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SPECIAL REPORT

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# Denuclearizing North Korea

The Case for a Pragmatic Approach to  
Nuclear Safeguards and Verification



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January 2019

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## About the Author

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# Denuclearizing North Korea: The Case for a Pragmatic Approach to Nuclear Safeguards and Verification

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## Executive Summary

North Korea's (the Democratic People's Republic of Korea or DPRK) decisions on nuclear verification matters will not be made in isolation but will be influenced by political, economic and strategic developments.<sup>1</sup> Realistically, the DPRK will seek to retain what it regards as an effective nuclear deterrent until it is convinced it no longer needs nuclear weapons to ensure its survival and the survival of the regime—and until it is convinced that the risks involved with having nuclear weapons, and the political, economic and opportunity costs, exceed the perceived benefit. Accordingly, progress on denuclearization and associated verification will depend on progress on broader issues, especially the development of a peace process and a sustainable relationship with the United States.<sup>2</sup> This paper addresses only verification-related issues, but should be read in this broader context.

For any agreement on denuclearization in the DPRK, it will be essential to establish effective verification arrangements. The conventional approach to verifying nuclear commitments, exemplified by International Atomic Energy Agency (IAEA) safeguards, is based on detailed declarations, confirmed by inspections and monitoring. A rigorous approach will be required to achieve the ultimate outcome—*complete verified irreversible disarmament*. However, getting to this point is likely to require a series of intermediate steps, progressively building confidence and trust on both sides. The broad commitments needed at the outset could be verified by less intrusive, *more qualitative* approaches, with subsequent negotiations proceeding on a step-by-step basis for more specific commitments and corresponding verification measures.

One basic commitment, essential to any ongoing peace process, is maintenance of the DPRK's halt to testing of nuclear weapons and nuclear-capable missiles. This commitment can, if necessary, be monitored remotely, with no declarations and no inspections, for example by the Comprehensive Nuclear-Test-Ban Treaty Organization's International Monitoring System and by national monitoring activities by concerned states (*national technical means*).<sup>3</sup>

A further essential commitment is for the DPRK not to expand its nuclear arsenal. The most practical way of establishing a ceiling on nuclear weapons is by a fissile material cut-off—that is, a halt to production of further plutonium and highly enriched uranium (HEU). From that point on in the denuclearization process, declarations and inspections will become necessary,

though the details of specific commitments, and the corresponding verification measures, will be matters for negotiation. While cessation of reprocessing and enrichment at the Yongbyon site can, to some extent, be monitored remotely, it will also be necessary to address the issue of enrichment operations undertaken elsewhere in the DPRK. This will require the DPRK to declare fissile production facilities at other sites, and to reach agreement on monitoring and inspection arrangements.

Beyond cessation of testing and fissile material production, major areas to be addressed include: (a) a separation plan between any ongoing civilian nuclear activities and military nuclear holdings, with agreement to place civilian activities under IAEA safeguards; and (b) progressive rollback of military holdings, including warhead dismantlement and removal of fissile material. Specific details to be considered include responsibility for the various verification and monitoring functions, including the possibility of bilateral or regional inspection arrangements and the possible establishment of a Northeast Asia nuclear-weapon-free zone.

This paper describes steps that could be taken to help lower tensions and build confidence, and at the same time pave the way for the gradual introduction of safeguards and related verification measures in the DPRK. These steps would be verifiable, through verification measures designed for each step. Over time the coverage of verification in the DPRK would be extended. Ultimately—and this should be clearly understood at the outset—assurance that the denuclearization process is successful will depend on progress towards the application of IAEA safeguards to the whole of the DPRK and full cooperation by the DPRK as this work proceeds.

Also required, but not covered in this paper, are programs, and appropriate verification/monitoring, to convert nuclear weapons-related laboratories, workshops and factories to peaceful purposes, to redeploy specialists from the nuclear weapon program to peaceful purposes, and to track key specialists to ensure they don't become involved with nuclear weapon programs elsewhere.

## I. Basic Commitments that will be Required from the DPRK

To provide some context for this discussion, the commitments that will be required to achieve eventual nuclear disarmament in the DPRK can be outlined as follows.

- No further nuclear weapon and (nuclear-capable) missile tests. (Nuclear and missile tests are not addressed in this paper.)
- The DPRK will cease production of fissile materials, namely, highly enriched uranium (HEU) and separated plutonium (that is, plutonium recovered from irradiated fuel by reprocessing).
- If nuclear production and nuclear activities continue during and after the denuclearization process, these will be for exclusively peaceful purposes, under IAEA safeguards. A

*separation plan* will be needed to ensure that peaceful activities are fully and verifiably disentangled from the weapon program until the elimination of the latter is complete.

- The DPRK will accept and cooperate with monitoring and verification arrangements, including IAEA safeguards where applicable, to demonstrate that it is meeting its commitments.
- The DPRK will progressively roll back its nuclear weapon program. Nuclear weapons will be dismantled, and fissile materials will be removed from the DPRK.<sup>4</sup>
- The DPRK will commit not to export nuclear material, technology and know-how unless under IAEA safeguards.
- When the weapon program has been eliminated, the DPRK would return to the Nuclear Non-Proliferation Treaty (NPT) as a non-nuclear-weapon state, covered by IAEA comprehensive safeguards, the additional protocol and other confidence building measures that may be agreed.

## II. Ideal Model for Verification of Nuclear Disarmament

There is no established model for verification of nuclear disarmament. The only precedent for a state that had nuclear weapons and disarmed is South Africa, but this was very different from the DPRK's circumstances.<sup>5</sup> South Africa dismantled its warheads secretly, then submitted the recovered HEU to IAEA safeguards, as part of joining the NPT as a non-nuclear-weapon state.

A model framework for disarmament verification, based on (a) the commitments listed above and (b) conventional verification approaches, is outlined as follows. This model can serve as a point of reference, a basis of comparison between what actually applies at a particular time and what will be needed eventually to ensure complete verified irreversible disarmament at the end of the denuclearization process. These stages are not necessarily sequential—some stages or steps within the stages could occur in parallel.

### ***Stage 1: Cease production of fissile materials (HEU, plutonium)***

- (a) Declaration of all fissile material production facilities (enrichment, reprocessing).
- (b) Monitoring to ensure production has ceased. This will require access by inspectors, and installation of monitoring equipment.

### ***Stage 2: Proscription of weapon-related activities***

Negotiations would need to define activities that should be terminated at the outset, and activities to be phased out. These include:

- (a) Subcritical testing—such testing runs counter to the commitment to denuclearize and should be proscribed. Locations where subcritical testing was conducted should be declared to facilitate verification that the activity has ceased (this is partly covered in stage 3 (e)(ii)).
- (b) Tritium—declaration of relevant facilities (reactor, separation plant) and material flows is required. The negotiations need to cover when production of tritium will be proscribed (whether at the outset or later).
- (c) Plutonium clean-up—negotiations need to determine whether existing plutonium can be chemically treated to remove americium build-up.
- (d) Manufacture of new warheads—fissile cut-off will proscribe production of further fissile material, but warheads could be produced from existing fissile stocks or from dismantlement of existing warheads. Such activity seems inconsistent with a commitment to denuclearization. The negotiations need to cover whether such activity is proscribed.

### ***Stage 3: Declaration of all nuclear material, all nuclear facilities and nuclear-related locations***

- (a) Nuclear material—total quantities per material category for all nuclear material, including in warheads, and inventories at each nuclear facility.
- (b) Total fissile material per material category (HEU, plutonium) in warheads or military custody will be *black boxed*, that is, the overall quantity of each material will be declared without details on forms and locations (unless the DPRK is prepared to provide detailed information at this stage). These materials would be verified when declared excess (stage 5) or when recovered through warhead dismantlement (stage 6).
- (c) Nuclear facilities—enrichment and reprocessing facilities should be declared in stage 1. In stage 3 all related facilities will be added: reactors, fuel fabrication, conversion, mines/mills, storage, radioactive waste storage, etc.
- (d) Historical nuclear material flows (production, consumption, losses)—declarations and supporting documentation will be required in due course, but is not essential at the outset. It is essential that the DPRK undertakes to retain all records and to preserve all facilities, materials and wastes needed eventually to confirm historical material flows and establish the nuclear material balance.

- (e) Nuclear-related locations and activities—declarations including:
  - (i) Activities, items and materials covered by the IAEA additional protocol, such as centrifuge R&D and centrifuge manufacturing; and
  - (ii) Dual-use activities with potential nuclear weaponization application (similar to the Iran Joint Comprehensive Plan of Action—JCPOA).
- (f) Development of a separation plan—peaceful activities to be fully and verifiably disentangled from the weapon program until the elimination of the latter is complete.

Declarations of actual warheads will be required at an appropriate stage, to be negotiated. Declarations of missiles will also be required but are not covered in this paper.

***Stage 4: Inspections of declared facilities and related nuclear materials***

- (a) Where facilities are to be shut down/decommissioned—inspections will be required to verify that facilities have in fact been shut down.
- (b) Where facilities will remain in operation—inspections will be required to verify they are operated as agreed. Agreement will be required on what will remain in operation.
- (c) Nuclear materials—safeguards will apply, including tracking nuclear materials to verify that they remain in peaceful use. Fissile materials (HEU and plutonium) are not required for peaceful uses, and these materials would be removed from the DPRK. They could be replaced by an equivalent quantity of low enriched uranium (LEU) fuel if there is a demonstrated need for such fuel.
- (d) Nuclear-related locations—nuclear-related activities should be terminated if the relevant nuclear activity (e.g., enrichment) is shut down. Inspections will be required to verify that nuclear-related activities have been terminated, or that continuing activities are consistent with the denuclearization agreement.

Depending on what is negotiated on the matters covered in stage 2, declarations and inspections to confirm shutdown would apply.

- (e) Establishment of a procurement channel where required for agreed nuclear-related activities and potential weaponization activities (similar to the Iran JCPOA).

***Stage 5: Excess nuclear materials in the military program to be declared and removed from the DPRK or transferred irreversibly to safeguarded program***

As noted, HEU and plutonium are not required for peaceful nuclear activities.

***Stage 6: Progressive reduction in warheads (dismantlement)***

- (a) Warheads are to be dismantled and fissile materials recovered from dismantlement will be treated as excess materials (to be verified and removed from the DPRK).
- (b) An issue to be negotiated is how dismantlement would be monitored/verified. Internationally an approach is being developed for warheads to be dismantled by the possessor state under monitoring arrangements that enable inspectors to confirm that a warhead entered the dismantlement process and a corresponding quantity of fissile material exited—see section 2(d) below.

***Stage 7: Verification activities to provide assurance against the existence of undeclared nuclear facilities and nuclear materials***

This is likely to be a contentious area as it requires intrusive activities including *special inspections* or challenge inspections. A special inspection can be initiated by the IAEA to investigate possible undeclared nuclear activities. A challenge inspection is one that can be initiated by a treaty party to investigate a possible violation.<sup>6</sup> The DPRK needs to understand that special inspections, or possibly challenge inspections if these are negotiated as part of the denuclearization agreement, are a necessary aspect of verification, without which confidence is not possible. This is discussed further in section 3(d) below.

It should be noted that for some of the activities covered in stage 2, detection of undeclared activities could be quite difficult.

Stage 7 will include establishing a historic nuclear materials balance, drawing on declared material flows (stage 3(d)), facility operating records, sampling and analysis of materials, interviews of personnel and related activities.

Activities to provide assurance against the possible existence of undeclared warheads and missiles will also be required but are not covered in this paper.

***Stage 8: Confidence that the DPRK is a non-nuclear-weapon state***

Demonstrated by full cooperation in meeting IAEA safeguards requirements (comprehensive safeguards agreement, additional protocol and other requirements such as monitoring of potential weaponization activities), and likely restraints on proliferation-sensitive capabilities.

### III. A Pragmatic and Incremental Approach

From current indications, it is unlikely the DPRK will agree to follow the ideal model described above, at least not from the outset. For example, the DPRK has said that making a full declaration before the two sides trust each other would amount to providing a list of targets for attack.<sup>7</sup> Progress—including declaring currently secret nuclear facilities, declaring nuclear material inventories, giving access to IAEA inspectors, declaring warhead numbers, and (monitoring of) actual reductions in warhead numbers—will depend on (a) what incentives and concessions the DPRK is given and (b) the levels of confidence and trust reached.

Thus, a pragmatic approach is called for, recognizing that progress towards the ideal denuclearization framework will be incremental. The essential objectives of such an approach, and the extent to which effective monitoring or verification is possible, are outlined below.

#### *Ensuring Stability—Capping the Weapon Program*

The immediate objective must be to stabilize the nuclear situation and minimize the nuclear threat. If the DPRK accepts the principle of denuclearization it must refrain from provocations such as nuclear tests, ballistic missile tests, and deploying additional nuclear weapons.<sup>8</sup> For its part, the United States needs to recognize that progress requires actions to reduce tensions and build confidence—all of which require a serious US commitment to normalizing relations with the DPRK.

To date, the DPRK has maintained a unilateral freeze on nuclear and ballistic missile tests. Tests are outside the scope of this paper, but adherence to the freeze can be monitored by national technical means, national intelligence, and (for nuclear tests) the Comprehensive Nuclear-Test-Ban Treaty's International Monitoring System.

Cut-off of fissile material production: Some assurance against the DPRK's build-up of warheads can be given through ending further production of fissile material—in other words, by stopping enrichment and reprocessing. This is not an *absolute* assurance against producing further warheads, however, because we don't know the size of the DPRK's existing HEU and plutonium stocks, which could be drawn upon for further warheads. But a fissile material cut-off would place a finite (albeit uncertain) ceiling on warhead numbers.

HEU: Estimates of the DPRK's enrichment program vary depending on the assumptions made (e.g., whether there is at least one other enrichment plant of similar capacity to the plant at the Yongbyon Nuclear Scientific Research Center). One eminent authority, Professor Siegfried Hecker, estimated in December 2017 that the DPRK's holdings of HEU were 250-500 kg, sufficient for 12-24 warheads.<sup>9</sup> Some other estimates are larger, and we must assume that further production has been added in 2018.

Plutonium: There is no indication of any reactor outside Yongbyon, so we have a better idea of the possible inventory. In December 2017, Professor Hecker estimated that the DPRK's plutonium holdings were 20-40 kg, sufficient for 4-8 warheads.

If the DPRK agrees to a fissile cut-off, ideally it would declare all its enrichment and reprocessing facilities, and provide access by IAEA inspectors or initially perhaps inspectors provided by Six-Party participants.<sup>10</sup> The enrichment plant and reprocessing plant at Yongbyon are known—US experts including Professor Hecker have visited the enrichment plant, and the IAEA has previously monitored the reprocessing plant and the 5 MWe reactor (the source of most of the DPRK’s plutonium)—so there seems no reason for the DPRK to refuse inspector access to these facilities.

The DPRK has said it is willing to dismantle the nuclear facilities in Yongbyon as the United States takes “corresponding measures,” but it is not clear which facilities. Presumably, this would include the 5 MWe reactor and the reprocessing plant, but it is not known whether the DPRK is prepared to close the enrichment plant.<sup>11</sup> As noted above, it is essential that the DPRK retains all records and preserves all facilities (or components), materials and wastes needed eventually to confirm historical material flows and establish the material balance. This will require appropriate arrangements at Yongbyon, and in due course elsewhere, either to preserve essential items or to complete the required analyses before such items are disposed of.

Initially, while arrangements for inspector access are being negotiated, it would be possible to use remote monitoring<sup>12</sup> to indicate if the Yongbyon facilities are in fact shut down, including:

- (i) Reprocessing plant—satellite imagery, thermal satellite imagery, and atmospheric sampling (Kr-85 emissions) could provide medium-high confidence of a shutdown;
- (ii) 5 MWe reactor—satellite imagery, thermal satellite imagery, and atmospheric sampling (Xe-133 emissions) could provide high confidence of shutdown. However, remote monitoring will not show what is already in the spent fuel pond, nor accurately quantify spent fuel discharges; and the
- (iii) Enrichment plant—satellite imagery, to some extent thermal satellite imagery, and possibly spectral analysis (looking for the presence of  $UF_6$ ) could provide low-medium confidence of a shutdown.

It is unlikely the DPRK will be prepared to reveal facilities elsewhere, at least until it is confident these would not be attacked. If the DPRK shuts down facilities, there is no reason for it not to declare the facilities, but it may want to keep the option of restarting fissile production if the denuclearization agreement fails. Pending a fuller declaration, the DPRK could be asked at least to declare the number and capacity of enrichment facilities and any other reprocessing facilities, without revealing their locations.

If the DPRK refuses to declare enrichment and reprocessing facilities, a commitment not to produce further fissile material will be very difficult to monitor outside the Yongbyon site. Enrichment plants are difficult to detect—where they *are* positively identified, remote monitoring *might* indicate if they are operating, but at only low confidence. Reactors and reprocessing facilities outside Yongbyon are not suspected, but cannot be excluded—detection of Kr-85 would indicate undeclared reprocessing (though this could be hard to distinguish from Russian and possibly Chinese<sup>13</sup> emissions).

Other indicators to monitor for include: uranium mining—if enrichment and reactors are closed uranium is not required, so ongoing mining could indicate undeclared enrichment or reactors; uranium conversion operations; and procurement efforts for centrifuge components, specialized materials, etc.

The impact of a cut-off commitment would be strengthened if the relevant facilities were decommissioned, as the DPRK has said it will do at Yongbyon (though as noted, it is not clear which facilities are meant and what concessions it expects in return from the US).

A commitment by the DPRK to cease enrichment and reprocessing would be a positive development—in fact, it would be pretty much essential to any agreement. However, if the DPRK is not prepared to declare all enrichment and reprocessing facilities within a reasonable time, it will be difficult to monitor a cut-off effectively (particularly enrichment), and the credibility of any agreement would be undermined. Even if the DPRK says it has declared all facilities it would not be possible to verify this until the full verification model outlined above can be implemented. Likewise, if the DPRK refuses inspector access to known/declared facilities within a reasonable period this will adversely affect monitoring and damage the credibility of any agreement.

### *Steps to Build Confidence*

The process of establishing stability, as outlined above, should contribute to confidence building, and create an atmosphere in which detailed steps towards denuclearization can be negotiated and implemented.

A number of actions are possible to demonstrate good faith and commitment to denuclearization. Ideally, the DPRK would declare all nuclear material and all facilities, as set out in the verification model. However, this may have to be approached incrementally, starting with some facilities and materials and subsequently widening the scope of the declarations.

There is no technical reason why safeguards cannot be introduced incrementally (facility-by-facility). It must be clearly understood, however, that an essential safeguards principle is irreversibility: once a facility is made subject to safeguards, the nuclear material in that facility will also be subject to safeguards, including if it is transferred to downstream facilities. Downstream facilities will also have to be subject to safeguards, otherwise safeguards would be meaningless.

### *Declaring Some Nuclear Material*

As a start, the DPRK could declare nuclear material that it does not consider especially sensitive. For example, if it declares some facilities at Yongbyon—the enrichment plant, the reprocessing plant, the 5 MWe reactor—and gives inspectors access to these facilities to monitor that they have been shut down, it would be an easy additional step to provide details of the nuclear material present in these facilities. In a series of subsequent steps, the DPRK could declare nuclear material located elsewhere.

### ***Declaring Some Nuclear Facilities and Placing Them Under Safeguards***

If the DPRK declares the inventory of nuclear material at facilities being monitored at Yongbyon, it would make sense to accept safeguards on these materials. This would enable inspectors to verify (characterize and quantify) the material. As noted above, safeguards would continue to apply if the materials are transferred to other facilities. This would be a first step in bringing nuclear materials in the DPRK under safeguards and in due course verifying historical material flows, which will be essential to enable an eventual conclusion that denuclearization has been completed. From here the DPRK could consider declaring further facilities and materials, on a step-by-step basis. This could start with other facilities at the Yongbyon site, and be extended later to other locations.

If the DPRK proposes to maintain a civilian nuclear program—power reactors, research and radioisotope production, fuel fabrication, possibly low enrichment (which would also require conversion)—it would be essential to place all the facilities and nuclear material under safeguards to provide assurance that the activities are not contributing to nuclear weapons. If the DPRK does not do this, remote monitoring would be ineffective to assure the activities are exclusively peaceful. As noted above, a separation plan is needed to ensure peaceful activities are clearly separated from the military program until the latter has been completely eliminated.

Continuing (low) enrichment would raise major issues. An ongoing enrichment program could provide cover for an undeclared enrichment program, and used to justify mining, uranium conversion, centrifuge manufacture, centrifuge R&D, training of personnel, and so on. An enrichment program presents a break-out risk, especially if the DPRK argues for expanding the program to the scale needed to fuel power reactors.<sup>14</sup> Continuing enrichment could not be considered unless robust safeguards apply (IAEA additional protocol plus JCPOA-type limitations<sup>15</sup>).

### ***Declaring Some Fissile Material Excess and Submitting it for Disposition***

As a way of demonstrating a commitment not to increase its nuclear arsenal and to reduce this arsenal over time, the DPRK could be invited to declare some HEU and/or plutonium as excess to its military program and to submit this material to inspectors for disposition. This would significantly boost confidence in the DPRK's good faith.

Disposition is best undertaken after removal of the excess material from the DPRK, but vitrification or other disposal options in the DPRK might be considered. The United States (or the Six Parties) could commit to providing energy assistance equivalent to the energy value of HEU and plutonium submitted for disposition. This could take the form of LEU fuel for power reactors, if the DPRK needs this, but could also be in the form of non-nuclear energy sources.

### ***Dismantlement of Some Nuclear Warheads***

A dramatic step in progressing towards denuclearization would be handing over a number of nuclear warheads for dismantlement. The DPRK is likely to be reluctant to give anyone access to warheads, because it will want to maintain secrecy over its warhead designs. In this case, dismantlement would be undertaken by DPRK personnel under monitoring arrangements

allowing inspectors to confirm that a warhead enters a dismantlement facility and corresponding quantities of HEU or plutonium exit the facility.<sup>16</sup>

As an alternative, the DPRK could declare it has dismantled a certain number of warheads, and hand over the HEU or plutonium, but this would have the disadvantage that no one could be sure any warheads were actually dismantled (on the other hand, it would result in a reduction of fissile material held by the DPRK).

## IV. Verification-Related Issues

### *Inspectors*

Most of the nuclear verification tasks required in the DPRK will correspond, or be very similar, to IAEA safeguards, so it is appropriate for these tasks to be undertaken by IAEA inspectors. In due course, a safeguards agreement will be required between the DPRK and the IAEA, based on a standard safeguards agreement modified to reflect the circumstances applying in the DPRK (where for some time only specified materials and facilities will be subject to safeguards).<sup>17</sup>

If any proliferation-sensitive information is involved, the IAEA can ensure this is dealt with by appropriately cleared inspectors from nuclear-weapon states, following precedents set in Iraq, Iran and Libya.

There may be some reluctance to have early involvement by the IAEA, and in any case, negotiation and conclusion of a safeguards agreement will take time. If for any reason the deployment of IAEA inspectors is delayed, monitoring and some other verification tasks could be undertaken by suitably qualified personnel from states involved in the denuclearization process (for example, the Six Parties) and from other states willing to support the process and acceptable to the other parties involved. However, it should be recognized that the IAEA has to be involved as soon as possible, having regard to its nuclear verification mandate, specialized expertise and equipment, and the integrity it brings through its international standing. The objective should be to develop DPRK-IAEA cooperation as soon as possible.

### *Possible Bilateral Safeguards Arrangements*

The DPRK and the Republic of Korea (ROK) may wish to consider whether to establish bilateral safeguards arrangements, similar to those of the Argentine-Brazilian Agency for Accounting and Control of Nuclear Materials (ABACC). This would involve joint inspections by the IAEA and an ROK/DPRK bilateral inspectorate. Such arrangements may be useful, for example, for transparency and confidence building. One factor to consider is that the ABACC arrangements are reciprocal; thus, following this model would result in DPRK inspectors participating in inspections in the ROK as well as *vice versa*. Another possibility might be to establish a Northeast Asia nuclear-weapon-free zone supported by a regional safeguards inspectorate.

### *Safeguards Training*

In the period 1986 to 2002, Australia, in cooperation with the IAEA, conducted a series of safeguards training courses for DPRK personnel. These courses were very successful; Australian personnel were impressed with the proficiency and positive attitudes of their DPRK counterparts. It is not known how many of the alumni of these courses are still engaged in the DPRK nuclear sector. Courses of this kind will be invaluable in familiarizing DPRK personnel with the IAEA safeguards system and practices.

### *Violations and the Inspection Mandate*

For whatever verification arrangements apply in the DPRK, a key question will be how to define and detect violations. Safeguards violations are well defined by almost 60 years of IAEA practice, but in the DPRK's case, safeguards requirements are likely to be state-specific for some time. As shown by the dispute over whether the 1994 Agreed Framework proscribed uranium enrichment, it is essential to establish a clear understanding of the DPRK's obligations, what would be considered a violation, and how (and whether) a violation can be detected.

A violation must be clearly defined in terms of the applicable obligations. For example, if the DPRK has no obligation to declare all nuclear material, for it to have undeclared nuclear material is not *prima facie* a violation, and it is not appropriate for inspectors to look for *generic* undeclared material. Having undeclared nuclear material is only a violation if there is an obligation to declare that particular material.

If the DPRK undertakes to shut down the Yongbyon enrichment plant, but it continues to operate it, this would be a violation. The verification objective is to provide assurance that the plant is not enriching—so verification activities must be designed and implemented to detect any enrichment operation at that facility. On the other hand, if the DPRK continues to enrich elsewhere, and at the particular point in time it has given no undertaking not to do this, then detection of enrichment elsewhere would not constitute a violation (though, depending on the circumstances, it may have a serious impact on *trust*).

If the DPRK wants to operate the Yongbyon facility to produce LEU, then the standard safeguards objectives would apply, and inspectors would have to implement activities to meet these objectives—specifically, to ensure that all nuclear materials passing through the facility are correctly recorded (including enrichment levels) and accounted for, no HEU is produced, and all nuclear materials leaving the plant remain under safeguards. So, broad objectives (such as determining whether a facility is shut down or operating) can be addressed by qualitative measures (including external monitoring where appropriate), but more specific objectives will require more rigorous verification measures.

### *Special Inspections*

The issue of special inspections or challenge inspections was touched on in section 2, stage 7, above. The DPRK can be assured that a mandate to look for *undeclared* facilities and materials is not *carte blanche* for access anywhere for any purpose. As just discussed, in the verification context *undeclared* means something that *should* have been declared in accordance with the agreements applicable at the time in question. Obviously, until the DPRK is required to

give up all its warheads it will have some nuclear material it is not yet obliged to submit for inspection—verification activities will not be seeking to locate items and materials unless the DPRK is required to declare them and has not done so. As the purpose of verification against undeclared facilities and materials is to detect possible *violations* of applicable agreements, it follows that the potential scope of special inspections will be limited initially but will expand commensurate with the scope of safeguards coverage. Clarity on these matters is essential to avoid misunderstandings about respective rights and obligations and the level of assurance provided by the verification arrangements.

## V. Conclusion

Unlike South Africa—which had dismantled its warheads and joined the NPT as a non-nuclear-weapon state and was thus committed to accepting *comprehensive safeguards* (safeguards on all its nuclear material and activities)—the application of safeguards and associated verification measures in the DPRK will present unique challenges. For a start, the DPRK is not prepared to declare all its nuclear material and facilities until sufficient levels of trust and confidence have been built. Further, the DPRK is likely to retain some warheads for some time, so there is no question of seeking to apply comprehensive safeguards at the outset.

In these circumstances, specific commitments could be negotiated, and corresponding verification measures introduced incrementally. This paper has described how a number of steps would help build confidence in the DPRK’s good faith, and at the same time pave the way for the gradual introduction of safeguards and related verification measures. These steps would be verifiable, though verification would be limited to the specifics of each step.

Initial commitments could be (relatively) simple to monitor, so verification could be qualitative. For example, cessation of nuclear and missile tests can be monitored remotely. Likewise, a fissile material cut-off at Yongbyon could be monitored remotely, though providing inspector access would enable more reliable results. However, a fissile material cut-off could not be monitored where facility locations are unknown, so the incremental approach needs to proceed at a certain pace if the process is to be credible.

Over time, the coverage of verification in the DPRK would be extended. Ultimately—and this needs to be clearly understood at the outset—assurance that the denuclearization process is successful will depend on progress towards the application of IAEA safeguards to the whole of the DPRK and full cooperation by the DPRK as this work proceeds.

## Endnotes

- <sup>1</sup> The author wishes to acknowledge support and feedback from participants in a closed-door seminar organized by the Carnegie Endowment for International Peace.
- <sup>2</sup> Leon V. Sigal argues there can be no verification without reconciliation; see Leon V. Sigal, “For North Korea, Verifying Requires Reconciling: The Lesson from A Troubled Past—Part I,” *38 North*, December 14, 2018, [www.38north.org/2018/12/lsigal121418](http://www.38north.org/2018/12/lsigal121418); and Leon V. Sigal, “For North Korea, Verifying Requires Reconciling: The Lesson from A Troubled Past—Part II,” *38 North*, December 28, 2018, [www.38north.org/2018/12/lsigal122818](http://www.38north.org/2018/12/lsigal122818). See also the author’s article: John Carlson, “North Korean nuclear crisis: Talks still the best option,” *The Interpreter*, September 4, 2017, [www.lowyinstitute.org/the-interpreter/north-korean-nuclear-crisis-talks-still-best-option](http://www.lowyinstitute.org/the-interpreter/north-korean-nuclear-crisis-talks-still-best-option).
- <sup>3</sup> Although the CTBT has not yet gained the necessary ratifications for entry into force, its International Monitoring System is operating provisionally and has played a key role in the detection of the DPRK’s six nuclear tests.
- <sup>4</sup> As there would be no civilian requirement for fissile materials in the DPRK there is no case for the DPRK to retain them.
- <sup>5</sup> Ukraine, Belarus and Kazakhstan are sometimes cited as states that had nuclear weapons and disarmed. These states had Soviet nuclear weapons on their territory following the dissolution of the Soviet Union, but they never had the capability of using the weapons. Thus, the situation was totally different to South Africa, or the DPRK. These states allowed the Russian Federation as the Soviet Union’s successor to take possession of the weapons.
- <sup>6</sup> Challenge inspections are provided for in the Chemical Weapons Convention.
- <sup>7</sup> Simon Denyer, “As clock ticks, South Korea looks for a leap of faith from Washington over North Korea,” *Washington Post*, November 21, 2018, [https://www.washingtonpost.com/world/asia\\_pacific/as-clock-ticks-south-korea-looks-for-a-leap-of-faith-from-washington-over-north-korea/2018/11/20/ce640cc6-ebdd-11e8-9236-bb94154151d2\\_story.html](https://www.washingtonpost.com/world/asia_pacific/as-clock-ticks-south-korea-looks-for-a-leap-of-faith-from-washington-over-north-korea/2018/11/20/ce640cc6-ebdd-11e8-9236-bb94154151d2_story.html).
- <sup>8</sup> It will be necessary to reach an understanding on launching of space vehicles.
- <sup>9</sup> Siegfried Hecker, “What we really know about North Korea’s nuclear weapons, and what we don’t yet know for sure,” *Foreign Affairs*, December 4, 2017, [www.foreignaffairs.com/articles/north-korea/2017-12-04/what-we-really-know-about-north-koreas-nuclear-weapons](http://www.foreignaffairs.com/articles/north-korea/2017-12-04/what-we-really-know-about-north-koreas-nuclear-weapons).
- <sup>10</sup> States participating in the Six-Party Talks were—in addition to the DPRK—China, Japan, the Republic of Korea, Russia and the United States.
- <sup>11</sup> If the enrichment plant is decommissioned it would be important to establish what happens to the centrifuges—ideally, they should be destroyed with inspectors present.
- <sup>12</sup> “Remote monitoring” is used here to mean monitoring from outside the DPRK, by national technical means.
- <sup>13</sup> China has a pilot scale civil reprocessing plant that operates infrequently.
- <sup>14</sup> The current DPRK enrichment capacity is estimated to be on the order of 30,000-50,000 SWU (Separative Work Units). The capacity required to provide the annual fuel requirements for a 1,000 MWe light water reactor is around 120,000 SWU.

- <sup>15</sup> The additional protocol extends the information to be provided to the IAEA and gives wider access rights for inspectors, including to nuclear-related locations such as centrifuge component manufacturing.
- <sup>16</sup> Arrangements for monitored dismantlement of warheads under conditions that maintain secrecy of design information have been piloted under the United Kingdom-Norway Initiative (see <https://ukni.info/>) and are now being looked at in the International Partnership for Nuclear Disarmament Verification (see <https://www.ipndv.org/learn/dismantlement-interactive/>).
- <sup>17</sup> This could be based on the IAEA model INFCIRC/66, but there are some advantages in using an appropriately modified version of INFCIRC/153. The problem with INFCIRC/66 is that it allows for some links between safeguarded and unsafeguarded activities, which may have seemed appropriate 50 years ago when INFCIRC/66 was formulated but is certainly not appropriate today.