

## 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.<sup>14</sup> 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.<sup>15</sup> 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.<sup>16</sup>

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.<sup>17</sup> 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

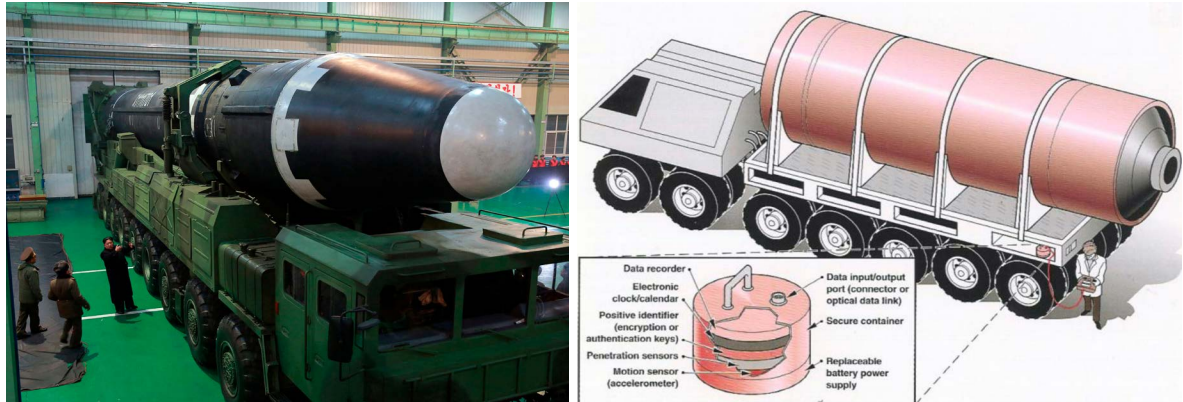
The most basic approach to confirming numerical limits is to rely solely on baseline declarations followed by notifications and regular data exchanges, which could be modeled, for example, on the procedures developed for the 2010 Strategic Arms Reduction Treaty (New START) signed by the United States and Russia. In the case of New START, since the treaty entered into force, the parties have exchanged tens of thousands of notifications.<sup>18</sup> 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 Arsenal: 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.<sup>19</sup> 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.<sup>20</sup> 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.<sup>21</sup> 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.”<sup>22</sup> 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.”<sup>23</sup> 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.<sup>24</sup> 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.





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

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

# CONTENTS

<b>About the Authors</b>	iv
<b>Introduction</b> Ankit Panda	1
<b>CHAPTER 1</b> <b>Designing a Verifiable Freeze on North Korea's Missile Programs</b> Joshua H. Pollack	5
<b>CHAPTER 2</b> <b>Designing Gradual, Successive Safeguards for North Korea's Nuclear Program</b> Marc-Gérard Albert	9
<b>CHAPTER 3</b> <b>Monitoring North Korean Nuclear Warheads</b> Alex Glaser	15
<b>CHAPTER 4</b> <b>The Merits of Probabilistic Verification in Complex Cases Like North Korea</b> Thomas MacDonald	21
<b>CHAPTER 5</b> <b>Using Open-Source Intelligence to Verify a Future Agreement With North Korea</b> Melissa Hanham	27
<b>CHAPTER 6</b> <b>A Nodal Monitoring System for Onsite Monitoring and Verification in North Korea</b> Pablo Garcia	33



**CHAPTER 7**

<b>Lessons From the Iran Deal for Nuclear Negotiations With North Korea</b>	<b>41</b>
Toby Dalton and Ankit Panda	

**CHAPTER 8**

<b>A Point-of-Entry Approach for Monitoring North Korean Imports and Exports</b>	<b>47</b>
Vann H. Van Diepen	

<b>Notes</b>	<b>53</b>
--------------	-----------

<b>Carnegie Endowment for International Peace</b>	<b>57</b>
---	-----------

**This work was made possible by a generous grant from the Korea Foundation.**

© 2021 Carnegie Endowment for International Peace. All rights reserved.

Carnegie does not take institutional positions on public policy issues; the views represented herein are the author(s) own and do not necessarily reflect the views of Carnegie, its staff, or its trustees.

No part of this publication may be reproduced or transmitted in any form or by any means without permission in writing from the Carnegie Endowment for International Peace. Please direct inquiries to:

Carnegie Endowment for International Peace  
Publications Department  
1779 Massachusetts Avenue NW  
Washington, DC 20036  
P: + 1 202 483 7600  
F: + 1 202 483 1840  
[CarnegieEndowment.org](http://CarnegieEndowment.org)

This publication can be downloaded at no cost at [CarnegieEndowment.org](http://CarnegieEndowment.org).

Photo: Korean Central News Agency/Korea News Service via AP, File