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New Approaches to Verifying and Monitoring North Korea's Nuclear Arsenal

Ankit Panda, Toby Dalton, Thomas MacDonald, and Megan DuBois, editors

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CONTENTS

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INTRODUCTION

ANKIT PANDA

In May 2021, following its classified review of U.S. policy toward North Korea, the administration of U.S. President Joe Biden announced its intention to pursue "a calibrated, practical approach that is open to and will explore diplomacy with [North Korea]."[1] While the administration retains the long-standing objective of denuclearization of the Korean Peninsula, it acknowledges that it seeks to "make practical progress" to increase the security of the United States, that of U.S. forces on and around the Korean Peninsula, and that of U.S. allies like South Korea and Japan. If North Korea agreed to pursue practical steps toward risk reduction, negotiators would face a range of challenges as they broke new ground, among the thorniest of which would be the need for novel methods to monitor and verify compliance with agreed-upon restraints.

THE VERIFICATION CHALLENGES NORTH KOREA POSES

In recent years, North Korea's nuclear and missile forces have made tremendous qualitative advances. In 2018, before the country's leader Kim Jong Un turned to international diplomacy with South Korea, the United States, China, and others, he called for North Korea to "mass produce" ballistic missile and nuclear warheads.[2] Official assessments since then, including by the U.S. intelligence community and the United Nations (UN) Panel of Experts pursuant to UN Security Council Resolution 1874, have suggested that Kim's directive has been implemented and continues to remain in effect.[3] At military parades in October 2020 and January 2021, Kim further unveiled new missile capabilities, including a new intercontinental ballistic missile possibly capable of carrying multiple warheads.[4] In the meantime, Kim has continued to emphasize that nuclear weapons represent the cornerstone of North Korea's national defense strategy.

Because the scope of North Korea's nuclear complex has grown substantially since the failures of prior negotiated agreements to cap its capabilities (such as the 1994 Agreed Framework and the Six Party Talks in the mid-2000s), a comprehensive agreement resulting in the country's rapid total disarmament is not a realistic near-term prospect. If Washington and Pyongyang resume either direct bilateral talks or multilateral talks on matters related to denuclearization of the Korean Peninsula, the most realistic formula for progress would involve initial caps on parts of North Korea's programs of concern—including its nuclear and missile programs—before a long-term move toward reductions and, eventually, elimination.

Negotiators and political decisionmakers sitting across from their North Korean counterparts would seek to maximize the verifiability of each phase of any agreement that is reached. Verification and monitoring would be critically important not only to the political viability of any potential future agreement but also to generating measurable progress toward denuclearization. As history shows, orthodox approaches to verification—with robust onsite inspections and other well-defined protocols—are anathema for Pyongyang. While North Korea at times has allowed limited, ad hoc inspections and onsite access, it has only done so after protracted and difficult negotiations—and the last time it did so was when its capabilities were considerably more limited. Notably, North Korea's checkered history with the International Atomic Energy Agency has shown no signs of improving since agency inspectors were evicted from the country in April 2009. Further, given the near total lack of trust between the United States and North Korea, policymakers cannot expect ideal verification conditions for potential near-term agreements. Even so, they should recall that verification is not an end in itself: it is a means of assessing and ensuring compliance with any number of potential agreements while also building confidence and sustainability along the way.

NOVEL WAYS OF VERIFYING AND MONITORING NORTH KOREA

The Nuclear Policy Program at the Carnegie Endowment for International Peace, with support from the Korea Foundation, convened a group of international experts over several workshops in early 2021 to study novel tools and approaches to the verification and monitoring of a range of possible nuclear and missile restraints on North Korea. Their findings and proposals are summarized in this compilation. The experts broadly addressed potential accountable items in North Korea, including missiles, fissile material stocks, and warheads; piecemeal and probabilistic approaches to general verification and nuclear safeguards; open-source intelligence techniques that might support verification and confidence-building efforts; import-export monitoring; and lessons from other monitoring regimes, including the 2015 Joint Comprehensive Plan of Action with Iran. Given the technical focus of this volume, the included chapters do not assess the political viability of any specific potential agreements or the sorts of concessions that North Korea may seek during implementation. The fundamental objective of this volume is to facilitate policymakers' understanding of a range of verification and monitoring approaches to facilitate practical and incremental progress on denuclearization.

While orthodox approaches to verification are unquestionably the preferred standard for any potential agreement, near-term political realities require flexibility and tempered expectations. The ideas contained in this volume are intended to fit this purpose. Over time, as agreements are implemented with these approaches and tools, broader confidence building with North Korea may facilitate a more favorable political environment that enables the application of more standard verification approaches.

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CHAPTER 1

DESIGNING A VERIFIABLE FREEZE ON NORTH KOREA'S MISSILE PROGRAMS

JOSHUA H. POLLACK

More than two years have elapsed since North Korea and the United States have had a meaningful diplomatic exchange on Pyongyang's nuclear and missile programs. Any attempt by the United States or others to resume negotiations with North Korea on its nuclear and missile programs would be predicated on understandings about what activities are compatible with in-depth talks. Part of these understandings would be a freeze on certain missile-related activities, both to create the political space for constructive, in-depth talks and to prevent Pyongyang from further enhancing its missile arsenal in the meantime.

OPTIONS FOR A FREEZE

The scope and extent of a freeze would depend on what sort of agreement can be reached, and verification requirements would follow from that agreement. Three broad options exist: freezing the *testing* of rocket engines or missiles; freezing the *production* of new missiles, launchers, or platforms; and freezing the *deployment* of new missiles, launchers, or platforms. In addition to providing greater or lesser benefits, these options can be assessed in terms of the United States' ability to verify them, their acceptability to North Korean officials, and the negotiating parties' ability to put them in place on short notice.

A Test Freeze

Testing rocket engines—with either ground tests or flight tests—is crucial for developing and evaluating new types of missiles and establishing their reliability. However, a significant drawback is that freezing these types of tests would do little to keep North Korea from expanding its missile force using proven designs.

Verification of a flight-test freeze for ballistic missiles is straightforward. Infrared detectors already in geosynchronous orbit above the Eastern Hemisphere can reliably verify the absence of these tests (or space launches, which are functionally similar). These highly capable systems are expressly designed to spot the heat plumes of rocket boosters as they lift ballistic missiles out of the earth's atmosphere.[5] However, it is not well understood how reliably they can detect ground tests of these engines, which could take place under cloud cover or even inside enclosed structures. It is also not well understood how reliably infrared satellites can detect the flight testing of ground-launched or sea-launched cruise missiles, which use small rocket boosters to get into the air. These missiles could be flight-tested below cloud cover.

Such verification issues have arisen in past negotiations with Pyongyang. Possibly with the question of cloud cover in mind, North Korea voluntarily facilitated U.S. verification of a testing freeze in 2018 by removing the upper parts of its largest ground-testing stand for liquid-propellant rocket engines.[6] The partly disassembled structure could be monitored by imagery satellites, providing further assurance that no ground tests were being conducted there.

A Production Freeze

The expansion or modernization of North Korea's missile forces could be held in check through a freeze on manufacturing activity, assuming sufficient knowledge of the locations of the production facilities involved.

Because the absence of sustained activity at specific sites can be observed with imagery satellites, the closure of entire industrial facilities could be readily verified with existing capabilities. It would not be nearly as simple to verify the partial closure of a facility or selective restrictions on the products leaving an active facility. To help verify compliance with the 1987 Intermediate-Range Nuclear Forces (INF) Treaty, the United States and the Soviet Union developed what was termed a continuous portal monitoring system that involved a standing U.S. presence at the gates of the main Soviet rocket engine plant, but this system took considerable time to negotiate and implement.[7]

A Deployment Freeze

The expansion or modernization of North Korean missile forces could also be held in check by a freeze on deployments of new or additional systems to missile operating bases.

Unfortunately, the absence of new deployments would be difficult to verify reliably in the absence of onsite inspections at missile operating bases, which North Korea would be unlikely to accept. North Korea has never declared the numbers or locations of these bases, although open-source researchers have identified at least some of them in commercial space imagery. These sites are found in remote mountain valleys, are heavily camouflaged, and are largely underground.[8] Imagery satellites could be used to watch for new construction at previously identified bases, but they obviously cannot characterize what sort of equipment is kept inside a tunnel or under a roof. A similar observation applies to submarines, which can be stored inside coastal tunnels when they are not at sea.[9]

TRADE-OFFS AND CONSTRAINTS

There are at least three major constraints on the scope and duration of a freeze and its associated verification measures. These include what the United States (and other negotiation partners) might be willing to offer in exchange for a freeze, how intrusive the associated verification measures would be, and how protracted the negotiation and implementation of those verification measures would be.

First, how much North Korea would be prepared to give up depends on what it can get. If the United States (or any other negotiating partner) wishes to ask for more, it would probably have to offer more. These sorts of trade-offs are not always announced explicitly, but they can nevertheless be observed in the diplomatic record. For example, the de facto freeze on missile testing that North and South Korea agreed to for the duration of the Olympic Games in early 2018 appears to have been implicitly conditioned on the nearly simultaneous announcement that no U.S.–South Korean combined military exercises would be held that spring.

Second, apart from the scope and duration of the freeze itself, more intrusive verification measures would be harder to get. Onsite inspections at military facilities would be difficult to negotiate under the best of circumstances, a limitation that tends to rule out any verified freeze on deployments.

Third, more complex verification arrangements, even if they are acceptable to North Korean officials, would take time to negotiate and implement. Measures that involve an onsite presence for foreign inspectors or the installation of monitoring equipment at production facilities might be useful as part of a subsequent agreement. Because a freeze is meant to create suitable conditions for a protracted diplomatic process, it should involve only those measures that can be implemented promptly.

Consequently, the forms of verification most suitable for an initial freeze are limited to the use of U.S. national technical means (such as satellites), potentially supplemented by voluntary measures undertaken in North Korea. This category could include a freeze on flight tests and space launches, ground tests of engines, or all activities at selected production facilities.

CONCLUSION

Based on what the United States believes it would need to enable serious negotiations, and what it is prepared to offer North Korea in exchange, a range of options may be identified.

Perhaps the single most essential step, a freeze on ballistic missile flight tests and space launches, could readily be verified from space. This freeze could apply to all missiles above a certain minimal range, or it could be limited to long-range missiles and space launches only. Long-range missiles would include the large inter-continental ballistic missile displayed in North Korea's October 2020 military parade, a missile that appears to be intended to serve as North Korea's first "multi-warhead rocket."[10]

Focusing on long-range missiles and space launches would address the single most pressing military concern for the United States, and such an approach might require fewer concessions than an across-the-board testing freeze. Conveniently, such a testing freeze would also be consistent with the precedent of Kim's April 2018 announcement of a unilateral and voluntary suspension of all nuclear tests and long-range missile tests. (Although Kim has said that this suspension is no longer in effect, he has continued to abide by it.[11]) On the other hand, such a narrow freeze would not address the most pressing military concerns of Japan and South Korea, who could argue that it represents a step away from the repeated demands of the United Nations Security Council for North Korea to abandon all ballistic missiles. Such a narrow arrangement might also fall short of satisfying the core political goal of a freeze: reducing tensions to create room for comprehensive negotiations.

Beyond seeking a freeze on the flight testing of all types of missiles (to be verified with national technical means alone), the United States could also seek a freeze on ground tests. Satisfactory verification of the absence of ground tests would be more likely to require North Korea to undertake voluntary measures.

The same observation might apply to a freeze on production at key facilities, if Pyongyang is willing to halt *all* work at given sites for an agreed-upon duration. This option appears to be the most extreme that might realistically be considered for a freeze arrangement. Because of the intrusiveness or complexity of the associated verification measures, neither a freeze on new deployments at military facilities nor *selective* restrictions on activities at production facilities appear feasible.

Note: This piece draws upon analysis in the following co-authored paper. See Joshua H. Pollack, Miles Pomper, Ferenc Dalnoki-Veress, Joy Nasr, and Dave Schmerler, "Options for a Verifiable Freeze on North Korea's Missile Programs," James Martin Center for Nonproliferation Studies, CNS Occasional Paper #46, April 30, 2019, https://nonproliferation.org/op46-options-for-a-verifiable-freeze-on-north-koreas-missile-programs.

CHAPTER 2

DESIGNING GRADUAL, SUCCESSIVE SAFEGUARDS FOR NORTH KOREA'S NUCLEAR PROGRAM

MARC-GÉRARD ALBERT

In pursuing the verified denuclearization of North Korea, international safeguards implemented by the International Atomic Energy Agency (IAEA) are the unquestionable standard for the verification of nuclear material and activities. However, given current realities, the implementation of such safeguards can only be a long-term goal and would entail a long and difficult process. Such monitoring and verification activities should pave the way for North Korea to ultimately conclude a comprehensive safeguards agreement and an additional protocol, the full implementation of which should remain the ultimate objective.

Building on many earlier studies, this article explores what paths might eventually lead to comprehensive safeguards and how verification and safeguards could be introduced in a gradual and successive manner as part of a phased denuclearization process. The verification approaches considered here are within the scope of IAEA safeguards, so they do not include North Korea's nuclear arsenal and associated weaponization activities, although the agency could be granted authority to take on monitoring tasks related to those areas as it has in past special cases (notably, the 2015 Joint Comprehensive Plan of Action with Iran).

THE BASIS FOR COMPREHENSIVE IAEA SAFEGUARDS

Historically, IAEA safeguards have been applied under a variety of mandates, and model safeguards agreements are applied in standard situations, notably for comprehensive safeguards under Article III of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT).[12] However, since the IAEA's verification mandate in a given case is determined by the specific terms of each agreement, a monitoring and verification mandate for North Korea could be modified according to specific situations, and such a mandate could be as wide or as limited as the negotiating parties agree to make it, subject to the approval of the IAEA Board of Governors.

Even with comprehensive safeguards as the ultimate objective, the gradual implementation of safeguards would have to adopt specific technical objectives and approaches. The basis for comprehensive safeguards is Article III of the NPT, and the general objective of such safeguards is to detect the diversion of significant quantities of nuclear material in a timely manner before a state seeking to break out can produce its first nuclear weapon. Practical safeguarding measures stem from this goal and aim at detecting, in particular, the diversion of the approximate quantity of nuclear material needed for one weapon. While this technical objective has value in a situation involving a state that has been compliant with its treaty obligations to date, that objective is not relevant to North Korea today, given that Pyongyang has already produced multiple nuclear weapons.

The referenced safeguards approach begins with a comprehensive declaration by the state in question of detailed information on all its nuclear activities, facilities, and material within the scope of the safeguards.[13] The IAEA then gains access to the declared items and additional associated information (like operating records, for instance). Verification activities, which are generally conducted in a systematic manner, can then proceed. These activities include the verification of all nuclear material with a strict fixed periodicity and a detailed accounting of this material. At the end of the verification process, the IAEA aims to reach a conclusion on the correctness and completeness of the state's declarations and on the peaceful use of nuclear material with a high level of confidence. In addition, standard verification adheres to a strict timeline so that potential violations are detected quickly.

SUCCESSIVE SAFEGUARDS AND GRADUAL IMPLEMENTATION

Notably, the elements of this approach could be broken up and applied in parts, gradually and sequentially, in a case like North Korea. Instead of being implemented over a state's entire civil nuclear complex at once, safeguards can be implemented in stages, providing only partial verification with incomplete knowledge and reduced confidence. Thus, safeguards could serve interim objectives related to transparency and confidence building and create the foundation for achieving the ultimate objective of full implementation and more complete assurances.

Staged implementation could apply with respect to the nature of such verification, its scope, its level of detail and/or accuracy, its timing, and the level of confidence provided. For starters, the nature of such verification may be—rather than full oversight of North Korea's nuclear program's activities, quantities of materials, and characteristics—the mere monitoring of a freeze, that is to say the absence of activities, production, or movement of materials at declared facilities.

With respect to scope, early phase verification could include partial coverage over space, facilities, and/or a range of nuclear activities and materials (such as the coverage of only plutonium production and processing facilities); it could also include partial declarations and verification. The level of detail involved in these early verification activities could vary as only a limited range of information might be declared or accessed. Verification activities themselves could be limited and/or nonsystematic, and they could be performed with less accuracy in the verification of quantities.

As regards timing—while in standard safeguards practice, the three elements of declaration, access, and verification closely follow one another for rapid detection—these three elements could be decoupled in a staged approach, and some of these actions could be deferred for extended periods of time. This could be the case, for instance, for declarations, access to declarations, or certain verification activities (such as access with limited activities and deferred, detailed verification).

Finally, stages could also apply with respect to the level of confidence in verification results, including the acceptance of staged levels of assurances with reduced confidence and the use of probabilistic approaches providing partial assurances.

FROM GRADUAL TO COMPREHENSIVE SAFEGUARDS

Drawing on IAEA approaches, tools, and practices—as well as precedents for ad hoc verification by the agency—approaches departing from traditional safeguards may be applied for interim, ad hoc monitoring and verification. Such approaches could open windows on North Korea's program, which could in turn be progressively enlarged to reveal, over time, the full scope of the country's nuclear complex and lead toward standard full-scope safeguards. Such an approach could also allow a progressive restoration of the damaged working relationship and practices between North Korea and the IAEA.

This article does not intend to propose a ready-to-use roadmap; rather, it explores options that could be used and combined in defining and negotiating possible denuclearization paths for North Korea. Such options could include the ad hoc monitoring of specific facilities, which is close to the provisions in previous 1994 and 2007 mandates; the monitoring of specific activities (such as reactor operation, conversion, and waste management, for instance); item-specific verification with limited geographic coverage; the safeguarding of fixed quantities of nuclear material; the safeguarding of specific types of nuclear material (such as certain fuel, uranium, uranium ore concentrate, uranium hexafluoride, enrichment tails, certain waste, and nonweaponized stocks of highly enriched uranium and of plutonium, or according to isotopic composition).

In particular, the verification of waste products (including irradiated elements, waste from fuel cycle operations, and enrichment tails) could be among the useful first steps toward safeguards in a verified denuclearization process, as waste verification lends itself well to a step-by-step approach, is less intrusive than the verification of fissile material, and still provides useful insights on past production of those materials.

Nonsystematic and probabilistic verification could allow several approaches in which, rather than seeking high assurances through systematic verification of each activity, a satisfactory and progressively increasing level of assurance could be achieved by the probabilistic assessment of compliance over North Korea's nuclear program as a whole.

Gradual safeguards would also offer a range of options on the submission of declarations. Overall, it was proposed to start with a global declaration of nuclear material in North Korea without details; similar phasing concepts could be applied at less global levels—by declaring, for instance, the total quantity of a certain type of equipment or material or the total quantity of certain fissile material with given characteristics, with details to be provided at a later stage. Declarations could also cover only parts of the activities or materials in question, like material at a certain location (such as Yongbyon) to be expanded at later stages. It also has been suggested that modern information technology could offer ways for North Korea to submit encrypted declarations that could not be altered and would be intended to be read immediately rather than at another, later stage.

For individual facilities or specific nuclear material, various levels of declaration and verification could also be envisaged as indicated in table 1 below.

Table 1. Potential Stages of Declaration and Verification

Increasing levels of declaration and verification	Declared items	Verification activities applied to the declared items
↓	Existence Nature and status	Access Verification of nature and status
	Characteristics of the facility/material (complete or partial, with respect to scope or detail)	Access Verification of characteristics
	Material flows (complete or partial)	Access Verification of nature, characteristics, and quantities with various levels of accuracy
	Material inventories (complete or partial)	Access Verification of nature, characteristics, and quantities with various levels of accuracy
	Operating records	Access
	Historical records (complete or partial)	Access

In addition, some safeguard measures—including, for instance, those on certain materials such as waste—could surface useful information regarding other materials or facilities, thus expanding overall insight into the country's full program.

Such options could be combined (with respect to scope) to constitute an ad hoc, successive approach and (with respect to timing) to compose a gradual process of phased provisions of information, access, and implementation of verification. This approach could have the effect of ratcheting up the implementation of safeguards gradually by expanding coverage, producing more detailed information on the quantities and characteristics of North Korea's nuclear materials and facilities, encompassing increasingly sensitive items for Pyongyang, producing over time a complete history of the full scope of the country's programs, and helping move verification conclusions from partial to full confidence.

BENEFITS, RISKS, AND CONDITIONS

Such successive and gradual approaches to eventual comprehensive safeguards offer some real benefits. They could have verification significance, albeit less significance than comprehensive safeguards, and they could have value as confidence-building measures in a progressive denuclearization process. Furthermore, these approaches could be well-suited and tailored to support a process likely to be long and progressive, while offering a range of negotiation options. Importantly, all verification and monitoring measures need not be defined upfront; they can be agreed upon and implemented progressively (if this approach fits within the general scope of a potential future agreement). Finally, these approaches may allow an earlier and easier introduction of IAEA verification in North Korea than would be the case if more demanding measures were required up front.

Beyond these benefits, policymakers should be aware that these approaches carry specific risks. These approaches would likely be more susceptible to deception than comprehensive verification. They would offer lower probabilities of detecting noncompliance, may offer less conclusive findings, and they may increase the risks of false positive or negative conclusions. In addition, if not designed and implemented with great caution, they may lead to the irreparable loss of information resulting in the loss of completeness in the knowledge of past and present North Korean activities. Overall, these measures may be deemed to produce insufficient confidence, a limitation that would be compounded by the fact that partial confidence and associated probabilities are conceptually more difficult to apply in practice and may be misinterpreted, notably at political levels. These risks and their potential consequences, as well as possible mitigation measures, would have to be thoroughly analyzed in an overall assessment.

In addition, several conditions would have to be taken into account in defining such approaches. They would have to be compatible with and designed toward the final objective of implementing comprehensive IAEA safeguards in North Korea. In particular, the fact that safeguarding measures or information may be incomplete along the way should not compromise the possibility of eventually reaching completeness, and North Korea would need to agree to preserve the information needed for the IAEA to draw its conclusions. Also, to account for the conceptual difficulties and risks of misinterpretation with respect to partial confidence and associated probabilities, the remaining possibility of false positive or negative conclusions should be factored into analysis and decisionmaking. Overall, such technical approaches would have to be thoroughly defined and presented so as to adequately inform political decisionmaking.

Finally, if such approaches were to be implemented, several broader points would have to be considered, including the role of the IAEA, the agency's relationship to the P5 countries (particularly for the verification of North Korea's nuclear arsenal), and the role of other actors or mechanisms. The acceptability of deviations from standard safeguards implementation and the associated risks would have to be assessed along with how discrepancies and potential noncompliance would be managed. In addition, successive and phased safeguards would obviously have to fit with broader phasing issues, both technical and political.

CONCLUSION

Safeguards could be implemented in North Korea according to successive and gradual schemes. Such approaches could allow small steps that may be useful and necessary in a progressive denuclearization process while maintaining both verification significance and value as confidence-building measures. However, their political feasibility and acceptability, as well as their associated technical and political risks, would have to be thoroughly analyzed. In any event, comprehensive safeguards in North Korea should remain the standard and the final objective.

CHAPTER 3

MONITORING NORTH KOREAN NUCLEAR WARHEADS

ALEX GLASER

In his 2018 New Year's Day speech, North Korean leader Kim Jong Un called for the country to "mass-produce" nuclear warheads.[14] As North Korea continues to make fissile material and build out an increasingly diverse array of nuclear delivery systems, its growing warhead stockpile will need to be addressed in any future arms control or denuclearization agreement. Meanwhile, U.S. President Joe Biden will reportedly not seek a "grand bargain" with North Korea and instead will consider a "calibrated practical approach," which may include several steps by various stakeholders and will likely take, even in the best of cases, multiple years to implement.[15] As a result, policymakers and negotiators should be prepared to verify and monitor limits on several aspects of North Korea's growing stockpile of nuclear warheads.

A potential agreement with North Korea may include several potential verification and monitoring procedures confirming limits on (and monitored storage of) nuclear warheads or other items, such as ballistic missiles and launch vehicles. Moreover, negotiators may seek to verify the nondeployed status of nuclear weapons, which could be packaged with the monitored storage of nuclear warheads. One idea, for instance, could be to separate warheads and delivery vehicles geographically and to confirm their locations periodically by openly displaying randomly selected items, such as mobile missile launchers. Further down the line, verifying the dismantlement of nuclear warheads—followed by monitored storage, removal, or disposition of fissile materials recovered from these weapons—would be preferable and probably would be considered necessary. Finally, to complete this process, inspectors would seek to confirm the completeness of North Korea's declarations and inventories of its nuclear activities; this could involve methods of nuclear archaeology to reconstruct the history of the program. These methods were once considered as part of a U.S. proposal in 2008 to verify the plutonium declaration that North Korea had made earlier that year.[16]

Unfortunately, there are no true precedents for warhead monitoring in North Korea to build upon. There were some bilateral efforts between Russia and the United States in the 1990s to explore potential warhead monitoring and verification measures, but these attempts were abandoned at an early stage.[17] Even though an arms control or comprehensive denuclearization agreement with North Korea does not currently appear imminent, especially one that would include warhead monitoring and dismantlement, it is still important now to begin considering several basic principles for verification approaches and technologies to support policymakers and negotiators.

REQUIREMENTS FOR RELEVANT MONITORING CONCEPTS AND TECHNOLOGIES

There have been long-standing R&D efforts to support advanced warhead monitoring concepts and related verification technologies, and these efforts may offer new and innovative solutions in the coming years. If an agreement with North Korea is reached, however, a different set of criteria or priorities may apply.

First, critical verification technologies ought to be available for rapid deployment and for initial measures: simplicity trumps ingenuity. Driven by the potential urgency and, to some extent, the uncertainty of what will be required, technologies and concepts that are most relevant for the case of North Korea ought to be available off the shelf and ready for deployment as soon as they are needed.

Second, negotiators must be sensitive to the issue of intrusiveness in seeking to verify and monitor agreements with North Korea. Pyongyang is likely to object to an approach that is inspired by comprehensive safeguards. At the same time, the early presence of large numbers of inspectors at many sites would likely generate more questions and concerns than immediate answers. Overall, it appears preferable to minimize the frequency of onsite inspections and direct access to items, at least in the early phases of the process. Instead, a gradual phase-in of such activities may be preferable.

Third, Pyongyang may seek to preserve secrecy pertaining to design information and the role of specific facilities (among other issues). In particular, North Korea may not want to give away exact storage locations (namely, the GPS coordinates) of monitored items or, at least, not the coordinates of all such items at the same time. It may therefore be important to devise concepts that allow reasonable amounts of what could be termed privacy without compromising overall verification objectives.

Finally, it could be advantageous to be able to offer some reciprocity when considering monitoring concepts, verification approaches, and perhaps even elimination technologies. The elimination of solid rocket motors, the conversion or elimination of liquid rocket fuel, and the safe disassembly of warheads and down blending of materials can be complex processes that could offer opportunities for reciprocal exchanges. This back-and-forth negotiating could be particularly challenging in the North Korean context, and in the case of warhead monitoring in particular, where there are stark asymmetries in terms of the negotiating parties' demands, expectations, and capabilities.

With these criteria and caveats in mind, one can start to explore some possible warhead monitoring options.

DIFFERENT WAYS OF CONFIRMING WARHEAD NUMERICAL LIMITS OR NONDEPLOYED STATUS

There are several approaches that could be used to confirm numerical limits or the nondeployed status of nuclear weapons. The discussion below highlights concepts that minimize onsite access of inspectors to facilitate early adoption of verification measures while providing some confidence in the nondeployed status of certain systems. Naturally, these measures cannot be as robust as other approaches based on more traditional concepts—such as those in IAEA safeguards, for example—but they could be particularly valuable as a confidence-building measure. This may be especially true in the case of North Korea, where cooperation on verification has historically been difficult to achieve.

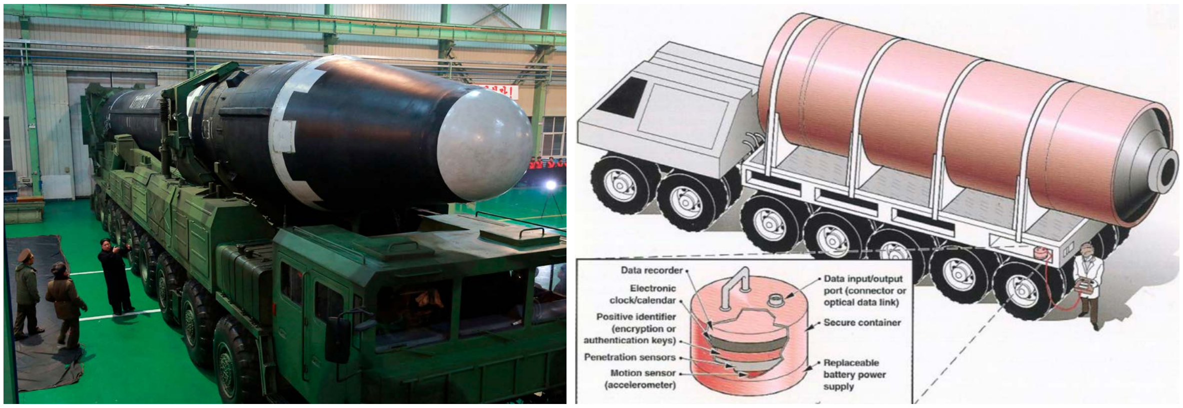
Absence Regime With Baseline Declarations

The most basic approach to confirming numerical limits is to rely solely on baseline declarations followed by notifications and regular data exchanges, which could be modeled, for example, on the procedures developed for the 2010 Strategic Arms Reduction Treaty (New START) signed by the United States and Russia. In the case of New START, since the treaty entered into force, the parties have exchanged tens of thousands of notifications.[18] Declarations of total numbers are made on a biannual basis.

While New START only deals with deployed strategic weapons, this basic concept could in principle be expanded to include warheads that are in storage. During an inspection of a selected site, the host would get credit, so to speak, for disclosing the number of items declared for that site and identifying those items as such. In other words, if North Korea declared a certain number of items for a particular site, then that many items would also be expected and accepted. These declared items would be considered treaty-accountable items and never accessed or inspected. The inspectors would then be allowed to confirm that other items available at the site are *not* treaty accountable. Of course, if a site was declared not to hold any warheads or other treaty-accountable items, then none should be found. For this approach, no tags or seals are needed, and no treaty-accountable items are ever directly accessed or inspected.

Such an approach only provides moderate confidence in confirming a country's total weapons inventory, especially in the early phases of an agreement, but this method could be implemented with very little preparation and with minimal requirements for inspection equipment. The approach could be strengthened over time by, for example, tagging items as North Korea becomes more comfortable with the process and the procedures; one particular tagging concept, known as the buddy tag, is illustrated in figure 1 below.

Figure 1. Applying Buddy Tags to North Korean Missiles



Left: North Korea's Hwasong-15 missile on its transporter erector launcher. Confirming limits on such launchers may be a key part of a future agreement with North Korea. (Photo: Korean Central News Agency/Korea News Service via AP, File).

Right: An artist's depiction of the buddy-tag concept supporting verification of limits on mobile missile launchers. In a tagging regime using buddy tags, a party would declare a certain number of items (launchers or warheads) and receive exactly one unique and unclonable tag for each. The monitored party would then co-locate these tags with the items and must be able to produce them during an inspection. Source: Reprinted with permission of the artist, Jim Fuller, via U.S. Department of Energy. For a more detailed discussion, see Alexander Glasser and Moritz Kütt, "Verifying Deep Reductions in the Nuclear Arsenals: Development and Demonstration of a Motion-Detection Subsystem for a 'Buddy Tag' Using Non-Export Controlled Accelerometers," IEEE Sensors Journal 20, no. 13 (July 2020), https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9025267.

Another related option would be for North Korea to gradually reduce the size of its nuclear weapons complex without revealing where exactly its nuclear weapons and long-range ballistic missiles remain. This approach would entail removing such items from various sites and corralling them at a facility or limited number of facilities that would be off-limits to inspectors. It would only offer inspectors access to sites that have been cleaned out, so to speak. North Korea could keep the sites it considers most important for last.

This plan builds on the concept of deferred verification, which envisions a closed segment, where all military activities take place and no inspection is ever carried out, and an open segment, which would be entirely accessible to inspectors with no undeclared materials, items, or facilities.[19] This concept would give North Korea the most flexibility, but it would not directly confirm any reductions or eliminations, instead providing only limited confidence that the number of facilities and locations supporting the country's nuclear weapons complex would be reduced.

Remote Monitoring of Treaty-Accountable Items

In the early stages of an agreement, while providing baseline information on the size of its stockpiles, North Korea may not want to reveal the storage locations of its nuclear warheads, warhead components, and long-range missiles. As a major confidence-building measure, and to demonstrate a sensitivity to North Korean concerns regarding intrusiveness and privacy early on, such items could still be accounted for while in storage.[20] For example, warheads could be brought from their storage location(s) to some agreed-upon sites, placed in containers with agreed-upon special electronic or optical seals, and returned to their secret locations. For each warhead, radiation measurements could confirm that items declared as nuclear warheads or components have signatures consistent with items containing kilogram-sized quantities of plutonium and/or uranium. Periodically, North Korean officials could prove that these seals have not been removed—even without granting inspectors access to the containers—by presenting randomly selected items again for physical inspection.

Secure Virtual Inspections

Another possible approach to conducting inspections at sensitive nuclear facilities could be to have only the host access the site while the inspector follows the activities remotely—either from directly outside the facility or even from a distant location (possibly without traveling abroad at all). Communication between the host and the inspector could be established using various methods and technologies. A straightforward method would be a live video stream, but other technologies could also be considered. The main advantage of this concept of "secure virtual inspections" could be to avoid granting inspectors any access to facilities that are considered particularly sensitive.[21] There are many ways to prove that a video stream is live and that the transmitted data has not been tampered with. For example, the host country inspector could display a unique identifier or random totem object during the inspection operation to verify the video feed's authenticity.

It is worth noting that such a concept could have similar benefits for arms control inspections in other contexts—such as bilateral U.S.-Russia agreements—and possibly also for standard IAEA safeguards. Transmitting live video or other data streams may come with its own security concerns, however. In this case, it is not clear which aspects of a particular approach North Korean negotiators would consider appealing or problematic, and it may therefore be particularly useful to have a broader menu of warhead monitoring options available.

VERIFYING THE DISMANTLEMENT OF NUCLEAR WARHEADS

A more long-term objective concerns the dismantlement of North Korea's existing warheads. Despite the aspirational nature of this goal, policymakers should understand the tools available for a verified dismantlement of warheads separately from other provisions, such as a production freeze on fissile material or some form of monitored warhead storage.

Some have argued that North Korean weapons ought to be shipped out of the country for storage and dismantlement elsewhere. For example, in May 2018, then U.S. national security adviser John Bolton suggested that North Korean denuclearization means "getting rid of all the nuclear weapons, dismantling them, taking them to Oakridge, Tennessee."[22] However, little is known about the safety and security features of these devices. As Siegfried Hecker and his colleagues rightly observed in 2018, "the weapons must be disassembled by the people who assembled them."[23] This is true for the North Korean case just as it is true for any other nuclear weapon state; unless there is a true emergency, it is hard to imagine a situation where international shipments and foreign handling of nuclear weapons would be preferable to an approach that involves local personnel and facilities.

One approach could be for North Korea simply to deliver nuclear weapons to be dismantled in the presence of inspectors at an agreed-upon facility or submit a specified amount of plutonium and highly enriched uranium recovered from dismantled warheads for international safeguarding.[24] Eventually, the amount of fissile material submitted would have to match the amount and composition of the material declared to have been produced and used for weapons. Some material would have been lost in weapons production and consumed in tests.

If the presence of inspectors during dismantlement is considered critical, one option could be to use a technique sometimes referred to as a black box. This approach involves a secure building or room that is designed specifically for the purpose of concealing an operation within a defined space. For example, it could only have a single point of access. Such a room could be swept for hidden objects or secret passageways beforehand. North Korean experts would then conduct all dismantlement activities in private, so to speak, after which the room would be swept again to ensure that all fissile materials (and, if applicable, tritium) have been recovered. Even if North Korea would allow more direct involvement of third parties in the process, it's unclear whether international inspectors would want to be present during the dismantlement of these devices.

CONCLUSION

A North Korean denuclearization or even a freeze of its nuclear program will be a complex political process which, even in the best case, is likely to take many years to negotiate and implement. Concepts are needed to monitor the existing stockpile of weapons and, in particular, perhaps to confirm its non-deployed status. This article has outlined a few concepts that could be used to do so. Given the complicated history with North Korea, simple and non-intrusive approaches to monitoring and verification may be a more realistic and therefore preferable short-term goal. Initially, these measures may not be very robust, but they could lay the foundation for a cooperative relationship with North Korea. Over time, these measures could be strengthened, but the very first step toward nuclear verification may be the most difficult but also most important part of such a process.

CHAPTER 4

THE MERITS OF PROBABILISTIC VERIFICATION IN COMPLEX CASES LIKE NORTH KOREA

THOMAS MACDONALD

Apart from the well-rehearsed scenario of a freeze on plutonium production at North Korea's Yongbyon facility, any prospective agreement that freezes or otherwise proscribes activity in other parts of North Korea's nuclear weapons complex would involve far more complicated issues of monitoring and verification. Especially if an agreement were to get into issues on missile forces or weapons-related R&D—both of which would be necessary to ultimately reach denuclearization—novel and innovative approaches would be needed for monitoring, assessing, and ultimately verifying North Korea's compliance.

Probabilistic verification offers a compelling alternative. It is a framework for verifying complex nuclear agreements in conditions where access and confidence are limited—as is likely to be the case in any near-term scenario with North Korea. If an agreement with Pyongyang is pursued, policymakers and negotiators should keep the virtues of probabilistic verification in mind as they consider how to approach verification and monitoring.

THE TRADITIONAL APPROACH TO VERIFICATION

Verification is the process of deciding whether to believe a party is meeting their commitments under an agreement. This process is often informed by monitoring systems, including sensors that detect anomalous or noncompliant behavior. For example, a sensor that measures the enrichment levels of uranium hexafluoride gas could serve as part of a monitoring system for verifying an agreement designed to prevent a country from producing highly enriched uranium.

Monitoring and verification have historically been approached by focusing narrowly on monitoring a small handful of activities where a breach of the agreement could be easily detected with high confidence. For example, under the Joint Comprehensive Plan of Action with Iran, uranium enrichment at the country's Natanz facility was monitored with an online enrichment monitoring system that could detect if Iran were enriching above acceptable limits in real time.[25] This is an effective approach to verification that has been successfully applied to arms control agreements over the years. However, it suffers from key problems in the context of North Korea, owing to the breadth and complexity of the country's nuclear program, limited outside knowledge of the program's elements, potentially limited onsite access for inspectors, and the lack of trust between the negotiating parties.

This narrow approach can only be applied to verifying agreements when the activities being limited can be monitored with high confidence. Limits on deployed U.S. and Russian nuclear warheads and delivery systems under the 2010 Strategic Arms Reduction Treaty (New START), for example, are straightforward to monitor with a combination of overhead imagery and onsite inspections.

Some activities, however, do not lend themselves to easy monitoring. Difficulties may arise when limits are placed on small objects that are easy to hide (such as nondeployed nuclear warheads), where there is ambiguity about an object's purpose (as with dual-use technologies), or because the activity is inherently low in visibility (in cases of certain weaponization activities, such as hydrodynamic calculations). Achieving high confidence in monitoring under these conditions, if even possible, may require a level of intrusiveness that may not be politically acceptable.

This narrow approach can also conflate verification and monitoring. While it may be attractive to interpret a detection of a breach by a monitoring system as definitive proof of a breach in the relevant agreement, compliance assessments are ultimately political judgment calls. All monitoring systems are imperfect—and missed detections and false alarms are inevitable—so no individual piece of data is above reproach. False alarms can be politically damaging to an agreement as they undermine trust on both sides. Taking a reductive view of monitoring and verification—namely, that something is only verifiable if it can be monitored with high confidence—ignores the fact that human judgment is a necessary component in any compliance assessment.

These challenges are particularly acute in the case of North Korea. Depending on the precise scope of an agreement with Pyongyang, there may be a wide array of items and activities that would need to be monitored (including fissile material, warheads, and ballistic missiles), each of which would be more or less difficult to monitor. North Korean concerns over the intrusiveness of verification and monitoring efforts and security will only complicate matters further. They will likely object to large numbers of inspectors on the ground or highly intrusive monitoring methods that may be required to achieve monitoring with a high degree of confidence.

THE ALTERNATIVE OF PROBABILISTIC VERIFICATION

Probabilistic verification embraces the fact that well-informed expert judgment is an integral part of a verification regime. Rather than only considering activities that can be monitored with a high degree of confidence and making compliance decisions only based on those monitoring systems, probabilistic verification seeks to assess compliance with the whole of an agreement by considering and assimilating all sources of information, even those that may be of a low or intermediate degree of confidence. Assessing all available information builds context for compliance decisions, creating the flexibility to verify complex agreements.

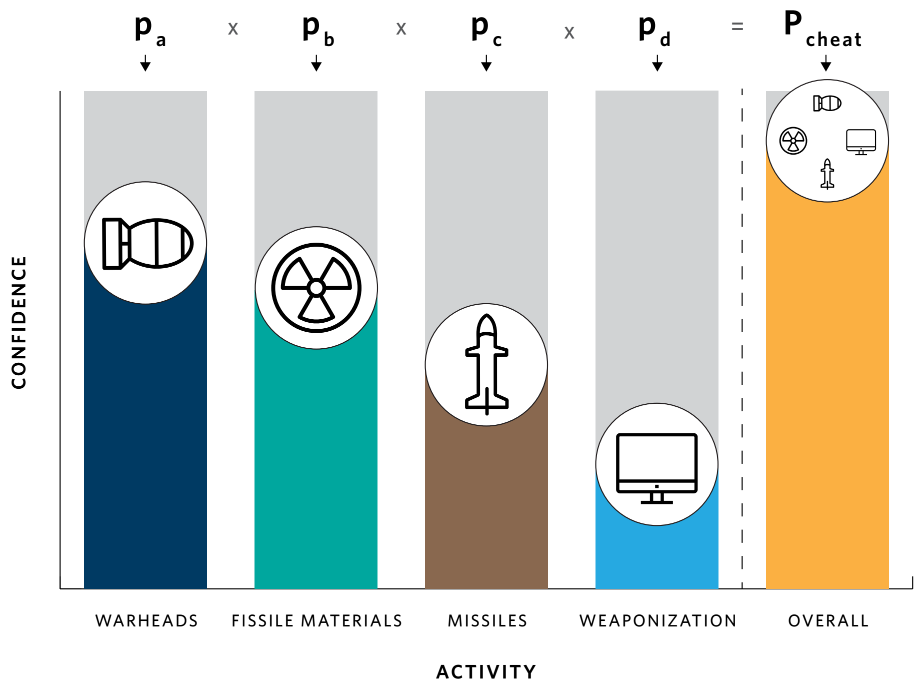
The narrow approach to verification has a strict requirement for high confidence monitoring of all activities that are covered by an agreement. If an activity cannot be individually monitored with sufficient confidence, it may be excluded from an agreement or the agreement may be contorted to fit the capabilities of the requisite monitoring systems. For example, the 1987 Intermediate-Range Nuclear Forces Treaty was negotiated to blunt the proliferation of intermediate-range, ground-launched nuclear missiles. However, monitoring systems were not capable of distinguishing nuclear and non-nuclear weapons of the same range capability without a politically unacceptable level of intrusiveness. As such, the agreement banned both nuclear and non-nuclear intermediate-range weapons and ultimately fell apart some years later after Russia developed and fielded an intermediate-range, ground-launched cruise missile. Building agreements around verification capabilities can undermine the effectiveness and durability of the agreements themselves.

Instead, agreements should be designed first and foremost with political objectives in mind. If it is valuable to proscribe an activity in an agreement, it should be proscribed even if a country's compliance on that individual activity cannot be monitored with high confidence. Verification should be assessed at the broader level of the entire agreement. So long as limits are set in such a way that gaining a meaningful advantage by cheating requires evading multiple monitoring systems, then one's overall confidence that cheating would be detected will exceed one's confidence in any individual monitoring system.

For example, if, as part of a denuclearization agreement, limits or prohibitions were placed on North Korean warheads, ballistic missiles, and transporter erector launchers (TELs), then reconstituting or increasing the country's number of nuclear-armed TEL-transported missiles would require cheating on each of these limits. Gaining a meaningful advantage by cheating without being detected would require evading the monitoring of all three activities in concert, an inherently more difficult prospect than evading detection on any single activity (see figure 2).

Assume hypothetically, for instance, that North Korea perceived that the chances of being able to cheat without getting caught was 50 percent on each activity—a coin flip. If that were the case, then Pyongyang's perceived chances of getting away with cheating on all three activities would be the same as winning three consecutive coin flips (only 12.5 percent). Even if certain activities can only be monitored with low confidence, such an approach still helps increase the overall probability of detecting cheating. Further, by increasing both the probability of detection and the complexity of cheating, cheating can be more strongly deterred in the first place.

Figure 2. The Merits of Probabilistic Verification



Probabilistic verification is a layered, or defense-in-depth, approach to verification. A real-world analogy of such a concept in practice can be found in airport security. Airport security is ensured by layering multiple security measures. The most obvious layers of security at an airport are at the security checkpoint. A passenger's identity is confirmed with photo identification, their bags are x-rayed, and the passenger passes through a metal detector or millimeter-wave scanner. This layer can be rather porous or easily dismissed as security theater. Millimeter-wave scanners have been known to struggle to detect handguns hidden in a particular way, for example.[26]

However, there are multiple other layers of security, many of which may not be outwardly obvious. When tickets are purchased, they are linked to a credit card and identity that can be checked against no-fly lists. Within the terminal itself, behavior can be monitored either by patrolling police or closed-circuit television cameras. Additionally, there may be drug- and explosive-sniffing dogs present. Each of these layers may be prone to failure by itself, but collectively they can make malfeasance difficult enough that travelers and airport operators alike feel they have a sufficient level of security. This system can also create enough doubt in the minds of would-be perpetrators to have a significant deterrent effect, which strengthens the robustness of the system as a whole.

There is a recognition in probabilistic verification that there is a separation between monitoring systems and verification. While monitoring systems provide information, verification requires a compliance assessment. In such an assessment, all information available from monitoring systems, along with contextual information, is combined with expert analysis and judgment to reach a decision on whether or not a given agreement as a whole is being complied with. This process would mirror conventional intelligence assessments, a process for which there is much experience and expertise to draw on. Such assessments are implicitly part of any verification process, but probabilistic verification makes this element of the process explicit to better clarify the assumptions underpinning monitoring and verification.

CONCLUSION

Probabilistic verification provides a framework for approaching the verification and monitoring of complex and difficult agreements. The traditional approach to verification would be hindered in the case of North Korea due to both the variety of items that would need to be included and the potential for limited confidence in the requisite monitoring systems. By contrast, probabilistic verification can handle—and make use of—monitoring systems that can only achieve low levels of confidence. This does not mean that high confidence monitoring should not be sought wherever possible or that an overall low degree of confidence in the ability to detect a breach of the agreement should be accepted. It only means that probabilistic verification has the flexibility to allow political goals—not monitoring systems—to shape a future agreement with North Korea.

CHAPTER 5

USING OPEN-SOURCE INTELLIGENCE TO VERIFY A FUTURE AGREEMENT WITH NORTH KOREA

MELISSA HANHAM

Publicly available information has long been used in intelligence tradecraft, but the growing capabilities of open-source information in civil society means it has a new and positive role to play in diplomacy and arms control with North Korea. Open-source intelligence (OSINT) can be defined as information that is not derived from classified sources. It can be found in the public domain in speeches or government documents, for example. Commercially available data like satellite images, photos, video, news articles, and trade data are also increasingly available at a price point that universities and NGOs can afford. New sensors and data sources are creating ever-growing possibilities for verification, and the human capacity of government officials and other actors alike to handle this data is also growing. Civil society now regularly provides arms control and proliferation analysis on North Korea, a trend that was only emerging a decade ago.

OSINT has numerous benefits if used properly. By its nature, OSINT is not classified and therefore can be shared not only with allies and international organizations but also with adversaries to enable dialogue on arms control and disarmament issues. It is not a replacement for traditional intelligence methods or onsite inspectors; rather, it can act as a complementary source of information to boost transparency with the public, build trust with adversaries, and improve inter- and intra-governmental coordination and efficiency on verification. After decades of negotiations with North Korea with little or no success, OSINT can provide a fresh way of communication that builds trust toward an eventual agreement, while also offering additional support to traditional verification methods if and when an agreement is reached.

THE BENEFITS OF OPEN-SOURCE INTELLIGENCE

OSINT is publicly verifiable and can be proven or disproven without revealing government intelligence sources or methods. OSINT experts and practitioners in civil society actively debate findings and each other's methods—often on social media—in a transparent way that can build confidence in such assessments. Furthermore, because many of these discussions are happening on social media, global participation and diverse types of expertise (technical, linguistic, and local knowledge, for example) can be applied. Because this manner of debate and problem solving happens in real time, this work occurs rapidly, sometimes more rapidly than traditional intelligence can be collected, analyzed, and vetted for consumption by policymakers or ultimately for release to the public.

OSINT has two major contributions for potential future agreements with North Korea. First, it can help build trust ahead of the conclusion of an agreement. For example, the United States can provide OSINT evidence of its own activities around the Korean Peninsula to build confidence toward a stage where official security guarantees could be negotiated. The relationship between the United States and North Korea is so fraught that trust-building activities should be seized upon as soon as possible. Even without direct participation by North Korea, civil society in the United States and the other former participants in the Six Party Talks—China, Japan, Russia, and South Korea—can begin providing open-source assessments for crisis scenarios. The greatest risk of nuclear escalation on the Korean Peninsula is due to an accident or miscalculation stemming from scenarios ranging from a natural disaster to a limited military exchange leading to a rapid escalation.[27] By regularly and publicly analyzing not only their own but also North Korea's perceived threats in a transparent format, members of civil society from these countries can begin to test potential mechanisms for an eventual agreement.

Tabletop exercises in a track 2 or track 1.5 format that focus on crisis scenarios or mock negotiations could be simulated with the participation of local universities and think tanks in the region with real OSINT analysis. These exercises could even produce a public readout. Though not official, they would provide North Korea with ideas about how its neighbors would react in various situations and perhaps illuminate to the regional parties which negotiation tactics and terms are most relevant. North Korea may not choose to join tabletop exercises or mock negotiations on such sensitive topics. Creating tabletop exercises on other, non-nuclear topics, like vaccine distribution and flood mitigation, would provide a lower-stakes opening for collaboration. Ties between North Korea and NGOs in some European countries already exist. As trust is built, exercises could gradually take on crisis scenarios related to natural disasters and nuclear safety, for example. In time, civil society may be in a position to gauge the desirability and political commitment to security guarantees that can benefit all parties in the region.

Second, OSINT can make a real contribution to the verification and monitoring of an eventual negotiated agreement. To do so, OSINT data and methods should be baked into the agreement from the start to augment rather than undermine other forms of closed-source verification. The 2015 Joint Comprehensive Plan of Action with Iran has already shown that investigative journalists and think tank researchers will use OSINT regardless of whether or not such methods are in the agreement in question. It is therefore best to provide channels where OSINT analysis can be used constructively (such as in compliance commission discussions) rather than used by spoilers to second-guess those tasked with verification. A final agreement may, for instance, include provisions allowing for North Korea to verify security guarantees provided by the United States, such as changes in equipment or personnel deployments. OSINT can be a useful way of facilitating information exchanges on troop levels and readiness exercises or even a way of reconfirming the 1991 withdrawal of U.S. nuclear weapons from the Korean Peninsula.

Additionally, OSINT can help negotiators to balance the aspects of negotiations that are most important for preventing proliferation with those that are most readily measurable with current verification technology. Inspectors on the ground have much higher fidelity with instrumentation, while OSINT can be extremely effective for multisensor monitoring of above-ground nuclear and missile facilities using commercial space-based sensors, for example. Commercial sensors today outnumber military sensors and provide greater frequency of coverage with the availability of high-cadence imagery on a daily or even more frequent basis.[28] U.S. reconnaissance sensors still outpace the spatial resolution (which can be thought of as "sharpness" of an image) of commercial satellite imagery. Even though U.S. commercial satellite companies are not permitted to show objects smaller than approximately 30 centimeters by 30 centimeters under U.S. export control regulations, high resolution commercial satellite imagery is still capable of monitoring objects like buildings and vehicles, making it sufficient for verification of nuclear and missile facilities without revealing U.S. military satellite capabilities. Despite export controls and sanctions, the data should be vetted, licensed, and made available to all parties to the agreement (including North Korea) to reduce information asymmetries and build trust.

Lastly, OSINT can complement the verification process after an agreement is concluded. Technological advances and the sheer number of sources for data are exploding in the commercial sector. Governments should adopt OSINT into their own analysis for this reason alone. Further, verification questions and challenges can be addressed transparently with OSINT information that can be shared and verified without revealing sources and methods. Finally, OSINT can improve the efficiency and robustness of onsite inspectors' work.

OSINT SENSORS AND NOVEL APPROACHES

A variety of OSINT technologies and methodologies are increasingly available to civil society. Electro-optical sensors capture visible light in shades of red, green, and blue seen by the naked eye as well as light outside of the visible spectrum, which can be false-colored (which means colored with light humans can see) for analysis.[29] Near-infrared light has proven useful for monitoring traditional camouflage, identifying burn scars from missile tests, and tracking unusual logging activities at North Korea's Punggye-ri nuclear test site, for instance.[30] Thermal infrared sensors on the United States Geological Survey's Landsat satellites, though weak compared to military sensors, can additionally monitor heat signatures through their publicly available imagery.[31] With cooperation from North Korea, onsite inspectors could take measurements of roof temperatures of buildings involved in the fuel cycle like the 5 megawatt electric reactor at Yongbyon—and then could continually monitor the facility from space to see if these buildings are operating within acceptable limits or not.[32]

Hyperspectral sensors, though still emerging in the commercial sector, can capture many slices of the electromagnetic spectrum, allowing them to identify the chemical signatures of materials on the ground.[33] One such sensor called the DLR Earth Sensing Imaging Spectrometer is located on the International Space Station. Just as parties to the Open Skies Treaty inspected aerial sensors and jointly conducted verification activities on aircraft, someday parties may seek to inspect or install their own sensors on the International Space Station.

Synthetic aperture radar—which does not rely on sunlight like electro-optical imagery does—works at night, through cloud cover, and even through some light roofing materials, as Allison Puccioni pointed out in an article that showed North Korea stacking an Unha rocket through the roof of its launch tower at Sohae.[34] Synthetic aperture radar images can also be mixed temporally to show how the surface of the earth over North Korea's nuclear test site sunk after the most recent Punggye-ri nuclear test—and it can even be used to monitor container or vehicle movement.[35]

One criticism of commercial satellite imagery has been that the data could be tampered with for political gain. There is no evidence to suggest that North Korea has ever done this, but states such as Russia have questioned the reliability of imagery provided by states in IAEA safeguards settings. However, states that do not trust the sensors of a particular country can choose to receive data from any or all other commercial providers in other involved countries such as China, Japan, Russia, South Korea, and the United States (or beyond) to compare findings. While data from one sensor could be compromised theoretically, it is unlikely data from all sensors could be. States that are concerned about data being tampered with before it is distributed could require satellite companies to use advanced techniques in digital watermarking and reject images without it. Furthermore, photos and videos from North Korean state media are already regularly used to indicate fuel cycle activity and capabilities, which corroborates data coming from space. Additionally, scientific publications are scoured and networked with natural language processing techniques to reveal emerging technologies. This broad spectrum of sources and techniques makes it very difficult to spoof or discredit these OSINT techniques.

Focusing specifically on the nuclear fuel cycle, there are some facilities that are easier to monitor with OSINT techniques than others. Monitoring mining, milling, testing, and reactor activities are among the easier tasks, while enrichment, reprocessing, and warhead storage can be difficult because these latter activities have few signatures observable from afar other than traffic activity. OSINT tasking should therefore focus on leveraging its strengths and on supporting the work of onsite inspectors to help them act as effectively and efficiently as possible within the bounds of a future agreement with North Korea.

Missiles and submarines are still easier to monitor with OSINT techniques. Activities like the production of solid or liquid fuel, engine testing, launch setup, and missile storage and testing take place above ground and require specialized facilities with unique structures and heavy-duty roads with wide turning radii that make them relatively easy to spot. The movement of a site's gantry tower—or the portion of the launchpad that supports the missile—is already monitored closely, as is the presence of ships in ports.[36] However, North Korea has already developed an advanced shell game of continually moving its road mobile missiles through caves, warehouses, and highway underpasses. Transporter erector launchers are a chokepoint for missiles, as the number of missiles a country can launch is limited to the number of launchers it has before retaliation from an adversary destroys the vehicles. Thus, monitoring facilities for manufacturing heavy-duty vehicles and tanks has become a cottage industry among OSINT enthusiasts who seek to gauge how many launchers North Korea could produce. The Sinpo South Naval Yard, where North Korea refurbishes and maintains its submarines, has many easy-to-monitor sites that indicate the testing, production, and deployment of assets including the site's missile ejection test stand, large warehouses, dry docks, ports, submersible test barge, and the submarines themselves.[37]

CONCLUSION

OSINT analysis of any future deal with North Korea will happen regardless of whether it is desired by the framers of an agreement or not. Therefore, it is best to get ahead of the curve and embrace the many benefits that these techniques and tools offer by earmarking funds, providing resources for ethical tradecraft, cultivating human capital globally, and investing in access to data and tools for a diverse cross section of civil society. Some simple steps can be to provide training to OSINT analysts and journalists not just in the United States but also throughout Northeast Asia. Governments can also ease the financial and legal burdens of collecting and preserving North Korean media and licensing data for export. Building up an ethical, strong, and capable OSINT community has benefits to reaching, negotiating, and verifying future arms control agreements with North Korea.

CHAPTER 6

A NODAL MONITORING SYSTEM FOR ONSITE MONITORING AND VERIFICATION IN NORTH KOREA

PABLO GARCIA

North Korea's history of deception to clandestinely develop its nuclear weapons program suggests that any type of monitoring and verification system would require onsite monitoring to supplement open-source intelligence and U.S. national technical means. On-the-ground monitoring would be indispensable, especially for a broad-scope agreement.

Yet such a task poses notable challenges. Unlike verification monitoring systems that were developed for arms control agreements between the United States and Russia, verification for a North Korea agreement would require a system capable of capturing information about multiple small facilities that were originally designed to be hidden. In addition to monitoring fissile material production, onsite monitoring would also be needed at missile production facilities in support of a production ban and at military sites where nuclear items are located and where internal access is not granted.

One approach that could provide flexibility for a range of monitoring applications would be the development of a nodal monitoring system (NMS). Increasing verification R&D investments now in the development of such a system would be an adaptable way to strengthen confidence in any potential future agreement with North Korea.

ASSUMPTIONS ABOUT MONITORING IN NORTH KOREA

Policymakers and negotiators involved in future monitoring talks with North Korea should insist on obtaining physical access to monitor facilities and installations. To this end, they need to be ready to deploy a flexible and effective system to address onsite monitoring in situations where full access may be limited. Some desired key attributes for such a system can be identified based on several educated assumptions.

First, North Korea may grant access to only one or a very limited number of its installations. As a result, a suitable monitoring system may need to start small but be capable of expanding in size over time and if greater access is later granted. In addition, North Korea's nuclear weapons and missile complex has many different types of installations. These include R&D labs, test facilities, production and assembly facilities, and active military installations. In recognition of this complexity and breadth, a suitable approach would need to be adaptable and capable of being easily tailored to specific installations and the activities they host.

Second, the geographic distance between these North Korean facilities should be considered as well. North Korean installations that may be subject to monitoring and verification activities are spread out around the country and are located in remote areas without good infrastructure for the services that a monitoring system and its deployed personnel would require. Accordingly, this monitoring system would need to provide some cost-effective, self-supporting infrastructure services with very little or no reliance on local infrastructure.

Third, accurate information (especially from open sources) about North Korea's facilities is limited. Furthermore, trust between North Korea and other countries would be low early in the process of seeking verification, and relevant experts from other countries would likely have low confidence in information provided by North Korea for verification purposes. As a result, an effective monitoring system would need to be designed to circumvent deception and concealment.

Fourth, while North Korea would likely resist permitting a large group of onsite inspectors, there is a precedent for placing small numbers of inspectors at select locations. A verification system would need to minimize onsite staff and inspectors, and it must be planned in such a way as to extend remote monitoring where needed to cover wider areas. Inspectors should expect little to no cooperation and active attempts at concealment. The monitoring system should support probabilistic monitoring at key points and include strong anti-tampering capabilities.

Finally, onsite monitoring should be designed to last for a few years, and the system should be modular in design so that monitoring capabilities can evolve over time. Ensuring ways to sustain the monitoring system over the long term needs to be a design consideration from the start to minimize operational costs and to allow the system's capabilities to be refreshed when needed. The system should also be readily capable of adapting to monitor additional installations, to downsize, or even to face removal when monitoring is no longer required.

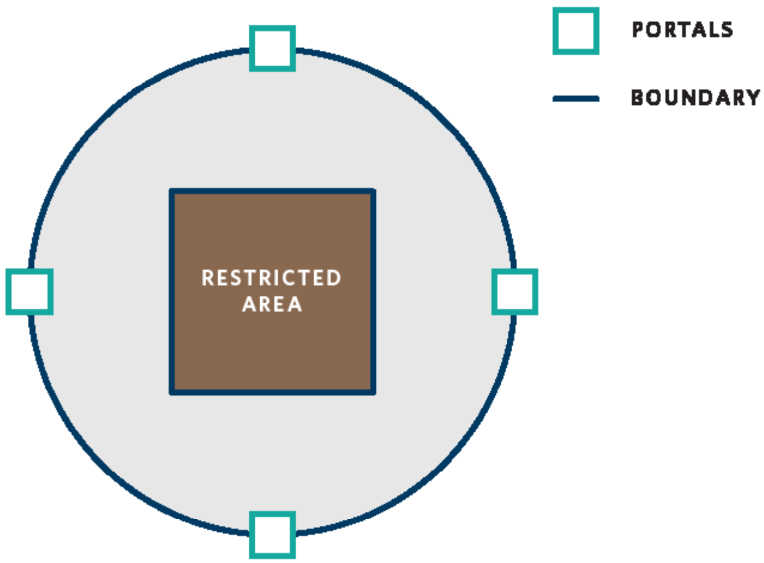
A systematic approach that is well thought out based on these assumptions and attributes would provide flexibility for future negotiations in support of a range of readily implementable options. Chiefly, verification could require an onsite monitoring system that allows for scalability and adaptability while maintaining robustness to prevent deception and tampering. Further, such an approach should be designed to require minimal deployed personnel, self-support in the field, and long-term sustainment.

DESIGN REQUIREMENTS FOR A NODAL MONITORING SYSTEM

The NMS concept was proposed by experts at the Center for Strategic Studies of the China Academy of Engineering Physics during a track 1.5 dialogue in 2018, held under the Chatham House rule. If designed and implemented correctly, the NMS could address the attributes listed above.

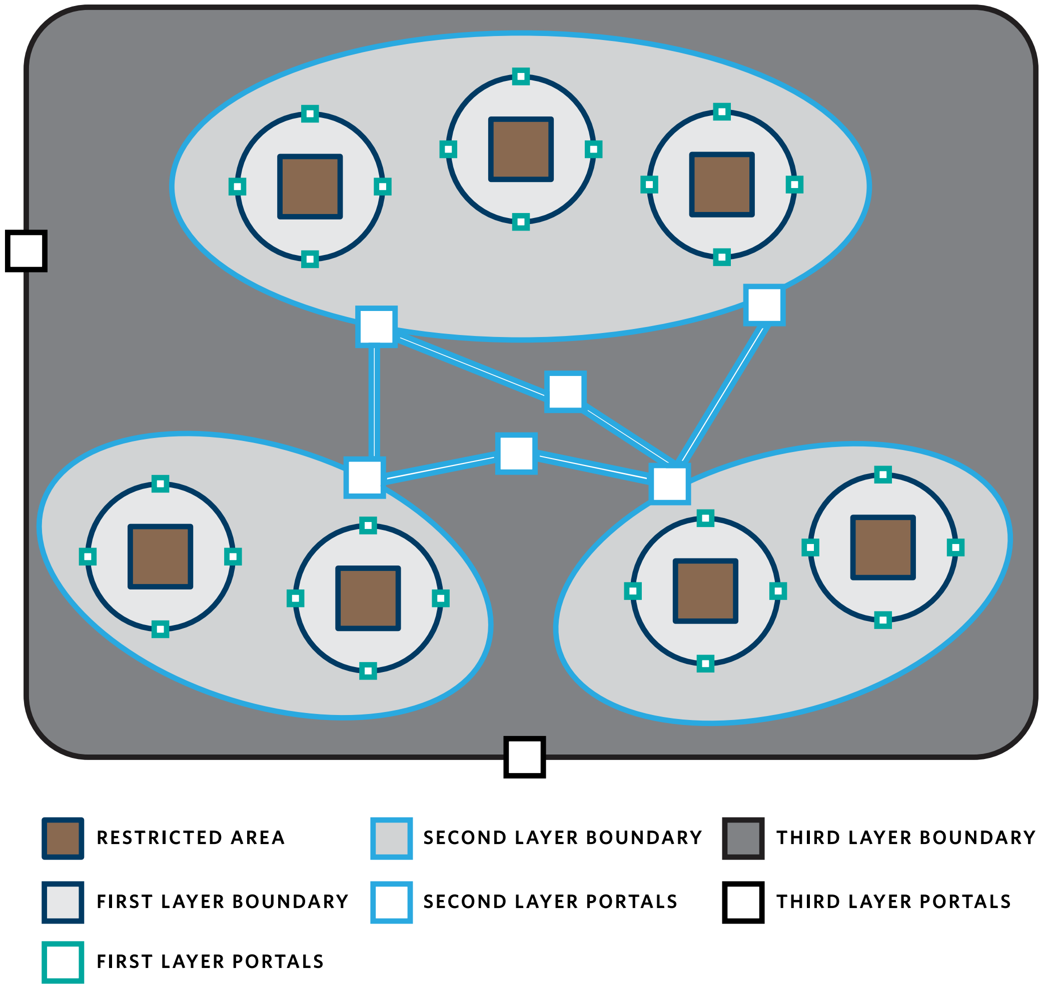
As shown in figure 3, a single node of an NMS is basically a continuous monitoring portal approach that involves one or multiple portals around the restricted area that is under observation. Each node would center on a restricted area to which inspectors are not granted access. The monitoring party would place a boundary around this area, a portal (or multiple portals) for inspecting incoming or outgoing items, sensors along the boundary to detect unapproved movement, and sensors at the portal(s) to screen for permitted or unpermitted items.

Figure 3. A Single Node in a Nodal Monitoring System



The NMS concept expands on this basic approach by nesting or layering multiple nodes, as shown in figure 4. Nodes could be added or removed over time if conditions such as trust, security, inventory, and permitted access were to change. This feature, while adding complexity, makes this concept scalable and adaptable—two of the key desirable characteristics stated above.

Figure 4. A Three-Layer Nodal Monitoring System



One potential model to monitor North Korea's nuclear program is the system that was employed in the Soviet Union during the Cold War. Over thirty years ago, U.S. inspectors employed continuous portal monitoring under the Intermediate-Range Nuclear Forces Treaty at a solid rocket motor production facility in the city of Votkinsk.[38] The design and operation of this monitoring system offers a wealth of experience applicable to the design and implementation of an NMS for North Korea, which could be considered an evolution of single-site or single-node continuous portal monitoring. After thirty years, many technical advances are now available that could be readily applied to reduce the requisite development costs and ensure the successful implementation of a more complex NMS, one that could be applied to multiple types of facilities and that could be used to screen for a variety of restricted items or materials.

Inevitably, successfully implementing an NMS in North Korea would pose certain challenges. The NMS concept is designed so that nodes can be dynamically added, removed, and even tailored for specific activities at a very granular level. But ensuring that the system has this flexibility means that adaptability must be prioritized from the outset of the design phase. Policymakers need to understand that limiting flexibility early on to curb costs would affect the future function and performance of the system as it evolves. Moreover, in addition to strong engineering and program management, the development team should include legal and treaty experts from the start to ensure that an NMS would be not only technically sound but also compliant with the terms of the treaty or agreement at play. Verification R&D investments made now would support the development of such a system, and making such investments could also provide negotiators and policymakers flexibility and leverage in future monitoring talks with North Korea.

Accordingly, a suitably crafted NMS would need to strike a balance between structure and flexibility through a modular design that would enable deployed inspectors to make future enhancements so they could take full advantage of the range of NMS capabilities. Doing tabletop exercises with mockups or with computer simulation tools to create digital twins as the NMS is developed would go a long way toward ensuring that the needs of inspectors are met as the situation on the ground changes.

Separately, the tailoring of each node would need to accommodate a wide range of geographies, node sizes, and item types. The target to be monitored can range from a large installation, a specific facility, or a building within an installation all the way down to a single room or vault. It could even be a specific item such as a warhead or mobile missile launcher. The nodes would need to make appropriate use of technologies to minimize personnel requirements, given likely limits on the number of permitted inspectors and other deployed personnel. Small nodes within the NMS architecture could be great candidates for unmanned or remote monitoring.

Finally, a robust architecture would be needed to connect the nodes within an installation and then to link those across installations or multiple regions. This architecture should ensure data and information integrity while enabling information sharing with partner entities that may be involved in supporting monitoring of an agreement with North Korea.

A WAY TO ENSURE RAPID IMPLEMENTATION AND SCALABILITY

It is plausible that an agreement with North Korea could first permit onsite monitoring access to a specific installation or a very limited number of installations. Policymakers and negotiators would want to be ready to deploy an NMS without significant delays so as to immediately capitalize on North Korea's commitments. By investing in the development of an NMS monitoring system now, potential monitoring parties could reduce the time required to implement the system once an agreement is reached. This would make it more difficult for North Korean facilities to employ concealment or deception between the time an agreement were reached and onsite monitoring were implemented.

One useful idea borrowed from physical security of critical facilities is to have the necessary key elements ready, integrated, and pretested for a fast initial implementation. Applied to the NMS, this could take the form of a node-in-a-box, designed for a rapid initial deployment. Once installed, a more comprehensive design and construction could follow, building on the initial deployed model. This arrangement would also provide a great opportunity to work with and build relationships with the monitored party at an early stage. Installations and facilities initially targeted for elimination as part of a treaty could be ideal candidates for initial NMS deployment sites.

A range of new technologies could facilitate a compact node-in-a-box and provide the foundations for a robust NMS. These include:

- low-power electronics and encrypted communications for sensor nodes;
- microgrids with renewable energy options to power the nodes at remote sites;
- network-based secured video cameras, microwave detectors, and other sensors for effective implementation of monitored boundaries or perimeters;
- small unmanned air vehicles for perimeter and boundary monitoring if such flights are allowed within approved corridors around monitored facilities;
- artificial intelligence–based analysis of inspection images and sensor data to reduce the burden on deployed personnel;
- blockchain solutions for authenticating data and ensuring the integrity of information;
- a secured Internet of Things network to connect nodes that are unattended or infrequently attended to;
- worldwide Wi-Fi coverage with systems like Starlink to provide communications capabilities at remote sites; and
- modern data architectures to enable adaptability, scalability, sustainability, and appropriate information sharing with treaty partners or other third parties as required, tying the whole system together.

CONCLUSION

One of the key advantages of the NMS concept is its modularity. This feature would allow the NMS to be applied not only to monitoring scenarios involving North Korea but conceivably also to future onsite monitoring activities in other regions.

Furthermore, the same modular characteristic would be useful in facilitating multilateral engagement, joint development, and cost sharing with regional partners. Even the monitored country—in this case, North Korea—could participate in design reviews, red-teaming, acceptance testing, and even the design of some of the system's elements within export-control limitations. Doing so would enable trust building and engagement with North Korea on a peer-to-peer level. North Korea's active participation in NMS design, inspection, and testing or exercises would also increase Pyongyang's confidence that the deployed monitoring system does not include any undeclared additional monitoring functionality. A joint or multilateral approach to development would instill confidence in the NMS design and implementation, while also ensuring that the model is transparent and readily accepted by all relevant parties.

CHAPTER 7

LESSONS FROM THE IRAN DEAL FOR NUCLEAR NEGOTIATIONS WITH NORTH KOREA

TOBY DALTON AND ANKIT PANDA

Despite major differences between the cases of Iran and North Korea, there are several useful observations from the lengthy talks between Iran and the P5+1 negotiating parties (China, France, Germany, Russia, the United Kingdom, and the United States) that might be applicable to future talks with North Korea. In particular, the innovative proscriptions and monitoring and verification provisions developed in the Joint Comprehensive Plan of Action (JCPOA) could be useful should North Korea agree to monitored constraints on its nuclear program.

DIFFERENT CASES, SIMILAR CHALLENGES

Iran has never produced nuclear weapons, despite conducting extensive R&D activities to support weapons acquisition. Even prior to the JCPOA, the international community—via International Atomic Energy Agency (IAEA) inspections pursuant to Iran's safeguards agreement—had a fairly comprehensive picture of Iran's nuclear program. With major unanswered questions about Iran's design work on nuclear weapons, however, JCPOA negotiators sought to bound Iran's fissile material accumulation and production potential and subject its nuclear activities to more rigorous IAEA monitoring. In this manner, Iran's nuclear program would maintain a peaceful veneer, and the timeline for Tehran's potential to break out of the agreement and produce nuclear weapons would be about one year, giving the international community time to mount a response.

In contrast to these goals, North Korea possesses an active and growing arsenal of nuclear weapons and a complex, dispersed supporting infrastructure with various elements. North Korea's nuclear activities have been effectively unmonitored for decades (aside from a few periods of partial monitoring), so baseline knowledge of its activities and inventories is poor, and it would be nearly impossible to reach certainty that all of the country's warheads, missiles, or fissile materials were accounted for. Even well-known facilities at the Yongbyon complex have gone unmonitored since the IAEA was last evicted from the country in April 2009. Much of what is known or believed about North Korea's nuclear activities (in the public domain, at least) is shaped by Pyongyang's propaganda efforts. There are major uncertainties about the locations of some activities, including the number of uranium enrichment facilities it operates. Meaningful constraints on North Korea's nuclear arsenal—as well as the consequences of Pyongyang breaking out of an agreement—would have to extend well beyond fissile material to other relevant activities, such as missile production. Finally, unlike Iran, North Korea appears not to trust the IAEA as an independent monitoring body of nuclear activities.[39]

Yet aspects of the two cases are similar enough that innovative elements of the JCPOA negotiations could provide useful lessons. For instance, with North Korea, negotiators would need to address a likely demand to permit trade activity in technology and goods that would flow into claimed peaceful nuclear and space activity; in the Iranian case, the JCPOA stipulated that nuclear-related imports were to be sent through an approved procurement channel in line with internationally established standards (see JCPOA Annex I, Section P).[40] Other similarities include establishing a prohibition on exports of nuclear weapons–related items and (perhaps) missiles, securing provisions to facilitate access to sensitive sites (see JCPOA Annex I, Section Q), and proscribing certain research activities that would permit qualitative improvements to the performance of nuclear weapons (see JCPOA Annex I, Section T).[41]

MONITORING IMPORTS

For Iran, relief from multilateral sanctions was an important negotiating objective, and presumably it would be for North Korea too. The P5+1 sought to monitor Iran's nuclear-related imports once the sanctions that banned such goods were removed while facilitating the few imports necessary to redesign Iran's 40 megawatt (thermal) heavy water reactor at Arak to be more proliferation-resistant—imports that would have remained otherwise prohibited by the UN Security Council (UNSC). UNSC Resolution 2231 satisfied the aims of both sides by removing the prior sanctions regime and the associated UN sanctions committee while also permitting imports of previously banned nuclear items, subject to P5+1 approval.[42] This resolution also established a channel for monitoring Iranian procurement facilitated by the UN secretariat, a channel that provided the P5+1 governments with information about requested transfers for their approval. In addition, the procurement channel ensured that the IAEA would be notified of certain nuclear imports relevant to safeguards in Iran.

For the P5+1, an important benefit of the procurement channel was the ability to partially shape Iran's nuclear activities through the control of imports for ten years starting when the JCPOA entered force. This channel also created a de facto understanding that any nuclear-related imports pursued by Iran outside the procurement channel would be suspicious and cause for evaluating Iran's compliance with the agreement's terms.

Implementation of the procurement channel since the JCPOA came into force has not been without glitches. Not least, the UN secretariat was not sufficiently staffed to support the operations of the channel, and it would have been better—if not politically, then practically—to keep the sanctions committee intact, albeit with a different name and function. Drawing from these lessons, an adapted procurement channel could be a useful component of an agreement with North Korea. A complementary approach to augment the monitoring gains of the channel would be to give exporting states the authority to conduct and report end-use verification monitoring to the UN (or another cognizant monitoring authority). This approach could facilitate, for example, inspection requests associated with military- or space-related facilities.

REGULATING TRADE

In addition to a mechanism for managing procurement, JCPOA negotiators were also mindful of the potential that Iran could export nuclear and missile items to third countries, especially those of concern such as Syria or North Korea. Moreover, since Iran is not a member of the Nuclear Suppliers Group (notwithstanding its possession of fuel cycle capabilities) or the Missile Technology Control Regime, Iran has not conformed its policies with obligations contained in international trade regimes to condition sales of technologies that could be used for weapons of mass destruction. Section P of the JCPOA's Annex I stipulates that the joint commission comprised of the P5+1 states approve any nuclear-related trade Iran would undertake with third countries for a period of fifteen years.[43]

A similar requirement for approvals of North Korean exports of nuclear and, if possible, missile technology, equipment, or other related goods is an important objective for negotiators, given Pyongyang's proliferation record. Such prohibitions are already contained in existing UNSC resolutions. That said, for purposes of diplomacy, an export prohibition could be framed effectively in more permissive terms, namely that North Korea would express its intention not to export certain goods, with any such exports to be approved by a designated body associated with overseeing implementation of the agreement.

One means of combining both an import- and export-monitoring and approval function would be by establishing a nuclear and missile commerce commission (or an organ with a similar nomenclature) within the UN secretariat. This body could be charged with facilitating both functions and conveying pertinent information to the relevant authorities that may be monitoring and/or inspecting North Korea's nuclear and missile programs. Drawing on the JCPOA experience, it would be prudent to specify the operational procedures of such a commission in detail so as to mitigate potential delays, including by specifying the languages in which relevant information should be made available.

ESTABLISHING ACCESS DEADLINES

JCPOA negotiators gave special consideration to securing IAEA access to undeclared Iranian sites long suspected of having a nuclear-related purpose. Delays in Iranian acquiescence to access requests could cause significant technical challenges for determining compliance, as well as political challenges to the sustainability of the agreement. Accordingly, in Section Q of the JCPOA, negotiators established a process that effectively capped the length of time that Iran could stall an access request at twenty-four days. Although this period seems lengthy, under the prevailing IAEA safeguards arrangements, there was no limit on how long Iran could delay or deny an access request.[44]

Future agreements with North Korea presumably would not start from a baseline assumption of blanket access to any site connected to (or suspected of association with) the country's nuclear weapons program. This is an important distinction from the requirement for Iran to provide such access under its IAEA safeguards agreements. Instead, access to North Korean sites or facilities is likely to be negotiated more on an individual basis. However, there would come a point—under a comprehensive fissile material freeze agreement, for example—at which concerns about undeclared activities could require access to suspected North Korean fuel cycle facilities. Establishing a clear process with given timelines for handling access requests would be important for managing concerns about Pyongyang's delay tactics. Equally, given Iranian statements after the JCPOA entered into force that the agreement did not apply to military sites, it would be important to seek in negotiations with North Korea clear language that access would not be limited by the need to protect military secrets.[45]

Outside the IAEA, the JCPOA also established a secondary track for access requests: members of the joint commission could call a meeting to raise specific concerns about access. A majority vote of the joint commission would be sufficient to trigger an access requirement. Depending on how the monitoring body for a potential agreement with North Korea would be constituted, a secondary system in which designated member states are able to address access challenges would be desirable.

BANNING WEAPONIZATION R&D

Although Iran has denied accusations it has carried out work on nuclear weapons designs or other activities involving possible military applications of nuclear technology, the IAEA possesses credible evidence cataloguing a range of suspected Iranian activities that violated its nonproliferation commitments.[46] Despite a baseline Iranian declaration concerning these activities and general uncertainty around the question of possible military dimensions, the permanent prohibition on weapons research, design, and development is an important principle contained in Annex I, Section T of the agreement. The language in that section draws from the Nuclear Suppliers Group Part 2 Guidelines (the so-called dual-use list) as well as information provided by the IAEA about suspected Iranian activities.[47]

Based on publicly available information and North Korean claims, it appears that Pyongyang has successfully tested and started to serially manufacture at least two standardized nuclear weapon designs, and Pyongyang probably continues to carry out weaponization R&D.[48] Since North Korea's last nuclear test in September 2017, the country's leader Kim Jong Un has mentioned "sub-critical" testing and alluded to the pursuit of tactical nuclear weapons, which could entail new weaponization R&D activities.[49] If a future agreement were to stipulate a freeze or cap of Pyongyang's nuclear weapons program, it would be important to include provisions prohibiting further activities that could be used to modernize or improve the quality of its existing nuclear arsenal, similar to the provisions in Section T. Ultimately, a North Korean baseline declaration of such activities would be instrumental to determining compliance during a final denuclearization phase; like Iran, it is unlikely North Korea would provide such information at the outset. There may be additional activities or equipment not contained in Section T that would be more relevant to the advanced stage of North Korea's nuclear weapons development. Negotiators could reasonably start with the entirety of Sections 5 and 6 of the Nuclear Suppliers Group Part 2 Guidelines.

A key challenge with respect to Section T that would also apply to North Korea is the lack of established means for monitoring compliance with a prohibition on weaponization. Indeed, many pertinent activities—such as computer simulations—are inherently difficult to monitor with any confidence, and detecting undeclared facilities where such activities might take place is an added challenge. Furthermore, the IAEA, which is responsible for monitoring Section T, does not have standard tools or protocols for monitoring such activities. Even so, creating a principle that such activities are inconsistent with the agreement would be vital to this purpose. Notably, it may be necessary to permit North Korea to undertake certain activities for purposes of safety, surety, or stockpile stewardship; these activities should be subject to monitoring and access requirements. In a late-phase agreement that may cover the dismantlement of all or part of North Korea's nuclear warheads, certain exemptions could be included to allow the country's nuclear scientists to participate in warhead dismantlement activities.

CONCLUSION

One important but less observed virtue of the JCPOA is that it draws on a variety of inspection mandates, including not only those in the JCPOA itself but also those in Iran's Comprehensive Safeguards Agreement and additional protocols. As the IAEA executes inspections in Iran, all three mandates have been used and invoked. In the case of North Korea, vesting multiple bodies with monitoring mandates could provide greater flexibility.

The provisions of the JCPOA contain a range of deadlines. Some expire in ten years or fifteen years, while others are permanent. A similar approach could prove useful with North Korea. Certain activities—including aspects of the country's nuclear energy program, such as uranium enrichment (if it cannot be banned)—could be frozen for specific periods to incentivize sustained compliance and implementation. Other activities, such as weaponization research, should be prohibited for the life of the agreement. Despite the many meaningful differences between the cases of Iran and North Korea, the JCPOA provides important and useful precedent for how future negotiators might proceed with incorporating innovative verification and monitoring approaches.

ACKNOWLEDGMENTS

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CHAPTER 8

A POINT-OF-ENTRY APPROACH FOR MONITORING NORTH KOREAN IMPORTS AND EXPORTS

VANN H. VAN DIEPEN

Monitoring imports to and exports from North Korea of items relevant to the production and operation of nuclear weapons and/or missiles would strengthen any negotiated limits on the country's nuclear weapons and missile programs. Existing United Nations Security Council (UNSC) resolutions ban the export to and import from North Korea of a wide variety of items that could contribute to its nuclear weapons and missile programs. These resolutions also require the inspection of cargo destined to or originating from North Korea, and they require countries to seize and impound ships caught smuggling illicit items.

These UNSC resolutions could be even more effective at strengthening negotiated limits on North Korea's nuclear weapons and missile programs if they were enhanced with requirements that, first, all cargo only be permitted to enter North Korea immediately after going through inspection at one of a few designated road, rail, sea, and air points of entry (POEs) and that, second, all cargo coming out of North Korea must first be inspected at these same POEs before moving on elsewhere.

A POE system could be negotiated with North Korea as part of an agreement to place limits on its nuclear weapons and missile programs. Alternatively, such a system could be imposed without negotiations with Pyongyang through action by the UNSC to augment such an agreement. The Security Council could even impose such a system in the absence of negotiated limits on missile- and nuclear weapons–related items to increase pressure on North Korea or in response to a provocation. Chinese cooperation would be needed to secure the kind of new UNSC resolution necessary to establish a POE system, and just as with current restrictions on North Korean imports and exports under existing UNSC resolutions, Chinese (especially) and Russian cooperation would be key.

MONITORING NORTH KOREAN IMPORTS AND EXPORTS

Monitoring imports to and exports from North Korea could help with detecting and deterring noncompliance with limits on Pyongyang's nuclear weapons and missile programs while also bolstering confidence in North Korean compliance with those limits.

Such monitoring would serve these purposes in three key ways:

- First, monitoring would help detect missile- and nuclear weapons–related imports into North Korea that would indicate Pyongyang is cheating on the agreed-upon limits, and such monitoring would also impede North Korea's ability to cheat by preventing such imports.

- Second, monitoring would allow Pyongyang's negotiating partners to detect exports from North Korea in support of its activities in third countries designed to circumvent agreed-upon limits (such as attempts to conduct prohibited North Korean missile tests in Iran). Such monitoring also would obstruct such circumvention by impeding the transport of items that would be needed from North Korea to make such attempts elsewhere.

- Third, such monitoring would help detect and impede North Korean exports in support of other countries' own nuclear weapons or missile programs. Such support would violate the terms of a future agreement with North Korea or parallel UNSC resolutions, constitute a North Korean provocation, undermine U.S. and international security by fueling those other countries' nuclear weapons and missile programs, and provide export revenues that Pyongyang could use to support its own nuclear weapons and missile programs.

Current UNSC resolutions ban the export to and import from North Korea of a host of missile- and nuclear weapons–related items, and these resolutions require the inspection of all cargo bound for or originating from North Korea to identify such items for seizure. The inspection requirement of these UNSC resolutions is implemented by all member states wherever North Korea–linked cargo originates from, or travels through, on its way to or from the country. This means that inspection resources are spread thin, member states' capacity limits are difficult to redress, and North Korea and its customers have more choices in exploiting weak links in this system. (Transshipment and finance hubs such as Hong Kong, Malaysia, Singapore, and the United Arab Emirates have been exploited by North Korea in the past, as well as China and Russia.[50])

ADDING A POE REQUIREMENT

The existing UNSC inspection requirement—and monitoring of missile- and nuclear weapons–related imports and exports in support of negotiated limits on Pyongyang's nuclear weapons and missile programs—could be implemented more effectively if existing UNSC resolutions were enhanced with a requirement that all cargo only be permitted to enter North Korea immediately after going through inspection at one of a few designated road, rail, sea, and air points of entry (POEs). Additionally, the

POE requirement should stipulate that all cargo coming out of North Korea must first be inspected at these same POEs before moving on elsewhere. Geography and logistics suggest China would be the best location for the POEs, although Beijing has been inconsistent in its implementation of UNSC resolutions on North Korea. In theory, POEs could be located almost anywhere (although the closer to North Korea, the better).

Because a POE requirement would bind all UN member states, this approach would have to be instituted by the Security Council via a new resolution (such as one that would codify or endorse the results of U.S.–North Korea negotiations limiting Pyongyang's nuclear weapons and missile programs). But the POE portion of such a resolution would be relatively limited since the POE system would only add to the existing limits a restriction on the routing of cargo.

The POE system could result from U.S. negotiations with North Korea on its nuclear weapons and missile programs (as a collateral constraint agreed to by Pyongyang to build confidence in its compliance with an agreement). Alternatively, such a system could be imposed on North Korea as part of the international community's external monitoring of an agreement on its nuclear weapons and missile programs. A POE system would usefully augment almost any kind of negotiated constraints on North Korea's nuclear weapons and missile capabilities. POE provisions would even be a useful way to augment existing UN sanctions in the absence of any new agreement with Pyongyang on its nuclear weapons and missile programs.

The practical advantages of a POE system would be diverse. Inspection and capacity-building assets could be focused on these POEs. Any cargo going to or from North Korea not certified as having gone through these POEs would automatically be deemed illicit and subject to seizure anywhere in the world under existing UNSC resolutions (along with the ships carrying them). Although Pyongyang could still try to smuggle goods across other parts of the Chinese or Russian borders (except by rail) or could try to sneak ships or even aircraft into and out of North Korea without going through the designated POEs, such attempts would automatically be deemed illicit, and such ships would be increasingly vulnerable to seizure over time. Moreover, the current UNSC requirements on all UN member states worldwide to inspect North Korea–linked cargo and seize illicit shipments and ships would remain in parallel with the POE system. The current arrangement would still offer opportunities in other countries to catch missile- and nuclear weapons–related items smuggled around or snuck through the POEs.

IMPLEMENTING A POE SYSTEM

There are different ways a POE system could be designed. It could be implemented in a bare-bones way by relying on the existing inspection authorities in the country (likely China) or countries hosting the POEs as required under the current UNSC resolutions. Alternatively, the system could be implemented in a more elaborate manner. Potential ways to enhance the implementation of the POE system include multilateral mechanisms, cargo certification processes, and oversight authorities for import and export financing.

- **Multilateral mechanisms**. The UN, the P5, or other directly interested states (including Japan and South Korea) could assist China (the presumptive POE host) with oversight, conducting inspections, and/or making decisions about shipment blocking. The involvement of other countries could lessen the burden on China of the additional inspections and seizures triggered by the POE requirement, both in terms of resources and personnel as well as the responsibility for evaluating and deciding to block imports and exports. Involving other countries also would increase the effectiveness of inspections, particularly if other countries helped to vet imports and exports using their own information resources. Cargo information from the POEs also could be shared with the UN Panel of Experts established pursuant to UNSC Resolution 1874, the International Atomic Energy Agency, and the Organization for the Prohibition of Chemical Weapons to assist them in their work.

- **A system to certify cargo as POE-inspected**. Cargo leaving the POEs—whether inbound or outbound—and its accompanying paperwork would be recorded and stamped to indicate it had been inspected. Suspect North Korea–related cargo could then be checked to see if it had been recorded (and was the same cargo as the records indicated), while unstamped North Korea–related cargo detected outside the POEs would automatically be deemed illicit. This practice would enhance monitoring and deter efforts to sneak cargo around the POEs.

- **Parallel oversight of the financing of North Korean imports and exports**. A parallel UNSC requirement could be established to stipulate that the funding for North Korean imports and exports going through the POEs must go through UN-designated banks. Decisions to permit imports and exports to proceed from the POEs would be coordinated with funding information from the designated banks, either directly between the import/export and finance implementers or via the UN North Korea Sanctions Committee. This approach would provide an additional layer of restraint, offer more data to be evaluated along with inspection data, and further deter proliferation finance.

The international community has experience in implementing these types of measures, one or more of which were included in the implementation of UN sanctions against Iraq from 1990 to 2003 and the handling of the procurement channel for the Joint Comprehensive Plan of Action (JCPOA) with Iran since 2015. The Iraq sanctions included all three of these measures covering a large volume of trade, but their implementation was plagued by corruption and active undermining by various UNSC members.[51] The JCPOA with Iran included a multilateral transaction-vetting mechanism and a means of certifying cargo that was much more successful, but this mechanism handled only a few transactions.

MONITORING AND ASSESSING COMPLIANCE

Attempts to sneak prohibited cargo through the POEs would primarily be monitored by inspecting cargo on its way in and out of North Korea. At a minimum, such monitoring would be performed by the country hosting the POE, but ideally this would be done by a UN or multinational team. Efforts to sneak prohibited cargo around the POEs would primarily be monitored via U.S. and other UN member states' national technical means, just as has long been the case for existing UNSC restrictions on imports and exports. Data from the inspections and information from various countries' national technical means would reinforce each other in monitoring both types of cheating. Any of the three implementation enhancements noted above would further bolster the system.

Just as with current UN sanctions, data on noncompliance would be assessed by the UN North Korea Sanctions Committee, and the United States and other states would be free to draw their own compliance conclusions as well. In the event of noncompliance, as with current UNSC resolutions, the Security Council could impose additional measures (such as strengthening the monitoring system or adding further sanctions against North Korean persons or entities), and the United States and other countries also could take actions of their own, such as sanctioning both North Korean and other entities involved in illicit transactions.

China's role in the implementation of the proposed POE system would be essential. This is the case because the POE system must be initiated via a UNSC resolution that China could veto and because the best locations for the POEs would be in China. It is unclear if Beijing would support a POE system given the current state of U.S.-China relations, although Beijing's interest in a negotiated resolution of the North Korea nuclear issue may lead it to cooperate. China already faces substantial implementation and enforcement challenges with existing UNSC restrictions on North Korean imports and exports that would persist under a POE system, but if Beijing were prepared to accept U.S. and other outside assistance in POE cargo inspections and decisionmaking, many of these challenges could be substantially mitigated.

CONCLUSION

Monitoring imports to and exports from North Korea of items related to the production and operation of nuclear weapons and missiles would help the international community detect and deter noncompliance with negotiated limits on the country's nuclear weapons and missile programs and, by extension, bolster confidence in Pyongyang's compliance with those limits. This proposed POE approach is one promising way of making such monitoring a more manageable task.

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