Fox News Sunday, December 29, 2002, that the North Korean enrichment program "didn't happen just in the last year or two. It's a decision they made and a program they started four or so years ago, and we found out about it this summer." On NBC's Meet the Press, Powell said, "They were motivated four, five years ago, if not earlier, to make the political decision to move down the road of finding a second way of developing nuclear weapons."

U.S. National Security Advisor Condoleezza Rice told CNN on October 20, 2002, that there was evidence of North Korea's pursuit of this program going back to at least 1999 but that the United States had decided to confront North Korea on the basis of evidence confirmed only this past summer. The *Washington Times* reported that it had obtained a 1999 Department of Energy (DOE)

report that revealed that a North Korean company tried to circumvent Japanese export controls by purchasing two "frequency converters" from a Japanese company.[19]

The DOE report said that the purchases showed that North Korea was "in the early stages of a uranium-enrichment capability." It also said that, "on the basis of Pakistan's progress with a similar technology, we estimate that [North Korea] is at least six years from the production of highly enriched uranium, even if it has a viable centrifuge design." On the other hand, with significant technical support from other countries such as Pakistan, the time frame could be decreased by several years.

The Global Security Newswire quoted sources close to U.S. intelligence that the Pyongyang had imported at least 2,000 centrifuges, double the number previously believed.[20] It also reported that North Korea began a uranium enrichment program in 1997 and acquired the centrifuges a year later, according to U.S. and Japanese sources.[21] A North Korean defector who had belonged to the technical division of North Korea's uranium enrichment facility reportedly told South Korean authorities details of the facilities location and the technology used there. The defector reportedly said Pyongyang started its nuclear development program in 1998.[22]

Deputy Secretary of State Richard Armitage, in testimony on February 4, 2003, before the Senate Foreign Relations Committee, said the U.S. government had noticed, "some anomalies in [North Korean] procurement patterns" beginning in 1994. Secretary of State Colin Powell, on NBC's Meet the Press on December 29, 2002, said that the program had begun "four or five years ago, if not earlier." [23]

Where Are the Enrichment Activities Taking Place?

The *Korean Herald* reported that, according to a diplomatic source, "The United States has indicated that the North Korean Academy of Sciences, near Pyongyang, is suspected of being one of three sites where North Korea conducted uranium-enrichment tests as part of its nuclear program.[24] The other two suspected sites are the Hagap region, located in Changgang Province, and the city of Yeongjeo-dong in Yanggang Province about 20 kilometers from the Chinese border.

Joby Warrick quoted Daniel Pinkston of the Monterey Center for Nonproliferation Studies as saying that U.S. officials have declined to reveal the location in question but that previously, speculation about enrichment plants had centered on three locations, including a suspected underground facility in Changgang Province known as Hagap.[25] CNN (December 3, 2002) cited a senior administration official as saying that U.S. intelligence does not know where the plant—most likely underground—is located.

What Progress Has the Program Made toward Producing Highly Enriched Uranium?

It is not known what progress North Korea has made toward enriching uranium. Intelligence officials assert that while they lack conclusive evidence, they believe it unlikely that the uranium enrichment effort has reached a level at which North Korea has produced nuclear weapons using the enrichment method. "It takes a very long time to produce a weapon based on that system," said a U.S. intelligence official. "And there would be more fingerprints."

An article by Seymour Hersh in the *New Yorker* cited a CIA report that said that "North Korean scientists began to enrich uranium in significant quantities in 2001."[26] Hersh has clarified to the author that his use of the term, "significant quantities," does not refer to the terminology used by the IAEA to signify the approximate quantity of nuclear material required to manufacture a nuclear explosive device.

(As employed by the IAEA safeguard system, the significant quantity for highly enriched uranium is 25 kilograms.) Thus the Hersh article seems to be asserting that North Korea may have begun enriching uranium in 2001 but not in sufficient quantities to manufacture a nuclear weapon.

Administration officials have refused to say whether North Korea had acknowledged successfully producing a nuclear weapon from the project.[27] Nor would administration officials who briefed reporters say whether they think North Korea has produced such a weapon. "We're not certain that it's been weaponized yet," another official was quoted as saying.[28] In addition, the United States received reports of significant construction activity that appeared related to a uranium enrichment facility.[29]

Anonymous administration officials have also been quoted as saying that North Korea likely has not advanced far in its efforts to produce a nuclear weapon from HEU.[30] They said that the United States received intelligence last summer that Kim Jong Il's government was "trying to get equipment to move to production levels of uranium enrichment." The U.S. undersecretary of state for arms control and international security, John Bolton, said in a press conference on October 22, 2002, "What we have said publicly and in consultations is not that the North Koreans have nuclear weapons produced through the uranium enrichment program" but that North Korea is "seeking a production scope capability to produce weapons-grade uranium."

A CIA study has been cited as stating that North Korea could begin producing highly enriched uranium in the next three years.[31] It quoted the CIA as saying, "We recently learned that the North 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."

CNN (December 3, 2002) quoted a senior administration official as saying that a gas centrifuge plant to enrich uranium could be ready as early as next year. An article by Jim Hoagland reported that unnamed sources "say that the North Koreans possess 2,000 to 3,000 centrifuges and are already enriching uranium."[32]

Nuclear Fuel (November 25, 2002, p. 1) reported on a CIA estimate that the DPRK would be able to produce significant quantities of weapons-grade HEU by about 2005. This presupposes that the DPRK has obtained unprecedented assistance from foreign sources in building gas centrifuges, plus a complete design package for a proven subcritical centrifuge using aluminum. In mid-November, the CIA provided Congress with a "consensus estimate" that concluded that last year the DPRK had begun seeking centrifuge-related materials in large quantities and that it could be making two or more bombs' worth of HEU per year "as soon as mid-decade."

This assessment assumes a vast amount of outside help with a high probability that the aid included the complete design package for a proven machine. The assessment has the DPRK beginning large-scale centrifuge production in 2001 and producing an HEU significant quantity by 2005. According to the *Nuclear Fuel* article, Western officials would not confirm that Pakistan had exported between 2,000 and 3,000 centrifuge rotor assemblies to the DPRK. Sources said that information coming to light suggested that individuals with years of experience inside Pakistan's uranium enrichment program had given the DPRK the design package for an aluminum centrifuge, prototype components, and manufacturing and some diagnostic assistance, which might dramatically reduce the timeline for the DPRK to enrich uranium. The DPRK sought assistance from a variety of sources, including China, Japan, Pakistan, Russia, and Eastern Europe, but most of the assistance related to the rotor assembly itself came from Pakistan, including some high-grade aluminum used in the components.

The design of the aluminum centrifuge had at least some of the characteristics of the design that the Pakistanis had stolen from Urenco. However, based in part on procurement information, the design of the DPRK machine is believed to represent a composite design not identical to the Urenco design. The design did not match known Western centrifuge designs.

The *Nuclear Fuel* report also said that some information suggests that the DPRK may have "slavishly followed a recipe" calling for some more advanced components or materials, as called for in the design package provided by its helpers. That would explain why North Korea tried to purchase more advanced materials for the machines than were in fact necessary, including the 6,000-grade aluminum and pure cobalt for top bearing assemblies. Some of Pakistan's aluminum-design rotor assemblies relied on 2,000-grade aluminum and used earlier-generation magnetic bearings, made of aluminum and nickel, not samarium and cobalt. The DPRK sought to obtain dozens of kilograms of cobalt powder with a purity in excess of 99.99 percent. Pure cobalt is not on nuclear commodity control lists. DPRK did not need samarium–cobalt bearings for an aluminum centrifuge, nor did it require 6,000-grade aluminum, but it may have sought it in the mistaken belief that it would have shortened the path to producing HEU.

One expert told *Nuclear Fuel* that, if in fact the basis of the DPRK machine is a subcritical aluminum centrifuge with a throughput of around one SWU machine per year, with 2,000 machines in place, the DPRK could enrich "enrich at least enough HEU for a bomb a year." "If we assume the DPRK started building machines in earnest about a year ago, it might just be able to start" enriching a bomb's worth of HEU a year in 2005, assuming there were no unanticipated bottlenecks. But that also assumes that the DPRK is willing to take decisions and shortcuts that would mean that the initial failure rate of the machines might be as high as 10 percent and that, "after two or three years of operation, a very large number of machines would crash." (This is the path that Pakistan followed in the 1970s and 1980s.)

A South Korean newspaper reported a senior Seoul official as saying that the South Korean government had received information from the United States that North Korea might have enough enriched uranium to manufacture two nuclear bombs, and that U.S. intelligence had put the estimated quantity of enriched uranium at about 30 kilograms.[33] It also reported another South Korean official as saying that North Korea probably used more than 1,000 centrifuge isotope separators to enrich the uranium and that the U.S. government had also relayed the location where the "substance is stored."

NOTES

1. Associated Press, November 7, 2002, as reported online by Yahoo! News.
2. Peter Slevin and Glenn Kessler, "Bush Plans Diplomacy on N. Korea's Arms Effort," *Washington Post*, October 18, 2002, p. A01.
3. It takes about 200 SWU to produce 1 kilogram of HEU (90 percent) from about 200 kilograms of natural uranium. The IAEA defines 25 kilograms as a so-called significant quantity or the amount of HEU that is required to manufacture a nuclear weapon. Countries with a sophisticated capability could make do with less.
4. This would include all enrichment items on Annex B Clarification of Items on the Trigger list of the Nuclear Supplier Guidelines (NSG) contained in the IAEA document, INFCIRC/254/Rev.4 Part 1, section 5, as well as the dual-use items in section 3 of the annex to Part 2 of INFCIRC/254. These cover all enrichment technologies, not just a centrifuge.
5. As defined in the NSG Guidelines, Part 1 Annex, section 5; as well dual-use items, as defined in the NSG Guidelines, Part 2 Annex, section 3.
6. Again, this would include items in the NSG Guidelines, Part 1 Annex, section 5; as well as the dual-use items listed in the NSG Guidelines, Part 2 Annex, section 3.

7. When uranium of a composition and purity suitable for fuel fabrication or enrichment leaves the plant or process stage in which it has been produced, the nuclear material is supposed to become subject to safeguards in accordance with the DPRK NPT safeguard agreement.
8. Under the DPRK NPT safeguard agreement, the DPRK is obliged to declare all nuclear material design information in respect of the facility and records of each material balance area in the facility. Under an IAEA Board of Governors decision in 1992, states concluding new full-scope safeguard agreements with the IAEA are obliged to provide design information on new facilities when the facility is being planned. This provision applies to agreements concluded before the 1992 board decision only if the country volunteers to make the change. Before that time, states with full-scope safeguard agreements had been required to provide the IAEA with design information for a new facility as soon as possible but usually not later than 180 days before that facility was scheduled to receive nuclear material for the first time. The precise requirements for the DPRK are reflected in the subsidiary arrangements negotiated between the DPRK and the IAEA, and probably contain a 180-day requirement.
9. Enrichment technology holders agreed in 1981 with the IAEA and EURATOM to implement a set of procedures, known as the Hexapartite agreement, to verify that a centrifuge enrichment plant was producing only low-enriched uranium and not HEU. The Hexapartite agreement provides for short-notice inspections within the cascade area of the plant under a set of guidelines called "limited frequency unannounced access."

   This approach permits short-notice inspections within the cascade area. It also provides for the use of portable assay equipment to be taken into the cascade area for determining whether a part of the plant is producing HEU, and for monitoring of the uranium flows into and out of the plant. Such an approach would not have to be applied to verify a freeze of the North Korean enrichment program.
10. For a description of IAEA steps in verifying the correctness and completeness of South African nuclear materials and installations and the status of its dismantled nuclear weapons program, see Adolf von Baeckman, Garry Dillon, and Demetrius Perricos, "Nuclear Verification in South Africa," *IAEA Bulletin*, vol. 37, no. 1, 1995.
11. Office of Technology Assessment, *Environmental Monitoring for Nuclear Safeguards* (Washington, D.C.: U.S. Congress, 1995).
12. Office of Technology Assessment, *Environmental Monitoring.*
13. See von Baeckman et al., "Nuclear Verification."
14. UN Security Council Resolution 1441, Paragraph 5.
15. Doug Struck and Glenn Kessler, "Hints on N. Korea Surfaced in 2000," *Washington Post,* October 19, 2002, p. A19; and Bill Gertz, "North Korea Can Build Nukes Right Now," *Washington Times,* November 22, 2002.
16. Joby Warrick, "U.S. Followed the Aluminum," *Washington Post,* October 18, 2002, p. A01.
17. Central Intelligence Agency, "Acquisition of Technology Related to Weapons of Mass Destruction and Advanced Conventional Munitions," report to Congress, December 2001, available at www.cia.gov/cia/publications/bian/bian.
18. Daniel Pinkston, "When Did WMD Deals between Pyonyang and Islamabad Begin?" available at www.cns.miis.edu/research/korea/index.
19. Gertz, "U.S. Saw North Korea's Work to Enrich for Nukes," *Washington Times,* October 18, 2002.
20. Global Security Newswire, November 21, 2002, available at www.nti.org/d_newswire/issues/2002/1/21/3p.
21. Dow Jones Business News, November 19, 2002, available at www.yahoo.com.
22. *Daily Yomiuri Shimbum,* December 17, 2002, available at www.yomiuri.co.jp/newse/20021218wo01.
23. "N. Korea's Uranium Enrichment Efforts Shrouded in Mystery," *Arms Control Today,* May 2003, www.Armscontrol.org/act.2003_05/uraniumenrichment_may03.asp.
24. "U.S. Pinpoints 3 Suspect Sites in North Korean Program," October 21, 2002, www.koreaherald.co.kr.
25. Warrick, "U.S. Followed the Aluminium."
26. Seymour Hersh, "The Cold Test," *New Yorker,* January 27, 2003, p. 42.
27. David Sanger, "North Korea Says It Has a Program on Nuclear Arms," *New York Times,* October 17, 2002, p. A1.
28. Sanger, "North Korea Says It Has a Program."
29. Warrick, "U.S. Followed the Aluminium."
30. Slevin and Kessler, "Bush Plans Diplomacy."
31. Gertz, "North Korea Can Build Nukes Right Now."
32. Jim Hoagland, *International Herald Tribune,* November 11, 2002, www.iht.com/cgi-bin/generic.cgi?template=articleprint.tmplh&ArticleId=76506.
33. *Joonggang Ilbo,* "North's Uranium Is Put at 30 kg," October 25, 2002, english.joins.com/Article.asp

North Korea's Nuclear Problem: Political Implications and Inspection Formats

Seongwhun Cheon

Since October 2002, with Pyongyang's brazen admission of a secret uranium enrichment program and then its recent announcement of its withdrawal from the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), North Korea's accelerated nuclear ambition has continued to astonish and befuddle the international community. During this period, North Korea has also obstructed the monitoring activities of the International Atomic Energy Agency (IAEA) and evicted on-site inspectors from the country. As a result, North Korea could potentially restart once frozen key facilities in a month or two, thereby triggering another crisis on the Korean peninsula.

Although seemingly plunging ahead with its nuclear program and nullifying its international obligations, the Democratic People's Republic of Korea (DPRK) is also demanding direct negotiations with the United States. North Korea justifies this behavior by blaming the George W. Bush administration for its hostile policy of labeling North Korea as part of an "axis of evil" and of targeting it for a preemptive strike.[1]

In return for an enrichment and plutonium program freeze, the DPRK has asked the United States to meet several conditions: (1) to recognize its sovereignty; (2) to confirm nonagression and security assurance; and (3) to not obstruct its economic development.[2] North Korea has declared that it has no intention of becoming a nuclear power at this stage, the truth of which can be verified between it and the United States.[3]

In this chapter, I give my thoughts on the possible interim and final solutions to the nuclear inspection issue with regard to North Korea's uranium and plutonium programs. However, I first discuss my views on the political implications of North Korea's nuclear gambling, for several reasons: The nuclear inspection inevitably will become part of a broader political compromise or resolution; it is important for the concerned states to reach a firm consensus regarding the importance of the issue and how to approach it, especially in view of looming gaps in perception between Seoul and Washington; and geopolitical and nonproliferation considerations will become a determinant of the shape of any inspection format.

THE POLITICAL IMPLICATIONS OF NORTH KOREA'S NUCLEAR GAMBLING

The political implications of North Korea's nuclear gambling stem from four main factors. These are the North Korean regime's bad and worsening image, increasing awareness and cooperation in the international community since September 11, 2001, the implications for Korean unification and a non-nuclear Korean peninsula, and unjustifiable security demands by North Korea.

The North Korean Regime's Bad and Worsening Image

The DPRK is the only country in the world that has violated the NPT twice, and it finally broke away from the treaty. Such inscrutable behavior has hardened images of North Korea as an unreliable and unpredictable "rogue state." It has further fixed the global image of the North Korean leadership

as a dictatorial regime obsessed with clinging to power at all costs while treating its people as hostages. And it has given added credence to the Bush administration's rigid perceptions of and approaches toward the Kim Jong Il regime.

Increasing Awareness and Cooperation in the International Community since September 11

To confess a second secret attempt to develop nuclear weapons and to finally withdraw from the NPT are indeed historic actions. By doing so, the North Korean regime drew sharp attention from the international community, which led to a consolidation of the community's will to bring a final and complete resolution of the problem. The simple reason is that no one wants to be fooled again and again by a rogue regime. Such a rigid mood is articulated in this phrase: "Fool me once, shame on you; fool me twice, shame on me."[4] This may be the current climate of opinion in the United States. But I think it should also be shared by other members of the international community.

The tragedy of September 11, 2001, was a turning point. Since then, one would expect much stronger international cooperation to counter the proliferation of weapons of mass destruction (WMD). And since September 11, it has been regarded as a part of a war against terrorism to keep rogue regimes and terrorist groups from developing WMD.

Whatever the target, multilaterally coordinated efforts, often being coercive, will by definition be more widely supported by the international community. North Korea will not be an exception in this context. China and Russia, having their own wars against terrorism, will not be able to protect North Korea when more pressing steps will need to be taken in case current mild approaches to sooth North Korea eventually fail.

Implications for Korean Unification and a Non-Nuclear Korean Peninsula

North Korea's nuclear showdown with the world has two important policy implications for Korean unification and a non-nuclear policy of South Korea. First, because North Korea's bad image in the international community has worsened, South Korea will bear much more of a burden in the future process of unification. Unless North Korea grows mature enough to be a responsible member of the international community, the unification of the two Koreas will not be able to attain international support and assistance, which is an essential component of unification. Therefore, South Korea, with the helping hand of the world, should put more effort toward bringing about real and constructive changes in North Korea and to keep the North Korean regime peaceful.

Second, Korean unification will not be feasible and welcome unless the international community firmly believes that unification does not disturb regional stability and peace. In this context, it is becoming more important to eliminate international suspicions over the two Koreas' nuclear ambitions. In terms of nuclear suspicions, Seoul is in a far better position than Pyongyang. But recently expressed public attitudes in South Korea toward North Korea's nuclear problem—for example, the emotional understanding of Pyongyang's nuclear weapons program, pointing to Washington as a source of the problem, and putting "national cooperation" ahead of "international coordination"—could taint the integrity of South Korea's non-nuclear policy. South Korea should make stronger efforts to enhance the transparency of its non-nuclear policy and to educate the general public on why sticking to the policy is important for the national interests of both North Korea and South Korea.

In the end, the international community should share the view that South Korea is justified in taking the lead on unification. No one in the world would like to accept Korean unification under the terms of North Korea, which has proven, once again, to be adept at deception and fraud and to be obsessed with nuclear weapons.

Unjustifiable Security Demands by North Korea

Is North Korea's demand of security assurance reasonable and justifiable? The answer is probably no. If North Korea did not present an offensive military threat to its neighbors, it is unlikely that it would face the same range of military capabilities arrayed against itself. It is North Korea's abnormal philosophy and recalcitrant behavior that have created its own hook—in fact, Pyongyang is self-entrapped. So it is North Korea's responsibility to wriggle off the hook and get out of the trap.

Consider the NPT withdrawal. North Korea is the only country to have broken away from the treaty. Except for the United Nations, which has 190 members, the NPT with its 186 members is the largest international gathering (India, Israel, Pakistan, and North Korea are the UN members that are not party to the NPT). It should be noted that the NPT is the strongest international regime to assure security for states that do not possess nuclear weapons. Five states that do possess nuclear weapons made two promises to meet the security interests of states without such weapons. Positive security assurance, agreed to by UN Security Council Resolution 255 on June 19, 1968, promises Security Council action for any NPT member state that is under threat of attack with nuclear weapons. Negative security assurance, individually declared since 1975, confirms that states possessing nuclear weapons would not use or threaten to use them against any UN non–nuclear weapon state that is party to the NPT or any comparable international agreement that binds parties not to acquire nuclear explosive devices. There is an exception clause for the United States, however: in the case of an attack on the United States, its territories, or armed forces, or its allies, by a non–nuclear weapon state "allied to" or "associated with" a nuclear weapon state in carrying out or sustaining the attack.[5] To rejoin the NPT and forgo its strategy of achieving unification by force is the best way that North Korea can be provided with a robust security guarantee supported by the international community.

The DPRK has also denounced the United States for targeting it for a nuclear and preemptive strike. This is a misleading argument as well. The Bush administration's Nuclear Posture Review presents three contingencies or possible scenarios in which nuclear weapons might be used in the future. This review is not a plain statement that Washington is determined to use nuclear weapons in any circumstances. The immediate contingencies involve "well-organized current dangers," an example of which is a North Korean attack on South Korea. The potential and unexpected contingencies are plausible dangers and sudden challenges caused by hostile powers possessing weapons of mass destruction. North Korea is one of the five countries that could be involved in all three contingencies (the other four are Iran, Iraq, Libya, and Syria). If these countries do not create situations that fit into contingencies—in the case of North Korea, if Pyongyang does not develop WMD and does not attempt to attack Seoul—there is no reason for it to worry about an American nuclear attack.

The Bush administration's preemptive strike policy is also based on its serious concerns about the dangers of WMD proliferation. The idea is that preventively curtailing a threat at its inception is better than waiting for the threat to grow to the extent that it could inflict damage on the United States and its allies. Again, unless North Korea develops WMD and long-range missiles, it is not a potential object of an American preemptive strike.

North Korea's leaders should remember that whatever security assurance they seek from the United States, it cannot but be limited. Washington's security assurance for Pyongyang would be terminated at the very moment Pyongyang invaded Seoul. If Pyongyang gives up unification by force, holds onto international norms and rules, and decides not to develop WMD, no country will be allowed to intimidate it in today's international order. Such an ill-justified threat would be condemned by the whole world. North Korea is indeed self-entrapped.

POSSIBLE SOLUTIONS TO THE NUCLEAR INSPECTION PROBLEM

With regard to the current confrontation between the DPRK and the United States, the prospect for prompt resolution of the problem is not bright. Pyongyang wants to have talks with Washington in parallel with keeping its nuclear programs, while Washington is willing to have such talks only after Pyongyang forgoes the programs. In view of the imminent danger of restarting plutonium facilities and the foreseeable risks of constructing uranium facilities, it is imperative to freeze North Korea's current activities as early as possible.

A Premise for Nuclear Inspections

The most likely formula for success at this time is an ad hoc multilateral forum where North Korea and the United States can meet face to face in return for North Korea freezing uranium- and plutonium-related activities. This is a basic premise for beginning discussions on nuclear inspections.

North Korea should be convinced to accept the reality that its nuclear problem is no longer a bilateral issue with the United States. It was North Korea that caused the issue to be internationalized by moving beyond the United States–Democratic People's Republic of Korea Agreed Framework. Pyongyang's withdrawal from the NPT did harm to the interests of the other 186 member states and is an issue to which the United Nations should pay proper attention. North Korea also needs to be persuaded, particularly by China and Russia, to freeze its current nuclear activities—both uranium- and plutonium-related ones—so as to foster auspicious circumstances for opening a negotiation process. A multilateral forum with a nuclear freeze would be a modest price for North Korea to pay if it does not want to continue on a collision course.

Conversely, the United States should be willing to come to a multilateral table if the above two conditions are met by North Korea. A freeze—short of North Korea's complete renunciation of its nuclear programs—may not be a very satisfactory answer to Washington. But it could be swallowed because it can become a stepping-stone, from which a final and complete resolution can be sought.

Potential Benefits and Pitfalls of Possible Inspection Formats

An ad hoc multilateral forum would need to discuss the whole range of issues related to North Korea's nuclear problem. With due consideration, including the political implications mentioned above, the forum might be able to find a proper resolution package and recommend it to the concerned parties. It could be imagined that both North Korea and South Korea as well as the United States would be asked to do much more than other parties at the forum.

An important part of this resolution package, I suspect, will be two main concerns: how the nuclear inspection will proceed, and what body or bodies will be responsible for the inspection. First are the procedures for inspection, for which a four-stage formula can be implemented.

At the first stage, North Korea makes initial declarations both on uranium- and plutonium-related activities, and the inspection body promptly dispatches on-site inspectors to physically supervise the freeze status. What should be declared about uranium activities is well documented in the chapter in this volume by Fred McGoldrick. In the case of plutonium, the declaration will have to report what has happened since the IAEA inspectors left the country. This stage should be accomplished within days of taking into account the urgency of the problem. North Korea's rejoining the NPT is deferred to the next stage.

At the second stage, ad hoc inspections are carried out to scrutinize initial declarations, and regular inspections are put on track to maintain the freeze status. At this stage, everything should be clear on uranium- and plutonium-related activities except for so-called past nuclear activities. This had been done before the IAEA began inspections in May 1992, and important questions about these activities were not answered through the Agreed Framework. At this stage, North Korea rejoins the NPT.

At the third stage, its "past nuclear activities" are declared by North Korea, and relevant information is delivered to the inspection body. At this stage, a complete picture of North Korea's nuclear program is drawn. The timing of this stage will be closely linked with the light water (LWR) power plant project if it keeps going on or with other alternatives to meet North Korea's energy demand as a part of the resolution package. The unresolved issue in the LWR project of when the inspection process should start probably will remain a bone of contention.

At the fourth and final stage, North Korea's nuclear facilities are dismantled and a permanent monitoring system is instituted to verify that the country is free of nuclear weapons. If the LWR project is abolished, a major question to encounter at this stage will be whether North Korea is allowed to keep some nuclear programs for peaceful purposes. If it is decided to be so, a Korean version of Cooperative Threat Reduction program (KCTR) can be implemented. A major focus of KCTR will be to turn the military elements of North Korea's nuclear infrastructure into peaceful uses. KCTR could also involve other elements of WMD in a bigger political framework and could be linked to a more comprehensive program for economic assistance to North Korea. Traditional wisdom in dealing with the North Koreans is to allow them to save face in order to attain the objectives of negotiation. Recognizing peaceful elements in their behavior is an effective, if not efficient, way to help solve problems caused by the North Koreans themselves.

The second main concern is the inspection body. There are at least five possible formats for creating an inspection body, each with pros and cons.

The first possible format is the Joint Nuclear Control Commission (JNCC). North Korea and South Korea formed the JNCC as an implementing mechanism of the Joint Denuclearization Declaration (JDD) in March 1992. But the JNCC failed to agree on the reciprocal inspection regime and has been stalled since 1993. This format would have the merits of revitalizing the JDD, which has been moribund since the Agreed Framework was signed, and of validating South Korea's role in addressing the nuclear issue. The JNCC format also meets South Korean President Roh Moo-hyun's desire to play a leading role in resolving the nuclear problem.

However, it is highly unlikely that North Korea will accept this option because it is Pyongyang's persistent strategy to marginalize Seoul's role in the nuclear area. The JNCC format is premised on

U.S.–South Korean policy coordination and needs Washington's support of Seoul's leading role. As was recently revealed, if North Korea had already obtained sensitive information and data about weapon design and testing, the United States might hesitate to allow South Korea to participate in the nuclear inspection.[6]

The second possible format is North Korea and South Korea plus the IAEA. This tripartite format is similar to the Argentine–Brazilian Agency for the Accounting and Control of Nuclear Materials, in that IAEA inspection and reciprocal inspections are allowed simultaneously. This format is better than the JNCC in that it would keep the merits and lessen the problems of the JNCC format. IAEA participation would be important to demonstrate that North Korea's nuclear problem is a global issue—not just restricted to a U.S.–DPRK bilateral domain. In addition to its technical expertise and inspection experiences, the IAEA would serve as a legal representative and political symbol of upholding the nonproliferation regime, reflecting the concerns of the other 186 NPT member states.

The third possible format is North Korea plus the United States. If North Korea demands inspection of U.S. military bases to check the nonexistence of nuclear weapons as a face-saving requirement to meet its security assurance, there is a strong possibility that the United States would need to be involved in the inspection process. This bilateral format might be the most favorable option for North Korea. At the same time, it is very unlikely to be implemented, given the Bush administration's rigid position toward the North Korean regime. This format is also undesirable for South Korea and the IAEA.

The fourth possible format is North Korea and South Korea plus the United States. This tripartite format is a feasible option with some chance of being adopted. It has the merits of the JNCC format and could reduce North Korea's reluctance by inviting the United States as a regular party. However, the lack of a role for the IAEA would be a major pitfall.

The fifth possible format is North Korea and South Korea, along with the United States, plus the IAEA. This quadripartite format is probably the most feasible option at this moment. By inviting the IAEA as an independent party into the Seoul–Pyongyang–Washington framework, this approach would have the further merits of highlighting the international aspect of the issue and sustaining the integrity of the nonproliferation regime.

NOTES

1. Some would say that it seems highly unlikely that North Korea actually believes that the United States would carry out a nuclear attack against it. However, the possibility of an American nuclear attack has been a major element of North Korea's threat calculations since the end of the Korean War, when the United States threatened to use nuclear weapons against China. It has been a persistent North Korean demand that the United States should withdraw nuclear weapons from the Korean peninsula and stop nuclear intimidation against North Korea. This demand was officially met by the Clinton administration in the joint statement issued at the end of high-level talks on June 11, 1993, which stipulated that the DPRK and the United States agreed to the principle of "assurances against the threat and use of force, including nuclear weapons." A similar assurance was made in the Agreed Framework signed on October 21, 1994.
2. "Statement by the DPRK's Foreign Ministry Spokesman," *The Pyongyang Times,* October 26, 2002.
3. "DPRK Government Statement on the NPT Withdrawal," *The People's Korea,* January 11, 2003.
4. Steve LaMontagne, "North Korea's Nuclear Program: An Assessment of U.S. Options," Policy Forum Online, Nautilus Institute, October 30, 2002; available at www.nautilus.org/fora/security/0218A_LaMontagne.html.
5. UN Document A/S-10/AC.1/30.
6. Seymour Hersh, "The Cold Test," *New Yorker,* January 27, 2003; available at www.newyorker.com/printable/?fact/030127fa_fact.

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