

# Dismantling the DPRK's Nuclear Weapons Program

---

*A Practicable, Verifiable Plan of Action*

David Albright and  
Corey Hinderstein

UNITED STATES  
INSTITUTE OF PEACE

PEACEWORKS



Library of Congress Control Number: 200591665

Peaceworks No. 54. First published January 2006.

The views expressed in this report are those of the authors alone.  
They do not necessarily reflect views of the United States Institute of Peace.

UNITED STATES INSTITUTE OF PEACE  
1200 17th Street NW, Suite 200  
Washington, DC 20036-3011

Phone: 202-457-1700

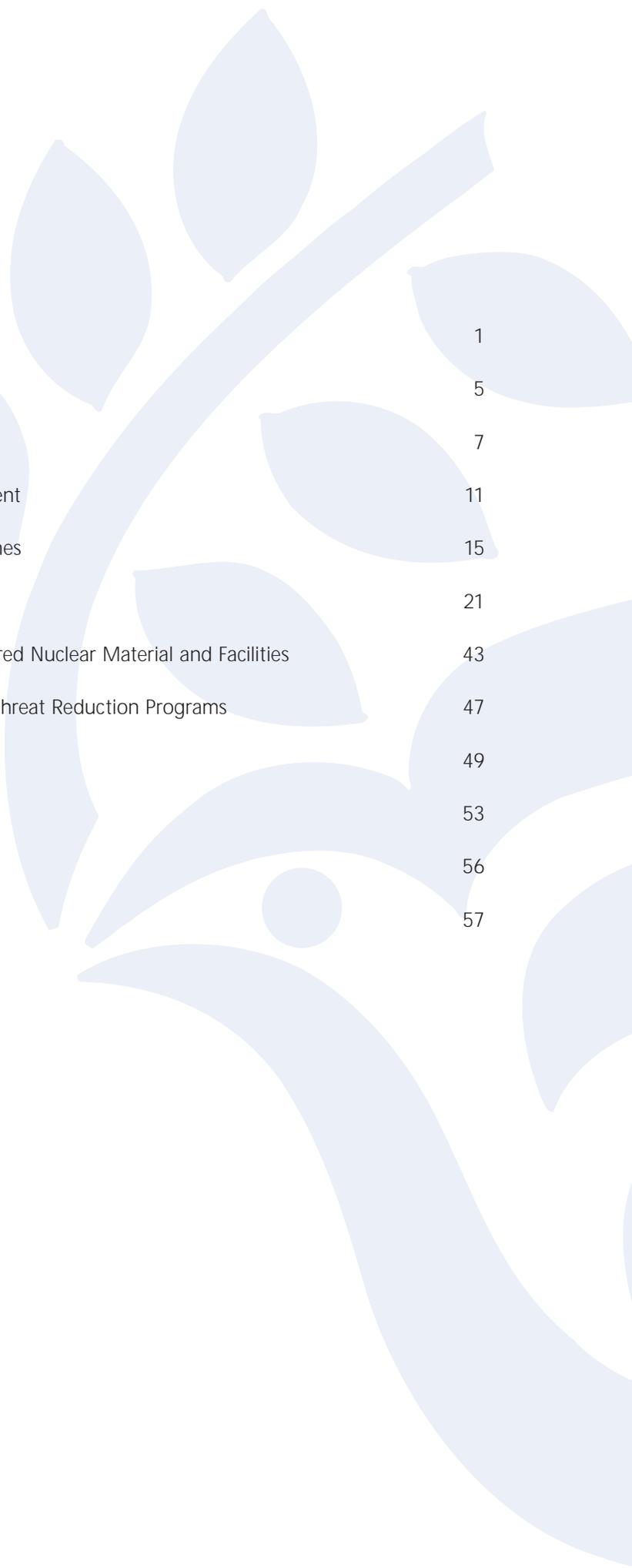
Fax: 202-429-6063

[www.usip.org](http://www.usip.org)



# Contents

Summary	1
Acknowledgments	5
1. Introduction	7
2. Cooperative Verified Dismantlement	11
3. Possible Dismantlement Approaches	15
4. Four Key Disarmament Tasks	21
5. Ensuring the Absence of Undeclared Nuclear Material and Facilities	43
6. The Special Role of Cooperative Threat Reduction Programs	47
7. Findings and Recommendations	49
Notes	53
About the Authors	56
About the Institute	57





## Summary

Verified dismantlement of the nuclear weapons program of the Democratic People's Republic of Korea (DPRK) can be accomplished successfully. Although difficulties abound in reaching an agreement with the DPRK to achieve this goal, the methods and steps involved in the dismantlement process are well understood.

Because this goal remains vital to U.S. and international security, the United States has joined with China, Japan, Russia, and South Korea in working toward verified denuclearization of the Korean peninsula with the cooperation of the DPRK. These six nations have launched a series of negotiations, called the Six-Party Talks, aimed at resolving the crisis over the DPRK's nuclear program. These nations are also attempting to create a plan to dismantle the DPRK's program in a manner with which all the nations can feel secure.

The states intend to implement cooperative verified dismantlement, which requires a state to voluntarily dismantle a nuclear program in cooperation with a verification body or organization. The goal of verified dismantlement is to obtain high confidence that the program no longer exists and that reconstitution will be difficult and likely to be detected relatively quickly or at least long before significant quantities of banned items are produced. In this sense, the dismantlement is called irreversible. The DPRK would conduct the actual dismantlement, and a verification organization would verify that the dismantlement has occurred.

In the process of negotiating a verified dismantlement plan, both the DPRK and the United States have made proposals that are unacceptable to one another due primarily to a lack of confidence in the other's veracity. A middle ground must be found to move forward with this important task.

The United States originally called its proposal the complete, verifiable, and irreversible dismantlement (CVID) of the DPRK's nuclear program. Under this proposal, once the DPRK had dismantled its nuclear program and permitted thorough monitoring, it could expect a range of economic and energy benefits and security guarantees from the United States and its allies. In its proposal, the DPRK stated its willingness to scrap its nuclear weapons program in a step-by-step approach if it first received a list of security guarantees and substantial economic and energy benefits. However, most of the DPRK's public statements have focused on an offer to freeze its nuclear program in return for benefits, with actual dismantlement to come later in the process. In addition, the DPRK has rejected the complete elimination of its civil nuclear programs and insisted on the completion of a large electricity-generating nuclear reactor, a step strongly opposed by the United States.

In September 2005, the six parties issued a statement in which they agreed that the goal of the Six-Party Talks is the verified denuclearization of the Korean peninsula. In that agreement, the DPRK committed to abandon its nuclear weapons and all nuclear programs and the other parties agreed to actions such as giving energy aid and working toward normalization of

relations. The agreement does not address many key disputed issues, such as the timing of dismantlement and rewards, how dismantlement will be verified, the scope of programs to be abandoned, and the future of the DPRK's civil nuclear programs. These issues will be addressed during subsequent rounds of talks.

This report outlines an approach that attempts to address the disagreements that the United States and the DPRK have with each other's proposals. This third proposal, called "progressive dismantlement," aims to allow a more informed discussion of the process of verified dismantlement.

The proposal involves three phases that would gradually denuclearize the Korean peninsula and bring the DPRK into compliance with both the Nuclear Non-Proliferation Treaty (NPT) and North-South agreements. Verification would occur throughout the process, and incentives and security guarantees would also be implemented in stages linked to the dismantlement and verification steps.

This approach takes into account the underlying suspicions of the parties to an agreement. U.S. officials worry that the DPRK would cheat and hide key nuclear materials or facilities. The DPRK leadership likely suspects the other parties' commitment to rewards and their motivations for conducting certain verification activities. The progressive dismantlement model recognizes the initial lack of trust among the parties and allows confidence building through the successful implementation of initial cooperative steps. Verified dismantlement is more likely to succeed in a positive and cooperative climate.

This report discusses the three main nuclear programs subject to dismantlement and the procedures and actions necessary to verify their dismantlement. It also discusses the challenge of bringing the DPRK into compliance with the NPT. All told, then, four tasks must be undertaken:

- Task 1: Halting plutonium production, separation, storage, and waste-processing facilities.
- Task 2: Achieving verified dismantlement of any nuclear weapons and the irreversible, verifiable dismantlement of the set of facilities involved in researching, developing, testing, and manufacturing nuclear weapons.
- Task 3: Dismantling any uranium enrichment activities and the facilities to research, develop, test, and make enrichment equipment, such as gas centrifuges.
- Task 4: Implementing the DPRK-IAEA safeguards agreement and bringing the DPRK into compliance with the NPT after it rejoins the treaty.

All four tasks will require the verification organization to conduct a range of activities to ensure that dismantlement has occurred and that sensitive items are destroyed or shipped out of the DPRK, as well as to gain confidence in the absence of undeclared materials, equipment, and facilities. The pace and outcome of the process will depend primarily on the DPRK's transparency and cooperation with the verification organization.

The report concludes that the best choice for a verification organization is the International Atomic Energy Agency (IAEA) supplemented by nuclear experts from the nuclear weapons states, a plan called IAEA Plus. This approach has the advantage of using the expertise the IAEA has gained through routine safeguards activities and experiences in Iraq, Iran, South Africa, and Libya and the special resources and expertise of the nuclear weapons states.

The report emphasizes that the DPRK must be cooperative with and transparent to the verification organization and the other parties to any agreement. Such commitment will likely depend on the DPRK's belief that its vital interests are served by an agreement to verifiably dismantle its nuclear weapons program. Because of the suspicions that exist between the DPRK and the other participants in the Six-Party Talks, a goal of the negotiators should be to find ways to gradually improve the political and security atmosphere between the DPRK and the other parties. An improved atmosphere can ease the verification process and the task of developing confidence that the DPRK is not hiding portions of its nuclear program.

The report shows that verification should start early in the implementation phase of any agreement. Delays in implementing verification could make it more difficult to achieve confidence that the DPRK is dismantling its programs according to its commitments.

During the verification process, inspector rights of access will be critical. As a result, U.S. negotiators should encourage the DPRK to grant unrestricted access to sites as deemed necessary by the verification organization, with the understanding that the DPRK can take reasonable steps to protect vital secrets in programs that are not covered by a dismantlement agreement. This report discusses how these concerns can be balanced under a vigorous verification plan.

The United States should modify its position on future DPRK civil nuclear programs. It has already accepted an exemption for the use of radioisotopes in nuclear medicine and civil industries. The continuation and expansion of such civil programs is vital to any nation and may contribute to effective dismantlement by providing jobs for displaced nuclear scientists and technicians. The fate of nuclear electricity generation programs is more controversial, but any construction work on a nuclear reactor is unlikely before the DPRK has accomplished verified dismantlement. In addition, if a power reactor is built at some future date, IAEA inspections can provide adequate verification against potential misuse of this reactor.

Although achieving cooperative verified dismantlement has many possible pitfalls and trials, the outcome is of the utmost importance for the security of the international community. If the Six-Party Talks can come to an agreement, then a realistic process to denuclearize the DPRK will be under way for the first time. All members of the Six-Party Talks should set this goal as their highest priority.





## Acknowledgments

This report is the result of work carried out during several years at the Institute for Science and International Security (ISIS). It has been made possible by the generous financial support of the Ploughshares Fund, the Asia Foundation, the Prospect Hill Foundation, the Ford Foundation, and the United States Institute of Peace.

The authors gratefully acknowledge the contributions made to the development of the underlying verification approach by André Buys, Robert Kelley, Mitchell Reiss, Svein Thorstensen, Bernard Wishard, Jon Wolfsthal, and Houston Wood III. The list of people in government and international organizations who have greatly assisted our efforts is longer, but these people prefer to remain anonymous.

We would also like to thank the many participants at a series of workshops in China, Japan, South Korea, Germany, and the United States who were instrumental in developing the information and findings of this report. Critical to this effort was a series of intensive discussions with DPRK officials about the verified dismantlement of the DPRK's nuclear weapons program that spanned more than two years.

We would especially like to thank Joel Wit for his central contribution to this effort and his constant encouragement to further develop and widely disseminate our findings.

We also give special thanks to Paul Stares, head of the Research and Studies program at the United States Institute of Peace, and to Nigel Quinney for his production assistance.



## Introduction

The nuclear weapons program of the Democratic People's Republic of Korea (DPRK) remains at the center of U.S. and international security concerns. Whether or not it is the reality, the *perception* that the DPRK has a growing number of nuclear weapons poses an increasing challenge to the U.S. government and governments in the region.

The current size and status of the DPRK's nuclear weapons program are unknown. DPRK officials have often stated since February 2005 that the DPRK has nuclear weapons, but they have refused to say how many or whether the weapons could be delivered by ballistic missile, which is the most threatening delivery system to Japan and the United States. DPRK officials have also declared that the state is developing its nuclear weapons capabilities, including increasing the quantity and improving the quality of its nuclear arsenal.<sup>1</sup> The officials refuse, however, to explain what this statement means in practice. Despite these uncertainties, the DPRK is increasingly believed to have at least a few nuclear weapons and the plutonium to make several more. Debate continues on whether these weapons can be launched successfully on ballistic missiles such as the Nodong missile.

Unclassified information and some publicly available U.S. intelligence assessments suggest that the DPRK could have separated enough plutonium for three to nine nuclear weapons.<sup>2</sup> In April 2004, it may have discharged enough plutonium in irradiated fuel from its 5-megawatt electric reactor to allow it to build two to four more nuclear weapons. It could separate the plutonium from this newly discharged fuel by the middle of 2006. These assessments, however, remain highly uncertain.

Currently, the DPRK has the capability to produce enough new plutonium for roughly one to two more nuclear weapons per year in its 5-megawatt electric reactor at the Yongbyon nuclear center. The DPRK's reported uranium enrichment program may eventually give it the capability to make enough highly enriched uranium for several nuclear weapons per year. If the DPRK finishes its 50-megawatt electric reactor at Yongbyon, this reactor could produce enough plutonium for ten nuclear weapons each year.

A U.S. priority is convincing the DPRK to dismantle its nuclear program in a verifiable, irreversible manner. The United States has joined with China, Japan, Russia, and South Korea in working toward a verified denuclearization of the Korean peninsula, which is a goal DPRK officials say they share. These six nations have launched a series of negotiations, called the Six-Party Talks, aimed at resolving the crisis over the DPRK's nuclear program.

At the June 2004 meeting, the DPRK and the United States each made proposals that were unacceptable to the other. Initial discussions confirmed that arriving at an agreement to verifiably dismantle the DPRK's program will be complicated. The scope of the agreement, the timing of various steps, and the benefits that accrue to the DPRK will require complicated negotiations. The six parties met again in late July 2005 for the first time in more than a year,

and in September 2005, they agreed on a set of principles for future discussions, including that "the goal of the Six-Party Talks is the verifiable denuclearization of the Korean Peninsula in a peaceful manner."<sup>3</sup>

Significantly, the DPRK committed to "abandoning all nuclear weapons and existing nuclear programs and returning, at an early date, to the Treaty on the Non-Proliferation of Nuclear Weapons and to IAEA safeguards." For its part, the United States "affirmed that it has no nuclear weapons on the Korean Peninsula and has no intention to attack or invade the DPRK with nuclear or conventional weapons." The statement confirmed the DPRK's right to peaceful uses of nuclear energy, without defining the scope of such acceptable uses. Other issues, such as normalization of relations, resolving outstanding issues between the DPRK and Japan, economic cooperation, energy assistance, and the negotiation of a lasting peace on the Korean peninsula, were acknowledged, but the relationship and timing of these efforts with the denuclearization process is yet to be negotiated. The parties did agree to take steps on all agreed-upon issues according the principle of "commitment for commitment, action for action."<sup>4</sup>

A key challenge that has faced the negotiators is agreeing on a set of steps to irreversibly dismantle the DPRK's nuclear weapons program. The United States proposed in July 2004 a front-loaded process, whereby the DPRK would declare and relinquish its plutonium, enriched uranium, and any nuclear weapons. After taking these initial steps, the DPRK would submit to intrusive inspections and monitoring and receive a set of economic, political, and security benefits.<sup>5</sup> The U.S. approach is heavily influenced by the manner in which Libya recently dismantled its secret nuclear weapons program and invited the International Atomic Energy Agency (IAEA) to verify its dismantlement and compliance with the Nuclear Non-Proliferation Treaty (NPT).

The DPRK proposed first establishing a "freeze" on its plutonium program, which would be accompanied by a range of benefits. Despite evidence gathered by the United States and other countries, the DPRK has denied having a uranium enrichment program. At an unspecified future date, the DPRK would dismantle its nuclear weapons program in conjunction with a verification arrangement.

Whatever negotiated approach is taken to dismantle the DPRK's nuclear program, adequate verification of its conditions will be critical. Verification must be performed in a manner that provides high confidence that the DPRK has dismantled its nuclear program completely, has not continued undeclared nuclear activities, and has come into full compliance with the NPT. As a result, any verification arrangement will need to be robust to be effective.

Unlike the cooperative, verified nuclear dismantlement in South Africa and Libya, the verification process in the DPRK could be severely challenged by the DPRK's extreme secrecy about its nuclear and military programs and its belief that a state of war remains between it and its neighbors and the United States. The success of this effort will depend on the DPRK becoming open and transparent to those tasked with verifying a dismantlement agreement. During the initial period of the IAEA's inspections under the NPT in 1992, the DPRK took several steps that demonstrated its openness with the IAEA.<sup>6</sup> However, at critical moments, particularly

when confronted with discrepancies in its declarations to the IAEA, it withheld cooperation, which precipitated a crisis. Although the DPRK initially demonstrated its ability to provide adequate openness during this IAEA process, it subsequently showed a defensiveness that has made progress on verifying the NPT impossible since then.

If the current effort to verifiably dismantle the DPRK's nuclear weapons program is to succeed, the DPRK will have to be sufficiently transparent to allow the verification process to work. Finding the correct balance between intrusiveness and effectiveness could prove to be one of the toughest obstacles to negotiating an agreement.

A decision by the DPRK to allow adequate verification should be interpreted as the DPRK calculating that the political and economic benefits ultimately offered in the Six-Party Talks are worth the security costs of abandoning its nuclear weapons program. Even with such a decision, the DPRK would likely remain suspicious and could possibly seek to hide some of its nuclear activities, perhaps as a hedge in case of a breakdown in the agreement. To reduce the likelihood of this undermining the agreement, a goal of the negotiators should be to find ways to gradually improve the political and security atmosphere between the DPRK and the other parties. Although adequate verification could be accomplished even with tensions remaining between the DPRK and other parties, strengthening the political and security atmosphere during the cooperative dismantlement process could significantly ease the verification process and the task of developing confidence that the DPRK is not hiding portions of its program.

Despite the difficulties, verified dismantlement of the DPRK's nuclear weapons and fissile materials production programs can be accomplished. This report discusses the technical and practical steps needed to achieve that goal. However, the report does not go into detail on the confidence-building and economic and security initiatives that can help alleviate the DPRK's excessive secrecy and mistrust and improve its perceived political and security situation. A goal of this report is to lay the basis for a verified dismantlement agreement that, despite real doubts, all members of the Six-Party Talks can conclude best serves the interests of all.



## Cooperative Verified Dismantlement

In broad terms, cooperative verified dismantlement requires a state to voluntarily dismantle a nuclear program in cooperation with a verification body or organization. The process is termed “cooperative” to contrast it with the UN Security Council dismantlement resolutions applied to Iraq after the 1991 Persian Gulf War.

The goal of verified dismantlement is to obtain high confidence that the program no longer exists and that reconstitution is difficult and likely to be detected relatively quickly or at least long before significant quantities of banned items can be produced. In practice, the state conducts the actual dismantlement and a verification organization verifies that the dismantlement has occurred. The verification organization may also assist the state in the destruction of some program elements, if required.

Dismantlement may involve the destruction of key items in-country or their transport to another state able to secure or destroy them. The DPRK may agree to send certain key items overseas to provide additional confidence that the dismantlement is irreversible. In this case, the verification organization also needs to verify that the items are located or have been destroyed in this other state. Plutonium and enriched uranium are expected to be sent overseas; operating nuclear facilities would likely be dismantled in the DPRK.

Although the recent case of Libya can provide useful lessons, the Libyan nuclear program was far smaller than the DPRK's; did not involve relatively large, operational facilities; and did not produce any nuclear weapons. In addition, Libya faced a far different security environment, which reduced its incentives to hold back information or concessions. The DPRK would likely remain deeply suspicious of the motives and actions of its neighbors and the United States during the negotiation and implementation of an agreement. Thus, the DPRK may insist on a confidence-building period prior to taking irreversible steps to dismantle its nuclear weapons program.

Who verifies the actual dismantlement of nuclear programs is a negotiable topic. Although the IAEA is usually selected as the organization to verify nuclear dismantlement, as in the cases of Libya and South Africa, other possibilities exist and may be favored by negotiators in the case of the DPRK. Negotiations may result in the creation of another verification organization or a mandate to bolster the IAEA's inspection rights and expertise in nuclear areas beyond that found in its safeguards department. Different models for the verification organization may also be needed to accomplish different tasks. In any case, an agreement would likely need to include a procedure whereby the verification organization would report to the parties of the agreement.

The many candidates for the verification organization include

- a specific organization created by the United States, other acknowledged nuclear weapons states (NWS), and other states in the region;
- "IAEA Plus," which would involve the IAEA safeguards department supplemented by experts or assistance from key member-states (variants of this model were used in Libya and South Africa); and
- a bilateral or regional inspection agency.

In the case of verifiably dismantling any DPRK nuclear weapons and associated nuclear weaponization program, nuclear weapons experts from the NWS will be expected to play a critical role. The verification organization will need to assess sensitive nuclear weapons information and equipment. These experts could be formed into a separate organization or assigned to the IAEA safeguards department. The latter step was followed in the case of South Africa after it declared in 1993 that it had built nuclear weapons. A variant of this approach was also used more recently in Libya by the IAEA. Although the DPRK remains highly suspicious of the IAEA, DPRK officials seem to prefer an international verification organization rather than a system dominated by U.S. experts. Nonetheless, the United States may insist on having its own experts play a lead role in the verification process. It may want to create a nuclear dismantlement and inspection arrangement similar to the recent U.S.-British effort in Libya. In that case, as in any other model, the group should coordinate closely with the IAEA.

No matter what organization verifies the dismantlement process, the IAEA safeguards department will be responsible for verifying that the DPRK is in compliance with the NPT. As a result, any effort to create a separate verification organization should be fully aware that the IAEA will also need to be involved in the verification process and will independently make a determination whether the DPRK has come into compliance with the NPT and its safeguards agreement.

Dismantlement could occur either prior to the onset of verification activities or concurrent with verification. Concurrent dismantlement and verification is the preferred option because it would likely result in greater confidence. Accomplishing adequate verification after the dismantlement of a program is possible but more difficult and can take longer. Nonetheless, the IAEA was able to establish that South Africa had dismantled its entire nuclear weapons program, even though the verification started several years after the dismantlement took place.

Based on experiences in Libya and South Africa, the most important prerequisite for a verification process to work is that the state believe that verified dismantlement is in its vital interests. According to former members of the South African nuclear weapons program, verified dismantlement is unlikely to succeed without such a belief.

The DPRK has to fulfill many specific prerequisites for the successful verification of the dismantlement of nuclear programs. Full transparency and cooperation will mean granting the verification organization a series of rights, including

- permitting broad access to sites and facilities;
- providing detailed declarations;
- allowing access to records, including program documents, procurement data, and possibly personnel records;
- allowing interviews with program staff and officials; and
- permitting environmental sampling at declared sites and elsewhere.

In addition, the DPRK will need to allow inspectors access to military sites, a step it has resisted in the past. Procedures will need to be developed that permit the DPRK to protect sensitive, nonnuclear items without compromising the effectiveness of an inspection.

In general, the verification organization is expected to need more extensive rights than established under the IAEA Model Additional Protocol (INFCIRC/540).<sup>7</sup> Because the process of verified dismantlement occurs during a finite period of time, these extraordinary rights could be established on a temporary basis.

The verification organization will require equipment that goes beyond the range of equipment typically used during safeguards. The “toolbox” of verification equipment should be negotiated ahead of time, as DPRK officials often are suspicious of equipment they don’t understand or use themselves. There should be a mechanism, however, for the verification organization to add new types of equipment or import additional equipment, if required.

On the other hand, the verification organization must make several commitments to the DPRK. It must

- possess extensive knowledge about the type of program to be dismantled;
- have the tools to ensure with a high degree of confidence that the program is dismantled, especially the ability to establish the completeness of any declaration; and
- act in a professional and fair manner and protect sensitive information.

Ensuring the irreversibility of the dismantlement process is essential. To achieve irreversibility, the DPRK will need to destroy certain facilities, equipment, and documents or ship certain items overseas. Ongoing monitoring of certain nonnuclear or dual-use activities and personnel may be necessary.

To make the process less costly and facilitate reemployment of personnel, the dismantlement process should involve the conversion of parts of the program to other viable purposes. Nuclear programs often involve equipment and skills that can be converted to nonproscribed activities. The goal should be to create economically viable alternatives or enable the gradual transfer of program personnel to other allowed activities. In the case of the DPRK, parties to the Six-Party Talks should explore opportunities for joint ventures. Cooperative threat reduction (CTR) programs in the former Soviet Union provide a useful model for many possible activities in the DPRK.<sup>8</sup>

Ongoing monitoring of certain nonnuclear activities will likely be necessary once the dismantlement process is completed, particularly if some activities are converted to civilian purposes. In any case, any remaining nuclear materials will require ongoing monitoring. The IAEA safeguards department is the best choice to conduct ongoing monitoring of nuclear and non-nuclear activities or facilities.

Many countries will likely be suspicious that the DPRK has not declared all its nuclear materials or facilities to the verification organization. A negative can never be proved; thus, a verification organization cannot prove that there are no undeclared materials or facilities. Instead, the verification organization will develop a set of procedures and actions that over time will allow it to develop confidence that undeclared activities do not exist in the DPRK. As part of this process, the verification organization will need to investigate many accusations and follow up on its own leads about undeclared activities. The DPRK will need to accept such activities by the verification organization as part of dismantling its programs and coming into compliance with the NPT.

The creation of a dismantlement program in the DPRK will be part of a larger agreement involving the DPRK, the United States, and other states or international organizations. These negotiations will focus on creating the basic responsibilities, rules, and procedures for the dismantlement process for both the state and the verification organization.

Funding of the dismantlement and conversion processes should be established during these negotiations. Both the DPRK and the verification organization will require funds to accomplish their goals. In addition, any CTR-type activities will require funds.

The actual resources and number of personnel required by a specific verification organization will vary. The core effort is estimated to require a few dozen specialists and a budget of several million dollars a year. Shipping materials and equipment out of the DPRK would involve additional costs. The process of dismantling the DPRK's nuclear weapons program could be achieved within a year or two, although the entire process of conversion and building confidence about the lack of undeclared activities could take several more years.

These core activities will need to be supplemented by support from IAEA member-states. Critical support activities will include the analysis of an expected large number of environmental samples, the supply of inspection equipment, the provision of procurement information about the DPRK's overseas suppliers, and member-state intelligence information about activities in the DPRK. Of particular importance will be the supply of procurement information learned through investigating the network led by the Pakistani engineer Abdul Qadeer Khan, the father of Pakistan's gas centrifuge program who illegally sold centrifuges to Iran, Libya, and the DPRK.

Conversion costs could easily exceed tens of millions of dollars, based on similar programs conducted in the former Soviet Union and South Africa. This activity will require the participation of the verification organization to fulfill its mandate, but the specific conversion activities should be funded from another source.

## Possible Dismantlement Approaches

The Six-Party Talks have so far been unable to agree upon a verified dismantlement approach. All parties to the talks have agreed that the ultimate goal is the denuclearization of the Korean peninsula, but only initial proposals have been presented.

In 2004, the United States and the DPRK each described the outlines of an agreement reflecting primarily their own interests. These proposals are mere sketches of a practical agreement with many details purposely left out to allow for negotiation, and neither proposal has been accepted by the other side.

This report outlines a more detailed approach that attempts to bridge, at least partially, the differences in the U.S. and DPRK proposals. This third proposal, called progressive dismantlement, aims to allow a more informed discussion of the process of verified dismantlement.

### The U.S. Proposal

The United States has, in the past, called its proposal the complete, verifiable, and irreversible dismantlement (CVID) of the DPRK's nuclear program.<sup>9</sup> Once the DPRK had dismantled its nuclear program under this proposal, it could expect a range of economic and energy benefits and security guarantees from the United States and its allies.

Although details of the U.S. negotiating position remain secret, the United States presented an offer at the third round of Six-Party Talks held in Beijing in late June 2004. In this offer, the United States, in coordination with South Korea and Japan, offered political and economic incentives or "corresponding steps" to the DPRK in return for the dismantlement of its nuclear program.<sup>10</sup>

The U.S. proposal was discussed in the summer of 2004 by Assistant Secretary of State for East Asian and Pacific Affairs James A. Kelly before the Senate Foreign Relations Committee.<sup>11</sup> He testified that as a first step the proposal called for the DPRK to commit to dismantling all its nuclear weapons programs.

The parties would then agree on a detailed implementation plan requiring

- the supervised disabling, dismantlement, and elimination of all nuclear-related facilities and material;<sup>12</sup>
- the removal from the DPRK of all nuclear weapons and weapons components, centrifuge and other nuclear parts, fissile material and fuel rods;<sup>13</sup> and
- a long-term monitoring program.

During a short initial preparatory period, of perhaps three months' duration, which would precede the dismantlement and removal phase, the DPRK would

- provide a complete listing of all its nuclear activities and cease operation of all its nuclear activities;
- permit the securing of all its fissile material and the monitoring of all fuel rods; and
- permit the publicly disclosed and observable disablement of all nuclear weapons, weapons components, and key centrifuge parts.

These actions by the DPRK would be subject to international verification. The exact verification arrangements and organization are not specified in the U.S. proposal.

As the DPRK carried out the above steps, the non-U.S. parties would "take some corresponding steps." These steps, however, would be temporary and reversible until dismantlement had been completed.

Non-U.S. parties would provide heavy fuel oil to the DPRK upon agreement of the overall approach, including the DPRK's agreement to dismantle all nuclear programs in a permanent, thorough, and transparent manner subject to effective verification.

Upon acceptance of the DPRK declaration, the involved parties, including the United States, would

- provide provisional multilateral security assurances, which would become more enduring as the process proceeded;
- begin a study of the DPRK's energy needs and nonnuclear ways to meet them; and
- begin a discussion of the steps necessary to lift remaining economic sanctions on the DPRK and on the steps necessary to remove the DPRK from the U.S. State Department's list of state sponsors of terrorism.

The U.S. proposal does not define all portions of the DPRK's nuclear program that would be covered by dismantlement requirements. Programs to produce and separate plutonium, enrich uranium, or make or stockpile nuclear weapons are included. Exemptions are expected to include nuclear energy programs involving medical isotopes and radioactive sources used in nonnuclear industries and agriculture. The United States is expected to oppose the operation of the small Russian-supplied research reactor at Yongbyon and restarting the light water reactor (LWR) project that was established under the U.S.-DPRK Agreed Framework.

The U.S. proposal is unclear about which organization or group would conduct the monitoring during the dismantlement and removal phases. U.S. officials have expressed support for the early involvement of the IAEA, although they have not stated whether the IAEA would be the only verification organization.<sup>14</sup>

## The DPRK Proposal

The DPRK has stated its willingness to scrap its nuclear weapons program in a step-by-step approach if it first receives a list of security guarantees and substantial economic and energy benefits. However, most of the DPRK's public statements have focused on an offer to freeze its nuclear program in return for benefits, with actual dismantlement to come later in the process.<sup>15</sup>

The DPRK proposed a package solution at the third round of the Six-Party Talks in June 2004 based on what it calls the principle of "word for word" and "action for action." As a first step, the DPRK proposed the "reward for freeze," which means that the DPRK would freeze all nuclear weapons-related facilities and their output if the United States would

- abandon its "hostile policy";
- lift its economic sanctions and blockade against the DPRK;
- remove the DPRK from the U.S. list of state sponsors of terrorism; and
- participate in the provision of energy assistance equivalent to 2 million kilowatts through the supply of heavy fuel oil or electricity.<sup>16</sup>

Although the DPRK mainly views the hostile policy of the United States as centered on perceived threats of attack, including with nuclear weapons, it also singles out CVID as an example of this hostile policy.<sup>17</sup>

The DPRK views its proposed initial step as a way to build mutual confidence with the United States. As part of the initial stage, the DPRK has stated, the United States would have to participate directly in the provision of rewards. Such participation does not have to be large, but it must be tangible, according to DPRK officials.<sup>18</sup>

In the past, the DPRK did not clearly indicate the exact facilities and activities that would be subject to a freeze. In fact, it sometimes stated that the 5-megawatt electric reactor might be classified as a civil facility not subject to the freeze.<sup>19</sup> The DPRK stated in 2004 its intention to freeze all facilities related to nuclear weapons and the products that result from their operation, as well as to refrain from producing, transferring, or testing more nuclear weapons.<sup>20</sup> The DPRK has said it wants to keep a civil nuclear program but said most of its nuclear program is weapons related, according to Kelly's Senate testimony.<sup>21</sup>

In the September 2005 statement, the DPRK committed for the first time to abandon all nuclear weapons and existing nuclear programs. Nonetheless, North Korea is expected to continue certain nuclear activities, such as those associated with medical and industrial radioisotopes. Beyond these activities, the parties do not appear to have agreed upon which programs will be exempted and allowed as nonbanned nuclear activities.

The DPRK has stated that "freeze for rewards" would be the first step toward eventual nuclear dismantlement.<sup>22</sup> A statement by the DPRK Foreign Ministry published by KCNA on June 28, 2004, said, "The DPRK's proposal for 'reward for freeze,' the first-phase action for a

package solution based on the principle of simultaneous actions, is the only way of seeking a step-by-step solution to the nuclear issue as it took into consideration the present conditions in which there is no confidence between the DPRK and the U.S.”<sup>23</sup> However, the DPRK has not discussed subsequent steps in any detail. The September 2005 statement does not address timing.

With respect to the NPT, the DPRK has also been vague. The DPRK Foreign Ministry spokesman was quoted by KCNA on July 14, 2004, saying the DPRK “will naturally return to NPT if the Korean peninsula is denuclearized and those fundamental elements, which compelled the DPRK to pull out of the treaty, are consequently removed.”<sup>24</sup> As part of the September 2005 agreement, the DPRK committed to “returning at an early date to the [NPT] and to IAEA safeguards.”<sup>25</sup> However, they have not described concretely a path to accomplish such a goal.

DPRK officials recognize that verification would be an important part of any agreement, but they have emphasized that verification would be determined by the scope of the agreement and the scope would need to be determined first. The DPRK has also been ambiguous about the organization conducting the verification, the intrusiveness of any verification arrangement, and the activities subject to verification.

### Progressive Dismantlement

The U.S. and DPRK proposals provide a starting point to construct a model agreement that can serve as the basis of a discussion of possible verified dismantlement arrangements. Although this proposal draws upon discussions with officials involved in the Six-Party Talks, it is meant to be illustrative and not authoritative.

The proposal involves three phases, the implementation of which would gradually denuclearize the Korean peninsula and bring the DPRK into compliance with both the NPT and North-South agreements to ban uranium enrichment and reprocessing facilities. Actions would move progressively from temporary disablement to irreversible dismantlement to removal of key items. Verification would occur throughout the process. Incentives and security guarantees would likewise be implemented in stages linked to dismantlement and verification steps.

This approach takes into account the underlying suspicions of the parties to an agreement. U.S. officials will worry that the DPRK will cheat and hide key nuclear materials or facilities. The DPRK leadership will likely suspect the other parties’ commitment to rewards and the motivations for conducting certain verification activities. The progressive dismantlement model recognizes the initial lack of trust among the parties and allows confidence building through the successful implementation of initial cooperative steps. Verification is more likely to succeed in a positive and cooperative climate.

***Phase One: Freeze, Declare, Disable, and Verify***

The first phase would be focused on freezing nuclear activities in the DPRK for up to a year and developing comprehensive declarations of key nuclear programs, activities, and materials. No nuclear material or key items would be removed during this phase.

Priorities in this phase would be the plutonium program, any enrichment programs, and nuclear weaponization programs. The actions taken would include cessation of key activities, presentation of comprehensive declarations by the DPRK, securing and sealing facilities and key items, including nuclear material and weapons, and effective monitoring of all nuclear programs. In addition, actions would be taken to temporarily disable key nuclear facilities and items such as nuclear weapons.

Verification would be done by the IAEA or a special group created for this purpose and would include the use of a range of tools such as seals, cameras, and environmental sampling. The verification organization would evaluate DPRK declarations to ensure that they are correct and make at least preliminary determinations about their completeness. The organization should also work to build confidence that the DPRK is complying with the freeze. The DPRK would also gain confidence that the verification organization is acting consistently with the agreement.

The DPRK would declare and present to the verification organization all its plutonium stocks, to be placed under monitoring. It would do the same with any nuclear weapons and components.

The verification organization would account for all these items during this phase. Negotiators would need to decide whether the fissile material in the nuclear weapons should be presented to the verification organization in the shape of weapon components or in other forms.

In addition, the DPRK would declare its entire complex of facilities and activities to produce and separate plutonium and to research, develop, test, manufacture, and deploy nuclear weapons. Members of the verification organization would visit all these facilities.

This phase would also include declarations on any uranium enrichment activities or establishing that such activities did not take place. Any enriched uranium would be presented to the verification organization. Questions about the DPRK's uranium enrichment activities would need to be addressed during this phase, although final resolution could occur after plutonium issues were settled.

Rewards would occur at the start of this phase, as well as later in the process upon presentation of a complete declaration. The principal reward would be the provision of heavy fuel oil or other energy supplies. For example, in July 2005 South Korea offered to provide the DPRK with 2 million kilowatts of electricity if it agreed to give up its nuclear weapons program. In addition, the DPRK should receive provisional security assurances from the United States and its partners. The DPRK should also be aware of the incentives and guarantees it would receive in the next phase.

***Phase Two: Verified Dismantlement and Removal of Key Items***

This phase would last one or two years and would focus on the verified, irreversible dismantlement of the DPRK's nuclear weapons program. Key items and materials would be removed from the DPRK during this phase. The verification organization would conduct rigorous activities to ensure that dismantlement was complete and verified. It would also accelerate the process of ensuring the absence of undeclared materials, equipment, and facilities.

At the beginning, plutonium, either in separated or unseparated form, would be removed from the DPRK. Plutonium production and separation facilities would be irreversibly dismantled or disabled. The verification organization would conduct a thorough accounting of all plutonium in the DPRK.

Key nuclear weapons components would then be removed from the DPRK and the weaponization complex would be dismantled or disabled. Verification would need to show that the DPRK had declared all its weaponization activities and nuclear weapons.

Any enrichment facilities or activities would be irreversibly dismantled, and any uranium hexafluoride and enriched uranium would be removed from the country. Centrifuge components, drawings, and single-use equipment would be destroyed or removed from the DPRK, and uranium conversion facilities would be dismantled. Certain facilities, equipment, or activities might be shifted to nonbanned uses, but single-purpose nuclear facilities would generally be dismantled or permanently disabled.

The DPRK would receive major benefits in this phase. These benefits would include additional security guarantees, economic assistance, compensation, diplomatic recognition, and its removal from the State Sponsors of Terrorism list. This phase would also include a range of initiatives modeled on cooperative threat reduction actions taken in other states.

The DPRK would be expected to keep certain civil nuclear energy programs. Civil nuclear energy assistance in the areas of medical isotopes and other radioactive sources for non-nuclear industries and agriculture could be expanded in this phase.

***Phase Three: Long-Term Monitoring and NPT Compliance***

During this phase, which would be indefinite and could overlap phase two, the DPRK would come into compliance with the NPT and establish long-term monitoring programs of its remaining nuclear energy programs and other programs that use equipment or personnel from dismantled programs.

The principal verification organization during this phase would be the IAEA. The DPRK would have already ratified the Additional Protocol and taken other steps to increase the effectiveness of IAEA inspections. For example, it could announce a policy to grant the IAEA unrestricted access to sites in the DPRK.

The resumption of the LWR project could occur in this phase, as well as the provision of additional economic assistance.

## Four Key Disarmament Tasks

An agreement to verifiably dismantle the DPRK's nuclear weapons program would need to identify the specific nuclear programs that require dismantlement. Negotiators would be expected to identify specific items subject to dismantlement and agree on a set of verification steps to ensure irreversible dismantlement of these items. Although negotiators would agree on many verification rights and procedures in general terms, they would also need to define the rights and procedures for specific nuclear programs. This section discusses the three main nuclear programs expected to be subject to dismantlement in an agreement and the additional task of bringing the DPRK into compliance with the NPT.

- **Task 1: Dealing with the plutonium production program.** This task focuses on plutonium production, separation, storage, and waste processing facilities. The principal aim will be to verifiably and irreversibly halt plutonium production and separation activities. The verification organization will need to verify DPRK statements about its past such activities. The DPRK will need to allow the removal of plutonium and irradiated fuel.
- **Task 2: Dealing with the nuclear weaponization program.** This task focuses on any nuclear weapons and the means to research, develop, test, and manufacture them. It involves the verified dismantlement of any nuclear weapons and the irreversible, verifiable dismantlement of the set of facilities involved in researching, developing, testing, and manufacturing nuclear weapons.
- **Task 3: Dealing with the uranium enrichment program.** This task focuses on the dismantlement of any uranium enrichment activities and the facilities to research, develop, test, and make enrichment equipment, such as gas centrifuges.
- **Task 4: Implementing the DPRK-IAEA safeguards agreement and bringing the DPRK into compliance with the NPT.** The DPRK will need to rejoin the NPT and come into compliance with it, including implementing the Additional Protocol.

All these tasks will require the verification organization to conduct a range of activities to gain confidence in the absence of undeclared materials, equipment, and facilities. This process could take years. Its outcome will depend primarily on the DPRK's transparency and cooperation with the verification organization.

### Task 1: Cooperative Verified Dismantlement of the Plutonium Program

The purpose of this task is to account for all plutonium in the DPRK, remove it from the DPRK, and verifiably dismantle, in an irreversible manner, the DPRK's program to make and separate plutonium. This task focuses on the DPRK's plutonium and its gas-graphite reactor program at the Yongbyon nuclear site. The main facilities in the gas-graphite program are

- a 5-megawatt electric reactor;
- a radiochemical laboratory;
- a fuel fabrication complex;
- a 50-megawatt electric reactor and 200-megawatt electric reactor; and
- nuclear waste sites.<sup>26</sup>

Although questions remain about undeclared materials and facilities, this program is the best known of all DPRK nuclear programs. It was subject to intense IAEA investigations during 1992 and 1993 and frozen and monitored by the IAEA from 1994 until December 2002 under the U.S.-DPRK Agreed Framework. The main facilities are subject to continuing scrutiny by overhead surveillance. In addition, independent experts visited several key sites in early 2004 and were briefed by DPRK experts about plutonium production and separation activities since the IAEA monitors left in late 2002.<sup>27</sup>



**Figure 1.** The 5-Megawatt Reactor at Yongbyon, September 11, 2005  
*Source:* DigitalGlobe—ISIS.

#### **Plutonium Stock**

The DPRK's plutonium stock and its means to produce and separate plutonium have been extensively studied.<sup>28</sup> Prior to the restart of the 5-megawatt electric reactor (figure 1) in early 2003, the DPRK had an estimated stock of 30–40 kilograms of plutonium.<sup>29</sup> With the restart of the reactor, this stock has been growing at a rate of about 5–7 kilograms of plutonium each year. Unclassified reports, confirmed by commercial satellite imagery obtained by the authors, indicate that the DPRK shut down the reactor in April 2005, likely to unload the fuel.<sup>30</sup> The reactor is estimated to have contained 10–15 kilograms of additional plutonium at that time, bringing the total plutonium stock to about 40–55 kilograms.

The plutonium must be separated from the irradiated fuel before it can be used

in nuclear weapons. Prior to 2003 and the unfreezing of the Yongbyon site, the DPRK was estimated to have up to 10 kilograms of plutonium in separated form, although this approximation was a “worst-case” estimate that was subject to continuing scrutiny and controversy.<sup>31</sup> This plutonium would have been separated in the radiochemical laboratory (figure 2) prior to about 1992. The worst-case estimate was that the DPRK separated, but did not declare to the IAEA, approximately 8–9 kilograms of plutonium produced in the 5-megawatt electric reactor. Some U.S. intelligence agencies believed that the DPRK also separated and did not declare up to another 1–2 kilograms of plutonium produced in the Russian-supplied IRT research reactor at Yongbyon. Other U.S. intelligence agencies believed the amount of plutonium produced in the IRT reactor was no more than a few hundred grams. The IAEA also independently arrived at this smaller estimate.<sup>32</sup> In any case, a reasonable estimate is that no more than about 10 kilograms of plutonium were separated prior to 1994, when the Agreed Framework froze all plutonium activities at the Yongbyon site.<sup>33</sup>

In its assessments, the CIA has focused on the estimate of 8–9 kilograms of separated plutonium. In interviews, CIA officials involved in these assessments have stated that there is a better than even chance that the DPRK separated this plutonium, although the basis for this specific judgment can be debated.<sup>34</sup> Nonetheless, after taking account of estimated losses, the CIA concluded that this is enough separated plutonium for one or perhaps two nuclear weapons. However, assuming losses of 20 percent, which is reasonable for an initial effort, the DPRK would have been unlikely to have enough plutonium for more than one nuclear weapon, needing approximately 4–5 kilograms of plutonium per weapon.

Until 2003, the bulk of the plutonium produced by the DPRK remained in almost 8,000 irradiated fuel rods stored in a pond near the 5-megawatt electric reactor and subject to monitoring by the IAEA. These rods contained an estimated 27–29 kilograms of plutonium.<sup>35</sup>

Since restarting the radiochemical laboratory in 2003, the DPRK may have reprocessed most of the 8,000 irradiated fuel rods stored under the Agreed Framework. The DPRK states that it has reprocessed all the fuel rods, but this statement remains unconfirmed.<sup>36</sup> Nonetheless, a reasonable conclusion is that the DPRK has separated a significant amount of plutonium from these rods, an estimated 15–28 kilograms. The lower estimate reflects confidence that at least many rods have been reprocessed, with the amount separated highly unlikely to be lower than this value. The upper bound is the amount that results if all the rods have been reprocessed, with only small losses of plutonium during the entire process.



**Figure 2.** The Radiochemical Laboratory at Yongbyon, September 11, 2005  
 Source: DigitalGlobe—ISIS.

It is unknown if the DPRK has started reprocessing the fuel that is believed to have been unloaded from the 5-megawatt reactor in the spring of 2005. The DPRK is likely to store the irradiated fuel in water for a few months prior to its reprocessing to allow its radioactivity and heat to decline. Afterward, all the fuel could be reprocessed within six to twelve months.

Assuming that the recently unloaded fuel has not yet been separated, the DPRK has about 15–38 kilograms of separated plutonium. At 4–5 kilograms of plutonium per weapon, this plutonium is enough for three to nine nuclear weapons.

If the DPRK separated the 10–15 kilograms of plutonium from recently discharged fuel, it would have in total 25–53 kilograms of separated plutonium. It could build about five to thirteen nuclear weapons from this plutonium.

In August 2005, Japanese media reported that U.S. satellites had detected a plume at the 5-megawatt electric reactor, indicating the reactor had been refueled and operation had resumed. A September 11, 2005, satellite image of the 5-megawatt reactor shows a steam plume from the cooling tower, indicating that the reactor has resumed operation.

Uncertainties surround how much fresh uranium fuel the DPRK has in stock, although the DPRK is reported to have enough to refuel the 5-megawatt electric reactor one to two more times using fresh fuel fabricated prior to 1994 (figure 3). However, the amount of fuel fabricated since the freeze ended, in 2002, is unknown.

DPRK officials recently stated that construction of the 50-megawatt and 200-megawatt electric reactors had restarted. Media reports state that at the beginning of July 2005 a mobile crane was moved to the site of the 50-megawatt electric reactor.<sup>37</sup> A September 11, 2005, satellite image of the 50-megawatt electric reactor construction site showed new activity, though not the resumption of large-scale construction. Visible in the image is a new road surface at the site and possibly a mobile crane. Because of the long period of inactivity at these reactor sites and the effect of the weather on the unfinished reactors, the completion of these reactors would likely take years. If finished, the 50-megawatt electric reactor could produce enough plutonium annually for roughly ten nuclear weapons.

### ***Step-by-Step Approach for Verified Dismantlement of the DPRK's Plutonium Program***

This section outlines the major steps necessary to verifiably dismantle the DPRK's plutonium program, focusing on the facilities and activities of the key nuclear sites at Yongbyon. Although significant difficulties are expected in implementing any plan to dismantle the plutonium program, the steps required to shut down, disable, seal, monitor, and eventually dismantle or decommission the key facilities are relatively well understood.

Unlike the later sections of this report that discuss DPRK nuclear weapons and uranium enrichment programs, about which much less is known, this section concentrates on a range of relatively well-understood facilities and activities involved in plutonium production and sepa-

ration. Tasks 2 and 3 focus on the process whereby the verification organization implements a verified dismantlement plan targeted at programs that are much less understood than the plutonium program. The approach taken in the discussion of Tasks 2 and 3, which frames the dismantlement process without knowing specific facilities or activities, also informs and supplements the Task 1 discussion.

**Shutdown and Temporary Disablement.** After the DPRK shuts down key facilities, the verification organization will need to ensure that they are disabled. During the freeze under the Agreed Framework, the DPRK maintained the facilities so that it could quickly restart the reactor and reprocessing plant. In a new agreement focused on irreversible dismantlement, the facilities would not be maintained in such a manner. Initially, disablement steps could be temporary, such as turning off and then removing fuel from the reactor. The radiochemical laboratory could be shut down, process lines emptied, and power cables disconnected. In the following phases of an agreement, more permanent disablement measures would need to be taken. The goal would be to significantly impair the ability of the DPRK to restart the reactor or reprocessing plant.

The DPRK will need to decide, in consultation with the other parties to the agreement and the verification organization, the best way to store discharged fuel from the 5-megawatt electric reactor to delay corrosion of fuel cladding and ease verification. Discharged fuel should also be stored in a manner that will facilitate its transportation out of the DPRK.



**Figure 3.** The Fuel Fabrication Complex at Yongbyon, September 11, 2005  
Source: DigitalGlobe—ISIS.

**Presentation of Plutonium.** The DPRK would be expected to present all of its plutonium in the initial phase of an agreement. This plutonium could be in many forms, including unirradiated powder or metal, irradiated fuel or sludge, and various chemical forms found a reprocessing plant.

How much plutonium the DPRK turned over would have a significant impact on the subsequent activities of the verification organization. For example, if the DPRK relinquished 45 kilograms of plutonium in both separated and irradiated forms, the verification organization would likely conclude preliminarily that the DPRK had turned over most of its plutonium, although this conclusion would require stringent verification. However, if it presented only 30 kilograms of plutonium, the verification organization could not conclude that the DPRK had relinquished all of its plutonium. In the unexpected case that the DPRK presented a large amount of plutonium, such as 80 kilograms, the verification organization would need to

determine why the estimated stock of plutonium was so far from the actual total. In either of these last two cases, the verification effort would likely take longer.

**Initial Monitoring.** The verification organization will need to monitor the closing and temporary disablement of all key facilities. It will also need to secure and seal the plutonium presented by the DPRK.

**Declaration.** The DPRK must declare its activities associated with making and separating plutonium. There are two periods—post-2002 and pre-1994—that require detailed treatment. A potentially difficult issue is how to treat the outstanding issues between the IAEA and the DPRK in 1992 and 1993 concerning the inconsistencies in the DPRK declaration about the quantity of plutonium that it possessed. Although the priority in the initial period may be post-2002 activities, the earlier period will need treatment before any plutonium is removed from the DPRK. A decision will need to be made as to whether to clarify these issues in the initial declaration or deal with them in a later version.

The declaration should include details of the production and separation of plutonium, a list of facilities involved in such activities currently or in the past, and a detailed history of this program, including major political and technical milestones. It also needs to include planned future goals and timelines and a description of the manufacturing entities involved in making key components of the major facilities.

Because of their value for forensic work, the DPRK should declare all its nuclear waste sites and provide information about the waste stored at these sites. The verification organization should have the right to access and take samples from waste sites.

With regard to activities since December 2002, the declaration should answer the following questions:

- What has been the fate of the irradiated fuel that was discharged from the 5-megawatt electric reactor in 1994 or since the freeze ended in 2002?
- How much of this irradiated fuel has been reprocessed?
- How much plutonium has been separated from this irradiated fuel?
- How much plutonium remains in irradiated fuel?
- Has the IRT reactor operated?
- What is the current stock of fresh fuel for the 5-megawatt electric reactor?
- How much uranium has been mined?

As mentioned above, the DPRK has stated that it has reprocessed all the fuel rods discharged in 1994, although this statement has not been verified. The DPRK has not made any statement about the status of the fuel rods discharged in 2005. In any case, a declaration should discuss the fuel rods in detail, including their plutonium content. It should also provide records of the movement of irradiated rods.

**Verification of the Declaration.** This is a major step that will take approximately one year to accomplish, assuming full DPRK cooperation. The verification organization will need to conduct a wide range of activities to verify the correctness and completeness of the DPRK declaration, including accessing all these sites, taking measurements and samples, and interviewing key DPRK personnel and government officials.

With regard to any fuel discharged from the 5-megawatt electric reactor, the DPRK should provide sufficient access and information so that the verification organization can verify DPRK statements about the plutonium content of the discharged fuel rods. Specific measures could include providing operating records and burnup information about each fuel rod and allowing the verification organization to take measurements of any remaining irradiated fuel rods. This will require the DPRK to provide information not previously shared.

If the DPRK has reprocessed a significant fraction of the 8,000 fuel rods discharged in 1994 and those discharged in 2005, the verification organization will need to verify the number of unprocessed rods and the amount of plutonium, uranium, and waste separated from the fraction of the rods that were reprocessed. It will also need to see and verify the separated plutonium.

In addition, the verification organization will need to conduct activities at the radiochemical laboratory, such as reviewing operating and material accounting records, taking samples from waste tanks and swipe samples at a range of locations, and interviewing key personnel. Verification could be difficult without a full declaration of all plutonium separation activities, including a resolution of prior issues from 1992 and 1993.

**Removal of Plutonium.** The removal of all plutonium in the DPRK is critical to an irreversible dismantlement plan. Separated plutonium can be removed quickly, whereas irradiated fuel may require additional cooling and packaging before it can be removed safely. In addition, fresh uranium fuel or metal may also be subject to removal or disablement. Some items, such as heavily corroded or damaged irradiated fuel, may remain in the DPRK for ultimate disposal.

**Determining the Absence of Undeclared Materials and Facilities.** The verification organization will need to determine that the DPRK has declared its entire plutonium program. Making this determination could require several years and involve visits or inspections to sites outside the Yongbyon nuclear site. The verification organization would also conduct various nuclear forensic activities at the Yongbyon site and perhaps elsewhere. (See chapter 5 for a more extensive discussion of this issue.)

**Dismantlement or Permanent Disablement and Decommissioning of Individual Facilities.** Because facilities in the plutonium program, particularly the 5-megawatt electric reactor and the radiochemical laboratory, have extensive radioactive contamination, the priority in later phases would be on decommissioning these facilities rather than removal of their equipment outside the DPRK.

The permanent disablement of the 5-megawatt electric reactor could involve removing and destroying the fuel loading and unloading machine. After several years, the reactor could be entombed with concrete or disassembled.

The radiochemical laboratory would be subject to more permanent disablement in later phases of an agreement. Steps to achieve this could include removing key tanks, pipes, or equipment and destroying these items. In the longer term, the facility would be decommissioned. Single-use equipment would be verifiably destroyed or otherwise rendered unusable. Much of the equipment is radioactively contaminated and cannot be salvaged in any case.

The DPRK should give the verification organization sensitive designs, documents, and blueprints. The verification organization would either destroy the records or ship them overseas.

The fuel for the gas-graphite reactors has been made in the fuel fabrication complex, which was not maintained during the freeze under the Agreed Framework. In the initial phase of an agreement, these facilities would also be shut down, temporarily disabled as necessary, and monitored. Irreversible disablement and decommissioning would follow. Some dual-use equipment could be reassigned to nonbanned programs, although even this equipment may be radioactively contaminated and may need to be destroyed or otherwise disposed of.

The 50- and 200-megawatt electric reactors were never finished. In the longer term, these facilities could be demolished and key equipment destroyed or converted to nonbanned, monitored uses.

Specialized manufacturing equipment used to make reactor components, reprocessing plant equipment and components, and fuel fabrication equipment would also need to be destroyed or monitored against future misuse. Much of this equipment could be located away from the Yongbyon site.

## **Task 2: Cooperative Verified Dismantlement of Nuclear Weapons and the Nuclear Weaponization Program**

The purpose of this task is to verifiably eliminate nuclear weapons and the means to research, develop, test, and manufacture them. The dismantlement must occur in an irreversible manner, which requires the destruction of any nuclear weapons, key components, and certain equipment, as well as the conversion and monitoring of other equipment, facilities, and personnel.

### ***Characteristics of the DPRK Nuclear Weapons Program***

Little is known about the DPRK's nuclear weaponization program or its nuclear arsenal. However, estimates of the number of DPRK nuclear weapons can be derived from estimates of its stock of plutonium. In addition, available information, including statements from defectors, suggests that the DPRK has worked on mastering the manufacture of nuclear weapons for more than two decades, implying that it has created a complex of facilities to research, develop, test, and manufacture nuclear weapons.

Information, however, is scarce on the number, type, and deliverability of any DPRK nuclear weapons. In addition, media reports have discussed possible test sites that could be involved in testing high explosives components of nuclear weapons or in conducting a full-scale nuclear test.<sup>38</sup> There is a dearth of solid information on facilities that make up the DPRK's nuclear weaponization complex. As a result of uncertainties about the DPRK's nuclear weapons and the facilities to make them, the discussion in this section is more general than in the previous section on the plutonium program.

The DPRK's nuclear weapons program can be defined broadly, based on programs in other countries. It is likely focused on building an implosion-type nuclear weapon, which is a formidable undertaking, particularly if the weapon must fit on a ballistic missile. Its program would be expected to involve at least several hundred scientists, engineers, and technicians.

The program will need to design and build an extensive array of research, development, and testing facilities. It will also need manufacturing sites to make many of the components of nuclear weapons.

The DPRK would need to accomplish a range of tasks to build an implosion-type nuclear weapon, including

- theoretical calculations and computer codes;
- preparation of high explosives;
- experiments in preparing and using high explosives in the nuclear weapon;
- preparation and purification of metallic uranium or plutonium, including melting and casting of metals and quality control of these activities;
- obtaining or manufacturing necessary electronics, including items to produce and supply energy, arming and fusing systems, and safety systems;
- developing, testing, and manufacturing neutron initiators; and
- testing subsystems or mock-ups of a nuclear weapon or device.

Accomplishing these tasks would require a range of nuclear weaponization facilities, including

- nuclear and nonnuclear component manufacturing sites;
- high explosives test sites;
- nuclear weapon assembly facilities;
- nuclear weapon storage vaults; and
- underground test sites.

Close coordination would be required between the nuclear weapons program and the programs responsible for delivery systems, such as ballistic missiles and associated reentry vehicles. The overall weight and size of the nuclear weapon largely define its delivery mode. Typically, a weapon needs to weigh less than one tonne to be carried by a ballistic missile.

### ***Dismantlement Options***

There are two options for dismantling nuclear weapons in the DPRK. The first is concurrent dismantlement and verification, a strategy extensively researched in the context of U.S.-Russian nuclear arms control agreements. Its implementation in the DPRK should be technically straightforward. The second option is one in which dismantlement occurs before verification, the strategy followed by South Africa when it dismantled its nuclear weapons. The success of this strategy will depend on the DPRK creating extensive, verifiable records of its dismantlement of any weapons.

Key to this verification task will be access to sensitive information. The preferred option is for the verification organization to have access to detailed nuclear weapons design information, with its distribution within the verification organization carefully limited to prevent its spread. If the DPRK does not want to allow the verification organization access to such information, the verification process will be much more difficult. However, such an approach can still be successful.

The verification organization will need to implement steps to reduce the likelihood or ease of reconstituting a nuclear weapons program. Vital to this effort is to ensure that ongoing monitoring is established and effective.

The verification organization will also need to take a set of actions to provide adequate assurance of the absence of hidden weapons or nuclear weapons sites. This effort will be aided by parallel efforts to ensure that all of the DPRK's plutonium and enriched uranium has been accounted for and turned over to the verification organization.

### ***Step-by-Step Plan for Concurrent Dismantlement and Verification of a Nuclear Weapons Program***

This section outlines a series of steps involved in verifiably dismantling a nuclear weaponization program and the nuclear weapons produced by the program; the actual steps may differ in practice. Many details of these steps need to be developed before they can be implemented in an actual situation.

The first step is for the DPRK to produce a comprehensive declaration of its nuclear weaponization program, reflecting initial discussions with the verification organization and tours of the facilities. The declaration should include details of nuclear weapons development, production, and deployment, as well as a list of all the nuclear weapons or explosive devices built by the DPRK.

It should list and describe the main weaponization sites, including the research and development facilities, component manufacturing sites, high explosives test sites, nuclear weapons assembly facilities, nuclear weapons storage vaults, and underground test sites. The verification organization will need to visit sites associated with the program in the past and any sites now involved in providing key items or assistance to the weaponization program. The declaration needs to include a history of the program, including a chronology of major political and

technical milestones of the program and the strategy for deploying and using nuclear weapons. It should also include planned future goals and timelines.

The United States has proposed that during the initial stage all nuclear activities cease, nuclear materials be secured, and all nuclear weapons and weapons components be disabled.<sup>39</sup> During this initial phase, disablement could be temporary. For example, removing the fissile material (figure 4) from a weapon would disable it. In addition, the verification organization could remove a key battery from a weapon and weld in a pipe, or it could remove arming and fusing equipment (figure 4). For weaponization facilities, a range of options could be pursued that would temporarily disable the facility. At a high explosives component manufacturing facility, for example, high explosives presses could be made inoperable.

Next, the verification organization must develop a coherent technical understanding of the nuclear weaponization program in close consultation with the state. The verification organization needs to understand the origin, scope, accomplishments, and timing of the program. This understanding should be based on a detailed study of the declaration, a review of documents, visits to key sites, and discussions with program officials, scientists, and technicians. The verification organization will also need to incorporate information learned elsewhere that may supplement or contradict DPRK statements. Any discrepancies in the DPRK's declaration need to be addressed in this step.

The DPRK will then need to develop a plan for dismantlement or removal of key items from the country. The government may form a senior experts' committee to investigate methods to dismantle the program and draw up a schedule. It should develop its plans in consultation with the verification organization.

Separately, the verification organization must develop its own plan to achieve effective and timely verification of the dismantlement. For example, the verification organization will need to ensure that all laboratory, development, testing, and manufacturing facilities involved in the program have been fully decommissioned and abandoned or converted to a permitted use. The verification organization should develop its plans in consultation with the DPRK.

The DPRK and the verification organization will need to agree on a plan that incorporates the concerns of each party. Key agreements would include the exact items subject to destruction, removal, conversion, or ongoing monitoring. Careful records of dismantlement activities should be developed and maintained by both parties.

Based on the joint plan, the state would dismantle the program and convert equipment and materials to nonproscribed uses. Items that could not be converted to nonproscribed uses would need to be destroyed, rendered harmless, or removed from the DPRK. In this model, buildings or facilities would not, in general, be subject to destruction.

The DPRK's nuclear weapons contain plutonium or highly enriched uranium and possibly other nuclear materials such as natural uranium or depleted uranium. These materials, particularly any plutonium or highly enriched uranium, should be converted into non-weapons-usable

shapes and carefully subjected to materials protection, control, and accounting procedures. The fate of other nuclear materials in the weaponization program, such as natural uranium, depleted uranium polonium-210, tritium, or deuterium, should also be carefully tracked by the verification organization.

Any fissile material assigned to the nuclear weaponization program requires special care. At a minimum, the verification organization will need to carefully verify the accounting of all the fissile material assigned to the nuclear weapons program. The bulk of the effort to verify that the DPRK has declared all its fissile material will occur in the tasks focused on the DPRK's plutonium and uranium programs. However, a careful verification of the plutonium and uranium assigned to the nuclear weapons program could provide important information relevant to the broader verification effort to determine the completeness of the DPRK's declaration of all its plutonium or enriched uranium.

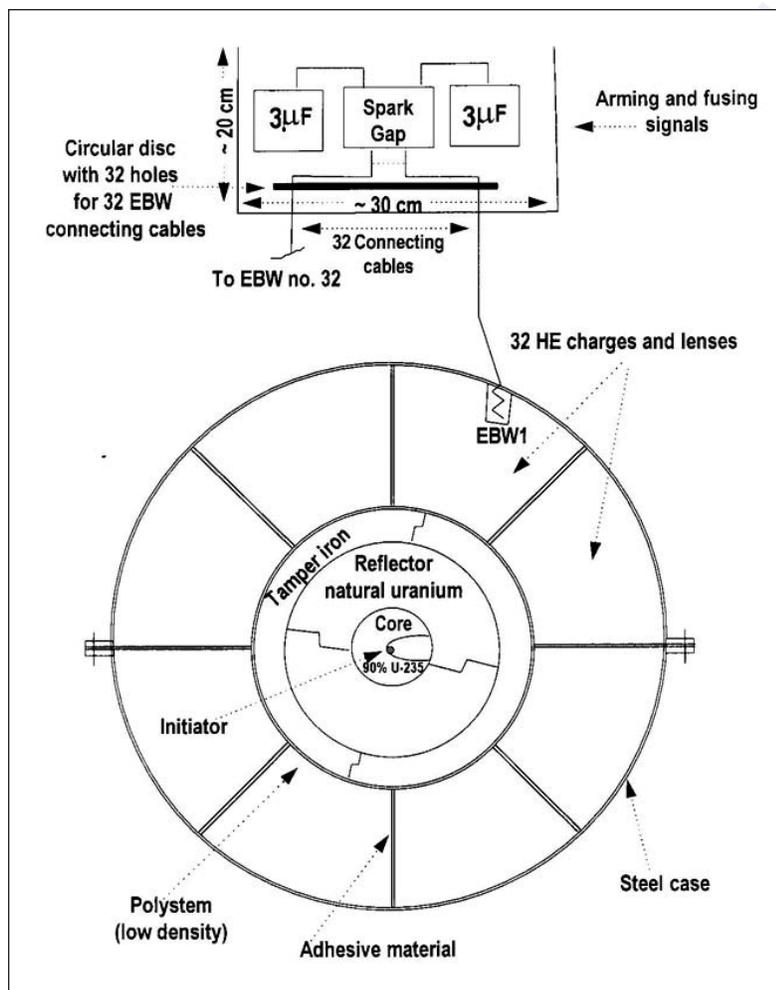


Figure 4. Schematic of a Fission Weapon

Included in the destruction plan would be major nonnuclear weapons components. Destruction is accomplished by smashing, cutting, burning, or other methods to disable the item against future use.

Certain manufacturing and testing equipment may be rendered unusable for future use in a nuclear weapons program. Rendering a machine tool unusable may involve destroying or sending overseas special fixtures or computer programs that enable a machine to make weapons components. Some dual-use equipment may need to remain subject to monitoring.

Designs, documents, and blueprints will need to be destroyed or removed from the DPRK. The destruction method may involve burning. Because documents are easily reproduced, this step must be viewed as largely symbolic by the verification organization. However, it remains important as a benchmark of cooperation and compliance.

Facilities and remaining equipment or materials would be converted to alternative, allowed uses. The purpose would be to continue to employ program personnel in productive work, and a priority would be placed on creating economically viable programs or joint ventures. For example, clean-room facilities could be converted to allowed high-technology uses and machine tools could be assigned other industrial uses.

Ongoing monitoring of certain nonnuclear activities may be necessary for an extended period. Nuclear material from weapons will certainly require ongoing monitoring until it is removed from the DPRK.

At the end of the agreed-upon process, the verification organization would reach and announce the conclusion that the nuclear weapons program had been dismantled according to the agreed-upon plan. The organization would also state that ongoing monitoring had been successfully implemented.

The entire verified dismantlement of nuclear weapons and the nuclear weaponization program can be accomplished in about one year. Another year or two may be required to develop assurance about the absence of any undeclared activities or items. Some of the timing will depend on the dynamics and success of the overall verification effort.

The above steps outline a process for the concurrent dismantlement and verification of a nuclear weapons program. Special considerations will be necessary by the DPRK if it pursues dismantlement before verification, as South Africa did. In such a case, the DPRK should conduct the dismantlement with the ultimate verification goal in mind, including keeping careful records of the dismantlement of the weapons and weaponization complex. Although verification can occur successfully after dismantlement, this effort is more difficult and might take much longer to accomplish. In particular, reaching a conclusion that the program has been completely dismantled and accounted for may take the verification organization significantly longer.

### ***Special Considerations in Dismantling Nuclear Weapons***

Special procedures will be needed to dismantle the nuclear weapons themselves. Even if removal is the agreed-upon option, the weapons will likely be removed piecemeal. Weapons experts from the verification organization will likely need access to sensitive information about the DPRK's nuclear weapons.

Some key steps will be to inventory parts of nuclear weapons; develop procedures to implement the dismantlement of the weapons; decide the fate of nuclear materials, such as converting plutonium weapon components into non-weapons-usable metal billets; decide the fate of nonnuclear components, i.e., which to destroy, scrap, or reuse; and create a set of detailed records of the dismantlement process.

The DPRK will create an inventory of all parts in weapons, underground test devices, cold devices, component or weapons testing programs, and in the weapons testing, development, and production pipeline. The individual components can be organized into various categories,

including nuclear components, electrical and electronic parts, explosives components, mechanical parts, and support equipment for the weapons.

The DPRK and the verification organization will need to reach agreement on which non-nuclear components to destroy, scrap, or use for other purposes. In general, the state would be expected to want to retain more components for future use than the verification organization would accept. These negotiations should occur early in the process.

For the actual dismantlement of nuclear weapons, the state will need to select a dismantlement site and create the necessary infrastructure. An existing nuclear weapons assembly site is a logical choice. The DPRK and the verification organization will develop detailed procedures to conduct and oversee the dismantlement process, including careful material control and accounting procedures for nuclear materials and careful records of the origin and destination of the various nonnuclear parts. Figure 5 is a chart of how dismantlement of nonnuclear components could be organized, based on procedures followed by South Africa in dismantling its nuclear weapons.

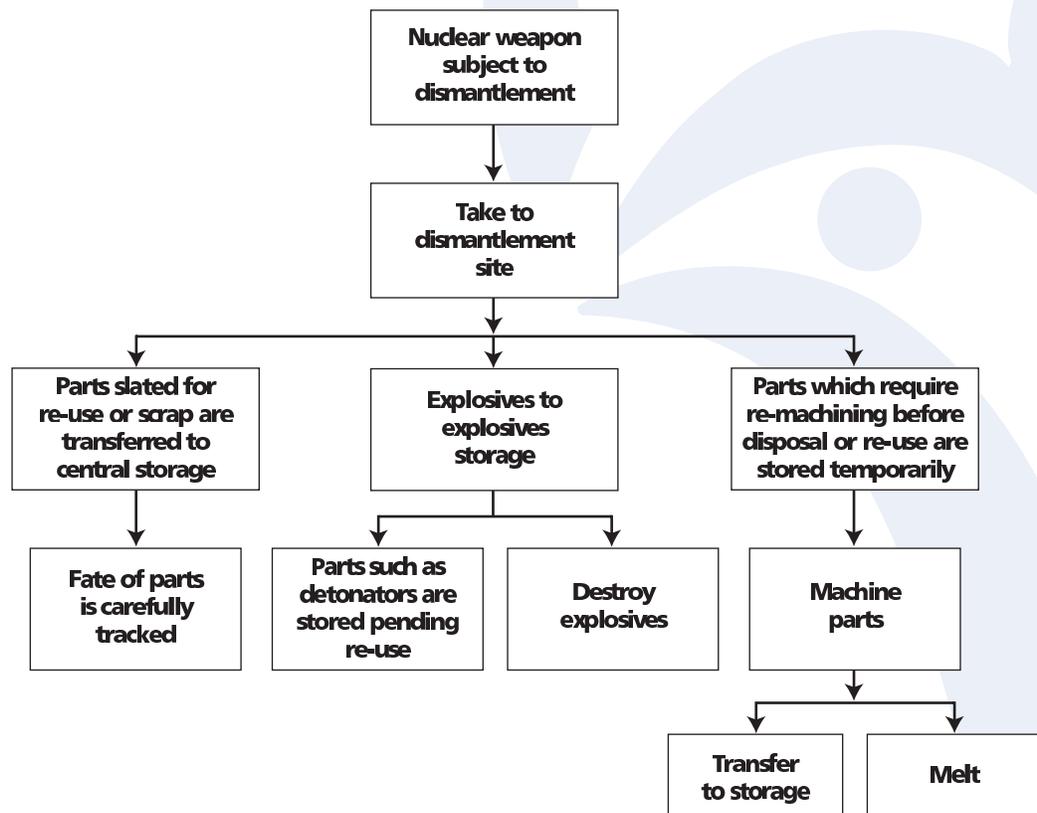


Figure 5. Disposition of Nonnuclear Components of Nuclear Weapons Subject to Verifiable Dismantlement  
Source: ISIS.

### Task 3: Verifiable Dismantlement of the Uranium Enrichment Program

The purpose of this task is to account for all enriched uranium in the DPRK, remove it from the DPRK, and verifiably dismantle the DPRK's program to make enriched uranium. Although the DPRK may have other enrichment methods, the main enrichment program appears to use gas centrifuges. The dismantlement must occur in an irreversible manner, which requires

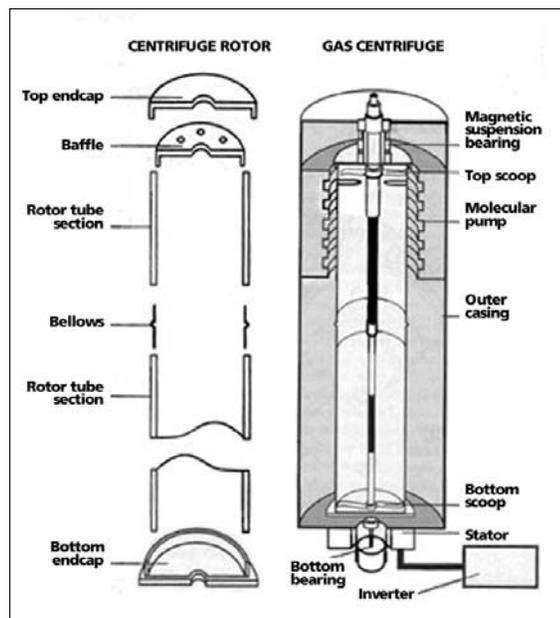
- the removal of any enriched uranium, uranium hexafluoride feed material, and major precursors of uranium hexafluoride, such as uranium tetrafluoride;
- the destruction or removal of any centrifuges, centrifuge components, and certain equipment; and
- the conversion and monitoring of other equipment and facilities.

#### *Uncertainties about the DPRK's Gas Centrifuge Program*

Little public information exists about the scope, status, and key facilities of the DPRK's gas centrifuge enrichment program. Complicating any discussion is the fact that DPRK officials regularly deny having any uranium enrichment program. U.S. officials retort that not only does the program exist, but the DPRK admitted having it. In October 2002, U.S. government officials confronted the government in Pyongyang with a U.S. intelligence assessment that the DPRK had a gas centrifuge program, which is used to make enriched uranium, and was progressing from having a research and development program to building a production plant involving thousands of centrifuges. According to U.S. statements, DPRK's First Vice Minister Kang Sok Ju told the visiting U.S. delegation that the hostile policy of the U.S. administration had left the DPRK no choice but to pursue such a program.<sup>40</sup>

During the first half of 2004, revelations emerged that the illicit smuggling network headed by Abdul Qadeer Khan, the founder of Pakistan's nuclear program, had sold about 20 gas centrifuges, centrifuge designs, and other types of key technical assistance to the DPRK. Pakistan president Pervez Musharraf said publicly in September 2005 that Khan had given centrifuge designs and whole centrifuges to the DPRK.<sup>41</sup> As a result of this information, an increasing number of governments have concluded that the DPRK has a gas centrifuge enrichment program. *Kyodo News* reported in early October 2004 that China had stated to other members of the Six-Party Talks that "there was at least an attempt [by the DPRK] for enrichment."<sup>42</sup> Until the revelations about the Khan network, a senior European intelligence official interviewed for this report could plausibly explain known DPRK purchases of materials and equipment usable in a centrifuge program as destined for other countries, such as Iran or Pakistan. He said that the DPRK has often bought items for other countries as a way to earn hard currency. However, he said that based on newer information he now believes the DPRK has established a gas centrifuge program.<sup>43</sup>

Publicly available indications of the size of a DPRK gas centrifuge plant include two procurement efforts involving DPRK intermediaries in 2001 and 2002. DPRK procurement agents attempted to obtain from Europe high-strength aluminum tubing, believed by experts to be



**Figure 6.** Diagram of a P2-Type Gas Centrifuge

Source: D. Albright and M. Hibbs, "Iraq's Shop-Till-You-Drop Nuclear Program," *Bulletin of the Atomic Scientists* 48, no. 3 (April 1992): 32–33.

slated for the stationary outer casing of a centrifuge.<sup>44</sup> Figure 6 is a schematic of a centrifuge similar to that believed to be sought by the DPRK, which shows the location of the outer casing. Pakistan calls this centrifuge the "P2."<sup>45</sup> The first order involved enough tubing for several hundred outer casings, which may have been intended for single-test centrifuges and a test cascade. In total, the agents wanted to purchase about 220 tonnes of tubing, enough for an estimated 4,000 P2 centrifuges. However, the orders were stopped before any of the tubing reached the DPRK. During the same period, the DPRK obtained from Russia 150 tonnes of aluminum tubing with similar or the same dimensions as the ones in the German orders.<sup>46</sup> Combined, the orders would have contained enough tubing for almost 7,000 P2 centrifuge outer casings.

Khan provided Libya plans for a centrifuge plant containing 6,000 P2 centrifuges arranged to make weapons-grade uranium and may have also provided the DPRK with these plans. Assuming reasonable losses, the two orders of tubing above would be appropriate for such a plant. Such a plant would be able to produce about 150 kilograms of weapons-grade uranium per year. If each weapon requires about 20 kilograms of weapons-grade uranium, the plant could produce enough material for about seven or eight nuclear weapons per year.

Despite a growing consensus on the existence of a gas centrifuge program, governments and experts differ on the status of such a program. Despite the importance of the aluminum tubing to the debate, it is important to remember that this type of aluminum tubing is relatively easy to procure internationally. Little evidence has emerged of DPRK procurement of large numbers of more sensitive centrifuge components. Thus, several key questions remain. Is the DPRK actively building a gas centrifuge plant able to make enough highly enriched uranium for several nuclear weapons per year? If so, how soon could the plant be finished? Or has the program stalled with the arrest of key players in the Khan network and increased scrutiny of the DPRK's procurements?

### ***Characteristics of a Gas Centrifuge Program***

For the purposes of discussion here, a gas centrifuge program must be defined broadly. Such a program requires commitment and resources and involves a large number of personnel. It needs to go through several stages to build an operational gas centrifuge facility, including

- the development of a prototype centrifuge;
- the creation of research and development facilities;
- the domestic and foreign procurement of necessary items;
- the construction of centrifuge manufacturing capabilities, facilities, and supporting infrastructure;
- the production of uranium hexafluoride;
- the construction of an experimental centrifuge cascade and pilot plant;
- the construction of production-scale cascades; and
- the creation of an infrastructure to maintain and improve centrifuges.

Typically, proliferant states' gas centrifuge programs have depended on extensive foreign procurement. The verification organization will need access to procurement information from the DPRK, and IAEA member-states should agree to provide supplier information. With procurement information, the verification organization will have significantly better success at both properly defining the scope of the gas centrifuge program and ensuring that parts of it are not hidden.

### ***Step-by-Step Plan for Concurrent Dismantlement and Verification of a Gas Centrifuge Program***

This section discusses a series of specific steps that would lead to the verifiable dismantlement of a gas centrifuge program where dismantlement and verification occur concurrently. The steps are similar to those discussed in the section on weaponization, but have been modified to account for a gas centrifuge program. As discussed in the prior section, these steps will need further development before they can be implemented in an actual situation.

The DPRK must produce a comprehensive declaration of its gas centrifuge program. The declaration should include details of centrifuge design, development, manufacturing, and operation. It needs to list and describe its main centrifuge sites, including the research, development, testing, and manufacturing facilities and any sites with operational centrifuges. It needs to include a history of the program, including a chronology of major political and technical milestones of the program. It should also include major planned future goals and timelines. The declaration should provide detailed information about the foreign procurement of key items for the centrifuge program. The DPRK will need to allow visits to its centrifuge and centrifuge-related main sites and access to key people in the program.

The DPRK will also need to shut down its centrifuge and centrifuge-related facilities and allow for monitoring and temporary disablement. At a centrifuge plant, shutdown would include emptying any cascades of uranium hexafluoride and turning off the centrifuges. Disablement could include removing power supplies and placing them under separate seal or welding or bolting canisters into the feed-and-withdrawal stations in any cascades. At centrifuge component manufacturing and centrifuge assembly sites, the DPRK will need to stop operations and temporarily disable the equipment. At uranium conversion facilities, the DPRK will need to stop operations, temporarily disable the facilities, and permit monitoring.

The DPRK will need to present to the verification organization any uranium assigned to or enriched in the centrifuge program, including any uranium at uranium conversion facilities. The verification organization will need to account for this material and ensure that it represents all the material actually assigned to this program.

The verification organization will need to develop a coherent technical understanding of the origin, scope, and timing of the centrifuge program in close consultation with the state. This understanding should be based on a detailed study of the declaration; a review of documents; and discussions with program officials, scientists, and technicians.

The DPRK will need to develop a comprehensive plan to dismantle its program or allow the removal of key items. The government may form a senior experts' committee to investigate methods to dismantle the program and draw up a schedule. The DPRK should develop its plans in consultation with the verification organization.

The verification organization must develop its own plan to verify the dismantlement of the program. The organization must identify actions that would be necessary to take in order to achieve effective and timely verification. The verification organization should develop its plans in consultation with the DPRK. This plan must detail the steps necessary for ensuring that items are destroyed or converted to nonprohibited uses and developing confidence that secret centrifuge activities or capabilities do not exist.

The DPRK and the verification organization will need to agree on a plan that incorporates the concerns of each party. Key agreements would include which nuclear materials, equipment, and other types of materials will be removed from the DPRK or be subject to destruction, conversion, or long-term monitoring in the DPRK. Careful records of dismantlement activities should be developed and maintained by both parties.

Based on the joint plan, the DPRK would dismantle the program and convert equipment and materials to other, nonproscribed uses. Many items would need to be converted to other uses. While many items would be destroyed, buildings or facilities would not, in general, be subject to destruction. At this point, agreed-upon items would be sent overseas from the DPRK.

Included in the destruction plan would be whole centrifuges, major centrifuge components, and cascade equipment. Destruction is accomplished by smashing, cutting, or other methods to disable the item against future use. If the number of centrifuges is relatively small, they can be sent overseas. Examples of the kinds of centrifuge components subject to destruction are shown in figures 7 and 8.

Certain centrifuge manufacturing equipment may be rendered unusable for future use in a centrifuge program. Rendering a machine tool unusable may involve destroying special fixtures or computer programs that enable the machine to make centrifuge components. Alternatively, some of these items may be sent overseas. Sensitive designs, documents, and blueprints should be sent overseas or destroyed, possibly by burning. Although ensuring the destruction of all

records is impossible, such a step nonetheless helps develop confidence that the state intends to comply.

The verification organization would witness the entire process of dismantlement and conversion. It would implement the agreed-upon program that would be used to verify the dismantlement of the program.

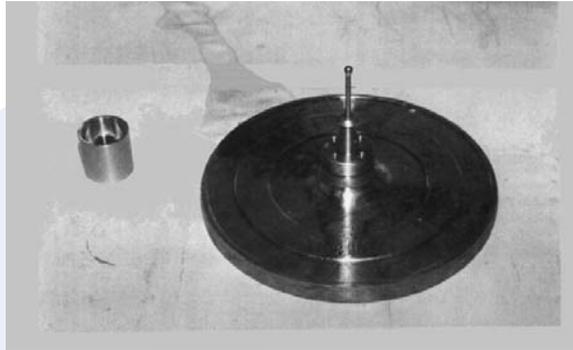
The verification organization will need to ensure that the DPRK is not hiding portions of its centrifuge program. To achieve this goal, the verification organization will need to use its rights fully and it may need to conduct a series of inspections throughout the country. In this effort, procurement information from both the DPRK and supplier states may be critical in reaching a final determination.

The verification process would focus on ensuring the accuracy and completeness of any DPRK declaration that the centrifuge program produced enriched uranium. It would use internationally accepted methods, including material balance, accounting procedures, and environmental sampling, to verify any declaration.

Three scenarios need to be considered. The first case is if no enriched uranium was produced. The second case is the production of a small quantity consistent with research and development activities. The third, and most difficult, case is the production of larger amounts of enriched uranium.

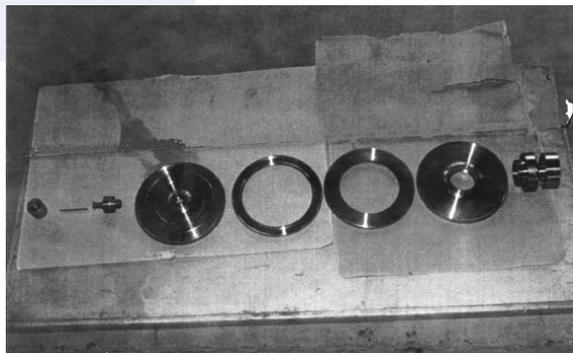
Facilities and certain equipment or materials should be evaluated jointly to decide what to convert to alternative, allowed uses. The purpose would be to continue to employ program personnel in productive work, with the priority being to create economically viable programs or joint ventures. For example, clean-room facilities could be converted to allowed high-technology uses, and machine tools could be assigned other industrial uses.

Ongoing monitoring of certain nonnuclear activities may be necessary. Nuclear material will require ongoing monitoring.



**Figure 7.** Assembled Bottom End Cap of a Gas Centrifuge and a Cup. The cup is part of the bottom bearing of a centrifuge.

*Source: IAEA Action Team.*



**Figure 8.** Components of a Gas Centrifuge. Components include, from left to right, a portion of the bottom bearing, the bottom end cap, and the top cap (second from right).

*Source: IAEA Action Team.*

At the end of the agreed-upon process, the verification organization would reach and announce the conclusion that the program had been dismantled according to the agreed-upon plan and ongoing monitoring had been successfully implemented.

#### **Task 4: Bringing the DPRK into Compliance with the NPT**

The successful resolution of the nuclear issue on the Korean peninsula will include the DPRK rejoining the NPT and coming into compliance with its safeguards agreement. The IAEA would be expected to undertake a range of actions to verify the DPRK's compliance with these agreements.

The IAEA has preliminarily defined many of its planned inspection activities in the DPRK, although it has not released these plans publicly. It earlier conducted extensive preparations for the resumption of inspections under the schedule established by the Agreed Framework. Prior to the end of IAEA monitoring activities at Yongbyon in 2002 and the subsequent demise of the Agreed Framework, the IAEA had regular discussions with the DPRK on preserving historical information, including data, reports, and operating records from the DPRK's nuclear facilities that would be needed during future inspections.

The timing of the resumption of IAEA inspections under the NPT will need to be determined during negotiations at the Six-Party Talks. The verification goals can be accomplished more effectively and efficiently if the DPRK allows NPT-type inspections to start early in the process of dismantlement, particularly if the verification organization is the IAEA. The DPRK, nonetheless, may insist that these IAEA inspections be distinct from the verification of dismantlement. If the verification organization is not the same as the IAEA, these groups will need to carefully coordinate their activities. Even in the case of two verification organizations, the dismantlement process would proceed more quickly if the IAEA was involved early on.

The IAEA should be prepared to inform the DPRK of what its inspections will involve, particularly given all the changes in international safeguards during the past decade. Since the Agreed Framework was signed in 1994, the IAEA has strengthened its safeguards system significantly to make it more difficult for nonnuclear weapons states that are party to the NPT to hide nuclear activities from inspectors. Its experiences in Iran, Libya, and South Africa have led to many changes in its inspections.

If the IAEA is to determine that the DPRK has come into compliance with the NPT, the DPRK must demonstrate its commitment to transparency by implementing the Additional Protocol. The Additional Protocol is becoming an international norm and is viewed increasingly as the minimum standard of internationally accepted and adequate inspections. It has been accepted by many countries, including South Korea, Japan, Taiwan-China, the European Union, Iran, and Libya. Several of these parties, including Iran and Libya, have also allowed the IAEA to exercise more extensive inspection activities than those specified in the Additional Protocol.

An important part of the IAEA's inspection process under the Additional Protocol is developing confidence in the absence of undeclared nuclear activities. As a result, the IAEA would seek to determine, using broader declarations and greater access granted under the Additional Protocol, that the DPRK does not have either undeclared stocks of plutonium or enriched uranium or undeclared facilities able to make them. Such inspections would complement and strengthen verification activities established during the dedicated dismantlement phases.

The IAEA needs to continue preparing for its safeguards work to resume in the DPRK. It will need to reevaluate information and data collected during the original set of inspections in 1992 and 1993 and assess information obtained afterward and learned through the verifiable dismantlement process, no matter what organization performs those verification tasks. It will have to prepare for the implementation of new inspections and once again do the basic work of comparing the DPRK's declarations to other information to establish whether these declarations are correct and complete.

IAEA members will need to provide political, financial, and technical assistance to the IAEA as it prepares to carry out its mission in the DPRK. These types of inspection efforts are resource intensive and occur against a background of limited funding for the IAEA in general.



## Ensuring the Absence of Undeclared Nuclear Material and Facilities

An important element in any negotiated verification regime in the DPRK will be creating measures whereby the verification organization develops confidence in, or credible assurances of, the absence of undeclared nuclear material or activities. This process is by its very nature time-consuming. As a result, in each of the four tasks discussed above, the verification organization will devote considerable time and resources to developing this confidence. Exactly how long the verification organization will need to complete these tasks will depend on the DPRK's cooperation and willingness to take steps to enhance its transparency.

In Libya and South Africa, for example, the governments committed to allowing IAEA access anywhere and providing additional information in documents and interviews with a wide range of officials, scientists, and technicians. These commitments went beyond those required by the NPT and were critical in enabling the IAEA and the international community to develop confidence in the absence of undeclared materials and facilities in these states. Likewise, the DPRK should be encouraged to make a similar range of commitments that further its transparency.

To earn the confidence of the verification organization, the DPRK will be requested to provide broader declarations that include more detailed information than typically provided under IAEA safeguards agreements. The verification organization will ask the state for permission to examine a variety of records and conduct its own interviews of key DPRK program personnel. It may ask for foreign procurement information from the DPRK and other states. The verification organization will also ask to visit sites to take environmental samples and have follow-up questions and requests.

In addition, the verification organization may seek access to a range of sites not listed in a DPRK declaration. The main reason that the verification organization might make such a request would be if it needed to resolve a question relating to the correctness or completeness of the DPRK's declared information. The basis for such a question could be results from environmental sampling, open source or third-party information, foreign procurement data, or inconsistencies in declarations or statements.

The DPRK has sensitive military sites that the verification organization may need to inspect. As a result, the DPRK will need to agree during the Six-Party Talks or other negotiations that the verification organization will have access to military and other sensitive sites.

The DPRK, however, may view some sites as too sensitive to allow inspections. If the DPRK refuses access to a site, it will need to satisfy the verification organization in other ways that no undeclared materials or activities have been associated with the site. Under the IAEA Additional Protocol, for example, if a state is "unable" to provide access, the state

must "make every reasonable effort to satisfy Agency requirements, without delay, through other means."<sup>47</sup>

However, a priority is preventing the DPRK from invoking this condition except in extraordinary circumstances. Toward this goal, the negotiators will need to impress upon the DPRK the necessity of the verification organization visiting sensitive sites, such as military facilities. More importantly, efforts at the Six-Party Talks and afterward to create a favorable political and security climate between the DPRK and the United States and its allies could have a significant impact on the DPRK's willingness to allow intrusive inspections.

In the negotiation of the verification arrangements, the DPRK and the other parties to the agreement may want to develop procedures for "managing access" by the verification organization to prevent the dissemination of proliferation-sensitive information, meet safety and physical protection requirements, protect proprietary or commercially sensitive information, or protect national security secrets. The international community has extensive experience in designing managed-access arrangements that can ensure the absence of undeclared activities while protecting state secrets. However, such arrangements cannot preclude the verification organization from gaining credible assurance of the absence of undeclared nuclear material and activities at a location.

To protect its secrets at a military site, for example, the DPRK may cover or otherwise hide sensitive nonnuclear-related equipment to prevent its being seen or otherwise characterized by the verification organization. The DPRK may want some of its officials to be present when the verification organization is at the site. These limitations on the inspections should not inordinately delay the granting of access to the verification organization, allowing the operators time to remove or destroy items.

To effectively accomplish its goal, the verification organization will also need to conduct certain activities at these sites. In particular, it will need to take environmental samples, use radiation detection and measurement equipment, and perhaps gain access to records and officials.

At some point, the verification organization and the parties to the dismantlement agreement will have to make a determination that they have enough confidence in their understanding of the DPRK's nuclear program to conclude that the DPRK has dismantled its nuclear weapons programs and is unlikely to have undeclared nuclear materials or facilities.

The verification organization will be primarily responsible for making this determination, using a wide variety of information and experiences that would be expected from several years of intensive verification in the DPRK. Such a determination would require a finding that the DPRK's declarations are correct and complete or at least a finding of no indications or evidence that such declarations are not complete. Such findings are bound to include some uncertainty, but any uncertainties should be shown to be small enough to justify the determination.

The verification organization would be expected to draw upon the IAEA's experiences in other countries, particularly Libya and South Africa, in making such a determination. After two successful verified dismantlement experiences, the IAEA is capable of reaching a conclusion on verified dismantlement using proven tools and methods.

After the verification organization has made such a determination, the parties to the agreement will need to ratify this determination. The agreement should include a mechanism for the parties to meet and discuss the conclusions of the verification organization, including such important matters as the absence of undeclared nuclear materials and facilities. If the verification organization is IAEA Plus, the IAEA Board of Governors could also pass a resolution in support of such a determination. A UN Security Council resolution could add credibility.

As discussed in Task 4, the search for undeclared nuclear activities will not end with a conclusion by the verification organization about the DPRK's dismantlement of its nuclear weapons program and its compliance with the NPT. The IAEA, as part of ensuring continued compliance with the NPT, will investigate any evidence of undeclared materials or facilities on an ongoing basis, making annual determinations about this issue as part of routine safeguards.



## The Special Role of Cooperative Threat Reduction Programs

The DPRK is being asked to sacrifice most of its existing nuclear programs. These programs enjoy extensive resources, contain large infrastructures, and employ thousands of scientists, engineers, technicians, and other specialists. The states requesting this sacrifice have an interest in assisting the DPRK in reducing the negative consequences of this large transformation of its nuclear establishment. Such assistance could also provide the DPRK nuclear establishment with a powerful incentive to cooperate with nuclear disarmament and prevent the future leakage of dangerous knowledge from its program.

Cooperative threat reduction programs have had a significant impact on the conversion of WMD programs to peaceful programs in Russia and the former Soviet states. The United States is also pursuing CTR programs in Libya and Iraq. These U.S.-led CTR programs have focused on dismantling weapons of mass destruction and their associated infrastructures, combining and securing stocks of weapons and related materials, redirecting professionals to non-weapons work, increasing transparency and building trust, and supporting cooperation that can prevent proliferation.

Some of these objectives, including dismantlement and increased transparency, would be included in a negotiated verifiable dismantlement program in the DPRK. However, it is important to develop other CTR activities in the DPRK during the dismantlement process, either as part of a negotiated agreement, such as a mandated benefit to the DPRK, or negotiated later on a bilateral basis.

One of the key issues for the DPRK is the thousands of people who will need to find new jobs. The DPRK can be expected to resist an agreement that requires it to give up all the human resources devoted to its nuclear weapons program without assistance in re-employing them. Therefore, projects intended to transition the program personnel to viable nonbanned projects would be a benefit to the DPRK.

A key focus for transition work could be expansion of the DPRK's civilian nuclear energy applications in the medical, industrial, and agricultural fields, all areas with substantial but decayed capabilities. These civil nuclear energy projects could serve to employ many scientists and technicians and could be a significant benefit to the people of North Korea whose nuclear medical, industrial, and agricultural programs have fallen behind programs around the world in status. The DPRK has stated that it intends to continue its civil nuclear energy programs, and CTR projects could focus on legitimate nuclear fields that pose no military danger.

Although most CTR projects would be run by states in cooperation with the DPRK, the IAEA could play an important role in providing peaceful, allowed nuclear assistance through its technical cooperation program. As a result, it is a priority that the DPRK rejoin the IAEA, which it left in 1994.



## Findings and Recommendations

Verified dismantlement of the DPRK's nuclear weapons program can be accomplished successfully. It can be done at a fair cost and in a reasonable amount of time. To work, it must be carried out by a verification organization that is technically competent, professional, and politically fair using a verification process that has the political support of all concerned parties. The DPRK must be cooperative with and transparent to the verification organization and the other parties to any agreement. Such commitment will likely depend on the DPRK's belief that its vital interests are served by an agreement to verifiably dismantle its nuclear weapons program.

States involved in an agreement will need to settle on realistic, effective verification arrangements. In particular, they should avoid unnecessarily intrusive verification requirements that would be seen by the DPRK as attempts to uncover secrets related to sensitive programs that are not subject to this agreement.

Calls to eliminate all vestiges of the DPRK's nuclear energy program appear at this point to be unrealistic. The DPRK is likely to insist on the continuation of many aspects of its civil nuclear energy programs, such as radioisotope use in nuclear medicine, isotope production for civil applications, and civil nuclear research. The continuation and expansion of such efforts may in fact contribute to effective dismantlement by providing jobs for displaced nuclear scientists and technicians. The fate of nuclear electricity generation programs, particularly the LWR project, wherein the Korean Peninsula Energy Development Organization builds two nuclear power reactors in the DPRK, is more controversial. Their resumption will be unlikely before the DPRK has dismantled its nuclear weapons program.

If the LWR project is resumed at some future date, IAEA inspections can provide adequate verification against potential misuse of these reactors, particularly if safeguards include real-time camera surveillance of the reactor and any spent fuel storage areas.

The necessary foundation for a verified dismantlement effort can be laid through detailed negotiations by informed parties that recognize the scope and stakes of such an effort. Because verification will be central to any agreement and complicated to negotiate, the parties must focus on it early in the negotiation process. The exact rights of the verification organization are expected to be a major issue. A primary goal of the negotiations is to find an optimal, effective verification arrangement that satisfies all parties.

Verification will need to start early in the implementation phase of any agreement. Delays in implementing verification could make it more difficult to achieve confidence that the DPRK is dismantling its programs according to its commitments. In addition, verification will play a key role in testing whether the DPRK is sincere in its commitments to dismantle.

A key test of any verification arrangement will be how the DPRK reacts to requests from the verification organization. Will the DPRK interpret any requests narrowly or be hostile to these requests? Will it cooperate in addressing any concerns or requests of the verification organization?

Although many verification organizations have been discussed, the best alternative for the verification organization is IAEA Plus, which is the IAEA safeguards department supplemented by experts from IAEA member-states. Other parties may want to take part directly in the verification process, as occurred in Libya, but giving the IAEA responsibility for verification poses the fewest problems and offers the most advantages.

In any case, the IAEA would be responsible for determining that the DPRK comes into compliance with the NPT. Thus, efficiency alone argues that the IAEA be given primary responsibility for the more straightforward tasks of verifying dismantlement of the DPRK's key nuclear weapons programs and long-term monitoring of dual-use items remaining after the dismantlement process. Making IAEA Plus responsible for verification will also help to avoid competing and possibly conflicting verification efforts.

To carry out dismantlement responsibilities in the DPRK, the IAEA will need rights beyond traditional safeguards and the Additional Protocol. Although an agreement reached during the Six-Party Talks or another suitable negotiating forum would detail these additional powers, the IAEA may also need UN Security Council approval to carry out this new mandate.

An agreement should also include a method, separate from the usual process of quarterly Board of Governors meetings, by which the parties review the efforts of a special entity within the IAEA. One possibility is for the parties to form a temporary oversight body responsible for the verification organization.

If the IAEA is not given lead responsibility, the negotiators will need to carefully work out the transfer of authority from the verification organization to the IAEA for long-term monitoring and the determination of whether the DPRK is in compliance with the NPT and its safeguards obligations.

During the verification process, rights of access will be critical. The DPRK should be encouraged to grant unrestricted access to sites as deemed necessary by the verification organization, with the understanding that the DPRK can take reasonable steps to protect vital secrets in programs that are not covered by a dismantlement agreement.

DPRK declarations will be extremely important to the verification process. If the experience of other cases is a guide, the DPRK may not provide adequate declarations initially. Nonetheless, the DPRK should be expected to supplement its declarations and provide additional information as the verification process progresses. Though a comprehensive initial declaration would help build confidence, lack of an acceptable first declaration should be seen not as noncompliance but as part of the process.

A reasonable approach needs to be developed for deciding when to dismantle key items in place and when to send them overseas. Nuclear material such as plutonium and enriched uranium should be removed. But not everything can or needs to be removed. In addition, certain items could be useful in nonbanned programs.

The verification organization will likely need several years to develop adequate confidence that the DPRK has fully dismantled its programs and does not have undeclared nuclear materials or facilities. Knowing when that point has been achieved could be one of the most difficult tasks facing the verification organization. Because of the importance of this issue, however, the agreement should include a process for the parties to agree collectively that such a point has been reached.

Despite all the difficulties, an agreement to verifiably dismantle the DPRK's nuclear weapons program remains vital to U.S. and international security. If the United States and its allies have the political will, they can achieve such an agreement. Although the entire verification process will likely take several years, the positive impact of dismantlement would be felt almost immediately. DPRK nuclear facilities would be disabled and monitored. Nuclear material would be declared, sealed, and verified. Any nuclear weapons would be disabled and monitored. These steps go far beyond the freeze under the Agreed Framework. Relatively early in the process, the DPRK would send out its most threatening nuclear material and start the process of verifiably dismantling its key nuclear weapons facilities. For the first time, a realistic process to denuclearize the DPRK would be under way. All members of the Six-Party Talks should set this goal as their highest priority.



## Notes

1. See, for example, "DPRK Warns of Stronger Nuclear Deterrence," *China People's Daily*, March 20, 2004.
2. Authors' assessment. For more information, see [www.isis-online.org](http://www.isis-online.org).
3. Joint Statement of the Fourth Round of the Six-Party Talks Beijing, September 19, 2005.
4. Ibid.
5. James A. Kelly, assistant secretary for East Asian and Pacific affairs, U.S. Department of State, "Dealing with the DPRK's Nuclear Programs," statement to the Senate Foreign Relations Committee, Washington, D.C., July 15, 2004, available at [http://ntinitiative.org/e\\_research/official\\_docs/dos/dosJuly15\\_04.pdf](http://ntinitiative.org/e_research/official_docs/dos/dosJuly15_04.pdf).
6. David Albright and Kevin O'Neill, eds., *Solving the North Korean Nuclear Puzzle* (Washington, D.C.: ISIS, 2000).
7. "Model Protocol Additional to the Agreement(s) between State(s) and the International Atomic Energy Agency for the Application of Safeguards," available at [www.iaea.org/Publications/Documents/Infcircs/1997/infcirc540c.pdf](http://www.iaea.org/Publications/Documents/Infcircs/1997/infcirc540c.pdf).
8. For more information on CTR activities in the former Soviet Union, see, for example, the Nuclear Threat Initiative's resource page at [www.nti.org/db/nisprofs/russia/forasst/nunn\\_lug/overview.htm](http://www.nti.org/db/nisprofs/russia/forasst/nunn_lug/overview.htm).
9. See, for example, Larry A. Niksch, "North Korea's Nuclear Weapons Program," CRS Issue Brief for Congress. Updated March 25, 2005, available at <http://fpc.state.gov/documents/organization/46412.pdf>.
10. Kelly, "Dealing with the DPRK's Nuclear Programs."
11. Ibid.
12. The United States did not define the term "disabling," but the basic idea of disablement is to apply an action that will interfere, in either a temporary or an irreversible way, with the use of the item.
13. Fissile material was not explicitly defined by Kelly, but it is assumed for the purposes of this discussion to include plutonium, highly enriched uranium, and low-enriched uranium, but not necessarily natural or depleted uranium.
14. Joint Statement.
15. "DPRK Tables Proposal to Freeze Nuclear Programs," *People's Daily Online*, February 27, 2004.
16. Statement by HE Mr. Choe Su Hon, Head of Delegation of the DPRK at the General Debate of the Fifty-ninth UN General Assembly, September 27, 2004.
17. Ibid.
18. Communication with the authors, 2004.

19. Communication with the authors, 2004.
20. DPRK Foreign Ministry spokesman on Six-Party Talks, June 28, 2004.
21. Kelly, "Dealing with the DPRK's Nuclear Programs."
22. DPRK Foreign Ministry spokesman on Six-Party Talks, June 28, 2004.
23. Ibid.
24. "Foreign Ministry Spokesman on DPRK's Stand on Nuclear Freeze and Way of Verification," Korean Central News Agency, July 14, 2004.
25. Joint Statement.
26. More information about these sites, including satellite images of them, can be found on the ISIS website, [www.isis-online.org](http://www.isis-online.org). See also Albright and O'Neill, *Solving the North Korean Nuclear Puzzle*.
27. Dr. Siegfried S. Hecker, "Visit to the Yongbyon Nuclear Scientific Research Center in North Korea." Testimony before the Senate Committee on Foreign Relations, January 21, 2004, available at [www.fas.org/irp/congress/2004\\_hr/012104hecker.pdf](http://www.fas.org/irp/congress/2004_hr/012104hecker.pdf).
28. Albright and O'Neill, *Solving the North Korean Nuclear Puzzle*.
29. ISIS Assessment; see also "ISIS Estimates of Unirradiated Fissile Material in de Facto Nuclear Weapon States, Produced in Nuclear Weapon Programs." Revised June 30, 2005, available at [www.isis-online.org/global\\_stocks/end2003/de\\_facto\\_nws.pdf](http://www.isis-online.org/global_stocks/end2003/de_facto_nws.pdf).
30. View the imagery at [www.isis-online.org/images/dprk/yongbyon\\_images.html](http://www.isis-online.org/images/dprk/yongbyon_images.html).
31. Albright and O'Neill, *Solving the North Korean Nuclear Puzzle*.
32. Interviews by authors, 2004.
33. Albright and O'Neill, *Solving the North Korean Nuclear Puzzle*.
34. See, for example, *ibid*.
35. *Ibid*.
36. Richard Roth, "US Doubts North Korea's Claims." [www.cnn.com](http://www.cnn.com). October 2, 2003. Available at [www.cnn.com/2003/WORLD/asiapcf/east/10/01/nkorea.nukes](http://www.cnn.com/2003/WORLD/asiapcf/east/10/01/nkorea.nukes).
37. Nobuyoshi Sakajire, "North Korea Brings in Crane Vehicle in Nuclear Construction Site Probably Six Party Talks in Mind," *Asahi Shimbun*, July 19, 2005, morning edition; translation by FBIS.
38. See, for example, David E. Sanger and William J. Broad, "Fresh Concerns of Atomic Moves by North Korea," *New York Times*, September 12, 2004, A1.
39. Paul Kerr, "US Unveils Offer at North Korea Talks," *Arms Control Today*, July–August 2004.
40. Kelly, "Dealing with the DPRK's Nuclear Programs."
41. See, for example, David E. Sanger, "Pakistan Leader Confirms Nuclear Exports," *New York Times*, September 13, 2005, A10.

42. See, for example, Yoo-Seong Hwang, "China Admits 'The DPRK Make an Attempt to Enrich Uranium,'" *Dong-A Ilbo*, October 4, 2004.

43. Interview with the authors, 2004.

44. The tubing had dimensions consistent with an old European gas centrifuge developed in Germany in the late 1960s and early 1970s. Abdul Qadeer Khan and his associates are known to have stolen this design in the mid-1970s and later deployed it within Pakistan as the "P2" centrifuge. The type and dimensions of the tubes correspond closely to the type and dimensions of tubes made by SCOPE, the Malaysian company contracted by the Khan network to make a range of aluminum P2 centrifuge parts for Libya.

45. See, for example, David Albright and Corey Hinderstein, "Unraveling the A. Q. Khan and Future Proliferation Networks," *Washington Quarterly* 28, no. 2 (Spring 2005): 111–128.

46. "North Korea Imports Nuclear Materials from Russia," BBC Monitoring International Reports, June 5, 2005.

47. Model Protocol.

## About the Authors

**David Albright**, a physicist, is founder and president of the Institute for Science and International Security (ISIS), a nonprofit, nonpartisan institution integrating technical, scientific, and policy research aimed at stopping the spread of nuclear weapons, bringing about greater transparency of nuclear activities worldwide, and achieving deep reductions in nuclear arsenals. He has published numerous assessments of secret nuclear weapons programs throughout the world and has been cited often in the media and appeared frequently on television and radio. He is coauthor of *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies* and *Solving the North Korean Nuclear Puzzle*. From 1992 until 1997, he cooperated actively with the IAEA Action Team focusing on analyses of Iraqi documents and past procurement activities. In June 1996, he was the first nongovernmental inspector of the Iraqi nuclear program.

**Corey Hinderstein** is the deputy director of ISIS. Her work includes key research and analytical contributions to state-specific proliferation assessments and case studies, including using commercial satellite imagery as a research tool.

## About the Institute

### United States Institute of Peace

The United States Institute of Peace is an independent, nonpartisan federal institution created by Congress to promote the prevention, management, and peaceful resolution of international conflicts. Established in 1984, the Institute meets its congressional mandate through an array of programs, including research grants, fellowships, professional training, education programs from high school through graduate school, conferences and workshops, library services, and publications. The Institute's Board of Directors is appointed by the President of the United States and confirmed by the Senate.

*Chairman of the Board:* J. Robinson West

*Vice Chairman:* María Otero

*President:* Richard H. Solomon

*Executive Vice President:* Patricia Powers Thomson

*Vice President:* Charles E. Nelson

#### **Board of Directors**

**J. Robinson West** (Chairman), Chairman, PFC Energy, Washington, D.C.

**María Otero** (Vice Chairman), President, ACCION International, Boston, Mass.

**Betty F. Bumpers**, Founder and former President, Peace Links, Washington, D.C.

**Holly J. Burkhalter**, Director of U.S. Policy, Physicians for Human Rights, Washington, D.C.

**Chester A. Crocker**, James R. Schlesinger Professor of Strategic Studies, School of Foreign Service, Georgetown University

**Laurie S. Fulton**, Williams and Connolly, Washington, D.C.

**Charles Horner**, Senior Fellow, Hudson Institute, Washington, D.C.

**Seymour Martin Lipset**, Hazel Professor of Public Policy, George Mason University

**Mora L. McLean**, Esq., President, Africa-America Institute, New York, N.Y.

**Barbara W. Snelling**, former State Senator and former Lieutenant Governor, Shelburne, Vt.

#### **Members ex officio**

**Michael M. Dunn**, Lieutenant General, U.S. Air Force; President, National Defense University

**Barry F. Lowenkron**, Assistant Secretary of State for Democracy, Human Rights, and Labor

**Peter W. Rodman**, Assistant Secretary of Defense for International Security Affairs

**Richard H. Solomon**, President, United States Institute of Peace (nonvoting)





## Other Titles in the Peaceworks Series

- *Downward Spiral: HIV/AIDS, State Capacity, and Political Conflict in Zimbabwe*, by Andrew T. Price-Smith and John L. Daly (No. 53, July 2004)
- *Biosecurity: Limiting Terrorist Access to Deadly Pathogens*, by Jonathan B. Tucker (No. 52, November 2003)
- *Healing the Holy Land: Interreligious Peacebuilding in Israel/Palestine*, by Yehezkel Landau (No. 51, August 2003)
- *Boundary Disputes in Latin America*, by Jorge I. Domínguez with David Mares, Manuel Orozco, David Scott Palmer, Francisco Rojas Aravena, and Andrés Serbin (No. 50, August 2003)
- *The Road Ahead: Lessons in Nation Building from Japan, Germany, and Afghanistan for Postwar Iraq*, by Ray Salvatore Jennings (No. 49, May 2003)
- *The Palestinian Reform Agenda*, by Nathan Brown (No. 48, December 2002)
- *The Israeli Military and Israel's Palestinian Policy: From Oslo to the Al Aqsa Intifada*, by Yoram Peri (No. 47, November 2002)
- *The Chaplain's Evolving Role in Peace and Humanitarian Relief Operations*, by Captain Paul McLaughlin (No. 46, September 2002)
- *The Ethics of Armed Humanitarian Intervention*, by C. A. J. Coady (No. 45, July 2002)
- *Democratic Values, Political Structures, and Alternative Politics in Greater China*, by David Zweig (No. 44, June 2002)
- *Training for Peace and Humanitarian Relief Operations: Advancing Best Practices*, by Robert M. Schoenhaus (No. 43, April 2002)
- *The Role of International Financial Institutions in International Humanitarian Law*, by Laurie R. Blank (No. 42, January 2002)
- *Controlling Weapons of Mass Destruction: Findings from USIP-Sponsored Projects*, edited by Deepa M. Ollapally (No. 41, September 2001)
- *Passing the Baton: Challenges of Statecraft for the New Administration*, with remarks by Samuel R. Berger and Condoleezza Rice (No. 40, May 2001)
- *From Revolutionary Internationalism to Conservative Nationalism: The Chinese Military's Discourse on National Security and Identity in the Post-Mao Era*, by Nan Li (No. 39, May 2001)
- *El Salvador: Implementation of the Peace Accords*, edited by Margarita S. Studemeister (No. 38, January 2001)
- *The News Media and Peace Processes: The Middle East and Northern Ireland*, by Gadi Wolfsfeld (No. 37, January 2001)
- *Conflict Management Training: Advancing Best Practices*, by Robert M. Schoenhaus (No. 36, January 2001)
- *Coercive Prevention: Normative, Political, and Policy Dilemmas*, by Bruce W. Jentleson (No. 35, October 2000)
- *Women in War and Peace: Grassroots Peacebuilding*, by Donna Ramsey Marshall (No. 34, August 2000)
- *Grappling with Peace Education in Serbia*, by Ruzica Rozandic (No. 33, April 2000)



**United States  
Institute of Peace**

An online edition of this report can be found at our website ([www.usip.org](http://www.usip.org)), together with additional information on the subject.