

Freeze and Verify: Ending Fissile Material Production on the Korean Peninsula

UNIDIR [online presentation](#) of the report

Pavel Podvig, ["Freeze and Verify: Ending Fissile Material Production on the Korean Peninsula"](#)

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Answers to questions asked during the event

Q: What about the civilian nuclear energy production facilities which are a generic part of a denuclearization process?

Pavel Podvig: At the start of the process, all nuclear reactors would have to be shut down. This would cover the Experimental Light-Water Reactor (if it is online at that point), the 5MWe gas-graphite reactor in Yongbyon, as well as the IRT-DPRK research reactor. Since the 5MWe reactor is essentially a dedicated plutonium production reactor, it must be shut down permanently. It should be possible, however, to resume operations of the ELWR and maybe of the IRT-DPRK reactor as well once they are placed under appropriate safeguards. Ideally, the enrichment facilities will be permanently shut down as well (as was required by the original denuclearization commitment). Enrichment and fuel fabrication services could be provided by foreign suppliers, such as Russia or China.

Q: Given the long history of distrust and deception in nuclear negotiations with the DPRK, how would your proposal ensure the accuracy of the declared amount of material already produced to evaluate the level of compliance?

A: It is likely to be an incremental process that would begin with establishing the basic consistency of the declaration. For example, the amount of plutonium declared by the DPRK in 2008 appeared to be consistent with the operating records of the reactor that it turned over to the United States that year. The same consistency check would be applied to the period after 2013. If the data are consistent it should allow to adjust the level of confidence, even if slightly, and move on to more intrusive verification procedures, such as nuclear archaeology, that could confirm the accuracy of the operating records. This process would serve two purposes – it would allow inspectors to improve the estimate of the amount of produced material and to see if the DPRK participates in the process in good faith, so the confidence in that estimate could be adjusted accordingly.

Q: Closing the material balance will clearly require some nuclear archaeology, including access to waste streams. The 1992-93 crisis was sparked by IAEA requesting access to Yongbyon waste facilities, which the DPRK refused to provide. How would you handle a dispute over a request to access such facilities that go beyond an initial declaration that

would clearly require scientific measures (e.g., sampling) and not just a visual inspection?

A: The shutdown phase of the freeze would not require access to waste facilities as it would focus on verifying that the (declared) production facilities are not operating. Detection of operating undeclared production sites could be done by a combination of looking for material flows (which are not supposed to exist under the freeze) and challenge inspections at suspect sites. Since the “violation threshold” is fairly high, hiding a relatively large operating facility would be difficult.

Closing the material balance will require more intrusive access, but probably not immediately. A basic consistency check based on an analysis of operating records and shipments of materials would provide some confidence in the absence of large non-operating facilities. For example, in a scenario in which LEU produced in Yongbyon was shipped to another location for further enrichment, these shipments would be difficult to conceal. It would also be difficult to determine the amount of material produced in Yongbyon with the accuracy of, say, several kilograms without access to enrichment tails, but it would not be necessary if the objective is to determine whether there is a large enrichment facility elsewhere that could process that LEU.

The reason the IAEA insisted on access to waste facilities in 1992-93 was, of course, the fact that it had to verify the correctness of the material declaration as the starting point of the safeguards application process. In the freeze arrangement this point will come much later, so the arrangement can tolerate the lack of access to production wastes for considerable time. So, while a refusal to grant access would slow down or even halt progress toward closing material balance (and subsequent elimination of the nuclear program), it would not prevent the implementation of the core obligation of the arrangement – an end of fissile material production. In that respect it would be different from the situation encountered by the IAEA in 1992-93, when the implementation of safeguards was not possible without resolving the dispute first.

Q: How would you assess an application of a cooperative threat reduction approach?

A: A cooperative threat reduction program would be an essential element of the denuclearization effort as it would allow to carry out verification activities in a cooperative manner and provide a way to establish confidence in the commitment of all parties to the process. I highly recommend the NTI report, [“Building Security Through Cooperation. Report of the NTI Working Group on Cooperative Threat Reduction with North Korea”](#) that covers this issue in considerable detail.

Q: How would this proposal impact the threat of proliferation from North Korea to other countries?

A: Not directly. A freeze of fissile material production would reduce the number of possible proliferation paths, but probably would not close some of them, such as transfer of proliferation-sensitive technologies.

Q: Clearer definitions need to be made for the facilities, materials, and responsibilities of parties. These were some of the problems encountered during the implementation of

the Agreed Framework and monitoring of the commitments done under the Six Party Talks. It is also worth noting that there is substantial difference between monitoring and verification. As South Africa and Libya have shown, the provisions of the comprehensive safeguards agreement and additional protocol are not sufficient when it comes to the verification of historical production of source and fissile materials. One has also to deal with facilities, which were built, operated and then dismantled. It should also be made clear that wastes, retained wastes and holdups in dismantled equipment are subject to declaration.

A: Yes, definitions will be important, especially since the freeze arrangement would be somewhat different from the standard IAEA approach in that it would focus on production activity, rather than on accounting of material. However, it could use elements of the CSA and AP. The experience of the Agreed Framework and the disablement period of 2007-2009 is, in fact, very valuable as these arrangements did suspend plutonium production.

Accurate verification of historical production is indeed extremely difficult and may not be possible. The experience of the United States and the United Kingdom who conducted internal audits of their production histories suggests that inventory differences would be at least a few percent. It is likely to be considerably higher in the DPRK case. It should be expected that at best inspectors will be able to reach a certain level of confidence in the absence of undeclared material. What level of confidence would be considered acceptable is a political rather than a technical question.

Q: Could you contrast your approach with the recent proposal for cryptographic escrow of declarations, with details unlocked over time? What are the relative merits?

A: Cryptographic escrow is an elegant concept. It assumes that the DPRK would prepare a declaration that includes all relevant sites at the outset of the process. The declaration, however, would be encrypted in a way that protects information about facilities and ensures that it cannot be altered. For a description of the concept see Sébastien Philippe, Alexander Glaser, Edward W. Felten, "[A Cryptographic Escrow for Treaty Declarations and Step-by-Step Verification](#)," *Science & Global Security* 27, no. 1 (2019): 3-14). The declaration would include information about sensitive facilities, such as weapon assembly plants or warhead storage and deployment sites (the "closed segment" in the deferred verification approach), as well as about less sensitive ones, such as facilities of the fuel cycle (the "open segment"). Verification of correctness and completeness of the declaration could then be done by selective inspection of various sites. The key feature of this approach is that it allows the parties to establish whether a certain facility was included in the declaration and, if it can be inspected, to verify that the information about the facility included in the declaration is correct.

While this approach could be useful in dealing with declarations of countable items, such as warheads or missiles, it does not seem to be applicable in the context of a freeze of fissile material production. For example, a declaration could include information about an enrichment facility outside of Yongbyon. Since the declaration is encrypted, the existence of the facility is not revealed in the beginning of the process. Neither is the information about its location, or the amount of material on site (even though it is included in the declaration). This means that the facility could continue to operate and produce material. As a precaution, it could maintain the on-site inventory at the declared level by shipping newly produced material off site. If the verifying organization

selects this site for an inspection, it would find no discrepancies with the declaration, since the facility was properly declared. This suggests that the escrow does not provide a reliable way of shutting down fissile material production.

The escrow approach could potentially be used to declare the amount of material (as well as site locations) in the closed segment. However, for it to work the verifying organization should be able to randomly select sites for inspections. In practice this would mean that the locations of sites where weapons are stored or deployed would have to be known (or would be found out by probing various locations). This raises the question of whether the DPRK would be prepared to reveal this information at early stages of the process. If the DPRK accepts this arrangement, it could be a valuable addition to the deferred verification scheme. But it is not a necessary element of the freeze arrangement.