NTI
BUILDING A SAFER WORLD

BUILDING SECURITY THROUGH COOPERATION

REPORT OF THE NTI WORKING GROUP ON COOPERATIVE THREAT REDUCTION WITH NORTH KOREA

By Lynn Rusten and Richard Johnson
With Steve Andreasen and Hayley Anne Severance

Foreword by Ernest J. Moniz and Sam Nunn

About the Nuclear Threat Initiative

The Nuclear Threat Initiative works to protect our lives, environment, and quality of life now and for future generations. We work to prevent catastrophic attacks with weapons of mass destruction and disruption (WMDD)—nuclear, biological, radiological, chemical, and cyber.

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We are grateful to Nuclear Threat Initiative (NTI) Co-Chair and Chief Executive Officer Ernest Moniz; Co-Chair Sam Nunn; and NTI Board Member Richard Lugar, who sadly passed away in April 2019 just before this report was completed, for their leadership on reducing WMD-related threats and for inspiring the Working Group on Cooperative Threat Reduction with the Democratic People's Republic of Korea (DPRK). We also thank NTI President Joan Rohlfing and Executive Vice President Deborah Rosenblum for their important contributions to this project.

Members of the working group, which includes highly respected experts, policymakers, and practitioners in the fields of cooperative threat reduction and denuclearization diplomacy with North Korea, have been extremely generous with their time and ideas. We appreciate their contributions, and we have done our best to ensure that their perspectives were taken into account as we wrote this report.

We also would like to thank the NTI Board of Directors for its support, and we give special thanks to NTI's generous funders, including the John D. and Catherine T. MacArthur Foundation and the Carnegie Corporation of New York, for their support of this work.

Finally, we are indebted to our colleagues at NTI who provided invaluable contributions to this report. In particular, we thank Steve Andreasen for drafting the notional "National Security Presidential Memorandum on Scientific and Technical Cooperation with the DPRK"; Hayley Severance for drafting the section on the potential role of cooperative threat reduction (CTR) in addressing potential biological weapons capabilities and for contributing substantially to the section on chemical weapons programs and elimination; and Brian Rose for the work he did while at NTI on the history of the CTR program and areas for cooperation on missile elimination. We also thank Beth Cameron, Catherine Crary, Mary Fulham, Corey Hinderstein, Laura Holgate, and Samantha Neakrase for their significant contributions to the project and report. We are particularly grateful to Mimi Hall and Carmen MacDougall of NTI's communications team.

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President Trump and North Korean leader Kim Jong Un in Singapore, June 2018.

FOREWORD

Ernest J. Moniz and Sam Nunn

The Korean Peninsula is one of the most volatile and heavily militarized places in the world, carrying tremendous risk of conflict and the potential for catastrophic nuclear exchange. Tensions heightened between the United States and North Korea amid alarming loose talk about nuclear weapons in late 2017 and early 2018, but the 2018 Pyeongchang Winter Olympics, where North and South Korea symbolically entered the opening ceremony together under a "unification flag" and fielded a joint women's hockey team, created a diplomatic opening. Intensified diplomatic contact between Republic of Korea President Moon Jae-in and Democratic People's Republic of Korea (DPRK) Chairman Kim Jong Un ensued, leading to an offer by President Donald Trump to meet with Chairman Kim.

In the run up to that historic U.S.-DPRK leader summit in Singapore in June 2018, Nuclear Threat Initiative (NTI) Co-Chair and former Senator Sam Nunn joined NTI Board Member and former Senator Richard Lugar to pen an op-ed in *The Washington Post*. That piece called for creative diplomacy to capitalize on the emerging opportunity, recognizing that eliminating the nuclear threat and achieving stability and security on the Korean Peninsula would require unconventional thinking and steps that are much broader than denuclearization.

They recalled the vital lessons from the Nunn-Lugar Soviet Nuclear Threat Reduction Act of 1991, establishing the Cooperative Threat Reduction (CTR) program. The legislation facilitated technical and financial assistance

to inventory, destroy, and dispose of nuclear and chemical weapons and their delivery vehicles in Russia, Belarus, Kazakhstan, and Ukraine and to dismantle biological production facilities following the breakup of the Soviet Union in 1991. The Nunn-Lugar CTR initiative also helped fund productive, peaceful scientific work for scientists who were employed in the weapons complex of the former Soviet Union, helping prevent the proliferation of their know-how to other states and non-state actors.

They wrote then—and we believe now—that this concept should be a critical component of any effort to verifiably dismantle North Korea's nuclear weapons and related programs as well as to prevent future proliferation of weapons, material, or know-how. Such cooperation also can be used to engage thousands of North Korean scientists and engineers—who are now employed in making weapons of mass destruction—in peaceful scientific and technical work.

Achieving security and stability and reducing catastrophic risks on the peninsula will require intensive, expert-level negotiations and comprehensive, step-by-step implementation over many months and years. This broader effort cannot be viewed solely as a bilateral U.S.-North Korean discussion. It also must include China, South Korea, Japan, and Russia and address the security and political concerns of all the parties, including economic and humanitarian matters.

Economic, military, and diplomatic pressure helped bring the North Koreans to the table, but reaching a successful agreement will require carrots as well as sticks. Although there are significant differences between North Korea in 2019 and the former Soviet Union in 1991, the cooperative threat reduction concept could be a powerful tool—a carrot—to support the verifiable reduction and elimination of North Korea's nuclear arsenal, its other weapons of mass destruction, and their delivery systems. Such a program could be developed, funded, and implemented jointly with our regional partners and other members of the international community. This report explores exactly that approach.

That a comprehensive and sustainable solution to the North Korean nuclear challenge has proven elusive for more than 25 years is a humbling fact that should not be ignored in crafting any policy recommendations for achieving denuclearization. The long history of mistrust and conflict between the United States and North Korea and of DPRK noncompliance will be difficult to overcome, but it should not deter policymakers from pursuing creative ways forward.

The incorporation of a cooperative threat reduction approach alone will not bridge the deep divide between the two sides but could serve as part of a broader and reinforcing set of mechanisms to begin to build trust and enhance security for all sides.

Dick Lugar was an inspiration for and enthusiastic proponent of exploring the ideas in this report before he passed away in April 2019. We benefited greatly from his advice, counsel, and friendship, just as our country and, indeed, the world benefited immeasurably from his bold vision and determined leadership. We all owe him a debt of gratitude, which can be paid most meaningfully by working to advance the principles of peace and civility that he championed.

By examining some of the history and lessons of the CTR approach and how it might be applied to the DPRK today, we hope this report and the legacy of Dick Lugar inspire those who are charged with negotiating toward a new future for a peaceful and denuclearized Korean Peninsula.

Scud C missile, military parade, Pyongyang, North Korea, 2017.

EXECUTIVE SUMMARY

The return to diplomatic engagement on the Korean Peninsula in 2018, sparked by the rapprochement between North and South Korea and the summits between President Donald Trump and North Korean leader Kim Jong Un in Singapore and Hanoi, has provided an opening to improve security in Northeast Asia and make progress toward the verifiable denuclearization of the Democratic People's Republic of Korea (DPRK).

The U.S. government's priority is to eliminate the threat to the United States and its regional allies posed by Pyongyang's nuclear, ballistic missile, and other weapons of mass destruction (WMD) programs, with a focus on achieving complete and verifiable denuclearization. The DPRK seeks, among other things:

- Normalization of relations with the United States and the international community
- A formal end to the Korean War
- The lifting of economic sanctions
- Removal of what it perceives as a long-term threat to its security posed by the United States
- Transformation of the North Korean economy.

If future negotiations yield an agreement on complete and verifiable denuclearization in the DPRK, the job at a minimum will entail the elimination of nuclear weapons and the direct means for producing them. The process will take years, and it is most likely to succeed in a step-by-step or action-for-action manner, with the DPRK taking steps toward

denuclearization (which could include dismantlement of missile programs) and the United States and other regional partners taking calibrated reciprocal diplomatic, economic, or other measures in response.

In addition to formalizing the DPRK's voluntary freeze on nuclear and missile testing, the next logical step in denuclearization would be a freeze on all fissile material production. The removal of nuclear materials and the dismantlement of nuclear weapons would come later.

To succeed, this process will require detailed and technical negotiations at the expert level. In addition, denuclearization is most likely to be achieved and sustained if it is embedded in a broader multilateral diplomatic process that addresses the security, economic, and political requirements of the key Northeast Asia nations (China, South Korea, Japan, and Russia as well as North Korea), including the prospect of eventual normalization of relations with North Korea.

Lessons from Cooperative Threat Reduction

To enhance prospects for comprehensive, verifiable, and enduring denuclearization of North Korea, the United States should incorporate into the negotiations an offer to Pyongyang of a Cooperative Threat Reduction (CTR) program. Such a program would facilitate the dismantlement of the DPRK's nuclear and other WMD programs and incentivize North Korea to take those dismantlement steps in return for technical and economic assistance on denuclearization and WMD threat reduction activities and to help redirect human and technical resources to civilian economic development.

To enhance prospects for comprehensive, verifiable, and enduring denuclearization of North Korea, the United States should incorporate into the negotiations an offer to Pyongyang of a Cooperative Threat Reduction (CTR) program.

While recognizing the important differences between the former Soviet Union in 1991 and North Korea today, such a program should adapt best practices and lessons learned from the successful CTR program that following the break-up of the Soviet Union was central to helping the former Soviet states eliminate, reduce, and secure nuclear, chemical, and biological weapons, materials, facilities, and means of delivery and to preventing WMD proliferation.

The involvement of multiple countries in a CTR effort would further contribute to achieving U.S. goals for denuclearization in ways that would both provide reassurance to the DPRK and benefit the United States by sharing the economic and implementation burden among the most interested and capable partners. The role of key regional parties—China, South Korea, Japan, Russia—is vital because of their relationships with the DPRK and the expertise and resources they can offer. Other states outside the region, as well as international organizations, could also play

North Korean leader Kim Jong Un and South Korean President Moon Jae-in meeting at the Demilitarized Zone, Panmunjom, May 2018.

a constructive role in supporting denuclearization and WMD threat reduction efforts in the DPRK.

A major benefit of such a program for North Korea could be increased scientific and technical engagement in non-sensitive areas with U.S. and other international scientists and experts—engagement that could help build trust and buy-in over the long run, bolstering the sustainability of the denuclearization process.

CTR activities also could aid in North Korea's longer-term economic development and integration into the international community. Involving states with which the DPRK may have more trust, such as China and Russia, would boost sustainability of the process, as would the key involvement of South Korea and international organizations such as the United Nations. U.S. officials should encourage key partners and allies to amplify the message to North Korea about the potential benefits of a CTR approach and confirm their willingness to contribute to CTR-style assistance.

The involvement of North Korean scientists and engineers in demilitarization activities is highly preferable to a unilateral, uncooperative, or imposed approach. North Korean experts and officials should be fully integrated into the dismantling and elimination process. The personal relationships, trust, and mutual respect between scientific and technical experts built and developed through cooperation on projects was crucial to the success of the CTR program with Russia. Those relationships were the foundation for cooperation and helped open the door to greater transparency, expanded understanding of what was feasible, and resolution of technical problems in implementation.

Areas for Cooperation

North Korea's nuclear program provides multiple opportunities for potential CTR dismantlement projects and for conversion to an exclusively peaceful civil nuclear program, which could be scaled and scoped depending on the outcome of negotiations. Potential cooperative activities related to reactor decommissioning or conversion, civil nuclear energy, downblending and disposition of nuclear materials, waste management, mining, nuclear health and safety, and environmental remediation are addressed in this report.

Similarly, potential areas for CTR cooperation in dismantling elements of the DPRK's missile inventory and production facilities include the demating and secure transport of warheads to storage and elimination

facilities; removal, transport, and neutralization of missiles and fuels; and elimination of missiles and launchers, production facilities, test sites, and other infrastructure. This report draws on the U.S. experience with CTR and other non-proliferation assistance programs related to missile elimination to illustrate possible avenues for cooperation.

Without prejudice to the sequencing of when such matters might be addressed in negotiations, the report also addresses how an offer of CTR assistance could play a role reducing risks from other North Korean weapons of mass destruction by assisting with elimination of chemical weapons and encouraging steps toward full compliance with the Biological Weapons Convention. In the context of eliminating chemical and biological weapons capabilities, the United States and other members of the international community could assist North Korea in building capacity for peaceful basic and applied research and development, as well as potentially on biosafety, biosecurity, and overall health security.

Of course the design and implementation of a CTR program and activities with North Korea would have to take into account gaps in knowledge of DPRK WMD and missile programs and the risk that North Korea would maintain or resuscitate covert programs. Those risks should be minimized to the extent possible while pursuing opportunities for progress.

In conjunction with ongoing and future negotiations, the United States, in close partnership with South Korea, should lead a multilateral effort to ensure the necessary resources, expertise, and political commitment to sustain a long-term cooperative program in support of denuclearization, dismantlement, and scientific redirection in North Korea. U.S. officials should begin reaching out to China, South Korea, Japan, and Russia, as well as international organizations and nations outside Northeast Asia, to encourage their readiness to participate in a potential CTR program and to stimulate their thinking on how best to contribute. This outreach could include discussions on creating a coordinating organization or other mechanism to facilitate cooperative multilateral efforts on dismantlement and scientific engagement.

In addition, implementation of a CTR program for North Korea likely will require new policy guidance, flexible legislative authorities, and resources from the U.S. government. The administration should lay the groundwork domestically for a CTR program, including by consulting Congress to ensure legislative authorities are sufficient, planning for potential funding requirements, and explaining the potential national security benefits for the American people.

In addition, implementation of a CTR program for North Korea likely will require new policy guidance, flexible legislative authorities, and resources from the U.S. government.

Additional considerations include the following:

- There will be a need for some relief from U.S. and UN sanctions to permit CTR assistance. Policymakers could start drafting a new UN Security Council resolution or, alternatively, prepare draft exemptions for specific potential activities.
- Legislative authorities permitting U.S. CTR-type programs to accept funding from other nations for use in recipient countries could be made applicable for assistance to the DPRK. To avoid delays, the United States could develop in advance the necessary memoranda of understanding with interested potential donor countries.
- The president should consider issuing a National Security Presidential Memorandum (NSPM) to spell out areas of scientific and technical cooperation related to denuclearization in which the U.S. government is prepared to engage with the DPRK. (A sample NSPM is provided in this report.)
- The U.S. government should conduct an inventory of U.S. human and technical capacity, to include reaching out to current and former officials and experts with nuclear, missile, and other WMD knowledge and experience implementing CTR programs to consider how their expertise might be tapped.
- The descriptive term—whether CTR or something else—chosen to describe a cooperative denuclearization program with North Korea should be one that is understood in a positive light by Pyongyang, other diplomatic partners, and the general public.

The president should consider issuing a National Security Presidential Memorandum (NSPM) to spell out areas of scientific and technical cooperation.

Athletes from North Korea and South Korea marched into the 2018 Pyeongchang Winter Olympics under a unified flag.

INTRODUCTION: A RENEWED OPPORTUNITY FOR DIPLOMACY

The Democratic People's Republic of Korea's (DPRK) nuclear weapons, other weapons of mass destruction (WMD), and ballistic missile programs represent one of the greatest threats to regional and global security today. The return to diplomatic engagement on the Korean Peninsula in 2018 sparked by the rapprochement between North Korea and South Korea following the Pyeongchang Winter Olympics has provided an opening to improve security in Northeast Asia. The unprecedented June 12, 2018, Singapore Summit between President Trump and Chairman Kim, along with the groundbreaking inter-Korean meetings between South Korean President Moon and DPRK Chairman Kim, has revived the potential for making progress toward verifiable denuclearization in the DPRK. Although the February 27–28, 2019, Hanoi Summit did not result in a tangible outcome on denuclearization, both the United States and North Korea have expressed a willingness to continue diplomatic negotiations. However, the path forward is uncertain, and the risk remains that the window for a successful negotiated outcome may begin to narrow in the coming months.

Historically, the United States' priority has been to remove the threat to the United States and its regional allies posed by Pyongyang's nuclear, ballistic missile, and other WMD programs, with a focus on achieving complete and verifiable denuclearization. The DPRK's diplomatic initiative is consistent with its long-stated goals to achieve the following:

- Normalize relations with the United States and the international community

- Declare a formal end to the Korean War and sign a peace treaty
- Lift all economic sanctions
- End the "U.S. hostile policy," including a tangible removal of the perceived long-term security threat to the DPRK and its political system and possibly by removing U.S. forces from the Korean Peninsula
- Transform the North Korean economy.

Despite previous diplomatic failures and understandable skepticism about any negotiating process going forward, pursuing negotiations is critical, given the devastating consequences of a conflict—nuclear or conventional—in Northeast Asia. Although this report does not focus on how negotiations should define "complete and verifiable denuclearization," at a minimum, denuclearization should result in the elimination of North Korea's nuclear weapons and the direct means for producing them. This process will take a long time and is most likely to succeed in a step-by-step or action-for-action manner, with the DPRK taking certain actions on denuclearization or dismantlement of other WMD or missile programs and the United States and other partners taking calibrated reciprocal diplomatic, economic, or other measures in turn. Over time, such steps could lead to normalization of relations between the United States and the DPRK, a peace regime, and the complete lifting of economic sanctions.

The logical next step in denuclearization, in addition to formalizing North Korea's voluntary freeze on nuclear and long-range ballistic missile tests, would be an early freeze on fissile material production, both at plutonium production reactors and uranium enrichment sites. A freeze at the major Yongbyon nuclear facility alone would be positive, but would not encompass North Korea's entire fissile material production program. It also would be important to formalize the DPRK's voluntary testing freeze early on in negotiations. Issues related to the removal of nuclear materials and the dismantlement of nuclear weapons themselves would logically come later.

Any negotiated agreement with Pyongyang—and its subsequent implementation—will require the involvement of technical experts to focus on the practical steps needed to dismantle and eliminate—in a verifiable manner—North Korean nuclear weapons, fissile materials, nuclear fuel-cycle facilities, missiles and production facilities, and potentially other WMD programs.

Exploring a Role for CTR in North Korea

Against the backdrop of reinvigorated U.S. diplomatic initiatives toward North Korea that began in early 2018, Nuclear Threat Initiative (NTI)

Co-Chair and former Senator Sam Nunn joined NTI Board Member and former Senator Richard Lugar to write an op-ed published in *The Washington Post*. That piece advocated that a CTR program for North Korea could contribute positively to a successful negotiation on denuclearization. Their idea draws from the highly successful experience of the Nunn-Lugar CTR program through which the United States, along with other nations and international organizations, helped Russia and the other newly independent states of the former Soviet Union eliminate and secure nuclear, chemical, and biological weapons, materials, and expertise, following the dissolution of the Soviet Union in 1991.

Although the CTR concept has evolved substantially since 1991, it has served as a model for WMD-related cooperative threat reduction and non-proliferation assistance activities around the globe ever since. With that in mind, in the summer of 2018 NTI convened a working group of experts on North Korea and the original and evolving CTR program to explore the potential application of CTR in the North Korean context, taking into account the significant differences between the situations of the DPRK today and the former Soviet Union in 1991. The Working Group on Cooperative Threat Reduction explored the potential benefits and complexities of pursuing CTR with the DPRK. This report captures these discussions and illustrates how a CTR program could help facilitate successful negotiations with the DPRK; how it might be structured; how a CTR program with international partners could contribute to the DPRK's denuclearization efforts and improve prospects for sustainability; and how CTR activities could help reduce future WMD and proliferation-related threats posed by the DPRK with potential positive benefits for the economy, health, safety, and security of the North Korean people.

This report is not a comprehensive blueprint for the application of CTR across North Korea's WMD programs, nor does it presume or prescribe a sequence of negotiations and denuclearization activities or attempt the detailed analytical work that is better left to governments. Rather, it aims to educate and inspire governments and organizations to pursue and participate in a cooperative denuclearization effort with North Korea.[1]

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1 Although referencing the original U.S. Department of Defense CTR program and related cooperative non-proliferation assistance programs conducted by the U.S. Departments of Energy and State in the early 1990s, this report, when discussing the applicability of a CTR approach to the DPRK, refers broadly to the concept of a cooperative, multilateral approach to providing technical, scientific, and material assistance to the DPRK that will assist in the dismantlement of nuclear, missile, and other WMD programs; enable scientific engagement; and potentially convert or redirect certain elements of the DPRK's military programs and scientific and technical expertise to civilian purposes.

WHAT TO DO IF THE TALKS WITH NORTH KOREA SUCCEED

Sam Nunn and Richard Lugar published this op-ed in *The Washington Post* advancing the concept of cooperative threat reduction for North Korea.

By Sam Nunn and Richard Lugar
***The Washington Post*, April 23, 2018**

As the United States prepares for historic discussions between President Trump and North Korean leader Kim Jong Un, the Trump administration and its international partners have a lot of work ahead of them. A successful summit, if it can be achieved, will be only the start of a long and complicated process. Eliminating the nuclear threat and achieving stability and security on the Korean Peninsula will require unconventional thinking and steps that are much broader than denuclearization. Just as we should prepare for the summit to go wrong, we should also prepare for it to "go right."

The stakes are high. The Korean Peninsula is the most militarized region in the world. North Korea has nuclear weapons and long-range missiles that can reach the United States, as well as South Korea and Japan—two allies the United States has pledged to defend. The entire world has an interest in ensuring the security of North Korea's nuclear, chemical and biological weapons and weapons-usable materials. The North also has thousands of artillery tubes located within 30 miles or so of Seoul, a formidable conventional threat to the South Korean capital and its population, including thousands of Americans living there.

Even if the two leaders reach an agreement, achieving security and stability and reducing catastrophic risks on the peninsula will require intensive, expert-level negotiations and comprehensive, step-by-step implementation over many months, or perhaps years. This cannot be viewed as a bilateral U.S.-North Korean discussion—it must also include China, South Korea, Japan and Russia, and it must address regional security and the political concerns of all the parties, including economic and humanitarian matters.

A successful negotiation requires that all those involved benefit from the outcome. It means all sides must give as well as get. Economic, military and diplomatic pressure helped bring the North Koreans to the table, but reaching a successful agreement will require carrots as well as sticks. The United States has announced it will insist that nuclear dismantlement precede economic benefits. North Korea will likely insist that substantial economic benefits be upfront. Can we develop tools that incentivize dismantlement and verification, as well economic benefits, to occur concurrently? History shows the answer is yes.

As the United States and its international partners develop a negotiating strategy and tools for North Korea, there are vital lessons to be learned by looking back to the early 1990s following the breakup of the Soviet Union.

In 1991, as the Soviet Union was disintegrating, we wrote legislation to provide technical and financial assistance for the inventory, destruction, and disposal of nuclear and chemical weapons and their delivery vehicles in Russia, Belarus, Kazakhstan and Ukraine. This became law as the Nunn-Lugar Soviet Nuclear Threat Reduction Act of 1991—also known as the Cooperative Threat Reduction (CTR) program.

The initiative also helped to fund productive, peaceful scientific work for scientists who had worked in the weapons complex, and also helped to prevent the proliferation of their know-how to other states and nonstate actors—including the

extraordinary lab-to-lab program in which Russian and American scientists worked cooperatively to secure materials usable in nuclear weapons. The United States and Russia learned to cooperate on threat reduction by working together in implementing the program from 1991 to 2012. With this valuable joint experience, if we are going to rebuild cooperation between Washington and Moscow, North Korea is a good place to start.

We believe this concept should be a critical component of any effort to verifiably and irreversibly dismantle North Korea's nuclear weapons and related programs, as well as prevent future proliferation of weapons, material or know-how. Such cooperation can also be used to engage thousands of North Korean scientists and engineers, who are now employed in making weapons of mass destruction, in peaceful scientific and technical work. This would also diminish the risk of proliferation of their deadly knowledge to other states or terrorists.

In the context of a more stable Korean Peninsula, we can look broadly to CTR as a model. A broad-based plan for cooperative activities in North Korea would provide incentives for the Kim regime to comply with the difficult commitments and strict verification and monitoring that will necessarily be part of a serious denuclearization agreement.

Though there are significant differences between North Korea in 2018 and the former Soviet Union in 1991, the cooperative threat-reduction concept could be a powerful tool to support the verifiable reduction and elimination of North Korea's nuclear arsenal, its other weapons of mass destruction, and their delivery systems. Such a program could be developed, funded and implemented jointly with our allies and other members of the international community.

There is certainly no guarantee that there will be a diplomatic breakthrough, but we must be prepared to seize the opportunity. We hope Congress and the Trump administration will use the lessons learned from Cooperative Threat Reduction to develop a more peaceful and secure future for the Korean Peninsula.

SECTION I

POLICY ISSUES

Senators Sam Nunn and Richard Lugar leaving the White House after the Nunn-Lugar proposal was signed into law on December 12, 1991.

BACKGROUND ON THE COOPERATIVE THREAT REDUCTION PROGRAM

In 1991, when Senators Sam Nunn and Richard Lugar sponsored the legislation that would lead to the Cooperative Threat Reduction program, the Soviet Union had just dissolved, leaving 12 newly independent states. Four of those new states had nuclear weapons and many had other elements of the massive Soviet military and WMD infrastructure on their territories. In its first year, the CTR program had $400 million in the Department of Defense (DoD) budget to help "the Soviet Union, its republics, and any successor entities to (1) to destroy nuclear weapons, chemical weapons, and other weapons, (2) transport, store, disable, and safeguard weapons in connection with their destruction, and (3) establish verifiable safeguards against the proliferation of such weapons."[2]

CTR was designed to encourage the cooperation and involvement of Russia and the other newly independent states in voluntarily scoping and implementing work to reduce nuclear, chemical, and biological risks. It also sought to help the successor states (as determined under international law for each treaty) to fulfill the commitments made by the Soviet Union in legally binding agreements including the Strategic Arms Reduction Treaty (START) of 1991 and the Biological Weapons Convention (BWC) of 1972. CTR enabled Belarus, Kazakhstan, and Ukraine to

2 Paul I. Bernstein and Jason D. Wood, "The Origins of Nunn-Lugar and Cooperative Threat Reduction" (Case Study 3, Center for the Study of Weapons of Mass Destruction, National Defense University Press, Washington, DC, 2010), 8.

fulfill their obligations in the context of acceding to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) as non-nuclear weapon states. Later, it also helped Russia and several other nations fulfill their obligations under the 1997 Chemical Weapons Convention (CWC).

Funding for the CTR program came initially from DoD, but over time the State Department and the Department of Energy (DOE) provided expertise and funding for CTR-related activities in the former Soviet Union and, later, in other regions. DoD alone spent nearly $7 billion on CTR programs between 1991 and 2013,[3] contributing to the deactivation of more than 7,600 former Soviet nuclear warheads; the destruction or elimination of over 3,880 launchers, delivery systems, and platforms; the sealing of 194 nuclear test tunnels; and the destruction of nearly 40,000 metric tons of declared chemical weapons agents.[4]

Key Executive Branch Agency Roles

Department of Defense

DoD initially defined three project areas in CTR: chain of custody, destruction and dismantlement, and demilitarization programs.[5] Chain of custody projects were designed to enhance safety, security, and control over nuclear weapons and fissile materials. This project area included programs to strengthen the security of nuclear weapons in transit from deployment locations around the former Soviet Union to central storage facilities and assistance to improve safety practices and security of nuclear weapons and materials at storage facilities.

CTR destruction and dismantlement projects provided technology and expertise to assist the recipient countries and their military and technical personnel in the elimination of nuclear, chemical, and other weapons and their delivery vehicles. Those programs helped Russia, Ukraine, Belarus, and Kazakhstan remove warheads and deactivate missiles and eliminate launchers and facilities to fulfill their obligations under the 1991 START Treaty. CTR activities were also instrumental in incentivizing Ukraine, Belarus, and Kazakhstan to relinquish the nuclear weapons left on their territories when the Soviet Union dissolved and to accede to the NPT as non-nuclear weapon states.

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3 National Academy of Sciences, *Global Security Engagement: A New Model for Cooperative Threat Reduction* (Washington, DC: National Academies Press, 2009), 7.

4 Defense Threat Reduction Agency, "Nunn-Lugar CTR Scorecard," May 2013, www.dtra.mil/Portals/61/Documents/20130501_fy13_ctr-scorecard_slides_may13.pdf.

5 Amy F. Woolf, "Nonproliferation and Threat Reduction Assistance: U.S. Programs in the Former Soviet Union" (CRS Report No. RL31957, Congressional Research Service, Washington, DC, 2012), was a primary source for the following description of the CTR program; the roles and activities of DoD, DOE, and State; and the G-8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction.

CTR later played a critical role in helping Russia eliminate the man-portable, nerve agent portion of its chemical weapons stockpile and the nerve agent production facilities it retained after the collapse of the Soviet Union, thereby facilitating Russian efforts to comply with its obligations under the 1997 CWC. The United States assisted Russia with the design and construction of a facility at Shchuch'ye for the destruction of thousands of metric tons of chemical nerve agents, helped install equipment in the facility, and trained Russian operators. The program also decontaminated and destroyed the Novochebohsarsk nerve agent production facility. Other countries also helped Russia destroy chemical agents, thereby enhancing the multilateral character of those cooperative activities. NTI contributed by issuing a $1 million challenge grant that was met by Canada and the United Kingdom to upgrade a rail system to safely transport Russian chemical artillery shells to Shchuch'ye for destruction. A European consortium led by Germany constructed a facility at Gorny to destroy blister agents.

Senator Richard Lugar inspects an SS-18 ICBM being prepared for destruction through the Cooperative Threat Reduction program, 2003.

The Soviet Union also had a substantial biological weapons research and production program, both military and under the ostensibly civilian Biopreparat. CTR helped improve safety and security at some of Russia's deteriorating Biopreparat research sites and provided peaceful employment for former biological weapons scientists in the late 1990s through the International Science and Technology Center (ISTC). Specific CTR projects facilitated the elimination of infrastructure and equipment at biological research and production centers that had the capability to produce biological weapons, including the Stepnogorsk Scientific Experimental and Production Base in Kazakhstan, a biological warfare production complex.

This cooperation with Kazakhstan led to similar projects aimed at reducing risks and enhancing safety and security at other Biopreparat facilities that stored pathogens capable of being weaponized. The program also improved disease detection and surveillance capabilities in several countries of the former Soviet Union.[6] Biologically focused CTR activities have expanded globally—primarily with support from the DoD Biological Threat Reduction Program and the Department of State Biosecurity Engagement Program—to include projects at civilian facilities to prevent

6 Joseph P. Harahan, *With Courage and Persistence: Eliminating and Securing Weapons of Mass Destruction with the Nunn-Lugar Cooperative Threat Reduction Programs* (Washington, DC: Defense Threat Reduction Agency, 2014).

theft and diversion of dangerous pathogens and to improve biosecurity, biosafety, and biosurveillance. These activities are also supported by broader health security focused programs from the U.S. Centers for Disease Control and Prevention and the U.S. Agency for International Development.

Demilitarization programs helped reorient former Soviet scientists and military infrastructure from military efforts to peaceful purposes. One such effort included the establishment in 1992 by the United States, Japan, the European Union (EU), and Russia of the ISTC in Moscow, which provided grants to Russian scientists and supported cooperative research. Several other former Soviet countries joined the Moscow-based center, and other nations, including Norway and the Republic of Korea, became donor countries. A similar center was established in Ukraine in 1993, with additional participating and donor countries. (The Moscow center was relocated to Kazakhstan in 2015 after Russia withdrew from participation.) Nearly 40 countries currently participate in these centers, which have funded projects to provide employment for scientists, including some who had been involved with or have expertise relevant to nuclear, biological, and chemical weapons and could, in the absence of adequate employment, be tempted to share their knowledge with other countries or terrorist organizations.

Demilitarization funds also supported military-to-military cooperation with recipient countries to help promote counterproliferation, demilitarization, military reform, and border control and monitoring to help deter, detect, and interrupt the unauthorized movement of weapons or related materials across borders. In 2004, Congress increased funding for CTR border-control programs to prevent nuclear materials and nuclear know-how from leaving the states of the former Soviet Union.[7]

Department of Energy

DOE has provided threat reduction and non-proliferation assistance to the former Soviet Union since the early 1990s. Its International Nuclear Materials Protection and Cooperation Program helped to secure nuclear weapons and weapons-usable nuclear materials in Russia by upgrading security—such as perimeter fences—at nuclear sites and consolidating these materials to sites where installation of enhanced security systems had been completed. DOE installed 450 radiation-detection machines around the former Soviet Union to help detect and intercept nuclear materials being smuggled across borders. In 1994, DOE initiated efforts to help retrain and reeducate Soviet-era nuclear scientists to reduce the risk that they would sell

7 Woolf, "Nonproliferation and Threat Reduction Assistance," 4.

their expertise to other nations or non-state actors seeking nuclear weapons. Through the Global Initiatives for Proliferation Prevention program, DOE promoted cooperation between thousands of Russian and American scientists on research with commercial potential and helped highly skilled Russian scientists find new employment. The Elimination of Weapons-Grade Plutonium Production Program helped Russia replace the Seversk and Zheleznogorsk nuclear reactors—which were based on the same design as the Chernobyl reactor and used for the production of plutonium for nuclear weapons as well as for civil nuclear power production and providing heating for local communities—with fossil fuel plants.[8] DOE's Global Threat Reduction Initiative, established in 2004, has worked to secure, to protect, and, in some cases, to remove vulnerable nuclear and radiological materials at civilian facilities worldwide to reduce the risk of terrorists obtaining materials to make nuclear or radiological weapons.

State Department

In addition to negotiating the "umbrella" agreements governing the provision of CTR assistance to foreign nations and to coordinating U.S. government non-proliferation assistance programs, the State Department itself funds certain programs. State's Global Threat Reduction Program now supports the two international science centers in Ukraine and Kazakhstan and several separate scientist-engagement programs intended to redirect former weapons scientists to civilian work through grants, industry partnerships, or training. Although these programs were originally implemented with the former Soviet Union, in more recent years they were extended to scientists in countries such as Iraq and Libya. The State Department also oversees the Export Control and Related Border Security program, which assists countries with interdicting nuclear smuggling and stopping the illicit trafficking of WMD and dual-use goods and technologies across borders.[9]

CTR beyond the Former Soviet Union

Many of the CTR and non-proliferation assistance programs that were born from the unique circumstance of the dissolution of the Soviet Union and were originally implemented in Russia and the former Soviet states have evolved and are now being implemented primarily outside of the former Soviet Union. The terrorist attacks of September 11, 2001, heightened global fears of terrorist groups acquiring WMD and weapons-usable materials. After CTR's success in the former Soviet Union, the

8 Woolf, "Nonproliferation and Threat Reduction Assistance," 45.
9 U.S. Department of State, "The EXBS Program," www.state.gov/t/isn/ecc/c27911.htm.

George W. Bush administration successfully applied the CTR framework to secure nuclear and radiological materials globally and to prevent their proliferation to countries including in the Middle East and Asia with active terrorist organizations.

The Obama administration further expanded CTR's global application to assist with both non-proliferation and counterterrorism efforts. This reflected the post-9/11 expansion beyond the former Soviet Union, as well as the expiration of the bilateral umbrella agreement governing CTR cooperation between the United States and Russia, and the fact that Russia no longer wanted the sort of assistance that was provided in the 1990s. CTR funding and authorities were essential to activities beyond Russia, including the U.S. contribution to the cooperative effort with Russia and other countries to eliminate Syria's declared chemical weapons stockpile in 2013–2014.[10]

The CTR program in the former Soviet Union is widely regarded in the West—and by many if not all in Russia and the former Soviet Union—as having been highly creative and successful in preventing the emergence of new nuclear states and reducing grave risks of WMD proliferation during a period of geopolitical upheaval. However, in recent years, President Vladimir Putin and others in the Russian political and military leadership have suggested they view that period as a time when the West took advantage of Russia's weakness and used those assistance programs to gain access to Russian military sites and practices that would not otherwise have been possible. Putin ended all CTR programs in Russia in 2016 and professed confidence that Russia could sustain sound non-proliferation and security practices on its own. Others in Russia express a more nuanced and positive view; for instance, members of the Russian scientific community to this day express appreciation for the scientist-to-scientist collaborations conducted in the 1990s.

Kazakhstan and Ukraine take a much more positive view of their respective experiences with CTR and express pride in their roles as nuclear-free non-proliferation leaders. Although the CTR programs in Russia were conceived and implemented in close coordination with its leaders at the time, the political environment and perceptions can change. This historical perspective underscores the importance of designing and implementing such programs with a focus on the cooperative aspect and sensitivity to the national and individual pride of the country and its personnel, recognizing that how such activities may be evaluated in the future is beyond control.

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10 Mary Beth Nikitin and Amy F. Woolf, "The Evolution of Cooperative Threat Reduction: Issues for Congress" (CRS Report No. R43143, Congressional Research Service, Washington, DC, 2014), fas.org/sgp/crs/nuke/R43143.pdf.

Leaders at the 2002 G-8 Summit in Kananaskis, Canada.

INTERNATIONALIZATION OF THE CTR APPROACH

The U.S. CTR program served as a model and beacon for other nations. In the 1990s, countries including Canada and Germany provided CTR-like assistance directly to the former Soviet Union or contributed to U.S. efforts. In the 2000s, U.S. authorizing legislation for CTR programs in DoD and DOE was amended to permit the receipt of funds from other nations to the U.S. Treasury as direct contributions to those programs. Following 9/11, the United States appealed to other countries to increase resources to help prevent a terrorist attack using WMD. This effort led to additional countries contributing to threat reduction work in the former Soviet Union and later in other regions.

Under Canada's leadership, at the July 2002 Group of Eight (G-8) Summit in Kananaskis, Canada, the G-8 countries (the G-7 major industrial countries: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, plus Russia) issued a statement outlining a new initiative entitled the "G-8 Global Partnership Against the Spread of Weapons and Materials of Mass Destruction—a long-term program to stop the spread of WMD and related materials and technology. The G-8 Global Partnership committed to a "10 plus 10 over 10" formula ($10 billion from the United States and $10 billion from the other G-8 members combined, over 10 years) to fund non-proliferation projects, initially in Russia and the former Soviet Union but increasingly to other regions.

The Global Partnership was renewed in 2011, with at least 27 countries participating as donor nations. Each nation allocates its own funds to those projects it views as high priority. The donor countries share common implementation principles, project ideas, and experiences, and they monitor progress via working groups and meetings. The programs are executed globally and include nuclear security, disposition of fissile materials, chemical weapons elimination, and biosecurity. Participating states beyond the G-7 include Australia, Belgium, Czech Republic, Denmark, European Union, Finland, Hungary, Ireland, Kazakhstan, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Republic of Korea, Sweden, Switzerland, and Ukraine. The Global Partnership also coordinates its activities with relevant international organizations. It would be an obvious source of expertise and resources for a CTR program with North Korea.

As this brief discussion of U.S. CTR programs and the Global Partnership has shown, the United States and other countries have offered assistance to countries around the globe to help them safeguard and eliminate dangerous materials, comply with treaties and agreements, and transition their weapons and military personnel to peaceful endeavors. This has been done in situations as varied and complex as the former Soviet Union, Iraq, Libya, and Syria. It is only logical that the United States and other nations and international organizations would consider whether and how a similar cooperative non-proliferation policy and assistance tool could incentivize and help North Korea denuclearize and redirect its weapons-related expertise to civilian endeavors.

Preparations to destroy an SS-19 ICBM through the Cooperative Threat Reduction program, Vakulinchuk, Ukraine, 1997.

LESSONS LEARNED FOR NORTH KOREA

Adapting CTR to North Korea first must account for the differences between North Korea today and the former Soviet Union in the early 1990s. The Soviet Union and the United States had a shared history of cooperation and experience with bilateral verification and transparency measures related to nuclear and other arms control agreements that included a tradition of information sharing and professional contacts between militaries and arms control inspectors, even at sensitive sites.

The former Soviet states were amenable to CTR, in part because it was intended to provide technical and financial assistance to help Russia and the other successor countries implement arms control obligations they had undertaken freely. Moreover, those agreements committed Russia to reduce but not completely eliminate its inventory of nuclear weapons and missiles. Belarus, Ukraine, and Kazakhstan, however, agreed to remove all Soviet nuclear weapons and strategic delivery vehicles from their territories. Russia and other former Soviet states had world-class scientists who were—to varying degrees—integrated into the international scientific community. The former Soviet states' leaders and scientists understood and shared international concerns about the risk of nuclear and WMD materials and expertise proliferating in the immediate post-Soviet period and welcomed assistance to prevent that.

In contrast, there has only been limited engagement and cooperation with North Korea on denuclearization, such as under the 1994 Agreed Framework or through the 2007–2009 Yongbyon disablement process

under the Six-Party Talks.[11] There have been scientific exchanges between China and Russia and North Korea, but the full scope of this contact is not publicly known. In the North Korean case, there is no established trust or shared goals with respect to denuclearization—that is, what will be done, on what timetable, and toward what end. Instead, shared goals will be a product, rather than the basis, of the negotiations.

Most notably, Russia retained an overt nuclear weapons program under CTR, whereas the United States will insist on complete dismantlement of North Korea's nuclear program, including all existing warheads. Moreover, Pyongyang's sincerity in pursuing denuclearization talks remains unproven. The circumstances around a failed Soviet coup preceding the breakup and the ensuing dissolution of the Soviet Union helped explain why the former Soviet states were prepared to take steps to dismantle nuclear and other WMD facilities. Yet uncertainty about North Korea's long-term intentions to permanently eliminate its WMD and missile programs raises questions about the potential for denuclearization negotiations and whether any related CTR programs would be successful. In designing and implementing CTR activities with North Korea, negotiators must be cognizant of uncertainty about the leadership's intentions, gaps in knowledge about the scope of the country's WMD and missile programs, and the need to mitigate against the risks and consequences of efforts by North Korea to maintain or resuscitate covert WMD or missile programs.

The level of North Korea's scientific and technical expertise and its integration with the international community is not comparable to that of the former Soviet Union, which has significant implications for how a CTR program would be implemented with the North Koreans on the ground, as well as for how CTR might help redirect personnel and expertise to the civilian economy.

In addition, unlike with the former Soviet Union where there was a consensus on the mutual threats posed by potential proliferation emanating from existing nuclear and WMD programs and stockpiles, the DPRK may take the view that the only "threat" requiring reduction is from the United States and its military alliances with South Korea and Japan. For this reason, it may be preferable to use a term other than "CTR" for North Korea to place greater emphasis on cooperation than on threat reduction in the terminology. Siegfried Hecker, a member of the Working Group on Cooperative Threat Reduction, has used the term

11 Mary Beth Nikitin, "North Korea's Nuclear Weapons: Technical Issues" (CRS Report No. RL34256, Congressional Research Service, Washington, DC, 2009), www.dtic.mil/dtic/tr/fulltext/u2/a513528.pdf.

"cooperative conversion,"[12] and there may be other terms that similarly could better characterize the program for a North Korean audience.

Identifying Mutual Strategic Benefits through CTR

The context described above makes it particularly challenging to design a truly cooperative approach to denuclearization with North Korea. A key question is what the United States and the international community could provide that North Korea would view as a strategic benefit. As noted, the DPRK's main goals in negotiating with the international community include normalizing relations with the United States and the international community; formally ending the Korean War and signing a peace treaty; removing economic sanctions; ending perceived threats to its long-term security; and transforming the North Korean economy. The decision to respond positively to any of these demands will require not only the United States but also the involvement of the other participants of the Six-Party Talks (South Korea, Japan, China, and Russia), although not necessarily a reconstitution of those talks. Similarly, a successful CTR program would greatly benefit from the participation of all the six parties as well as other members of the international community. Negotiators will need to identify appropriate and balanced "corresponding measures," to borrow a phrase from the September 2018 Pyongyang inter-Korean statement,[13] to pair them with specific denuclearization actions, and to embed them in any agreements with the DPRK. An offer of CTR assistance to encourage the DPRK to implement specific actions—according to whatever sequence of action-for-action measures is negotiated—could help prompt an agreement.

A key question is what the United States and the international community could provide that North Korea would view as a strategic benefit.

One way to achieve this goal would be to offer CTR assistance to help North Korea itself carry out specific denuclearization obligations and to facilitate converting elements of its militarized economy, facilities, and personnel to contribute to its civilian economic goals. Some concrete examples of how DPRK scientists and engineers could be engaged on discrete demilitarization activities and in technically related civilian work after the demilitarization activity is completed are described later in this report.

As any future negotiations proceed, parties should understand that while significant milestones toward denuclearization and enhancing regional security can, in principle, be achieved in two years—a timeline

12 "U.S. Nuclear Expert Hails N.K. Offer to Close Yongbyon Nuke Complex as 'Remarkable,'" Yonhap News Agency, September 27, 2018, english.yonhapnews.co.kr/news/2018/09/27/0200000000AEN20180927010400315.html.

13 Pyongyang Joint Declaration of September 2018, www.ncnk.org/node/1633.

that the Trump administration has at times indicated it is seeking[14]—a complete and enduring denuclearization process will take more time and can only succeed with the cooperation of North Korea. This process of denuclearization must be done *with*—not *to*—North Korea, an approach that is also essential if the international community hopes at some point to address chemical and biological weapons threats as well as nuclear ones. The DPRK's nuclear program has expanded dramatically over many decades, today consisting of all elements of a nuclear fuel cycle (uranium mining, conversion and enrichment, nuclear reactors, and reprocessing), weaponization, and delivery systems, in addition to an extensive array of research and development programs.[15] The program likely has hundreds of buildings across the country, but most are at Yongbyon.[16] The workforce is made up of thousands of North Koreans in various bureaus and agencies, particularly the General Bureau of Atomic Energy; the National Aerospace Development Administration; and multiple elements of the Korean People's Army, such as the Strategic Rocket Force. The technical tasks involved in dismantling and decommissioning a nuclear program require specific expertise that is relatively rare among experts even in the United States, and there are unique technical aspects of North Korea's weapons, equipment, and technologies that may only be known to the North Koreans. It would be impractical and unwise for an outside government to try to implement or impose denuclearization without close cooperation or involvement of the host government experts. For safety and security reasons alone, DPRK nuclear weapons experts should be the ones to dismantle the warheads they built, under agreed monitoring and inspection procedures that prevent transfer of specialized nuclear weapons knowledge to citizens of non-nuclear weapon states. Moreover, the cooperation and involvement of North Korean experts, scientists, and engineers would be essential to developing a complete and correct inventory of items and activities potentially subject to a denuclearization agreement, as well as to any future activities that address chemical and biological-related threats. Their involvement also would help build trust and support for a process that would result in the end of certain military programs, but ideally it would open new opportunities for using their expertise in civilian applications.

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14 Michael R. Pompeo, "On the Outcome of Summit Meeting between President Moon and Chairman Kim," press statement, U.S. Department of State, September 19, 2018, www.state.gov/secretary/remarks/2018/09/286039.htm.

15 See James Martin Center for Nonproliferation Studies, "Country Profiles: North Korea—Nuclear—Facilities," Nuclear Threat Initiative website, February 2013, www.nti.org/learn/countries/north-korea/facilities/.

16 See James Martin Center for Nonproliferation Studies, "Yongbyon Nuclear Research Center," Nuclear Threat Initiative website, May 2012, www.nti.org/learn/facilities/777/.

U.S. experience in the former Soviet Union points to other potential benefits of a CTR program with Pyongyang involving partners in the region and globally. These include the following:

- Incentivizing North Korea to agree to denuclearization measures by offering, in cooperation with international partners, to absorb much of the costs, to provide needed expertise and equipment, and to provide direct or indirect economic and other public benefits to the scientists, workers, and communities affected by the downsizing and changes in North Korea's defense and nuclear sectors
- Gaining direct insight into and confirmation of the process of eliminating DPRK WMD threats
- Facilitating or reinforcing robust verification of denuclearization commitments in any deal, including the essential involvement of relevant international organizations, such as the International Atomic Energy Agency (IAEA) with respect to the fuel cycle and potentially the Comprehensive Test Ban Treaty Organization (CTBTO) with respect to nuclear test sites
- Garnering buy-in from DPRK authorities and personnel by employing North Korean workers and integrating DPRK economic actors in the process
- Building trust through relationship-building and international scientific engagement with North Korean experts
- Redirecting scientists in order to reduce their incentive to proliferate sensitive knowledge, materials, and technologies to other states or non-state actors
- Discouraging and increasing the costs of reversing denuclearization
- Supporting the longer-term process of political normalization and DPRK integration into the international community, including by establishing ongoing and enduring U.S. and international engagement with the DPRK and by establishing ongoing contacts with U.S. and international scientists, experts, and organizations.

Western experts in 2008 view equipment removed from the Yongbyon nuclear facility in North Korea.

CROSS-CUTTING POLICY AND PRACTICAL CONSIDERATIONS

Several cross-cutting issues and recommendations to consider in devising a potential CTR program with the DPRK emerged from the working group discussion and the potential areas for CTR activities explored in this report, including those pertaining to nuclear, missile, chemical, and biological weapons programs. These issues range from legal authorities to the role of other nations and international organizations to the value of scientific engagement and likely cultural and logistical challenges, detailed below.

Legal Authorities and Impediments

The United States and other nations may need to address significant legal roadblocks to implementation of a CTR program, given the wide range of U.S. and UN sanctions imposed on the DPRK, as well as additional U.S. executive and legislative barriers to expending funds in North Korea (e.g., Glenn Amendment prohibitions for past nuclear tests, State Sponsor of Terrorism list), which would require "notwithstanding authority" for the program.[17] Any CTR program also must be consistent with the NPT and other non-proliferation obligations; for example, participating non-nuclear weapon states must not gain access to weapons information, and exports should not contribute to the development of WMD or their delivery systems. Detailed liability provisions to cover accidents or incidents that

17 "Notwithstanding authority" refers to provisions in U.S. law that permit government agencies to expend funds for use in certain circumstances "notwithstanding any other provision" in law that would otherwise restrict such use.

might occur during implementation of CTR-style programs as well as exceptions for taxes and customs duties may have to be negotiated with the DPRK, with a possible example being the liability agreements concluded for the Korean Peninsula Energy Development Organization (KEDO) reactor project under the 1994 Agreed Framework.[18] It would also be essential to ensure Vienna Convention protections for U.S. and partner officials and contractors engaged in DPRK work. UN Security Council (UNSC) resolutions also have explicitly prohibited scientific and technical cooperation with the DPRK, unless otherwise exempted by the UNSC committee that oversees the resolutions (the "1718 Committee"). Specifically, the UNSC will need to either repeal paragraph 11 of UNSC Resolution 2321, or it will need to provide exemptions—as provided for under the resolution—for activities that are "determined on a case-by-case basis … will not contribute to the DPRK's proliferation sensitive nuclear activities or ballistic missile related activities." Similarly, there may need to be exemptions provided for the transfer to North Korea of certain types of dual-use equipment banned by the UNSC resolutions (mostly those controlled by the multilateral export control regimes, such as the Nuclear Suppliers Group, the Missile Technology Control Regime, the Australia Group, and the Wassenaar Arrangement). It is possible (and perhaps desirable) that a comprehensive deal with North Korea could include the adoption of a new UNSC resolution that could address these various exemptions and transfer issues in a systematic way, but in the absence of such a resolution, targeted exemptions will be essential.

The administration would need to work closely with Congress to ensure it has the legal and legislative authorities and flexibility required to conduct a CTR program in the DPRK, as well as funding. Other states and international organizations wishing to participate may need to be mindful of the need to overcome similar hurdles in their countries or organizations, and the United States may need to obtain legislative relief or issue waivers so that third-country assistance to North Korea does not result in the imposition of U.S. sanctions. It would be prudent for the United States and other countries and international organizations to begin now to identify such roadblocks and the remedies for overcoming them.

Funding and In-Kind Contributions

In addition to U.S. funding and authorities—such as the "notwithstanding" authority of the DoD CTR program and the State Department Nonproliferation and Disarmament Fund (NDF)—donations from and participation by third countries and international organizations

18 See Woolf, "Nonproliferation and Threat Reduction Assistance," 52–53.

will be essential to cover costs, provide expertise, and share the burden. Existing legislative authorities permit U.S. CTR-type programs in DoD, State, and DOE to accept funding from other nations for use in recipient countries; this could apply to U.S. non-proliferation assistance programs in the DPRK as well. The United States could consider developing the necessary memoranda of understanding with interested potential donor countries in advance to avoid delays when the time comes to transfer funds.

Role of International Assistance and Organizations

A frequent theme in the working group was the potential of multiple countries to contribute to a CTR effort in ways that would be reassuring and helpful to the DPRK and that would share the burden among the most interested and capable partners. The regional parties—South Korea, China, Japan, Russia—are vital for their relationships with the DPRK and the expertise and resources they can offer. Kazakhstan sets a positive example of a country that takes national pride in its leadership on nuclear non-proliferation, having fulfilled its commitments to denuclearize and remove WMD with assistance from the CTR program. In fact, Kazakhstan could play a unique role and serve as an example in helping the DPRK see the positives in pursuing denuclearization with CTR assistance and reaping enduring international benefits from taking that bold step. France (as the current chair of the G-7 and a leader in the EU), Canada (as the "godparent" of the G-8 Global Partnership), along with the United Kingdom, Netherlands, Nordic States, and others are all likely, given their past records, to want to play a constructive role in supporting denuclearization and WMD threat reduction efforts in the DPRK. Those and other countries as well as other international organizations and entities, such as the United Nations and the EU, also may be willing and able to provide humanitarian and other forms of economic assistance to the DPRK to help incentivize its participation in denuclearization and WMD threat reduction activities.

Creation of a Multilateral Coordinating Body

Given the complexity of a DPRK denuclearization process involving multiple states and international organizations, it would be useful to consider the creation of a coordinating organization or other mechanism to oversee multilateral, cooperative efforts on dismantlement and scientific engagement. The Global Partnership and the ISTC are not only valuable precedents, but potential vehicles through which to organize and coordinate the provision of multilateral non-proliferation assistance

to the DPRK. Regional states (South Korea, Russia, China, Japan) and the 30 members of the G-8 Global Partnership who have experience in CTR-type efforts, as well as international organizations such as the IAEA, CTBTO, European Union (EU), Organization for the Prohibition of Chemical Weapons (OPCW), the Biological Weapons Convention (BWC) secretariat, the World Health Organization (WHO) and the World Organization for Animal Health (OIE) also could play important roles, but this will require management and coordination. Similarly, the ISTC could serve as a model or a vehicle for efforts to support civilian projects for North Korean scientific and technical personnel.

In addition to the ISTC, other previous models could be considered, such as KEDO, which was created to facilitate the construction of light water reactors in North Korea as part of the 1994 Agreed Framework. A variation on the KEDO model, which consisted of an executive board and a secretariat, along with a non-executive board and various advisory committees, could be appropriate in this case in that it would be an entity specific to the Korean Peninsula that would allow for a mix of contributing states and international organizations. In the KEDO approach, a set of primary contributors—namely Japan, South Korea, and the United States—provided the bulk of funding and administrative costs, while a set of other contributors augmented those donations. The creation of a secretariat would allow for a professional staff to oversee implementation and cost management of cooperative projects, while also providing the DPRK assurances that implementation responsibilities will be shouldered by a semiautonomous entity made up of multiple players. That said, the DPRK likely will be mindful of the Agreed Framework experience, which demonstrates that a KEDO-like entity is not immune to political pressure (and eventual collapse).[19]

Prioritizing Scientist Engagement in Dismantlement

Working group members agreed strongly that the involvement of North Korean scientists and engineers in demilitarization activities is highly preferable to a unilateral, uncooperative, or imposed approach. North Korean experts and officials ideally should be integrated into the dismantling and elimination process; it is unsafe and unrealistic to expect, for instance, that DoD would swoop in and fly or ship out the DPRK's assembled nuclear weapons.

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19 See James Martin Center for Nonproliferation Studies, "Korean Peninsula Energy Development Organization (KEDO)," Nuclear Threat Initiative website, 2011, www.nti.org/learn/treaties-and-regimes/korean-peninsula-energy-development-organization-kedo/.

The personal relationships, trust, and mutual respect between scientific and technical experts built and developed through cooperation on projects was crucial to the success of the CTR program with Russia. These relationships were the foundation for cooperation and helped open the door to greater transparency and expanded knowledge and understanding of what was feasible. Russian scientists and technical experts were more prepared to cooperate when their expertise was recognized and they were treated with respect and empathy. This also facilitated scientific collaboration in non-military areas and problem-solving when issues arose in the course of implementing specific CTR programs.

The personal relationships, trust, and mutual respect between scientific and technical experts built and developed through cooperation on projects was crucial to the success of the CTR program with Russia.

Those lessons presumably are applicable in North Korea, where there is an opportunity to approach North Korean scientists and engineers respectfully by engaging them in denuclearization and WMD threat reduction activities, should the DPRK permit. Direct scientist-to-scientist engagement could help mitigate the brain-drain problem. In addition, it could integrate DPRK experts into the international scientific community and help them apply their expertise to civilian pursuits. It is important to recall, however, that in the former Soviet countries, efforts to generate profitable, commercial enterprises based on the knowledge of weapons scientists were hampered by the larger economic realities—lack of capital, entrepreneurial skills, and market knowledge; confiscatory tax policies; and corruption. Similarly, attempts to derive direct economic value from demilitarization activities (e.g., trying to capture and commercialize by-products from defueled missiles, or literally converting missile factories into baby-stroller factories) often proved economically unviable. Many of these economic challenges likely will exist in North Korea. Once dismantlement work is completed, it may be difficult to integrate weapons workers into the broader DPRK economy. The success of this phase will depend more on the political and economic culture of the DPRK than on the character of any international cooperation.

Another core challenge, in contrast to the former Soviet Union, is that it appears the DPRK does not have a world-class scientific community; rather, it has engineers and technicians focused on military production as well as civil nuclear power, and, as a result, there will be an ongoing risk of North Korea maintaining or creating covert WMD or missile programs under any agreement. There will be both practical and national security constraints on the subjects and activities suitable for scientific and technical cooperation with North Korea, but the working group identified potential areas for bilateral and multilateral scientific and technical cooperation that could be attractive incentives for the DPRK while posing low risk of proliferation when conducted under strict monitoring. Such cooperation could be in areas related to peaceful nuclear activities,

chemical production processes, and health security. Opportunities for scientific and technical participation in specific denuclearization activities can help build trust and buy-in, thereby bolstering the sustainability of the denuclearization process, while also offering the promise of meaningful cooperation that could help build North Korea's longer-term economic development and integration into the international community.

Establishing U.S. Policy on Scientific and Technical Assistance to the DPRK through a National Security Presidential Memorandum

Working group members suggested it could be very useful for the president to issue an unclassified National Security Presidential Memorandum (NSPM) to spell out areas of scientific and technical cooperation related to denuclearization on which the United States government is prepared to engage with the DPRK. This NSPM would provide clear guidance to the U.S. government on which cooperative activities are permissible and would at the same time delineate areas where cooperation is out of bounds (or better suited for other nations to provide). A notional draft of such an NSPM is provided in this report. This document was intentionally drafted to pertain primarily to those activities directly related to assisting the DPRK with denuclearization activities. In the future, should conditions permit, such an NSPM could be modified or supplemented to encompass broader areas of permitted scientific and technical cooperation and engagement. Other countries (and perhaps international organizations) could consider developing similar guidelines to outline publicly the parameters of the scientific and technical cooperation they are prepared to undertake with the DPRK while minimizing proliferation risks.

Specifically, the draft NSPM broadly defines the purpose and limits of the program, including explaining that U.S.-DPRK scientific and technical cooperation related to denuclearization is in the U.S. national interest as it can:

- Contribute to safe, secure, transparent, and verifiable denuclearization in the DPRK
- Sustain the scientific and technical expertise of individuals whose participation is crucial in achieving complete denuclearization and encourage conversion or redirection of applicable expertise to civilian work
- Minimize the potential for reversal of DPRK denuclearization or of outward proliferation

- Facilitate related policy objectives on the Korean Peninsula including promoting peace, prosperity, and security and establishing new U.S.-DPRK relations.

The NSPM also would limit cooperation to those areas (or subjects) that would not jeopardize the security of the United States; would not enhance DPRK nuclear weapons or other military capabilities; and would not increase the risk of nuclear weapons, missiles, or other weapons of mass destruction proliferation—consistent with U.S. domestic laws, policies, and international obligations and commitments. The NSPM would approve three areas of cooperation and assistance: (1) scientific and technical cooperation relating to the elimination of relevant nuclear and missile programs and facilities; (2) scientific and technical cooperation relating to the potential conversion or redirection of programs, facilities, and scientific and technical personnel to civilian work; and (3) cooperation relating to health security, including the prevention, detection, and response for public health threats and public health emergencies of international concern. Any proposed additional areas of cooperation related to denuclearization would be referred to the president for decision. Finally, the NSPM would define responsibilities for authority and management of the program in the U.S. government.

Congressional and Public Support

Previous DPRK denuclearization efforts have failed in some part because of a lack of support (or outright opposition) from Congress. As with the original CTR program with the former Soviet Union, the administration and other CTR supporters will need to identify champions on the Hill for this work and to devise a Congressional engagement plan—including draft legislation and multiyear funding as necessary—to create a sustainable program for the long term. A public education campaign would be useful as well. Similar efforts may be needed in other nations that choose to participate.

Logistical Issues

The operating environment in North Korea is challenging at best. A full-scale logistics plan covering issues such as supply of equipment, protecting health and safety, access to electricity, clean water and food, interpreters, communications, and infrastructure needs will be essential. Staff and resources must be devoted to managing implementation and addressing unforeseen challenges. Interpreters likely will require additional training in the technical terminology that will arise, and variations in the Korean language between North and South could affect translations of certain technical documents.

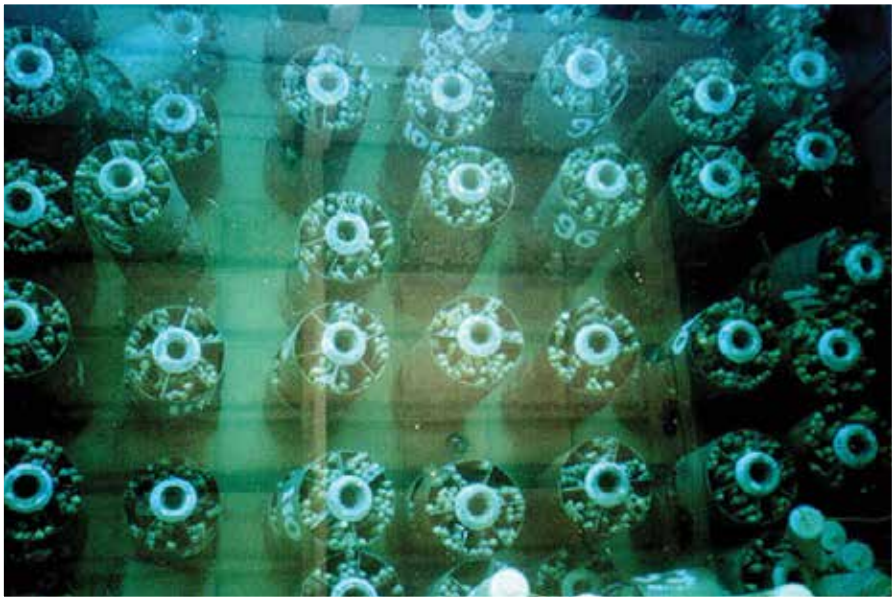
U.S. Government Capacity

Some in the working group expressed concern about whether the U.S. government still had the expertise it had in the 1990s to early 2000s to oversee and carry out a CTR program with North Korea. Most felt the expertise still existed or could be reconstituted, and many noted that the scope of the non-proliferation challenge in the DPRK—although significant—is much smaller than was the case with the former Soviet Union. The administration could seek now to inventory and locate the human and technical capacity it would need, to include reaching out to the military and to former officials and experts with experience in previous CTR efforts to consider how their technical expertise might be tapped.

SECTION II

POTENTIAL CTR ACTIVITIES IN NORTH KOREA

This report does not offer a comprehensive summary of all aspects of a CTR program for the DPRK. Rather, it explores several possible projects to illustrate the potential contribution of a CTR program and how it could be implemented. Specifically, it offers ideas in the areas of the nuclear fuel cycle, missile elimination, chemical weapons elimination, and reducing biological threats. For each area, the report addresses the cooperative aspect—the role North Korea would play, what type of CTR assistance and incentives it might get in return, and the potential contribution of the United States and other countries and international organizations.



Spent nuclear fuel in a cooling pond at the Yongbyon nuclear facility in North Korea.

DENUCLEARIZATION ACTIVITIES

The DPRK's nuclear program probably offers the widest array of potential projects that could both facilitate threat elimination and provide Pyongyang with sustainable civilian programs in the longer term. Because of the size and scope of the North Korean nuclear program, complete and verifiable denuclearization would require extensive physical steps, including dismantlement or substantial modification of multiple facilities and the elimination of substantial stocks of fissile material. From a CTR perspective, there are many potential cooperative activities related to nuclear fuel cycle facilities, nuclear materials stockpiles, waste management, and uranium mining; concurrent work in those areas by North Korea and partners could help hasten denuclearization. As further explained below, various partners could be involved in different aspects of eliminating or converting nuclear sites, with each partner bringing unique expertise and experience in distinct technologies or tasks.

This report does not offer detailed recommendations on negotiating strategy to achieve a denuclearization agreement, nor does it presume the outcome regarding whether the DPRK would be allowed to retain a civil nuclear capacity. Members of the working group think, however, that the likelihood of long-term, sustainable cooperation would be greater under an agreement that allows the DPRK to retain a civil nuclear program, which could be limited to small-scale research and medical treatment or expanded to include electricity production under strict monitoring. Proposals that have the DPRK retaining a civilian nuclear program are not new; previous

diplomatic attempts at denuclearization have incorporated the idea of providing the DPRK with light water reactors.[20] Over the past decade, both U.S. and South Korean experts have proposed CTR-type scenarios that included North Korean retention of some civil nuclear capabilities.[21] The establishment of a purely civil nuclear program would make it easier to redirect the large existing nuclear workforce into meaningful employment without requiring major retraining programs, and the civil program would be subject, at a minimum, to strict IAEA monitoring and verification, if not additional measures. Given the DPRK's track record on misusing fuel cycle facilities as part of an effort to develop nuclear weapons and taking into account the 1992 South-North Joint Declaration[22] calling for a ban on enrichment and reprocessing (ENR) capabilities on the Korean Peninsula, this report does not recommend any cooperative projects that would result in the DPRK's retention of ENR programs.

Decommissioning and Converting Nuclear Reactors

The DPRK has constructed or acquired multiple nuclear reactors over the history of its nuclear program, although only two have fully operated so far: the Soviet-provided IRT-2000 research reactor and the indigenously constructed 5MWe graphite moderated reactor, both at Yongbyon. Other graphite and light water reactors (LWRs) were fully or partially constructed but never operated, and one indigenously designed LWR reactor is still under construction. The 5 MWe reactor has served as the DPRK's primary plutonium source for its weapons, with separation occurring at the nearby Radiochemical Laboratory (reprocessing plant).[23]

Decommissioning Graphite Moderated Reactors

Whether an agreement allows the DPRK to maintain a civilian nuclear program, a likely outcome of any negotiated denuclearization plan will

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20 Bureau of Arms Control, "Agreed Framework between the United States of America and the Democratic People's Republic of Korea," U.S. Department of State, October 21, 1994, 2001-2009.state.gov/t/ac/rls/or/2004/31009.htm; Ministry of Foreign Affairs of the People's Republic of China, "Joint Statement of the Fourth Round of the Six-Party Talks," September 19, 2005, www.state.gov/p/eap/regional/c15455.htm.

21 Joel S. Wit, Jon Wolfsthal, and Choong-suk Oh, "The Six-Party Talks and Beyond: Cooperative Threat Reduction and North Korea" (Report of the CSIS International Security Program, Center for Strategic and International Studies, Washington, DC, December 2005); Jungmin Kang, "Redirecting North Korea's Nuclear Workers," *Bulletin of the Atomic Scientists* 65, 1 (2009): 48–55.

22 "South-North Joint Declaration," June 15, 2000, peacemaker.un.org/sites/peacemaker.un.org/files/KP%20KR_000615_SouthNorth%20Joint%20Declaration.pdf.

23 James Martin Center for Nonproliferation Studies, "Country Profiles: North Korea—Nuclear—Facilities."

be the eventual disabling and dismantling of the 5 MWe reactor, as well as the never-completed 50 MWe and 200 MWe graphite moderated plants at Yongbyon and Tanchon. Those reactors are based on an outdated design and are more suited for plutonium production than for modern research, medical, or electrical generation purposes.[24] Previous experience in initial disablement efforts during the Six-Party Talks revealed that North Korea was best suited to take the lead in doing the actual work of disassembling nuclear facilities.[25] Steps would include discharging and disposing of (or removing from North Korea) any spent nuclear fuel, removing and destroying key components of the reactor such as control rod drive mechanisms and refueling mechanisms, decontaminating facilities including the spent fuel pond, and eventually restoring the sites to green fields. However, a cooperative approach will be necessary to finance and facilitate disablement, dismantlement, and eventual decommissioning. This effort could involve several projects with outside partners, such as South Korea, Japan, China, or Russia, including the following:

North Korean operators overseeing fuel discharge at the 5MWe reactor at Yongbyon, 2008.

- Providing heavy equipment, personal protective gear, detection instruments, generators
- Training on decommissioning and decontamination
- Funding to dismantle nuclear materials production infrastructure, including paying North Korean workers for this work, and to enhance non-nuclear energy production.

There is a CTR precedent in the U.S. DOE-Rosatom joint Elimination of Weapons Grade Plutonium Production program, which aimed to halt Russian production of nuclear weapons-grade plutonium. The program was initiated in 2003 to shutter the three remaining Russian plutonium-producing reactors and replace them with non-nuclear energy sources. Together, the three reactors were able to produce more than one metric ton of plutonium annually, enough to make 250 nuclear weapons, according to DOE estimates. Besides proliferation concerns, the reactors also caused concerns about safety. All three were of the RBMK type, a light-water-cooled, graphite-moderated model that gained infamy through the Chernobyl accident in 1986. The program that facilitated those closures

24 See James Martin Center for Nonproliferation Studies, "Yongbyon 5MWe Reactor."

25 Siegfried S. Hecker, "Denuclearizing North Korea," *Bulletin of the Atomic Scientists* 64, 2 (2008): 44–49.

included U.S. assistance to help refurbish nearby fossil fuel and wind plants to compensate for the loss of energy from the decommissioned reactors.[26]

Converting Existing Reactors or Constructing New Reactors

Other North Korean reactors, such as the IRT-2000 and the incomplete Yongbyon Experimental Light Water Reactor, could be converted or reconstructed for purely civilian uses if the DPRK is permitted to retain a civil nuclear program and allows international inspectors to monitor activities at the reactor(s). Even in a limited civil nuclear program, a cooperative project could redesign or reconstruct a research reactor less prone to proliferation concerns, either at the existing IRT-2000 reactor site or at a new location. The IRT-2000 reactor is more than 50 years old, although it has been upgraded several times, and the DPRK apparently lacks the necessary highly enriched uranium fuel to operate the reactor.[27] Although it is possible that the existing reactor could be refurbished and refueled, a more attractive option to prevent proliferation would be to build a modern research reactor that would run on low enriched uranium. The reactor should be used for medical purposes, such as isotope production for cancer treatment, and other civilian research.

North Korea's Yongbyon nuclear complex prior to 2008 when the cooling tower was destroyed.

Electrical power generation would be another candidate for cooperative projects, if an agreement allowed the DPRK to possess power reactors under strict monitoring. Historically, this has been Pyongyang's most regular "ask" in return for denuclearization. In the 1994–2002 Agreed Framework,[28] the United States agreed "to make arrangements for the provision to the DPRK of a LWR project with a total generating capacity of approximately 2,000 MWe," and to "organize under its leadership an international consortium to finance and supply the LWR project to be provided to the DPRK." This consortium, KEDO, began a project to build two LWRs in the North Korean city of Sinpo, but the never-completed reactors were abandoned after the George W. Bush administration decided to exit the Agreed Framework in 2002.[29] Similarly, the September 19, 2005, Joint Statement of the Six-Party Talks included a reference to LWRs, although it was a less explicit commitment than the Agreed Framework pledge. In that statement, the DPRK "stated that it has the right to peaceful uses

26 Stephen Bunnell, "Russian Plutonium-Producing Reactors Closed," *Arms Control Today*, August 7, 2008. www.armscontrol.org/act/2008_07-08/RussianPlutonium.
27 Hecker, "Denuclearizing North Korea."
28 Bureau of Arms Control, "Agreed Framework between the United States of America and the Democratic People's Republic of Korea."
29 See James Martin Center for Nonproliferation Studies, "Country Profiles: North Korea."

of nuclear energy. The other parties expressed their respect and agreed to discuss, at an appropriate time, the subject of the provision of light water reactors to the DPRK."[30]

In a new deal, Pyongyang likely will again seek some guarantees on nuclear power, which would open a space for cooperative activities if agreed to by the United States. A large-scale LWR construction project, like the KEDO reactors, is one idea, but advances in reactor design open the door to other concepts, including the provision of small modular reactors (SMRs). SMRs or other advanced reactor designs also may be more suitable for electric power in the DPRK, where large-scale LWRs may be inappropriate for the current load demand and the extremely poor grid infrastructure.

The prospect of nuclear reactor conversion projects would allow for the involvement of multiple regional and international players. Russia could be a prime contender if the DPRK seeks to refurbish and redesign the existing IRT-2000 reactor, given its Soviet origins. The United States and the Republic of Korea also have newer and more advanced research reactor designs—such as the Hanaro reactor—that could be a better option for replacing the IRT. However, China also has experience in research reactors, including Beijing's role in partnering with Iran to redesign and reconstruct the Arak heavy water reactor as part of the Joint Comprehensive Plan of Action (JCPOA). For electrical power production, those same actors all have commercial designs for consideration, both LWRs and SMRs. Japan also has its own civilian power reactor designs. European firms, especially France's AREVA, are important players in this field and could be brought in as well. These power reactors all run on low enriched uranium fuel, which can be obtained in the competitive, multisource commercial nuclear fuel market, obviating the need for domestic enrichment. Negotiators also should consider how to address spent nuclear fuel, including how and whether it would be stored in the DPRK, or whether a "take-back" option could exist, such as the one in place between Russia and Iran for the spent fuel in the Bushehr reactor. Any long-term fuel disposition option should avoid the need for North Korean reprocessing, which would result in weapons-usable materials.

Nuclear Safety and Health

Nuclear safety would be ripe for a cooperative scientific engagement project, given long-standing concerns about the weak safety culture in the

30 "Joint Statement of the Fourth Round of the Six-Party Talks, Beijing, 19 September 2005," Six-Party Talks, Beijing, China, U.S. Department of State, www.state.gov/p/eap/regional/c15455.htm.

DPRK.[31] U.S. and Russian scientists would be particularly suited for such cooperation, perhaps through their national academies of science, which have a long history since Chernobyl of bilateral scientific cooperation on nuclear reactor safety. Japan has also become more active in promoting nuclear safety and best practices learned since the Fukushima accident. Safety culture also is a relatively uncontroversial area to involve the IAEA, which could serve the dual purpose of enhancing nuclear safety while improving the agency's image with North Korean officials, who tend to view the IAEA with suspicion.

Also, opportunities could open up to address potential long-term health impacts on the Yongbyon community. While no data exist on long-term health trends in the area, it is likely that decades of primitive nuclear operations—with a weak safety culture—have resulted in negative health impacts on both the nuclear workforce at Yongbyon and the broader local population. Cooperative approaches to assess health impacts and treat individuals affected by nuclear operations could both provide employment and redirection opportunities for local nuclear workforce employees and serve as a humanitarian gesture to further DPRK relations with the United States, China, and other nations that would join such an effort. Depending on the health situation, cooperative projects could include assessing and monitoring radiation effects on North Korean workers and local citizens and constructing or operating a health center to treat patients. Or, a more comprehensive hospital could be constructed for the residents of the Yongbyon region, borrowing the idea from the CTR project at Shchuch'ye. At Shchuch'ye, the international community constructed a hospital in a Russian community that was the site for a CTR-constructed facility for the elimination of chemical weapons stocks.

Nuclear Waste Management and Environmental Remediation

North Korea is known to possess sizable stockpiles of nuclear waste, based on previous declarations and considering its decades of nuclear fuel-cycle activities. A Sandia National Laboratory study from 2005 estimated there to be anywhere from 50 to 100 metric tons of spent uranium fuel and as much as 500,000 liters of liquid high-level waste, as well as additional high-level waste from the reprocessing plant.[32] Those quantities likely have

31 Matt Korda, "North Korea Nuclear Reactor Safety: The Threat No One Is Talking About," *38 North,* December 14, 2017, www.38north.org/2017/12/mkorda121417/.

32 Jooho Whang and George Baldwin, "Dismantlement and Radioactive Waste Management of DPRK Nuclear Facilities" (Cooperative Monitoring Center Occasional Paper, Sandia National Laboratories, Albuquerque, New Mexico, April 2005), www.sandia.gov/cooperative-monitoring-center/_assets/documents/sand2005-1981p.pdf.

at least doubled in the 10 years since the DPRK program resumed in 2009. There are multiple known storage locations of low and high-level wastes in the Yongbyon area, and there may be undeclared locations. Relatively little is known about North Korean nuclear waste management approaches; Siegfried Hecker has reported that North Korean nuclear officials told him the DPRK simply stores all its waste, without any additional treatment through reprocessing or longer-term disposition measures like vitrification.

Inside North Korea's Yongbyon nuclear facility following the removal of furnaces, including sand and insulating bricks and equipment used for making nuclear fuel.

For a variety of reasons, waste management is an important component of any denuclearization approach. The large amount of existing high- and intermediate-level wastes pose substantial environmental and health risks to the North Korean people, especially those in the nuclear workforce and the communities surrounding DPRK nuclear facilities. Moreover, in an ideal verification scenario, waste accounting will play an important role in verifying any North Korean declaration and in determining the amount of fissile material produced over the lifetime of the DPRK program.

Various forms of waste would require treatment and disposition, including spent nuclear fuel, waste generated from the reprocessing process, graphite blocks used as moderators in the 5MWe reactor, as well as other structural materials.[33] Depending on the approach taken by negotiators, multiple cooperative projects could address those waste management issues, serving both to provide employment and training for DPRK personnel and to head off serious environmental and health dangers for the North Korean people. Typically, countries possessing nuclear waste ultimately are responsible for disposing of high-level waste (HLW) in their own territory, as few if any other states are willing to accept HLW that is not their own. From the perspective of radiological security, there could be concerns about allowing the DPRK to store HLW over the long term, but in the near term it is possible to avoid some of these questions by shipping certain wastes outside the country for reprocessing, with the HLW to return to the DPRK later.

In this scenario, the DPRK will require numerous new facilities for handling and storing waste, and outside partners could contribute support to build facilities and provide training. For example, the 2005 Sandia study suggested the construction and operation of interim storage

33 Whang and Baldwin, "Dismantlement and Radioactive Waste Management."

locations, packaging facilities for spent fuel and HLW, decontamination facilities, long-term storage locations, and more.[34] In some scenarios, if the negotiators agree to allow monitored DPRK operation of the reprocessing plant for handling waste before the plant is dismantled, volume-reduction facilities could be built and operated before the waste is sent overseas for final reprocessing. Multiple international partners, including the United States, Russia, Japan, the United Kingdom, and France, have the technical expertise to help construct and operate such facilities and to conduct training. South Korea might also be a good candidate to assist in certain aspects of waste management. But any South Korean cooperation should not involve access to sensitive information or facilities relevant to North Korea's reprocessing activities. For example, Seoul currently does not possess PUREX (plutonium uranium redox extraction) reprocessing technology; providing South Korea access would raise proliferation risks.

Alternatively, negotiators might even allow the DPRK to reprocess its final core load of Yongbyon reactor fuel under strict monitoring and then hand over the reprocessed plutonium and waste to a third country for transfer and further treatment abroad. Although this scenario may seem risky from a non-proliferation perspective, it could be the most efficient because North Korea already possesses the facilities and the personnel to reprocess this particular type of fuel. Foreign partners (such as in Russia or France) may have the technical capabilities to reprocess DPRK fuel, but that might require significant modifications to their facilities, more complex transport and handling procedures, and extra time and money to complete a reprocessing campaign. Moreover, it is technically easier to handle the transportation of reprocessed plutonium than it is to transport spent nuclear fuel. However, any decision to allow for reprocessing in North Korea will need to weigh the potential downsides of such an approach, including the significant security issues that would arise surrounding the transport of reprocessed plutonium out of North Korea and to another location for final disposition.

It is likely the DPRK faces serious environmental contamination issues at Yongbyon, as well as potentially at other locations such as the Punggye-ri nuclear test site. The U.S. nuclear complex has been engaged in major environmental remediation projects for decades to address the contamination challenges that emerged across its nuclear fuel cycle locations, particularly the legacy of early activities such as at the Hanford site in the state of Washington. In addition to the United States, other countries such as Russia and China will have experience (and perhaps particular interest, given their borders with the DPRK) relevant to assisting with environmental remediation at fuel cycle and weapons sites.

34 Whang and Baldwin, "Dismantlement and Radioactive Waste Management."

Nuclear Materials

An agreement on DPRK denuclearization must address Pyongyang's significant stockpile of fissile material, along with other large quantities of nuclear materials. Although there is no confirmed accounting of DPRK fissile material production over the lifetime of the country's program, one academic estimate calculates that as of 2018 North Korea possessed at least 20 to 40 kilograms of separated plutonium and perhaps 200 to 500 kilograms of highly enriched uranium (HEU).[35] It is likely that much of this fissile material has been incorporated into nuclear warheads, although North Korea's apparent ongoing production activities would mean that at least some materials might still be non-weaponized in bulk form, in process lines, and contained in spent nuclear fuel.

An agreement on DPRK denuclearization must address Pyongyang's significant stockpile of fissile material, along with other large quantities of nuclear materials.

Fissile Material

North Korea cannot be considered "denuclearized" if it continues to possess HEU or plutonium, and it seems likely that U.S. negotiators also would seek to dramatically shrink if not eliminate any stocks of low enriched uranium (LEU). The most straightforward approach to achieve this goal would be to transfer all HEU and plutonium outside the DPRK for permanent dilution or disposition. As an interim step (such as a phased approach beginning with a fissile material production freeze), safe, secure storage of these materials in North Korea could be needed, preferably monitored by the IAEA. Furthermore, international inspectors will need to verify the material quantities and isotopic content before and after any transfer occurs. (U.S. CTR assistance to Russia provided for the creation of a national system of accounting and controls for nuclear materials and support for the construction of a facility for the long-term storage of HEU and plutonium declared excess to weapons needs.[36] However, these examples may not be applicable to North Korea since the aim is to ensure the expeditious removal of weapons-usable nuclear materials from the DPRK.)

Because much of this material is probably incorporated into nuclear warheads, the DPRK's weapons experts would be best suited to take the lead in disabling the warheads and removing the fissile material from the high explosive components of the weapons. Once removed from the weapons, the fissile material can be much more easily transported outside North Korea along with any other non-weaponized fissile material.

35 Siegfried S. Hecker, Robert L. Carlin, Elliot A. Serbin. "A Technical and Political History of North Korea's Nuclear Program Over the Past 26 Years" (Center for International Security and Cooperation, Stanford University, May 24, 2018), fsi-live.s3.us-west-1.amazonaws.com/s3fs-public/narrativescombinedfinv2.pdf.

36 Harahan, *With Courage and Persistence*, 31, www.dtra.mil/Portals/61/Documents/History/With%20Courage%20and%20Persistence%20CTR.pdf.

Although it is preferable to have the direct participation of the DPRK's workforce in the disassembly process, cooperative work with partner states could facilitate certain tasks. Partners could provide funding for DPRK experts to conduct warhead dismantlement and for international monitoring, and states could provide or deploy equipment to verifiably package, store, and transport the materials outside the country. The United States has developed several technologies specifically designed for materials removal, and Russia also has significant experience in this area. More broadly, there could be a unique role for China and Russia alongside the United States—as nuclear-weapon states parties to the NPT—to help oversee and confirm the disassembly of nuclear warheads without giving non-nuclear weapon states access to weapons information.

North Korea may seek compensation for transferring outside its borders the materials that have economic value. That could take the form of sanctions lifting or diplomatic recognition, or there could be a more direct nuclear-related benefit in the form of a "materials swap," if the DPRK is allowed to retain a limited civil nuclear program. For example, Pyongyang could receive, either immediately or over time, an equivalent amount of low-enriched nuclear fuel for use in its (future) civil nuclear power or research reactors. A partner state, such as Russia, could hold the material in escrow until such reactors were completed and ready to be brought on line. To further ensure peaceful use, in addition to regular IAEA monitoring, the fuel could be provided in small, "just-in-time" increments to avoid the stockpiling of fissile material in the DPRK. Besides Russia, the newly established IAEA fuel bank in Kazakhstan could play a similar role in storing fuel destined for DPRK civil purposes.

As an alternative to this "materials swap," North Korea could be required to downblend any HEU in bulk form (i.e., materials not already weaponized) and bring the enrichment level down to 5 percent or below. The DPRK could do this easily by mixing HEU stocks with depleted uranium or natural uranium. Iran took a similar step as part of the JCPOA to comply with its commitments not to possess any material enriched greater than 3.67 percent. Taking this a step further, North Korea could then ship this downblended LEU to a third country—such as Russia or the United States—for fabrication into nuclear fuel. South Korea might be a good candidate for receiving this fuel for use in their power reactors. The receiving state could then reimburse North Korea for the cost of the fuel. Russia followed a similar model—although on a much greater scale—to downblend and dispose of 500 metric tons of highly enriched uranium, with the resulting LEU fabricated and used in American nuclear

power plants.[37] This "Megatons to Megawatts" program was a highly successful cooperative effort between the United States and Russia to reduce nuclear risks that deserves consideration for application to the DPRK case. That said, the economic scale of the North Korean program is much smaller than was the case in Russia, with the North likely possessing only a few hundred kilograms of HEU. Nonetheless, the threat reduction benefits of downblending and conversion to reactor fuel might well argue in favor of this approach, despite the economic costs.

Uranium Mines

The DPRK likely sourced all its raw uranium from domestic mines and possesses processing facilities for yellowcake and conversion facilities to make uranium hexafluoride.[38] Depending on the future of the DPRK's nuclear program, uranium mines could be shut down, either because Pyongyang is abandoning all nuclear activities or because it will obtain fuel cycle services from the international market. The recent oversupply of raw uranium in the international market is an important factor related to whether the DPRK should continue uranium mining operations.[39] Various partners, including the United States, could aid in shutting down mining operations and in conducting any decontamination or other environmental cleanup associated with a transition away from uranium production. Although there is no direct proliferation risk from uranium mining, a decision to move toward mining other minerals could provide confidence in the denuclearization process while offering a more tangible benefit for Pyongyang by redirecting resources into a profit-making activity.

North Korea is assessed to have an abundance of rare earth metals and other minerals that are prized in the current market, especially for use in electronics, although estimates on the actual reserves vary widely.[40] A CTR program could help transition or augment mining operations from uranium to rare earth metals, creating a revenue source for a denuclearized DPRK and maintaining or expanding employment for a critical workforce. China and Russia are major rare earth metals producers

37 "U.S.-Russia Twenty-Year Partnership Completes Final Milestone in Converting 20,000 Russian Nuclear Warheads into Fuel for U.S. Electricity," press release, U.S. Department of Energy, November 14, 2014, www.energy.gov/articles/us-russia-twenty-year-partnership-completes-final-milestone-converting-20000-russian.

38 James Martin Center for Nonproliferation Studies, "Country Profiles: North Korea—Nuclear—Facilities."

39 "Uranium Suppliers Respond to Production Cuts," *World Nuclear News,* December 7, 2017, www.world-nuclear-news.org/UF-Uranium-suppliers-respond-to-production-cuts-0712177.html.

40 Anthony Fensom, "North Korea's Secret Fortune: $10 Trillion in Minerals?" *The National Interest*, December 19, 2017, nationalinterest.org/blog/the-buzz/north-koreas-secret-fortune-10-trillion-minerals-23727.

in the current market, and their firms could be well poised for investment and support for developing a rare earth production sector in the DPRK. Their geographic proximity also could serve to more easily integrate North Korean mining operations into broader supply chains already established in the region.

Uranium Enrichment

The Yongbyon Uranium Enrichment Plant is one likely source of HEU for the DPRK's uranium bombs, but there have been open-source reports arguing that North Korea likely maintains other clandestine uranium enrichment sites.[41] The status of North Korea's uranium enrichment program will be a crucial element of any denuclearization deal, given questions about possible undeclared facilities and the need to verify that no undeclared fissile material production would occur upon implementation of any agreement. In the most straightforward scenario, the DPRK would agree to declare, shut down, and eliminate its uranium enrichment facilities. This action would involve removal of centrifuges and associated cascade piping and related infrastructure, followed by either shipping the centrifuges out of the country or destroying them in situ. Similarly, the DPRK would need to declare and then verifiably dismantle all centrifuge component production facilities. Cooperative efforts could shut down and eliminate these facilities, and multiple candidates exist as potential partner states to assist this dismantlement work. These partners should be restricted to states already possessing uranium enrichment technology, namely the United States, Russia, China, Japan, France, or the Urenco states (Germany, Netherlands, and the United Kingdom).

Although eliminating DPRK centrifuge capability altogether would be preferable for preventing a covert uranium enrichment program, some centrifuges could be converted for peaceful purposes not involving fissile material, such as the production of stable isotopes. There is precedent for this concept based on the planned conversion of part of the Fordow enrichment facility in Iran, as negotiated in the JCPOA. Iran committed in the JCPOA to modify two of the Fordow cascades for stable isotope production. The Iranians entered into a contractual joint partnership with Russia to accomplish the conversion, with the intention of making minor modifications to the existing IR-1 centrifuges and reconfiguring the existing cascades. While the United States has withdrawn from its participation in the deal, Russian-Iranian cooperation on the stable isotope

41 Courtney Kube, Ken Dilanian, and Carol E. Lee, "North Korea Has Increased Production at Secret Sites, Say U.S. Officials," NBC News, June 29, 2018, www.nbcnews.com/news/north-korea/north-korea-has-increased-nuclear-production-secret-sites-say-u-n887926.

conversion process has continued so far. The lessons learned from this project could be applied to the North Korean case, although the DPRK's centrifuges use a different (P-2) design, a more advanced centrifuge derived from Pakistani and, ultimately, Urenco designs. Stable isotope production could also serve as a revenue source or at least help to meet domestic needs for medical treatment.

North Korea's Hwasong-12 intermediate range ballistic missile, Pyongyang, 2017.

BALLISTIC MISSILE ELIMINATION

North Korea has a large ballistic missile program and extensive supporting infrastructure. In some cases, considerable uncertainty exists with respect to the full scope of facilities involved in the production of ballistic missile propellants, engines, and other components, as well as the status of assembly and testing facilities and the size and location of its missile inventory.

Denuclearization negotiations with North Korea likely will include steps to reduce risks from its nuclear-capable ballistic missiles, including goals and benchmarks to halt, roll back, and convert or eliminate key elements of its missile program. The CTR experience with missile elimination in the former Soviet Union suggests there could be substantial opportunities for cooperation, such as providing direct assistance, training, and equipment to support elimination or conversion activities; establishing a reliable chain of custody for any transfer of materials and components to disposal facilities in North Korea or elsewhere; and involving the North Korean workforce and potentially helping with their redirection.

This report offers examples of how a cooperative approach could be applied, without making recommendations or assumptions about which ranges and types of ballistic missiles ultimately might be subject to an agreement. It is likely that strategic and intermediate-range missiles will be a primary focus and concern, but the details and sequencing of any negotiated agreement will be critical. This report also takes note of

potential opportunities for converting some elements of North Korea's missile program to civilian purposes, while recognizing that such an approach could increase the potential for North Korea to circumvent agreed missile constraints.

North Korea's Ballistic Missile Program

North Korea's ballistic missile program is large and spread across the country. It possesses a diverse number of systems at various stages of development, ranging from short-range systems to long-range ballistic missiles capable of reaching targets in the continental United States.[42] North Korea also has a space program that has launched several satellites into orbit.

North Korea's ballistic missiles rely heavily on Soviet, Chinese, and other foreign missile designs and components, and North Korea is a major exporter of ballistic missile technologies. The majority of North Korea's ballistic missiles are liquid fueled, although it continues to make gains in the development of solid-fueled missiles.[43]

The bulk of North Korea's ballistic missiles are road-mobile. These include both operationally deployed missiles like the Scud short-range ballistic missile (SRBM) and Nodong (Rodong) medium-range ballistic missile (MRBM) and those still in development like the Hwasong-15 intercontinental ballistic missile (ICBM). North Korea is reported to deploy ballistic missiles in hardened storage bunkers throughout the country.[44] When deployed, a transporter erector launcher (TEL) vehicle carrying a fueled missile exits the bunker to a cleared area, launches the missile, and then retreats back into the bunkers to escape detection and to reload.[45] North Korea also has a still-developing ballistic missile submarine program. Although North Korea is not known to possess any silo-based missiles, some of North Korea's earlier multistage missiles—particularly those with overlapping characteristics with North Korea's space launch vehicles—require fixed launch sites with launch pads and supporting

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42 Defense Intelligence Ballistic Missile Analysis Committee (DIBMAC) and National Air and Space Intelligence Center (NASIC), "Ballistic and Cruise Missile Threat 2017" (NASIC-1031-0985-17, NASIC Public Affairs Office, July 21, 2017), www.nasic.af.mil/Portals/19/images/Fact%20Sheet%20Images/2017%20Ballistic%20and%20Cruise%20Missile%20Threat_Final_small.pdf?ver=2017-07-21-083234-343.

43 Joseph S. Bermudez Jr. and Dan Dueweke, "Expansion of North Korea's Solid Fuel Ballistic Missile Program: The Eight Year Old Case of the Chemical Materials Institute," *38 North*, July 25, 2018, www.38north.org/2018/07/cmi072518/.

44 Allison Puccioni, "IHS Jane's Examines North Korean Missile Bases," *Jane's Intelligence Review*, 2015 www.janes.com/images/assets/017/49017/IHS_Jane_s_examines_North_Korean_missile_bases.pdf.

45 Puccioni, "IHS Jane's Examines."

infrastructure or would need to be launched as ICBMs from silos, roll-out-to-launch facilities, or other underground sites.[46]

North Korea has engaged in prolific missile launches in recent years, conducting an estimated 86 ballistic missile launches from 2012 to 2017.[47] This high rate follows some stagnation from the mid-1990s through the early 2000s. A November 2017 flight test of an ICBM with an estimated range of up to 13,000 kilometers, along with two previous tests of a missile with an estimated range of 10,000 kilometers in July 2017, demonstrated North Korea's capability to produce missiles with intercontinental ranges while maintaining robust regional capabilities. These programs appear to remain in development, although they may have some limited operational capability.[48] North Korea is capable of striking regional targets in South Korea and Japan with nuclear or conventional warheads.[49]

Eliminating Ballistic Missiles

Physically eliminating ballistic missiles and programs is comparatively straightforward relative to eliminating nuclear, chemical, and biological weapons and programs. The process of elimination requires the physical dismantlement and destruction of designated missiles, launchers, and infrastructure, as well as the disposal of the solid or liquid propellants. However, the logistics can be complex. Depending on the scope of a missile deal, elimination activities could include removing any deployed warheads or reentry vehicles, draining and transporting highly toxic fuel, crushing or cutting missile casings and launchers, and disposing of liquid and solid propellants. Verification would be necessary to account for and confirm the elimination of missiles and related infrastructure and would depend on an accurate declaration of capabilities covered by any deal, a major challenge in the case of North Korea.

Removing and Securely Transporting Nuclear Warheads

North Korea's reliance on road-mobile launchers and dispersed missile storage bunkers means that any elimination efforts likely would have to begin in the field. Little is publicly known about the operational status of

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46 See "Country Profiles: North Korea – Missile," Nuclear Threat Initiative (Monterey, CA: James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey, July 2017), http://www.nti.org/learn/countries/north-korea/delivery-systems/.

47 See James Martin Center for Nonproliferation Studies, "The CNS North Korea Missile Test Database," Nuclear Threat Initiative website, 2018, www.nti.org/analysis/articles/cns-north-korea-missile-test-database/.

48 Hans M. Kristensen and Robert S. Norris, "North Korean Nuclear Capabilities, 2018," *Bulletin of the Atomic Scientists* 74, 1 (2018): 41, doi.org/10.1080/00963402.2017.1413062.

49 Kristensen and Norris, "North Korean Nuclear Capabilities," 44, 48.

North Korean nuclear warheads, whether they are stored at central sites or operationally deployed.[50] The priority in any effort to eliminate North Korean ballistic missiles would be to demate any operational warheads and prepare them for secure transportation to central facilities for dismantlement.

The United States provided substantial assistance for the secure transportation of deployed nuclear warheads in Russia, Ukraine, Belarus, and Kazakhstan back to central storage facilities in Russia. From 1992 to 2012, CTR provided more than $400 million in funding for transportation security.[51] According to the Congressional Research Service, this included funding for armored blankets and special containers to protect warheads in transit and assistance to enhance the safety and security of the rail cars used for transportation. Funding also provided Russia with emergency response training, vehicles, and other equipment to respond to a nuclear weapons transportation incident.[52] Each of these elements would have to be considered for any consolidation of North Korean nuclear warheads from the field, and each would ideally require close coordination with North Korean scientists and engineers to ensure safety and security requirements are met.

The provision of some types of assistance is more appropriate to a state that is permitted to possess nuclear weapons under the NPT, such as Russia when it received such CTR assistance. However, some assistance to North Korea along these lines could be appropriate to enhance safety and security during the period when North Korea has undertaken but not yet fulfilled all of its commitments relevant to denuclearization.

Removing, Transporting, and Neutralizing Missiles and Fuels

Based on the Russian experience, forward-deployed ballistic missiles will need to be removed from storage facilities or launchers and prepared for transportation to designated missile neutralization facilities. Liquid-fueled missiles should be defueled on site before transport. The liquid propellant from ballistic missiles can then be placed onto tanker trucks or railcars for transport to central storage and disposition facilities, while the missile bodies are transported for neutralization and elimination.[53] Following removal and transport to fuel disposition facilities, liquid fuel can either be converted into a benign product or burned.

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50 Kristensen and Norris, "North Korean Nuclear Capabilities," 41.
51 Nikitin and Woolf, "The Evolution of Cooperative Threat Reduction: Issues for Congress," 23.
52 Nikitin and Woolf, "The Evolution of Cooperative Threat Reduction: Issues for Congress," 23.
53 Harahan, *With Courage and Persistence*, 123, 246–47.

The United States also has extensive experience in assisting in the destruction of Scud missiles that are similar to North Korea's liquid-propellant SRBMs and MRBMs. The State Department's Nonproliferation and Disarmament Fund (NDF) program oversaw and financed the destruction of former Soviet Scud missiles and support infrastructure in, for example, Hungary, Bulgaria, Poland, and Ukraine.[54]

The process for eliminating solid-fueled missiles is different from liquid-fuel systems because of significant differences in the nature of the fuel and missile systems. Solid propellants feature a mix of fuel and oxidizer in a solid state and are therefore optimal for mobile or submarine-launched ballistic missiles. Although normally safer to handle than most liquid propellants, solid propellant can become volatile if not stored properly or because of long-term aging. In Ukraine, the elimination of SS-24 ICBMs required special cranes to move the missiles; extensive improvements to roads and bridges to accommodate the weight of the missiles during transport; and construction of appropriate facilities for storage, disassembly, and disposal of both missiles.[55] In Belarus, road-mobile SS-25s were transported back to Russia with CTR support. Each of these efforts centered on extensive coordination between U.S. CTR program managers and leadership from Ukrainian, Belarusian, or Russian government, military, regulatory, and industry representatives. The United States also has experience in assisting in the destruction of SS-23 solid-propellant missiles much more similar to North Korea's current inventory. NDF oversaw and financed the destruction of former Soviet SS-23s and support infrastructure in Bulgaria and Slovakia.[56]

Finally, in the case of the former Soviet Union, particularly Ukraine, considerable efforts were made to explore whether by-products from the fuel from eliminated missiles might have a civilian use, but that effort largely proved illusory, expensive, and time-consuming. The lesson learned is that there is no real economic or civilian value to be gained from repurposing most of the highly toxic fuels used in ballistic missiles and the Working Group on Cooperative Threat Reduction does not recommend pursuing that path.[57]

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54 "Nonproliferation and Disarmament Fund," U.S. Department of State Archive, 2001-2009.state.gov/t/isn/ndf/; "U.S. State Department Helps Ukraine Eliminate SCUD Missile System," press release, U.S. Department of State, April 13, 2011, https://2009-2017.state.gov/r/pa/prs/ps/2011/04/160711.htm.

55 Harahan, *With Courage and Persistence*, 158–66.

56 "Nonproliferation and Disarmament Fund," U.S. Department of State Archive.

57 On the other hand, Russia chose to reuse its liquid fuel for space launch, after the CTR program had spent millions on a heptyl storage facility in the country.

Eliminating Launchers

North Korea's KN-08 intercontinental ballistic missile, Pyongyang, 2017.

Eliminating ballistic missiles also entails eliminating mobile missile launchers, associated support vehicles, and fixed-launch sites and infrastructure. The majority of North Korea's ballistic missiles use road-mobile launchers, while some use fixed launch pads. A 2017 report by the National Air and Space Intelligence Center estimated that North Korea possessed fewer than 250 known TELs assigned to operationally deployed missiles, with far more uncertainty about the number of launchers available for newer operational systems or those still in development.[58] The elimination of designated North Korean TELs through CTR-style programs could be fairly straightforward, with mobile launchers destroyed on site or alongside missiles at a special elimination facility. However, comprehensive declaration by the North Koreans as well as verification and monitoring would be necessary to accurately account for those launchers subject to elimination.

Consideration will need to be given to North Korea's nascent submarine-launched ballistic missile (SLBM) program. Although North Korea reportedly has only one active submarine with a limited capability to launch SLBMs, it has invested resources into developing related capabilities. For example, the Bukkeukseong-1 (Polaris-1) is a two-staged solid-fueled missile, tested in 2016. North Korea has since appeared to modify the missile into a land-based version, the Bukkeukseong-2. If an agreement included elimination of North Korean SLBMs or submarine-launch capabilities, part of the elimination process could include the verified dismantlement of North Korea's Sinpo-class submarine and associated infrastructure.

Site Elimination

In addition to missiles and launchers, storage areas and other infrastructure related to the operation or employment of North Korea's ballistic missiles could be subject to verifiable elimination under the terms of an agreement. The provision of CTR assistance to help eliminate Ukraine's 43rd Rocket Army's nuclear weapons storage areas provides some potential insights. In 1995, Ukraine signed an agreement for the elimination of infrastructure related to strategic nuclear forces and worked with the U.S. CTR program office to determine the requirements for

58 DIBMAC and NASIC, "Ballistic and Cruise Missile Threat 2017," 21, 25, 29, 33.

specific priorities. These included projects such as the elimination of ICBM support facilities, destruction of nuclear weapons storage areas, and other operations facilities. Elimination projects for operational infrastructure included steps such as inspecting empty fuel storage tanks, neutralizing residual toxic materials, and salvaging usable materials for Ukraine's commercial use. In the case of weapons storage areas, CTR program managers and implementing contractors worked with local workers to decontaminate and disassemble equipment and facilities. They also worked on environmental restoration of the sites.[59]

Eliminating Production Facilities and Supporting Infrastructure

In July 2018, reports emerged that North Korea was constructing new missiles at a factory that produced the country's first ICBMs capable of reaching the United States.[60] U.S. officials revealed that work continued on at least one and possibly two liquid-fueled ICBMs at a large research facility in Sanumdong, on the outskirts of Pyongyang. North Korea has an extensive infrastructure to support the production of ballistic missiles. An independent assessment of North Korea's nuclear and missile infrastructure identified at least 24 facilities associated with its long-range ballistic missile program, including missile production, launcher production, and related industries.[61] Those include facilities (a) to produce liquid and solid-fuel propellants, engine components, airframes, test sites, and mobile and submarine launchers and (b) to conduct research and development activities. Each of these activities employ scientists, engineers, military personnel, and other workers.

Three central facilities reportedly are associated with solid-fuel missile production: the Chemical Material Institute, responsible for the production of solid-rocket motors and airframes; the No. 17 factory, responsible for filling those airframes with solid fuel; and the Magun-po test site, North Korea's only known solid-fuel test site.[62] If North Korea agreed to limits on the production of solid-fueled missiles, those facilities possibly could be placed under some form of continuous portal monitoring, converted, or eliminated.

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59 Harahan, *With Courage and Persistence*, 167.

60 Ellen Nakashima and Joby Warrick, "U.S. Spy Agencies: North Korea Is Working on New Missiles," *Washington Post*, July 30, 2018, www.washingtonpost.com/world/national-security/us-spy-agencies-north-korea-is-working-on-new-missiles/2018/07/30/b3542696-940d-11e8-a679-b09212fb69c2_story.html.

61 Jeffrey Lewis, Grace Liu, Anne Pellegrino, and David Schmerler, "Verification Measures for North Korea's Nuclear and Missile Infrastructure" (final report prepared for the Nuclear Threat Initiative, James Martin Center for Nonproliferation Studies at the Middlebury Institute of International Studies at Monterey, Monterey, CA, forthcoming).

62 Ibid.

Closing Ballistic Missile Test Sites

North Korea has multiple test locations, including several publicly known sites, where it test-launches ballistic missiles and space launch vehicles (SLVs) and conducts static engine tests. In July 2018, North Korea reportedly began to dismantle elements of a missile engine test site at its Sohae Satellite Launching Station.[63] The move was hailed by Trump administration officials as an important achievement from the June 2018 Singapore Summit between the U.S. and North Korea leaders that was consistent with North Korean commitments, while others suggested that it did not constitute a significant step toward disarmament or reductions.[64]

The steps to shut down a missile site will vary by facility, but they could include destruction of launch pads and gantry towers; elimination of static engine test pads; and removal or destruction of support equipment, such as missile transporters and machine tools. Although many of these elimination activities can be verified through overhead observation, such steps may be reversible, and facilities and infrastructure may be dual use or relocated to new sites. These closure activities could therefore require on-site monitoring to provide assurance regarding completeness and irreversibility.

The same North Korean workforce that constructed and maintained the facilities could be employed to shut down and destroy the sites, but that workforce then will need to be redirected to peaceful activities. If North Korea is permitted to maintain capability for space launches in the future, qualified personnel could be directed toward this effort, but it would carry risks of a latent or covert DPRK ICBM capability. Alternatively, there could be an avenue for CTR-facilitated scientist-to-scientist cooperation and engagement with the international scientific community in satellite design and production—not in the SLV capability itself.

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63 See Joseph S. Bermudez Jr., "North Korea Begins Dismantling Key Facilities at the Sohae Satellite Launching Station," *38 North*, July 23, 2018, www.38north.org/2018/07/sohae072318/; and Choe Sang-Hun, "North Korea Starts Dismantling Key Missile Facilities, Report Says," *New York Times*, July 23, 2018, www.nytimes.com/2018/07/23/world/asia/north-korea-dismantling-missile-facilities.html.

64 See, for example, Zachary Cohen, "Trump Says New Images Show North Korea Has Begun Dismantling 'Key Missile Site,'" CNN, July 24, 2018, www.cnn.com/2018/07/23/politics/north-korea-satellite-images-38-north-sohae/index.html; and Matt Spetalnick, "U.S. Identifies North Korea Missile Test Site It Says Kim Committed to Destroy," Reuters, June 20, 2018, www.reuters.com/article/us-northkorea-usa-site/u-s-identifies-north-korea-missile-test-site-it-says-kim-committed-to-destroy-idUSKBN1JH02B.

Implementing CTR Assistance with Ballistic Missile Elimination

In general, CTR activities related to elimination of the North Korean ballistic missile program could include:

- The provision of equipment
- Direct implementation of programs with North Korean partners
- Management of programs through U.S. or local integrating contractors
- Engagement of North Korean workers through subcontracts
- Redirection of the ballistic missile workforce to peaceful programs.

There could be a role for several countries to assist with these activities.

Central to the success of CTR programs in the former Soviet Union and NDF programs elsewhere was the provision of U.S. integrating contractors to oversee and coordinate the work of local subcontractors. Except for the ballistic missile submarine eliminations and some initial efforts in the early 1990s, most of the eliminations were planned and managed by U.S. integrating contractors who partnered with Ukrainian and Russian subcontractors. In other cases, CTR and NDF program managers worked directly with the host-country government and military to determine needs and implement programs, without subcontractors.

For the North Korean workforce and industry supporting the ballistic missile program, much depends on the contours of any agreement. If North Korea is permitted to maintain any civilian space capabilities, its missile workforce could be redirected to elements of a space program. Other applications in the civilian aerospace or transportation sectors are possible, such as the development of modern rail systems to connect North Korea with South Korea, China, and Russia. Additionally, in the case of the former Soviet Union, the provision of essentials such as housing for Strategic Rocket Forces officers discharged because of the elimination of the missile and bomber systems proved important, given the deteriorating economic conditions of the former Soviet states. However, such assistance was controversial in the U.S. Congress and was legislatively prohibited in the mid-1990s; similar humanitarian assistance for North Korean personnel, if needed, might be better provided by other donor countries.

Contrasts Between the Former Soviet Union and the DPRK

In contrast to the situation with North Korea, CTR programs to assist missile elimination in the former Soviet Union were premised on the shared goal of helping former Soviet states meet their arms control obligations under START. By 1999, all DoD CTR programs were aligned to assist the Russian Federation accelerate strategic arms elimination programs to meet the START implementation deadline of December 2001.[65] Belarus, Kazakhstan, and Ukraine eliminated all strategic offensive arms from their territories, but Russia was permitted to retain a sizeable arsenal of nuclear weapons and missiles even after meeting its START obligations. In contrast, North Korea will have to be persuaded that there is benefit to giving up substantial elements of its missile capabilities, which it sees as a deterrent against the United States and (depending on the range of missiles eliminated) Japan, and perhaps China and Russia.

The United States and the former Soviet Union also had a shared history of exchanging military information and providing access to sensitive sites through negotiation and implementation of arms control agreements. While U.S.-North Korean engagement has occurred over the past decades on missile issues, there is no similar common experience or shared history of success. Building trust over time will require extensive engagement and alignment of mutual interests.

Another potential difference between the CTR experience in the 1990s and any projected cooperative measures for missile elimination in North Korea pertains to the depth of the Russian defense industrial complex and the presence of reliable local firms and enterprises to perform as subcontractors. Many of these private enterprises were formed from previously state-owned enterprises specifically to bid on CTR subcontracts and were populated with workers who moved in and out of the state-owned enterprises. The DPRK's military and economic structure will almost certainly necessitate a different approach for subcontracting or implementing CTR cooperative activities.

The Potential Contribution of Other Countries

Other countries, particularly Russia but also perhaps China, have the potential to play a positive role in assisting North Korea with missile elimination and related activities. Certainly Russia can draw on its substantial experience in eliminating missiles pursuant to arms control agreements and receiving CTR assistance in this area. Russia and China also might have unique expertise to contribute related to dismantling

65 Harahan, *With Courage and Persistence*, 231–32,

and eliminating North Korean missiles that could be based on Russian or Chinese designs or technology. Finally, it is possible that a country such as Russia could offer to carry out some of the required activities on its territory, such as elimination of missiles or disposal of rocket fuel, if there is a sound technical or practical benefit to conducting such activities outside of North Korea.

In international waters in 2014, the Cape Ray *container ship was used to neutralize chemical agents from Syria's stockpile.*

CHEMICAL WEAPONS ELIMINATION

The Singapore Summit Joint Statement reaffirms the DPRK's commitment to work toward complete denuclearization of the Korean Peninsula; it makes no mention of other WMD such as chemical or biological weapons. Addressing North Korea's nuclear weapons and delivery systems and programs is undoubtedly the highest priority for reducing the North Korean threat to regional and international security. That said, if negotiations progress and denuclearization proceeds in tandem with steps to "build a lasting and stable peace regime on the Korean Peninsula,"[66] at some point it will be appropriate and necessary to encourage North Korea to accede to the Chemical Weapons Convention (CWC) and eliminate its assessed significant stockpile of chemical weapons and agents, an undertaking that will almost certainly require and benefit from international cooperation and assistance.

North Korea's chemical weapons program began in the late 1960s and early 1970s with assistance from China and the Soviet Union. Although North Korea signed the 1925 Geneva Protocol prohibiting the use in war of chemical and biological weapons, the country is suspected to be one of the world's largest possessors of chemical weapons, behind only the United States and Russia before those two countries substantially eliminated

66 "Joint Statement of President Donald J. Trump of the United States of America and Chairman Kim Jong Un of the Democratic People's Republic of Korea at the Singapore Summit," The White House, June 12, 2018, https://www.whitehouse.gov/briefings-statements/joint-statement-president-donald-j-trump-united-states-america-chairman-kim-jong-un-democratic-peoples-republic-korea-singapore-summit/.

their declared chemical weapons stocks according to the CWC.[67] In 2012, South Korea's Ministry of National Defense estimated that North Korea possessed between 2,500 and 5,000 metric tons of chemical weapons.[68] (By comparison, Russia declared approximately 40,000 metric tons of chemical agents, and the United States had approximately 31,000 metric tons.) North Korea has a substantial and capable, if aging, chemical industry. It can produce potential dual-use chemicals such as ammonia, chloride, phosphate, fluorine, and sulfur. These chemicals, in recent years, have been acquired from China, Thailand, and Malaysia.[69] Although the specifics of Pyongyang's chemical weapons program and use doctrine are unknown, the world witnessed a demonstration of its capabilities in the winter of 2017 when Kim Jong Nam, Kim Jong Un's half-brother, was killed with the deadly nerve agent VX in an airport in Malaysia.[70]

North Korea is one of only three countries (along with Egypt and South Sudan) that has not signed the CWC, which bans the possession, production, stockpiling, and use of chemical weapons. If North Korea signed and acceded to the Convention (which would be the optimal but not the only way for it to agree to eliminate its chemical weapons), it would then be guided by the OPCW—the Convention's implementing body—on the steps it would need to take to come into compliance with the CWC. This move to compliance would include submitting detailed declarations of its chemical weapons stockpiles, production facilities, other related facilities (e.g., laboratories and test and evaluation sites), and types of riot-control agents possessed. Specifically, a State Party is required to declare, among other things, whether it:

- Owns or possesses any chemical weapons, or whether there are any chemical weapons located in any place under its jurisdiction or control
- Has on its territory old or abandoned chemical weapons or has abandoned chemical weapons on the territory of another state
- Has or has had any chemical weapons production facility under its ownership or possession, or that is or has been located in any place under its jurisdiction or control at any time since January 1, 1946

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67 Mark Fitzpatrick, ed., *North Korean Security Challenges: A Net Assessment* (London: International Institute for Strategic Studies, 2011), 161.

68 "2014 Defense White Paper," (report, Republic of Korea Ministry of National Defense, Seoul, 2014).

69 "North Korea's Chemical and Biological Weapons Programs" (Asia Report No. 167, International Crisis Group, June 18, 2009), www.crisisgroup.org.

70 Alexandra Bell and Abby Pokraka, "North Korea's Other Weapons of Mass Destruction," *Bulletin of the Atomic Scientists,* August 1, 2018, thebulletin.org/2018/08/north-koreas-other-weapons-of-mass-destruction/.

- Has transferred or received directly or indirectly any equipment for the production of chemical weapons since January 1, 1946
- Has any facility or establishment under its ownership or possession, or located in any place under its jurisdiction or control, that has been designed, constructed, or used since January 1, 1946, primarily for the development of chemical weapons
- Holds chemicals for riot-control purposes.

Were North Korea to accede, or perhaps as a condition of agreeing to accede, it would likely need and could request assistance to implement its obligations, including destruction of chemical weapons and agents and production facilities. CTR assistance was critical to helping Russia meet its obligation to eliminate a massive quantity of Soviet-era chemical agents and its chemical weapons production facilities and to helping Albania eliminate its small stockpile. In both cases, Germany and other countries contributed along with the United States to the safe elimination of those chemical weapons.

In the case of Syria in 2013–2014, the OPCW accepted a U.S.-Russia timetable for destruction of Syria's declared chemical weapons stockpile and verified the destruction of production, mixing, and filling facilities. The destruction of these chemical weapons was conducted through a multilateral international effort. The United States undertook the destruction of certain liquid agents because it had the capacity to place U.S.-made elimination equipment on a ship, the *Cape Ray*. On the ship, the chemical agents were neutralized in international waters after being removed from Syrian territory because of the dangerous security situation on land. Danish and Norwegian ships shuttled the agents from Syria to the *Cape Ray*, and security was provided by China and Russia. Commercial-grade chemicals, including the neutralized chemical weapons, were transported to the United Kingdom, Finland, Germany, and the United States for destruction

If North Korea agreed to eliminate its chemical weapons, it could benefit from international technical and financial assistance to help its own experts and scientists with the safe and secure elimination of its chemical weapons and agents, as well as its chemical weapons research and production facilities. One approach could be a cooperative international effort involving any of several countries with firsthand experience eliminating chemical weapons and production facilities and fulfilling their obligations under the CWC, including South Korea, the United States, Russia, China, and Japan. This area could be ripe for joint U.S.-Russia cooperation, given their experience working together to eliminate chemical weapons in Russia and, more recently, from Syria. North Korean chemical

This area could be ripe for joint U.S.-Russia cooperation, given their experience working together to eliminate chemical weapons in Russia and, more recently, from Syria.

weapons and agents could be eliminated on North Korean territory or eliminated on ships at sea, as was the case with Syria. In a CWC accession scenario, the OPCW would work with North Korea to develop a plan for its accession to and compliance with the CWC, as well as in confirming declarations, verifying destruction, and investigating any discrepancies.

Following the destruction of chemical weapons, CTR also could help build capacity, such as in the field of chemical security, through donations from regional and international partners to help employ North Korean experts. Entities like the Global Partnership and ISTC could be used as a clearinghouse for developing, approving, financing, and monitoring projects aimed at engaging weapons scientists, technicians, and engineers from North Korea in peaceful, civilian science and technology activities. The larger goal would be to reinforce the transition to an economy more responsive to civilian needs and to support basic and applied research and technology development. Any such efforts would have to be structured and conducted very carefully, under strict monitoring, to minimize the possibility they might assist a current or future covert DPRK chemical weapons program. This risk is very high in the chemical area given the lack of chokepoints (e.g., there is no equivalent to the absolute need for a specific and significant quantity of fissile material to make a nuclear weapon), the inherent dual-use nature of chemical technology, and our substantial uncertainties about the present DPRK chemical weapons program.

2015 meeting of States parties to the Biological Weapons Convention in Geneva.

BIOLOGICAL WEAPONS–RELATED CAPABILITIES

Given the priority of denuclearization, opportunities to address biological weapons–related risks in North Korea likely are a longer-term prospect. At the same time, any progress on addressing potential biological weapons–related risks would be a positive contribution to the ultimate goal articulated in Singapore by the United States and the DPRK of a "lasting and stable peace regime on the Korean Peninsula." Cooperative assistance in biosafety, biosecurity, and overall health security could provide a valuable benefit to the North Korean people, but it must be delivered in a manner that increases North Korea's civilian capacity and minimizes the potential for inadvertently contributing to the potential for a military program.

Although North Korea has biotechnology infrastructure that could support the production of various biological weapons agents,[71] little information is publicly available about the potential for any present-day offensive biological weapons capabilities. According to the *Bulletin of the Atomic Scientists*, President Kim Il Sung may have sought to acquire a biological weapons capability in the 1960s, and unconfirmed reports have alleged the investigation of disease threats such as the causative agents for anthrax, cholera, plague, and smallpox, as well as botulinum toxin and

71 Director of National Intelligence (DNI), "Unclassified Report to Congress on the Acquisition of Technology Relating to Weapons of Mass Destruction and Advanced Conventional Munitions, Covering 1 January to 31 December 2011" (DNI Report, Washington, DC), fas.org/irp/threat/wmd-acq2011.pdf.

hemorrhagic fever viruses.[72] North Korea acceded to the BWC in 1987, but has not made any biological research and development activities public through BWC annual declarations.

Building Confidence

Enhancing international confidence that North Korea has eliminated biological weapons (or that it does not have such a program) is an essential step in any effort to provide international assistance to North Korea in key areas of cooperative biological threat reduction. To do so, Pyongyang could agree to provide confidence-building measures in accordance with its status as a State Party to the BWC. Those could include declarations of past activities in offensive or past and current defensive biological research and development programs, as well as information about research centers, laboratories, infectious disease outbreaks, research publications, relevant legislation, and vaccine production facilities.[73] The value of an accurate declaration would be greatly enhanced if global experts were able to negotiate with North Korea a framework for international access to facilities that conduct life sciences research. The focus would be on facilities that could be reasonably anticipated to provide knowledge, information, products, or technologies that could be directly misapplied to pose a significant threat with broad consequences to public health and safety, agricultural crops and other plants, animals, the environment, or security. Such facility access would increase international confidence that North Korea is not engaging in offensive biological research; however, given the inherent dual-use nature of biological research, and North Korea's long history of opaqueness and noncompliance with nonproliferation agreements, even access to (and inspection of) those facilities would not guarantee the absence of a current or future covert biological weapons program.

Cooperative Engagement

If North Korea is prepared to eliminate facilities that are being, have been, or are capable of being used for developing, producing, or stockpiling biological weapons and if the United States is prepared to help mitigate these risks, DoD CTR and the Department of State Biosecurity Engagement Program are uniquely suited to provide assistance. They also

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72 Sonia Ben Ouagrham-Gormley, "Potemkin or Real? North Korea's Biological Weapons Program," *Bulletin of the Atomic Scientists*, July 18, 2017, thebulletin.org/2017/07/potemkin-or-real-north-koreas-biological-weapons-program/

73 United Nations Office for Disarmament Affairs, *Guide to Participating in the Confidence-Building Measures of the Biological Weapons Convention* (Geneva: United Nations, 2015), www.un.org/disarmament/publications/more/cbm-guide/.

could apply lessons learned from previous elimination efforts to ensure that any biological weapons–related infrastructure could no longer be used for nefarious purposes, assuming North Korea agrees to discontinue any offensive program. For example, with the full cooperation of Kazakhstan, the DoD CTR program successfully helped to dismantle the Stepnogorsk bioweapons production facility in Kazakhstan, despite challenges related to its remote location, harsh climate, and lack of sufficient energy infrastructure.[74] The Department of State took steps to redirect former biological weapons experts from Stepnogorsk to peaceful, civilian pursuits. Although DoD can provide technical advice, the work of dismantling facilities or redirecting staff with biological weapons–related expertise ideally should be done in concert with the North Koreans and as part of an international effort to enhance sustainability and because this effort would benefit the security of regional and global partners. Key partners such as South Korea, Japan, Canada, and the United Kingdom may wish to invest in such an effort. China and Russia also are potential candidates for cooperative activities.

Such assistance also could reduce the risks that (a) former weapons scientists would either continue or resuscitate covert programs or be hired to conduct biological weapons research for other state or non-state programs and (b) facilities that hold dangerous pathogens for legitimate purposes could experience accidental release or theft of pathogens caused by improper safety and security practices and infrastructure. The DoD CTR and the Department of State Biosecurity Engagement Program have extensive experience mitigating both risks, working to redirect former weapon scientists in the former Soviet Union and improving biosafety, biosecurity, and biosurveillance capabilities with partners in former Soviet states, the Middle East, South and Southeast Asia, and throughout Africa.

As noted, CTR has helped to redirect former weapons scientists through the ISTC. A similar entity could be created to bring together resources and expertise from a variety of interested nations. Such an entity could screen out research most likely to contribute unintentionally to biological weapons development and provide support only for activities that have a low risk for proliferation and are in accordance with biosecurity and biosafety best practices. As discussed in the case of chemical weapons, however, any such efforts would have to be structured and conducted very carefully, under strict monitoring, to minimize the possibility they might assist a current or future covert DPRK biological weapons program.

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74 Andrew C. Weber and Christine L. Parthemore, "Lessons from Kazakhstan: 25 Years of Countering Weapons of Mass Destruction Threats" (Report, Harvard Kennedy School Belfer Center for Science and International Affairs, Cambridge, MA, 2017), www.belfercenter.org/ publication/lessons-kazakhstan.

Benefits to Pyongyang from Increased Transparency

The international community should make clear to Pyongyang there could be public benefits that will ensue from transparently eliminating or successfully allaying concerns about any potential biological weapons–related infrastructure or activities. This should include an offer of substantial assistance in developing health security capabilities that would help stem and avoid significant public health crises.

An example of such assistance could be in bolstering DPRK capabilities to prevent, detect, and respond to future public health emergencies. According to the WHO, North Korea has weak capability in this area. In a serious outbreak, DPRK's vulnerable public health system could lead to degradation of internal safety and security and increase the risk of spread beyond North Korea so that the outbreak could become a regional and global threat. Any negotiated agreement could require North Korea to undergo the WHO Joint External Evaluation process,[75] followed by development of a National Action Plan for Health Security.

Separately, international humanitarian assistance, such as efforts to address North Korea's substantial challenge with tuberculosis and multidrug-resistant tuberculosis, should be undertaken as necessary and appropriate without links to other issues.[76]

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75 The Joint External Evaluation is a voluntary, collaborative, multisectoral process to assess country capacity to prevent, detect, and rapidly respond to public health risks occurring naturally or caused by deliberate or accidental events.

76 J. Stephen Morrison, Victor Cha, and Rebecca Hersman, "The Gathering Health Storm Inside North Korea," (commentary, Center for Strategic and International Studies, Washington, DC), www.csis.org/analysis/gathering-health-storm-inside-north-korea.

TEXT OF NOTIONAL NATIONAL SECURITY PRESIDENTIAL MEMORANDUM (NSPM)

NATIONAL SECURITY PRESIDENTIAL MEMORANDUM

MEMORANDUM FOR THE VICE PRESIDENT

THE SECRETARY OF STATE

THE SECRETARY OF THE TREASURY

THE SECRETARY OF DEFENSE

THE ATTORNEY GENERAL

THE SECRETARY OF ENERGY

THE SECRETARY OF HOMELAND SECURITY

THE SECRETARY OF AGRICULTURE

THE SECRETARY OF HEALTH AND HUMAN SERVICES

THE ASSISTANT TO THE PRESIDENT AND CHIEF OF STAFF

THE UNITED STATES TRADE REPRESENTATIVE

THE UNITED STATES PERMANENT REPRESENTATIVE
TO THE UNITED NATIONS

THE DIRECTOR OF NATIONAL INTELLIGENCE

THE DIRECTOR OF THE CENTRAL INTELLIGENCE AGENCY

THE ASSISTANT TO THE PRESIDENT
FOR NATIONAL SECURITY AFFAIRS

THE COUNSEL TO THE PRESIDENT

THE ASSISTANT TO THE PRESIDENT FOR ECONOMIC POLICY

THE CHAIRMAN OF THE JOINT CHIEFS OF STAFF

THE DIRECTOR OF THE FEDERAL BUREAU OF INVESTIGATION

THE ASSISTANT TO THE PRESIDENT FOR SCIENCE
AND TECHNOLOGY AND DIRECTOR OF THE OFFICE
OF SCIENCE AND TECHNOLOGY POLICY

SUBJECT: Scientific and Technical Cooperation with the Democratic People's Republic of Korea (DPRK) Related to Denuclearization and the Establishment of New U.S.-DPRK Relations

This National Security Presidential Memorandum (NSPM) establishes and directs the implementation of U.S. policy on scientific and technical cooperation with the Democratic People's Republic of Korea (DPRK) related to denuclearization and the establishment of new U.S.-DPRK relations. Such cooperation will be focused on the denuclearization efforts in the DPRK, including (a) the elimination of relevant nuclear and missile programs and facilities, and (b) the potential conversion and/or redirection of such programs, facilities and scientific and technical personnel to civilian work.

Section 1. Background. On June 12, 2018, in Singapore, Chairman Kim Jong Un and I committed to work toward complete denuclearization of the Korean Peninsula. We also committed to the establishment of new U.S.-DPRK relations, to join efforts to build a lasting and stable peace regime on the Korean Peninsula, and to cooperate for the promotion of peace, prosperity, and security of the Korean Peninsula and of the world.

Sec. 2. Purpose and Limits of the Program. U.S.-DPRK scientific and technical cooperation related to denuclearization is in the U.S. national interest in that it can:

- Contribute to safe, secure, transparent and verifiable denuclearization in the DPRK.

- Sustain the scientific and technical expertise of individuals in the DPRK whose participation is crucial in achieving the complete denuclearization of the DPRK; encourage conversion and/or redirection of applicable expertise to civilian work.

- Minimize the potential for reversal of DPRK denuclearization or of outward proliferation from the DPRK.

- Facilitate achievement of related U.S. policy objectives, such as promoting peace, prosperity, and security of the Korean Peninsula and the establishment of new U.S.-DPRK relations.

While I have determined that a carefully defined and monitored program of scientific and technical cooperation with the DPRK related to denuclearization efforts in the DPRK is in the U.S. national interest, such a program with the DPRK can only take place in the overall context of positive U.S.-DPRK relations and should be conducted consistent with other U.S. assistance and cooperative programs and U.S. policy objectives with respect to the DPRK. Therefore, the pace and scope of U.S. cooperation will be governed by our ongoing evaluation of the evolution of DPRK foreign and defense policy and progress towards verifiable

denuclearization efforts in the DPRK, recognizing that the program of cooperation established and directed by this NSPM is designed to facilitate such progress.

U.S. cooperation in this area will be limited to those items that the Secretaries of State, Defense, Energy, Health and Human Services, Homeland Security, and Agriculture determine will not jeopardize the security of the United States, enhance DPRK nuclear weapons or other military capabilities or increase the risk of nuclear weapons, missile, or other weapons of mass destruction proliferation. U.S. cooperation will be undertaken in accordance with U.S. domestic laws, policies, and international obligations and commitments, including in nonproliferation and export control. Specific scientific and technical cooperation guidance is contained in Sec. 3 of this NSPM.

Sec. 3. Areas Approved for Scientific and Technical Cooperation.

Guidelines for U.S.-DPRK Scientific and Technical Cooperation Related to Denuclearization Efforts in the DPRK. The following guidelines will serve as policy guidance for discussions and activities with the DPRK in this area:

(i) The United States is prepared to commence "technical talks" with the DPRK to explore cooperation and to reach agreement on specific activities in the areas outlined below. Any such agreed activities may begin only after approval by the Secretaries of State, Defense, Energy, Health and Human Services, or Agriculture, respectively. Once agreed, the United States will make the fact of this cooperative activity public.

(ii) Discussion and activities would be conducted only at the unclassified level and shall be consistent with, inter alia, the Atomic Energy Act (AEA). The United States will not seek to conclude an agreement with the DPRK under Section 123 of the AEA. A subsequent decision by me would be required to go beyond this.

(iii) Discussions and cooperative activities would focus on scientific and technical issues with the goal of sustaining the expertise of individuals whose participation is crucial for achieving the complete, verifiable, safe and secure denuclearization in the DPRK. Activities would also include scientific and technical cooperation related to the potential conversion or redirection of programs and/or scientific and technical personnel to civilian work. Activities that have direct applications to nuclear or other weapons of mass destruction, their delivery systems, or other weapons shall be prohibited. A subsequent decision by me would be required to go beyond this.

(iv) As appropriate, applicable, and practical, discussion and activities with the DPRK may be conducted in consultation or coordination with China, Japan, the Republic of Korea, the Russian Federation, and other countries and international organizations relevant to denuclearization efforts in the DPRK.

Subject to the guidelines above and the procedural limitations set forth in Sec. 5 below, the following areas of cooperation and assistance are approved:

- **Scientific and technical cooperation relating to the elimination of relevant nuclear and missile programs and facilities.** This could include cooperation on disablement, dismantlement, decommissioning and remediation of DPRK nuclear fuel-cycle, weapons production, and delivery system production facilities that does not transfer weapons technology to the DPRK. Such cooperation may include low-proliferation-risk technologies for radiation monitoring, health physics, environmental assessments, and disposition and cleanup of the DPRK nuclear enterprise.

- **Scientific and technical cooperation relating to the potential conversion and/or redirection of programs, facilities, and scientific and technical personnel to civilian work.** This could include activities of low proliferation risk such as the pursuit of nuclear medicine, peaceful industrial uses of radioisotopes and the potential production of nuclear electricity using low enriched uranium. This could also involve conversion / redirection of the DPRK's military missile program to non-military related purposes, and other technical cooperation to facilitate the redirection of nuclear fuel-cycle and weapons personnel to civilian and commercial work.

- **Cooperation relating to health security, including the prevention, detection and response for public health threats and public health emergencies of international concern.** This could include international assistance to bolster North Korea's health security capabilities and to address ongoing urgent public health crises within North Korea in ways that do not contribute to any potential DPRK biological weapons capability.

Sec. 4. Additional Areas. Any additional proposed areas of scientific and technical cooperation related to denuclearization efforts in the DPRK not authorized by this NSPM shall be referred to me for decision. Pending a decision by me, discussions with the DPRK of any such proposals made by the DPRK or another

country shall be limited to that which is necessary to ensure that the proposal is fully understood and evaluated.

Sec. 5. Authority and Management. Executive and technical management of the program will be the responsibility, respectively, of the Secretary of State, Secretary of Defense, Secretary of Energy, Secretary of Health and Human Services, and Secretary of Agriculture, in coordination with the Director of National Intelligence as required. The Secretary of State, Secretary of Defense, Secretary of Energy, Secretary of Health and Human Services, and Secretary of Agriculture shall establish internal guidelines and review procedures within their respective departments to ensure that individual projects and activities within the framework of this NSPM are consistent with the guidelines set forth in Sec. 3. A single point of coordination will be designated within the U.S. government; all proposals for cooperation and U.S. responses will be coordinated through this office.

To ensure that cooperation furnished under this program is properly coordinated with other U.S. diplomatic efforts and is consistent with the overall state of U.S.-DPRK relations, the following mechanisms will apply:

- For ongoing areas of cooperation the Secretary of State, Secretary of Defense, Secretary of Energy, Secretary of Health and Human Services and Secretary of Agriculture, in coordination with the Secretary of Homeland Security Director of National Intelligence and the Assistant to the President for National Security Affairs, shall ensure that periodic briefings (i.e., at least once every year) are provided to the Deputies Committee. These briefings shall update information concerning the status of the program since the last briefing and include an assessment of the value, impact and risk of these scientific and technical exchanges.

- The Secretary of State, Secretary of Defense, Secretary of Energy, Secretary of Health and Human Services, and Secretary of Agriculture shall similarly ensure that the Deputies Committee is briefed on any significant expansion or contraction of, or problems concerning, ongoing programs. Should there be a disagreement with any proposed contraction or expansion on national security and/or foreign policy grounds, the issue will be referred to me for decision and the proposed action held in abeyance.

/Signed/ The President of the United States

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ABOUT THE WORKING GROUP ON COOPERATIVE THREAT REDUCTION WITH NORTH KOREA

In 2018, the Nuclear Threat Initiative (NTI) convened a working group of experts on the Democratic People's Republic of Korea (DPRK) and the Cooperative Threat Reduction (CTR) program with the former Soviet Union. The working group was to examine the potential application of CTR in the DRPK context, taking into account the significant differences between the situation with the DPRK today and that of the former Soviet states in 1991. The working group explored the potential benefits and complexities of pursuing CTR with the DPRK. This report, an outgrowth of that work, aims to illustrate (a) how a CTR program with the DPRK could help facilitate successful negotiations with North Korean leaders; (b) how a program might be structured; (c) how international partners could contribute to DPRK denuclearization efforts and improve prospects for their sustainability; and (d) how CTR activities could help reduce future WMD and proliferation-related threats posed by the DPRK, with potential positive benefits for the economy, health, safety, and security of the North Korean people.

The working group provided NTI with expert feedback on the content and recommendations of this report. Experts in the working group participated in their personal capacities and did not represent the views or interests of their organizations, and their affiliations are listed for identification purposes only. In addition, participation in the working group does not imply concurrence with every aspect of this report or its recommendations.

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Steve Andreasen is a national security consultant to NTI and teaches courses on national security policy and crisis management in foreign affairs at the Hubert H. Humphrey School of Public Affairs, University of Minnesota. Previously, he served as director for defense policy and arms control on the U.S. National Security Council at the White House. He was the principal advisor on strategic policy, nuclear arms control, and missile defense to the national security advisor and the president. His articles and opinion pieces have been published in *Foreign Affairs*, *The New York Times*, *The Washington Post*, the *Los Angeles Times*, *Politico*, *Arms Control Today*, the *Guardian*, and many other international publications.

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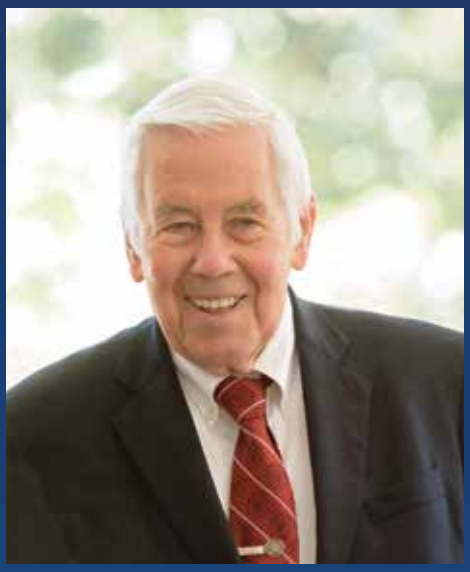

Richard Lugar

1932–2019

With enormous gratitude to Richard Lugar, an exceptional public servant and one of the world's most effective and tireless champions for reducing the threats from nuclear, biological, and chemical weapons.

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