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Cooperative Threat Reduction: Comparing the Russian Experience with DPRK Challenges

OCTOBER 2021

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ASIA-PACIFIC LEADERSHIP NETWORK (APLN)

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This paper was presented at the Cooperative Solutions for North Korean Denuclearization Workshops, September 2021, organized by the Asia-Pacific Leadership Network for Nuclear Non-proliferation and Disarmament (APLN). The workshops were sponsored by the ROK Ministry of Unification and the MacArthur Foundation, and supported by the Nuclear Threat Initiative as part of an APLN project on reviewing the potential for an effective Cooperative Threat Reduction plus (CTR+) proposal for the DPRK.

The research described in this paper was supported by the Asia-Pacific Leadership Network and the Ministry of Unification of the Republic of Korea.

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Cooperative Threat Reduction: Comparing the Russian Experience with DPRK Challenges

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12 October 2021

Introduction

When the Soviet Union dissolved into 15 independent states in late 1991, the U.S. government extended a helping hand to assist Russia and the other former Soviet states to mitigate the nuclear risks resulting from the breakup. Earlier in the fall, President George H.W. Bush launched the Presidential Nuclear Initiatives (PNIs), which were designed to reduce the threat faced by President Mikhail Gorbachev's beleaguered Soviet government. The presidential initiatives were followed by the landmark Cooperative Threat Reduction (CTR) congressional legislation, the so-called Nunn-Lugar program. U.S.-Russian cooperation continued for over two decades, greatly mitigating the nuclear dangers resulting from the breakup of the Soviet Union.

1991 – Senators Nunn and Lugar leaving the White House after briefing President George H.W. Bush on the Nunn-Lugar legislation

In this article, I examine what lessons can be drawn from the CTR program with Russia and other former Soviet states that may help the United States design a similar program with North Korea if the political conditions arise. The CTR program has been reviewed in dozens of books and hundreds of articles.[1] The potential applicability to North Korea was recently examined in several articles.[2] My analysis and recommendations are based on the documented histories of CTR programs and informed by my personal experience of being closely involved for over twenty years with the CTR programs in the former Soviet Union and having visited North Korea seven times, including four visits to the Yongbyon nuclear complex.

Despite the enormous difference in size of North Korea's nuclear program and the greatly disparate political conditions, important lessons can be drawn from the CTR experience with the former Soviet states to help design a potential North Korean program. The massive Soviet nuclear and missile programs were on the order of hundreds to one thousand times larger than those of North Korea. Politically, the Soviet Union collapsed from the inside. Russia became the legitimate heir of the Soviet nuclear weapons and missile assets during a time it faced unprecedented geopolitical, domestic, and economic challenges. North Korea has not collapsed. Although it has vowed to denuclearize, it continues to expand its nuclear and missile capabilities. Although its economy remains challenged, it continues to survive difficult times. Nevertheless, the following lessons emerge:

Importance of strong, sustained U.S. political support: Support for cooperative programs must be bipartisan and backed by the executive and legislative branches of the U.S. government. Since North Korea's nuclear programs took decades to build, reducing or eliminating them will take many years. Hence, political support must be sustained across presidential transitions. To be effective, the program must also provide for budgetary authority to support cooperative programs. The CTR programs of the former Soviet Union also demonstrated the importance of leadership from the very top. President George H.W. Bush backed the initial outreach to the former Soviet states but did little to support a strong effort on the ground. President Clinton's strong support resulted in the most effective years in the CTR program because it was also backed by Russia's President Yeltsin. President Putin's diminishing support for the program once he took over and eventual opposition, led to its demise. In North Korea, it will be essential to get support from Kim Jong-un because nothing happens without that.

Keep the focus on "CTR" – Cooperative, Threat and Reduction.

Cooperative: The programs must be truly cooperative to succeed. Projects should be conducted with each other, rather than one side dictating to the other. Common objectives are imperative to achieve cooperation.

Threat: It is crucial to stay focused on the threat and not expand to include grander political objectives such as democracy building or influencing domestic politics. The threat must be clearly defined as nuclear and possibly chemical and biological threats.

Reduction: Individual program objectives should focus on reducing the threat, not stretch objectives to try to eliminate the entire threat immediately. Eliminating the threat will take time and result from sustained threat reduction steps.

Involvement of technical professionals: Scientists and engineers should be involved early. They can build trust with their counterparts quickly based on mutual professional respect. Trust is necessary to tackle some of the most sensitive issues and to provide better access to key people and facilities.

Nuclear worker reorientation – important, but difficult: Concern about the "brain drain" and leakage of nuclear weapons knowledge prompted several U.S. assistance programs, but metrics were problematic, and success was difficult to achieve.

Focus on bilateral programs, but welcome international participation. Many of the key issues are sufficiently sensitive that they require bilateral cooperation for

technical and political reasons. However, some areas of cooperation can be strengthened by the participation of multiple countries.

Comparing the Technical Challenges

The North Korean nuclear program differs dramatically in size from the huge Soviet program. The Soviet Union possessed 39,000 nuclear weapons during the Cold War (with an inventory 27,000 remaining at the time of its collapse), a huge missile enterprise, approximately 1.4 million kilograms of fissile materials (highly enriched uranium and plutonium), and one million people in the nuclear industry. North Korea's nuclear enterprise is dangerous, but it is likely composed of fewer than 50 nuclear weapons, less than 1,000 kilograms of fissile materials and a nuclear workforce of a few thousand with an additional workforce of less than 10,000 in the missile business.

North Korea's nuclear enterprise is dangerous, but it is likely composed of fewer than 50 nuclear weapons.

The Soviet nuclear weapon enterprise consisted of ten dedicated, closed nuclear cities – of which three were physics/engineering design institutes, four housed nuclear weapons production and assembly plants (called the Serial Production Enterprises), and the rest were dedicated primarily to the production and storage of fissile materials.[3] Several production sites for other than fissile materials were located in other parts of the Soviet Union, including independent states after the demise of the Soviet Union. The huge missile enterprises are beyond the scope of this article but were described in detail in Harahan's CTR history.

In comparison, North Korea has its principal fissile materials production capabilities in the Yongbyon nuclear complex – dedicated to the production of plutonium, tritium, and highly enriched uranium. Mining of uranium ore and chemical conversion to yellow cake is done at the Pyongsan mining complex. North Korea has additional uranium conversion and centrifuge facilities to produce uranium hexafluoride and highly enriched uranium, although the number, capacity and location of these facilities is not known. The North's nuclear weapon design activities are believed to be at the Nuclear Weapons Institute, which is most likely in Pyongyang. The institute may also house the North's small nuclear weapons production and assembly capabilities.

August 9, 2007, Yongbyon – Hecker taken on tour through DPRK plutonium laboratory

The Soviet Union had two enormous nuclear testing grounds – the Semipalatinsk Testing Polygon in Soviet republic of Kazakhstan and the Novaya Zemlya nuclear test site above the arctic circle in Russia. The Semipalatinsk site presented a big challenge because after the Soviet collapse it was in the independent country of Kazakhstan as described in *Doomed to Cooperate*.[4] The Soviet Union conducted 715 nuclear tests, of which 124 were declared as peaceful nuclear explosions conducted in the territories of several Soviet republics. North Korea has only the Punggye-ri nuclear test site at which the North has conducted six nuclear tests between 2004 and 2017.

The Soviet nuclear workforce was huge. Of the one million people employed in the nuclear industry, some 100,000 were employed in the weapon development complexes with ten to fifteen thousand in possession of highly classified information and two to three thousand with knowledge of advanced nuclear weapon technologies.[5] In comparison, North Korea has on the order of a few thousand people in the nuclear weapons complex, with perhaps a few hundred with highly classified nuclear weapon design and engineering knowledge.

The nature of the nuclear workforce in North Korea is also strikingly different from that in the Soviet Union. The Soviet program was built on the shoulders of some of Europe's most distinguished scientists, including several Nobel laureates. Soviet scientists were trained and interacted widely during the first four decades of the 20th-

century with the great schools of European physics. Soviet engineers had a record of innovative technological developments, particularly in the military fields. The Soviet nuclear and missile programs were able to attract the best and the brightest of a well-educated Soviet populace into the 1980s. Soviet/Russian advances in mathematics over the past century are legendary. The nuclear weapon design institutes housed some of the very best. During my many visits to the Russian Federal Nuclear Center VNIIEF (the Russian equivalent of Los Alamos), I was able to witness their impressive mathematical skills applied to nuclear computations. The mathematics division had a staff of one thousand mathematicians and technicians.

In contrast, North Korean scientists had few international opportunities, outside of training opportunities in Russia and participation in the Joint Institute for Nuclear Research in Dubna into the 1960s. I am not aware of North Korean scientists having authored any of the ground-breaking research at Dubna. In fact, Soviet colleagues have told me that the North Koreans scientists remained quite isolated and did not interact broadly during their tenures at Dubna.

Cooperative threat reduction programs in North Korea should be structured to focus primarily on the reorientation of engineers, not scientists.

Today's North Korean nuclear scientists were trained almost exclusively in North Korean universities with little, if any, opportunity to connect with other scientists outside of the country. What I found during my visits to the Yongbyon nuclear complex were competent nuclear and materials engineers, not world-leading scientists. The North's nuclear program is not groundbreaking, nor does it need to be. It has prospered on adequate science and good engineering, taking well-known nuclear weapons knowledge to build a nuclear weapon arsenal. Consequently, cooperative threat reduction programs in North Korea should be structured to focus primarily on the reorientation of engineers, not scientists. Our experience in Russia showed that it is easier to reorient engineers than scientists. Engineers like to build things, so the challenge will be to find civilian projects that will allow them to exercise those skills.

Political Support

Political support in the U.S. to assist the Soviet Union as it was disintegrating in the early 1990s was weak. Senators Sam Nunn and Richard Lugar, the primary authors of the CTR legislation, pointed out many years later, "launching a major effort to assist

the Soviet Union was politically counterintuitive" at the time.[6] After more than 40 years of Cold War threats and several close nuclear calls, such as the 1962 Cuban Missile Crisis, the American public and the political leadership were looking to complete what was viewed as the Cold War victory and to collect a peace dividend, rather than to assist the adversary deal with nuclear challenges it faced as it collapsed.

Several key events and initiatives helped to provide support and set the stage for the passage of the landmark Nunn-Lugar legislation. Mikhail Gorbachev and Ronald Reagan turned toward détente away from cold-war confrontation at the historic Reykjavik summit in October 1986. The U.S. and Soviet Union followed with historic nuclear agreements – the Intermediate Nuclear Forces (INF) Treaty in 1987 and in the George H.W. Bush administration, the Threshold Nuclear Test Ban Treaty in 1990 and the Strategic Arms Reduction Treaty (START) at the end of July 1991.

The seminal event that tilted the stage toward nuclear assistance was the attempted coup by Soviet hardliners that put Gorbachev under house arrest at his dacha in the Crimea in mid-August 1991. Although, the president of the Russian Republic, Boris Yeltsin, helped to end the putsch three days later that restored Gorbachev to power, Gorbachev had apparently been relieved of the possession of the nuclear suitcase, the launch codes for the Soviet nuclear arsenal. This turned out to be the wake-up call to the new and potential dangers of instability in the Soviet Union. The nuclear threat was changing from nuclear weapons in the hands of the Soviet government to nuclear weapons and other nuclear assets getting out of the control of the Soviet and successor-state governments.

This lesson is important to remember as we think about potential futures on the Korean Peninsula. As dangerous as the nuclear weapons and nuclear assets are in the hands of Kim Jong-un, the risk they pose could be greatly increased if he is incapacitated or dies.

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The next critical steps toward cooperation were George H.W. Bush's Presidential Nuclear Initiatives. The principles that would guide U.S. policy were laid out by Secretary of State, James A. Baker, in early September. Baker announced these to include: the right to peaceful self-determination, respect for national boundaries, support for democratic government and the rule of law, support for constitutional guarantees for human rights, and adherence to international law and treaty obligations. Bush took unilateral steps to order the U.S. military services to eliminate thousands of tactical nuclear weapons and cancel dozens of strategic nuclear modernization programs. His actions included taking nuclear weapons off all U.S. surface ships and removing nuclear weapons from South Korea.

In a phone call to Gorbachev on September 27, 1991, Bush explained that he would take these measures in the hope that Gorbachev would reciprocate to move the two countries to lower nuclear risks. Gorbachev reciprocated on October 5.

The academic and non-governmental community stepped in to offer ideas to cooperate to reduce nuclear risks. Harvard University's John F. Kennedy School issued a particularly prescient report titled *Soviet Nuclear Fission*[7] to warn about the new nuclear dangers should the Soviet Union disintegrate. Other key contributions were made by MIT, Stanford University, the Carnegie Corporation of New York, and the Brookings Institution. Several creative initiatives for cooperation were briefed to the congressional leadership and helped to create the driving force for the Nunn-Lugar legislation, which passed with bipartisan support in December 1991.

Among the most unlikely and eventually most successful proponents of nuclear cooperation were the nuclear laboratories of Russia and the United States. The Los Alamos, Lawrence Livermore and Sandia national nuclear weapons laboratories developed close collaborations with their three Russian nuclear weapon counterparts.[8] In addition, several other Department of Energy laboratories supported collaboration in areas such as nuclear fuel cycle facilities, nuclear safeguards, nonproliferation, and environmental issues, as well as peaceful nuclear energy.

Executive branch leadership continued to be important after the dissolution of the Soviet Union at the end of December 1991. Although there were skeptics of cooperation with the former Soviet states, including a somewhat reluctant president, and enormous bureaucratic hurdles to overcome, Secretary of State James Baker, managed to establish cooperative activities in 1992. The Nunn-Lugar program received strong support in the Clinton administration, particularly from Secretary of Defense, William J. Perry, and Deputy Secretary of Energy, Charles Curtis.

The CTR programs housed in the Department of Defense were managed by the Defense Threat Reduction Agency. These efforts focused on supporting the destruction of excess missiles, storage of excess fissile materials, and mitigating the risks from Soviet chemical and biological weapons programs.[9] The Department of State managed the International Science and Technology Centers program, one of the key programs to reorient and retrain people in Russia and the other states of the former Soviet Union.

Although many of the threat reduction cooperative programs made substantial progress in the early and mid-1990s, they continued to face substantial congressional opposition. As Sharon Weiner points out the budget authority faced strong opposition each time the program came up for re-authorization in the 1990s. Members of Congress complained that the funds helped Russia's own weapons effort, was wasted, or would simply be better spent at home.[10] Hence, the CTR program

required continued attention and coalition building. In the 1990s, Nunn and Lugar managed to gain critical support from Senator Pete Domenici (NM), who became a co-sponsor of an expanded CTR program in 1996. He was able to shore up support on the skeptical Republican side of the Senate.

The CTR program enjoyed strong international support because the threat of the proliferation of nuclear weapons, materials and know-how was a global concern. The ISTC program, for example, was funded from the beginning by seven countries. The UK established its own CTR program that included a substantial effort to reorient former Soviet weapon scientists.

It is difficult to envision any administration in Washington assisting North Korea now or in the future unless Pyongyang agrees and takes concrete steps toward the elimination of its nuclear weapons program.

The political challenges to develop a successful cooperative threat reduction program with North Korea will be even more daunting than the CTR program with the former Soviet Union. Although North Korea has committed to denuclearize in past agreements with the United States, it has repeatedly insisted it would do so only in a phased step-by-step approach with commensurate U.S. actions. But during the past 20 years, Washington has not taken steps toward normalization of relations resulting in North Korea enhancing its nuclear capabilities instead of denuclearizing. It is difficult to envision any administration in Washington assisting North Korea now or in the future unless Pyongyang agrees and takes concrete steps toward the elimination of its nuclear weapons program. To do so, Washington will have to adopt a different approach from what it practiced in the past 20 years. Richard Johnson argues that it could be useful to introduce the additional incentive of offering a cooperative threat reduction program to help invigorate diplomacy while also laying the foundation for concrete denuclearization steps.[11]

The past record of U.S.-DPRK cooperation is not encouraging. The 1994 Agreed Framework was built on the concept of cooperation. North Korea would freeze its plutonium program and the United States would assist North Korea to build modern nuclear power reactors to provide much-needed electricity to the North along with steps to normalize relations. Had this effort been supported to its conclusion, it could have set the stage for denuclearization and normalization. However, intense political opposition strengthened by the 1994 U.S. elections that led to Republican control of both houses of Congress plagued the implementation of that agreement from the start. In addition, the North's decision to pursue diplomacy while concurrently keeping its nuclear weapon option open by pursuing the uranium enrichment path to the bomb, was seized upon by the incoming George W. Bush administration to kill the Agreed

Framework and end cooperation. Instead of this decision leading to reining in the North's nuclear weapon ambition, it served to enhance it. Pyongyang proceeded to build the bomb and demonstrate it with its first nuclear test in October 2006.

The Bush administration tried to recover from this unfortunate debacle during its second term by adopting a diplomatic approach in 2007 and 2008 to cooperate with Pyongyang to begin disabling the Yongbyon nuclear complex as the first step toward dismantling it. Cooperation between American and North Korean nuclear specialists on taking disablement steps was excellent, but that effort never proceeded to the dismantlement stage. The Bush administration moved the goal posts on the previously agreed declaration and verification provisions and Kim Jong-il's severe stroke in August 2008 made Pyongyang change its own course toward strengthening its nuclear deterrent as it felt politically more vulnerable. The Obama administration was greeted with a long-range rocket test and the North's second nuclear test in early 2009, from which it never recovered to pursue cooperation. The Trump administration first greatly increased the dangers with its "fire and fury" rhetoric in 2017, but then reached out politically to Kim Jong-un to lower political tensions. It was not able to overcome dysfunction and division in Washington to bring the good relationship between the two leaders to move North Korea toward denuclearization and nuclear cooperation.

I will next briefly examine the range of CTR programs implemented with Russia and other states of the former Soviet Union and draw lessons from those that may help in designing a potential program with North Korea.

Focus on CTR – Cooperative Threat Reduction

The objective of the American effort to work cooperatively with the former Soviet states was to reduce the threat posed by the sudden breakup of the Soviet Union. The former Soviet states recognized the serious nuclear security and safety dangers but did not have the financial means or political stability to cope with them. The George H.W. Bush administration encouraged its executive agencies to work with Russia and the other states to define the threats and develop programs to mitigate the threats. It demonstrated exemplary statesmanship by tailoring the programs to meet common objectives rather than delving deeply into domestic issues or attempting to achieve a grander vision of turning the states into copies of the democratic West. The common objectives of the CTR program were to reduce the threat of diversion of the huge Soviet nuclear assets and improving the safety and security of those assets, particularly since they were now at risk because they had to be relocated and then protected in an open and chaotic political environment.

Implementing the Nunn-Lugar CTR program required a combination of leadership from the executive branch, legislative branch, academic and non-government organizations during the second half of 1991. The Nunn-Lugar legislation was passed on December 12 by a vote of 84 to 6 in the Senate and by a voice vote in the House of Representatives. It resulted in a new U.S. government assistance program for the newly independent states of the Soviet Union. The initial legislation provided $ 400 million for the safe transportation, storage, accounting, and destruction of nuclear and other weapons in the Soviet Union – soon to become the Commonwealth of Independent States. The act stated that President Gorbachev requested Western assistance in dismantling nuclear weapons, and the President Bush proposed cooperation on the storage, transportation, dismantling and destruction of Soviet nuclear weapons. It defined the threat clearly. The retention of Soviet weapons by three new states (Ukraine, Kazakhstan, and Belarus) along with the bulk of the Soviet arsenal remaining in Russia created a new international danger because of potential instability in these states. It also warned of the threat of the potential seizure, theft, sale or use of nuclear weapons and components, and the threat of proliferation of nuclear weapons, materials, technologies, and know-how. The CTR program was not an attempt to denuclearize Russia, which was the legitimate heir of the Soviet nuclear stockpile. It also included eliminating the infrastructure that could be used to produce nuclear materials or nuclear weapons that remained in those three countries. It also targeted the elimination of chemical and biological weapons and infrastructures in those countries.

Cooperative threat reduction for North Korea requires a similar strong focus and U.S. government support. The threat from North Korea's nuclear program is first and foremost the potential of nuclear attack on U.S. assets or its allies, be it deliberate or through misunderstanding or miscalculation. Hence, in North Korea's case, the end goal of any nuclear agreement must be the elimination of its nuclear weapons and the means of production. Much like for the former Soviet states, cooperative programs must also be tailored to enhance the safety and security of North Korea's nuclear assets. They must also address the potential of export of nuclear weapons, materials, technologies, and knowledge. Whereas the scale of these is much smaller than for the former Soviet case, it is nevertheless critical. For example, North Korean nuclear scientists and engineers have the necessary tacit knowledge to produce plutonium and highly enriched uranium (HEU) to fuel nuclear weapons. They have demonstrated the ability to build nuclear devices, including likely hydrogen bombs, by detonating them underground. The knowledge gained through their nuclear tests likely exceeds those of all states except the P-5 states with nuclear weapons. The North Korean rocket scientists have also demonstrated the ability to

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build and launch ICBM-class missiles. The threat North Korea's nuclear and missile programs pose should be mitigated in a phased approach to halt, roll back, and eliminate nuclear weapons. My Stanford colleagues and I proposed a 10-year framework that reduces the threat in a phased manner.[12]

During the ten years following the breakup of the Soviet Union, the Nunn-Lugar program supported cooperation in the following areas:

1) Returning nuclear warhead from Ukraine, Kazakhstan, and Belarus to the Russian Federation along with the destruction of missiles stationed in these countries.
2) Improving the safety and security of former Soviet weapons during transport, storage, and disassembly.
3) Improving the safety and security of fissile materials.
4) Disposing of excess fissile materials.
5) Shutting down or converting facilities used for fissile materials production.
6) Improving the security of radiological materials.
7) Preventing the proliferation of nuclear weapons knowledge.
8) Reducing the threat of nuclear terrorism.
9) Assisting in the destruction of chemical weapons and mitigating the danger posed by former biological weapons laboratories and factories.

I review the key elements of cooperative threat reduction below.

Nuclear weapons and missiles.

The most urgent threat was that four nuclear states were created out of one. In addition to Russia, Ukraine, Kazakhstan, and Belarus were left with Soviet nuclear weapons in their territories. Ukraine, Kazakhstan, and Belarus possessed 1,868, 1,360 and 81 nuclear warheads respectively. Overnight, Ukraine and Kazakhstan became countries with the third and fourth largest nuclear arsenals in the world. The Nunn-Lugar congressional findings placed high priority on the transportation, storage, safeguarding, and destruction of former Soviet nuclear and other weapons.

Much of the early effort targeted the difficult situation in the Russian Federation, which inherited most of the nuclear weapons and the requisite nuclear and missile infrastructures. Enhancing safety and security during transportation was defined as one of the most urgent threats. The U.S. Department of Defense worked closely with Russia's Strategic Rocket Forces and the Ministry of Atomic Energy to define and implement the required improvements. The programs were truly cooperative with the Russian side identifying the vulnerabilities and then working closely with the American side, which supplied technical assistance and funding to mitigate the risks.

The scale of this effort was enormous. The thousands of missiles that were to be eliminated had to be disassembled, the nuclear warheads removed, the missiles and silos (or in some cases submarines) destroyed, and the nuclear warheads stored until the fissile materials could be removed and stored. The Soviet Union had an estimated 500 nuclear weapons storage sites that were eventually consolidated to about one hundred. It had 26 strategic missile divisions, 20 of which wound up on the territory of the Russian Federation. Most of the transport was by rail shipment, which was considered one of the most vulnerable aspects of nuclear reductions. Railcar security was upgraded with American help. The very first CTR project was the provision of armored blankets to place over nuclear warheads to protect them from small-arms fire during their transportation from Belarus, Ukraine, and Kazakhstan to Russia.

1996, Severodvinsk – Disassembling of a Soviet Oscar-class submarine (Todd P. Cichonowicz, U.S. Navy)

One of the earliest Russian requests for security enhancements was to have Americans provide safe and secure transportation/storage containers for fissile materials. The Department of Defense supplied Russia with 33,000 containers designed by Russian and American engineers and manufactured in the U.S. The construction of a modern fissile materials storage facility was one of the biggest and most contentious joint projects. However, despite disagreements right up to the commissioning of the storage facility, it was eventually opened. It greatly enhanced the security and safety of Russia's excess plutonium and highly enriched uranium.

The Clinton administration decided early in 1993 that CTR funds should be used to help Russia meet its START I strategic nuclear weapon reduction commitments expeditiously. Russia had typically replaced more than a thousand nuclear systems per year. However, with the greatly accelerated rate of retirements resulting from START

I obligations left Russia unable to meet those commitments. The U.S. worked cooperatively with Russia to eliminate the required nuclear warheads and their delivery systems. American support was provided to help Russia eliminate strategic missiles, missile silos, submarines and associated missiles, air-launched cruise missiles and bombers. The dismantlement work was highly technical and dangerous. Not only did the nuclear warheads have to be separated from the delivery system, but they had to be transported and disassembled (which could only be done by the Russian scientists and engineers because they were the only ones with the requisite knowledge to do so safely). The liquid rocket fuel presented another serious challenge because of the highly energetic rocket fuel. The Russian shipyards were not equipped to handle the required volume of dismantlement responsibilities.

The DoD safe and secure dismantlement programs with Russia were successful in reducing the threat that missiles and weapons posed. They were successful because the two sides had common objectives even if they disagreed on the details of the cooperative efforts. They also enjoyed high-level support in both governments. Secretary of Defense, William Perry, became personally involved along with his assistant secretary, Ash Carter. On the Russian side, the leaders of their Strategic Rocket Forces, Generals Viktor Esin and Evgeny Maslin were similarly personally committed. Both sides enjoyed strong support from their presidents.

The Department of Defense along with the State Department led U.S. efforts to work with the Russian Federation to help the newly independent states of Ukraine, Kazakhstan, and Belarus deal with their nuclear inheritance. These programs, which had strong U.S. government support across the political spectrum, were immensely successful. They resulted in all former Soviet nuclear weapons being returned to Russia for dismantlement by 1996. The destruction of the fleet of missiles, with the nuclear warheads having been removed and returned to Russia, in each of these countries was done with the aid of the U.S. DoD. It involved a large effort with U.S. military and defense contractors assisting the countries involved. These efforts should provide good lessons-learned for similar deactivation and destruction of North Korean missiles if a political agreement could be reached. Successful programs were also conducted to eliminate nuclear infrastructures in these countries. The largest and costliest of these was to eliminate the Soviet nuclear testing infrastructure at the Semipalatinsk Test Site that now resided in the independent Republic of Kazakhstan.

U.S experience with the programs to eliminate nuclear weapons, missiles, and infrastructure in the three former Soviet states should prove valuable for such efforts in North Korea if an appropriate political agreement is forged in the future. Again, the scale of the problem is enormously smaller – dozens of weapons in North Korea compared to the many thousand in the three states. One important lesson was that whereas the U.S. was able to assist the three states in destroying the missiles and their silos, the removal of the nuclear warheads and their disassembly was handled entirely

by the Russian scientists and engineers that designed and produced them. Similarly, in North Korea, it will have to be the North Korean scientists and engineers that disassemble the systems and dismantle the nuclear warheads. Destruction of the missiles could be done cooperatively as it was in the Soviet states.[13]

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Although the CTR program was not directed at denuclearizing Russia, it was a common objective of the Russian Federation and the United States to significantly reduce the nuclear weapon stockpiles of both countries as agreed in the START II treaty. The rapid return of thousands of Soviet nuclear weapons from the other former states presented an enormous safety and security challenge. President Clinton and President Yeltsin agree to have the nuclear establishments in their countries collaborate the enhance safety and security under such challenging conditions. Several such productive collaborations between Russian and American nuclear weapons laboratories are described in *Doomed to Cooperate*.[14] During the first ten post-Cold War years, the former Soviet and American nuclear weapon stockpiles were reduced by roughly 85 percent.

Nuclear materials.

The U.S. Department of Defense found Minatom very difficult to work with. U.S. officials complained about the ministry's culture of secrecy and suspicion.[15] In contrast to the largely successful projects run by the Department of Defense with the Russian Ministry of Defense, the attempts of the Defense and State Departments to work with Minatom were fraught with acrimony. For example, their efforts to work with Russia to improve the protection, control, and accounting of fissile materials (MPC&A) was the least successful of the DoD's CTR programs.[16]

The personnel and facilities to which the U.S. required access were viewed as too sensitive by Minatom officials. Minister Viktor Mikhailov assured U.S. officials that Russia had no problem securing and safeguarding its own fissile materials. Little progress was made until the scientists and engineers from the U.S. nuclear laboratories were able to develop a close working relationship with their Russian counterparts. The scientists and engineers began to build trust by collaborating on joint science projects, which helped to build the trust necessary to tackle the more sensitive nuclear security issues at their institutes and weapons facilities. I personally signed the first three MPC&A contracts on behalf of the U.S. Department of Energy with two of the weapons institutes and one the most important civilian nuclear institutes in June 1994.[17] I did so as director of the Los Alamos National Laboratory at

the time. Our collaborations were truly joint activities with specialists from each side visiting and working at sites in each country.

Any potential agreement with North Korea leading to the eventual elimination of its nuclear weapon program will also need a strong cooperative component to ensure the safety and security of fissile materials so long as North Korea retains them. Such a job will be much simpler with North Korea than the Soviet Union because the North Korean inventories of plutonium and highly enriched uranium is a thousand times smaller. North Korea will not require a new Fissile Materials Storage Facility, which the U.S. supported with several hundred million dollars in Russia. Deactivation of the fissile materials production facilities will also be much simpler because of the miniscule scale of the North Korean complex compared to that of the former Soviet Union.

The Russian CTR program also included efforts to dramatically reduce the inventories of fissile materials. The most successful of these was the 1993 U.S.-Russia HEU Purchase Agreement, commonly known as the "Megatons to Megawatts" Program. Under this Agreement, Russia downblended 500 metric tons of HEU, equivalent to 20,000 nuclear wearheads, into LEU over a period of 20 years.[18] This program earned Russia an estimated $17 billion over that time. For the U.S. it provided fuel for its fleet of light water reactors. Secretary of Energy, Ernest Moniz, reported at the end of 2013, "For two decades, one in ten light bulbs in America has been powered by nuclear material from Russian nuclear warheads."[19] It still left Russia with an inventory near 700 metric tons of HEU. The American inventory is somewhat less than 600 tons. By comparison, I estimate the North Korean inventory to be less than one ton. The HEU/LEU agreement, however, could be a good example for the disposition of North Korea's HEU. North Korea could downblend it and sell the resulting LEU for reactor operations to South Korea, the U.S., China, or another country with reactor fuel needs. Provisions could be made for any LEU that North Korea has already produced for eventual use in light water reactors to place the LEU under IAEA monitoring.

The U.S. and Russia also agreed on the disposition of roughly 34.5 metric tons of excess plutonium each. Plutonium is much more difficult to turn into civilian use. This program has been fraught with difficulties and is currently no longer operative. The two countries have decided to go their own way to dispose of their excess plutonium. For North Korea, plutonium disposition is not an issue

Cleaning up the Yongbyon nuclear complex and associated mining sites... [i]s an area in which the U.S. government could help to build an international collaboration to assist the North.

since I have estimated its total inventory to be less than 50 kilograms. Plutonium should not remain in North Korea. The simplest way is to sell the plutonium to Russia or the United States. It will be a simple matter to transport.

Environmental remediation of the nuclear facilities in North Korea will need to be addressed. These issues were also problematic in the Soviet nuclear complex. The scale of the environmental damage of the huge Soviet nuclear program was immense. This is one area in which the U.S. government chose not to support the efforts of Russia and the other states of the former Soviet Union to clean up the environmental consequences of their nuclear program. Some assistance was provided to the Government of the Kazakhstan to remediate the environmental problems on the former Soviet nuclear test site at Semipalatinsk. But most of the environmental efforts had some nuclear nonproliferation component to justify U.S. support.

Again, the scale of the problem in North Korea is much less. Nevertheless, cleaning up the Yongbyon nuclear complex and associated mining sites will be extensive and expensive. This is an area in which the U.S. government could help to build an international collaboration to assist the North. One of the North Korean sites that will require closure and environmental remediation is its Punggye-ri nuclear test site. The U.S. experience in working with the Kazakh and Russian governments to mitigate the test site environmental and security issues will prove helpful to tackle the North Korean case.

Mitigating the risk of the export of nuclear weapons knowledge.

The so-called "brain drain" and leakage of nuclear weapons knowledge was one of President George H.W. Bush's greatest concerns as the Soviet Union collapsed. The Nunn-Lugar CTR program provided support for the retraining and relocation of workers from the Soviet nuclear complex to civilian activities. Sharon Weiner reviewed the troubled history of these programs in *Our Own Worst Enemy*.[20] The Department of Energy managed the "Nuclear Cities Initiative" and the "Initiative for Proliferation Prevention." The State Department managed U.S. participation in the "International Science and Technology Center" program. As Weiner points out, from the collapse of the Soviet Union in 1991 through 2008, the U.S. spent over $1.2 billion trying to discourage the proliferation of nuclear, biological, and chemical weapons expertise from the Soviet successor states. Some of this was short-time support for scientists and engineers to provide income while keeping them engaged in interesting work instead of selling their expertise to other countries. Other objectives were more long-term efforts to create non-weapons jobs and convert entire organizations from military to civilian work.

Weiner concluded correctly that the results of these programs were mixed. The consensus within the U.S. government was that they failed, but Weiner points out that

that judgment depends on what the objectives were. If, as many did in the government, success was measured by the number of new jobs created and the transfer of workers to the civilian sector, then the results were disappointing. On the other hand, if success was measured by preventing the transfer of critical weapons knowledge and expertise, the programs were a resounding success. Moreover, these programs brought American and former Soviet professionals into close contact that allowed them to form close bonds and develop the trust necessary to help with more sensitive programs such as nuclear weapons and nuclear materials security. Such collaboration would also prove beneficial for North Korean and American professionals to work side-by-side to explore civilian applications for their technical talent.

To craft successful people reorientation programs, it will be important to ask the North Korean nuclear leadership about their own preferences. I found this to be critical in working with the Russian nuclear enterprise. The North Korean leadership has the best knowledge of what talents their workforce possesses and how these talents can be utilized in their country. American estimates are highly uncertain, both about the number of people involved in various programs and their technical skills and experience.

The Yongbyon nuclear complex is the only North Korean nuclear site to which Americans and the IAEA have had access. American technical teams were present during the 1994 to 2002 Agreed Framework and during the 2007 to 2008 disablement, as were the IAEA inspectors. I visited the Yongbyon site between 2004 and 2010. During my visits to the Yongbon site, I was able to make rough assessments of their workforce and their interests. Their capabilities are in reactor fuel cycle area, reactor construction and operations, and centrifuge operations. The IRT-2000 complex used to house nuclear research and medical isotope capabilities. Both have decreased significantly during the past 30 years because of the North's inability to acquire new HEU fuel from Russia.

During several of my visits, I asked Dr. Ri Hong-sop, director of the Yongbyon nuclear complex at the time, how he would like to see his technical people be engaged in civilian work should the North's nuclear weapon program be phased out and terminated. These discussions were held at times that the North was taking disablement steps at Yongbyon after the 2007 six-party agreements for disablement and eventual dismantlement. Director Ri told me that his wish is that Yongbyon could contribute to provide nuclear electricity for his energy-starved country. He made the case for the need for medical isotope production in the IRT-2000 reactor telling me it is needed to help treat thyroid cancer in North Korea. He lamented the fact that they had lost their research capabilities at the reactor. During my 2008 visit, I brought a detailed set of ideas about what could be done in civilian research and medical isotope production at the IRT-2000 reactor site. It was based on what one of my colleagues

had been able to accomplish at a similar reactor in Tashkent, Uzbekistan after the dissolution of the Soviet Union.

Director Ri said that in 2007 and 2008, Yongbyon technical professionals were not involved in light water reactor programs. They had not been involved in the KEDO reactor project that the U.S., South Korea, and Japan had sponsored, but terminated a few years before. Ri indicted that this would be an area his people could be involved in if a light water reactor program is resurrected. In discussions with Ri and others, I learned that the Yongbyon nuclear professionals had little contact with the DPRK Academy of Sciences and the Institute of Atomic Energy Research in Pyongyang. Based on my visits and discussions with the technical personnel, I concluded that the Yongbyon complex had few scientists but a cadre of capable, professional engineers who were able to build and operate the facilities to provide North Korea's fissile materials.

I discussed the potential of a CTR program with North Korea's diplomats during my visits. I found it interesting that they were less concerned about the future of their engineers than they were for their factory workers at Yongbyon – meaning the general supporting staff in the nuclear facilities. I was told that in prior years the nearby city of Yongbyon was a silk center for North Korea. The diplomats asked if the U.S. could help to expand the factories there to provide alternative work for the Yongbyon factory workers. I told them that this was exactly what we tried to do in the Nuclear Cities Initiative with the Russian nuclear complex.

Our North Korean hosts appreciated our concerns for their workers because it demonstrated a genuine Americans interest in helping the North with the reorientation of its nuclear workers. As much as these activities should be explored, I believe that the most immediate jobs for the Yongbyon nuclear workers for the next decade or so after the decision is made to terminate the weapons activities would be to disable the facilities and for the decontamination and environmental restoration of the site. In any case, what's required is to revitalize Track II engagements with the North Koreans to explore what they consider to be important.

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Potential CTR programs.

Cooperative threat reduction programs could be designed in each of the areas discussed above and much can be applied from the lessons learned from programs with Russia and the other former Soviet states. The June 2019 NTI Report develops a

set of sensible next steps that cover the areas discussed above.[21] Richard Johnson suggests that cooperative programs be pursued to help catalyze the more difficult denuclearization discussions.[22] William Moon, who was deeply involved with the U.S. DoD cooperative programs with the former Soviet Union, makes a similar recommendation to have the U.S. government pursue cooperative measures as a way to build confidence and encourage finalization of a complete agreement[23]. Based on his experience, he suggests initial cooperation should focus on safety and security, training, and infrastructure elimination.

Training is an essential component of all cooperative programs. We found it essential in the lab-to-lab cooperation with Russian nuclear professionals.[24] Our experience showed that it is essential to have the host country help identify the training needs. For example, the Russian nuclear institutes required no training on the scientific aspects of nuclear equipment or technologies. They knew those as well as we did. However, they requested training assistance with the very different methodologies of nuclear materials protection, control, and accounting we used in the U.S. compared to what worked for them in the closed Soviet system. They also showed great interest in business training required for their attempts to create new businesses and jobs. I expect the situation in North Korea and the needs of their nuclear professionals will be similar.

A novel approach - Cooperative military to civilian conversion.

Cooperative threat reduction programs may be able to catalyze a denuclearization agreement as suggested above. However, the focus on "denuclearization" will continue to be problematic in dealing with Pyongyang. Instead, Washington should offer Pyongyang a grand bargain to achieve the elimination of North Korea's nuclear weapons program by assisting Pyongyang in converting its military nuclear and space programs to civilian use.[25] Rather than arguing with Pyongyang about what denuclearization entails, Washington would insist that the North agree to halt, roll back, and eventually eliminate its existing nuclear weapons and its military nuclear and missile programs in return for assistance with civilian programs.

In concert with North Korea taking concrete steps to roll back its ability to produce bombs and missiles, Washington and Seoul would similarly take concrete steps to assist Pyongyang with civilian conversion. Such an effort would offer the best chance for the verifiable elimination of North Korea's nuclear weapons program. The magnitude of the North's nuclear and missile programs and the closed nature of the country will make verification of complete denuclearization virtually impossible. It will not be possible for inspectors, especially in an adversarial environment, to get unfettered access to all North Korea's facilities to verify that it has not secretly kept a few nuclear weapons, a few kilograms of plutonium, or one or more covert uranium centrifuge facilities. But working cooperatively with the North's nuclear and missile

specialists to convert North Korea's military infrastructure will greatly increase the likelihood of achieving adequate verification measures.

The question of allowing North Korea to retain a civilian nuclear program has been argued for decades. The Clinton administration's Agreed Framework was based on the premise that the North trade its plutonium production reactors for electricity-producing light water reactors. The Bush administration was adamantly opposed to Pyongyang retaining anything nuclear because of its belief that it will eventually use such facilities to reconstitute a military program.

The fears that civilian programs might provide critical assistance to the military program were mostly overblown. These fears failed to consider the risks and tradeoffs involved, and they led to the premature breakdown of potential pathways to resolving the nuclear crisis. For example, the Bush administration's decision to walk away from the Agreed Framework because of North Korea's clandestine pursuit of uranium enrichment led to North Korea building and testing the bomb. The Obama administration treated Pyongyang's attempted space launches in 2009 and 2012 as military endeavors, thereby shutting down opportunities for diplomatic solutions and opening the door to Pyongyang enhancing its nuclear arsenal.

If the offer to assist Pyongyang make the military to civilian transition in its nuclear and space programs is deemed attractive by Pyongyang, then I believe Washington can manage the risks involved.

Elimination of North Korea's chemical weapons as a confidence-building step for nuclear disarmament.

Whereas the primary focus of reducing the risks of North Korea's weapons of mass destruction programs must remain on the nuclear program, I believe that cooperation on the elimination of its chemical weapons may serve as a confidence-building measure to catalyze progress on the nuclear front. North Korea is estimated to possess between 2,500 and 5,000 metric tons of chemical weapons.[26] North Korea, Egypt and South Sudan are the only three countries that have not signed the Chemical Weapons Convention (CWC), which bans the possession, production, stockpiling, and use of chemical weapons. Israel has signed but not ratified the convention.

North Korea has made it clear that it will not eliminate its nuclear weapons until suitable normalization is reached with the United States. Kim Jong-un has indicated that the nuclear weapons will go last, and that he is prepared to take phased, reciprocal steps with Washington in that direction. Yet, each of the last three U.S. administrations has focused almost singularly on the North's denuclearization without taking requisite normalization steps, typically accusing North Korea of not keeping its end of agreements. At this point, the complete lack of trust between

Washington and Pyongyang precludes a resolution. Nuclear weapons have served as Pyongyang's deterrent against what it considers a hostile United States. Unless Washington agrees to a phased, reciprocal approach such as that offered by Kim in Hanoi, there is little hope of progress.

I suggest Washington offer Pyongyang a cooperative threat reduction program to help eliminate its chemical weapons as a confidence-building step toward nuclear cooperative programs. Unlike nuclear weapons, which the regime views as the guarantor for the survival of the country and the regime, chemical weapons offer very little as a deterrent against the United States. They are for the most part a terrorist weapon, not a national deterrent. Hence, Pyongyang should be much more amenable to eliminate these weapons. Taking demonstrable steps working cooperatively with the Americans may serve to build the trust between the two countries that is severely lacking today.

I suggest Washington offer Pyongyang a cooperative threat reduction program to help eliminate its chemical weapons as a confidence-building step toward nuclear cooperative programs.

Pyongyang could demonstrate its good intentions by signing and acceding to the CWC. Once done, it would then be guided by the Organization for the Prohibition of Chemical Weapons, the Convention's implementing body, on the steps it would need to take to come into compliance with the CWC. Pyongyang would have to submit detailed declarations of its chemical weapons stockpiles, production facilities, and other related facilities. All of this would establish a good precedent that North Korea is willing to comply with international norms of prohibiting chemical weapons, which 193 countries have accepted. It would serve as an important step for tackling the much more difficult nuclear issues in the future.

Moreover, there are substantial economic and technical benefits to joining the OPCW, which provides a wide range of capacity building activities aimed at supporting the scientific and economic development of its Member States. Member states have assisted new signatories financially to pay for the destruction of chemical agents and decommissioning of production and storage facilities. Incentives to comply with the CWC include assistance and protection against chemical attack, including the dispatch of emergency aid; economic and technological benefits, including the fullest possible exchange of chemistry information and technology; and removal of trade and other restrictions.

The cooperative disposition of chemical weapons in the former Soviet Union was one of the most successful CTR programs. In that case, it involved close cooperation with Russia because unlike for the case of nuclear weapons, Russia had no justification for

retaining chemical weapons. The CTR agreement helped Russia to accede to the CWC. Elimination of the weapons was then mandated by the OPCW. It was greatly assisted both financially and technically by the United States, which had gone through the process of eliminating its chemical weapon stockpile. By 2004, Russia had received $2 billion in financial support from the United States, the United Kingdom, Germany, the Netherlands, Italy, and Canada.

Russia had declared a stockpile of 40,000 metric tons of chemical agents. The U.S. had a stockpile of 31,000 tons. The chemical CTR program with Russia and other former Soviet states is described in detail by Harahan.[27] It is also featured in the NTI report.[28] The experience with the chemical CTR programs in Russia should be directly relevant to such programs designed for North Korea.

The biological weapons CTR programs with Russia and former Soviet Union states area described by Harahan and the NTI report. They may also provide lessons for potential programs in this area with North Korea. North Korea acceded to the Biological Weapon Convention in 1987 but has not followed through with annual declarations. Its program remains shrouded in secrecy and, hence, would not be an area in which confidence and trust could be readily established. Nevertheless, cooperative assistance in biosafety, biosecurity, and overall health security (such as in dealing with the current Covid-19 pandemic) would eventually greatly benefit the North Korean people.

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[1] The following list is a sample of books and articles used for this article: For the official history of the Department of Defense CTR programs, see Harahan, Joseph P., *With Courage and Persistence. Eliminating and Securing Weapons of Mass Destruction with the Nunn-Lugar Cooperative Threat Reduction Programs*. DTRA History Series (Defense Threat Reduction Agency, 2014); For the Department of Energy's lab-to-lab cooperation from American and Russian perspectives, see Hecker, Siegfried S., *Doomed to Cooperate* (Los Alamos Historical Society, Bathtub Row Press, 2016).; For review of CTR programs aimed at the people-focused CTR efforts, see Weiner, Sharon K., *Our Own Worst Enemy*, (The MIT Press, Cambridge, MA, 2011). For reviews of CTR programs for the Congressional Research Service and one of many CSR reports on CTR programs, see Wolf, Amy, "Nonproliferation and Threat Reduction Assistance: U.S. Programs in the Former Soviet Union," Congressional Research Service RL31957, March 16, 2012.

[2] "Building Security Through Cooperation: Report of the NTI Working Group on Cooperative Threat Reduction with North Korea," Nuclear Threat Initiative, https://media.nti.org/documents/NTI_DPRK2019_RPT_FNL.pdf (June 2019); Johnson, Richard, "Cooperative Approach to Denuclearization" , 38North, https://www.38north.org/2019/11/rjohnson110619/; Moon, William, "Initiating a cooperative denuclearization effort with North Korea", *The Nonproliferation Review*, (3 Jan. 2020), https://doi.org/10.1080/10736700.2019.1692551

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[4] Hecker, *Doomed to Cooperate,* 443-529.

[5] Harahan, *With Courage and Persistence,* 84.

[6] Ibid, p. v.
[7] Campbell, Kurt M. et al., *Soviet Nuclear Fission: Control of the Nuclear Arsenal in a Disintegrating Soviet Union,* (Cambridge: Harvard University Press, 1991).
[8] These programs are described in detail by Russian and American scientists and engineers in Hecker, *Doomed to Cooperate.*
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[11] Johnson, "Cooperative Approach to Denuclearization".
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[13] Harahan, *With Courage and Persistence,* 123.
[14] Hecker, *Doomed to Cooperate*, 173.
[15] Harahan, *With Courage and Persistence,* 93.
[16] Ibid, 81.
[17] Hecker, *Doomed to Cooperate,* 299.
[18] Pavlov, Alexander and Vladimir Rybachenkov, "Looking Back: The U.S.-Russian Uranium Deal. Results and Lessons", *Arms Control Today* (Vol. 43, No. 10, December 2013) https://www.armscontrol.org/act/2013-12/looking-back-us-russian-uranium-deal-results-lessons
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[22] Johnson, "Cooperative Approach".
[23] Moon, "Initiating a cooperative denuclearization effort with North Korea"
[24] Hecker, *Doomed to Cooperate.*
[25] Hecker, Siegfried S., Elliot A. Serbin and Robert L. Carlin, "Total Denuclearization Is an Unattainable Goal. Here's How to Reduce the North Korean Threat". *Foreign Policy* (June 25, 2018), https://foreignpolicy.com/2018/06/25/total-denuclearization-is-an-unattainable-goal-heres-how-to-reduce-the-north-korean-threat/
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