The Transparency and Verification Issues Involved in the Transition to a Nuclear Arms Reductions Regime Based on Controlling All Warheads

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To date, nuclear arms control has focused almost exclusively on limiting the number and characteristics of deployed delivery vehicles. As reductions continue, however, it will be increasingly important to also limit the total number of warheads, and perhaps the stockpiles of fissile materials available for weapons.

This is recognized is the March 1997 Joint Statement of Presidents Clinton and Yeltsin issued in Helsinki, which calls for a START-III agreement that includes:

> Measures relating to the transparency of strategic nuclear warhead inventories and the destruction of strategic nuclear warheads…to promote the irreversibility of deep reductions including prevention of a rapid increase in the number of warheads.

The Presidents also agreed to "explore, as separate issues, possible measures relating to…tactical nuclear systems, to include appropriate confidence-building and transparency measures," and to "consider the issues related to transparency in nuclear materials."

In this regard, the Helsinki statement is a step backward from joint statements issued in 1994 and 1995, which directed experts on both sides to immediately begin negotiating cooperative measures to ensure the transparency and irreversibility of nuclear arms reductions, including exchanges of data on warhead and fissile-material stockpiles. Russia effectively ended these negotiations in 1995, and I think it would be useful to explore the reasons for this and to see if we can address whatever concerns the Russian side might have so that progress can be made in this area.

The Helsinki statement could be interpreted in a very limited way. For example, transparency measures might be limited to strategic warheads, or only to warheads that are now on delivery vehicles to be dismantled under a START III agreement.

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However, I believe that the security benefits of such measures would be maximized if they applied to all warheads—tactical as well as strategic, reserve as well as deployed. In this context, we would need a comprehensive verification system for nuclear warheads, similar in many ways to the system we have developed for delivery vehicles.

Agreed limits on nuclear warheads and fissile material stockpiles, together with associated transparency and verification measures, would have several benefits:

- First, they would build confidence in each side's understanding of the size of the other's stockpiles of nuclear weapons and fissile materials, and the rate of reduction in these stockpiles.

- Second, they would build each side's confidence that the nuclear arms reductions being carried out are irreversible, and that the potential for rapid and large-scale breakout from agreed limitations is very low.

- Third, these measures would build each side's confidence that nuclear weapons and fissile materials are secure from theft or unauthorized use, and provide information needed to strengthen our mutual cooperation toward that end.

- Finally, such measures would build political support for ratifying and implementing the START agreements, would lay the foundation for much deeper reductions in nuclear arsenals; and would strengthen the nonproliferation regime by demonstrating our commitment to further nuclear arms reductions and, ultimately, the elimination of nuclear weapons.

A Transparency Regime

A comprehensive transparency regime would have several components, including initial declarations and exchanges of information, baseline inspections to gain confidence in the accuracy and completeness of the declarations, and inspections to verify the dismantling of warheads and the disposition of warhead components. Let me briefly review each of these components.

Declarations. As a first step, we must begin with a comprehensive declaration or exchange of data on the location, status, type, and serial number of every nuclear device that exists. This declaration would be updated at agreed intervals—every six months or so. Information also could be exchanged on facilities for warhead assembly and dismantling.

The location of a warhead would be a particular storage bunker or delivery vehicle. The status of a warhead would indicate whether it's in the active or reserve inventory or whether it's slated for dismantling and, if so, when. If steps had been taken to render the warhead unusable, such as removing tritium, batteries, or other components, this could be indicated as well. The serial number could serve as a tag for the warhead, or special tags could be developed and applied for this purpose. Tags would simplify verification by permitting the application of statistical sampling techniques.

In June 1995, the United States proposed a modest stockpile data exchange agreement, as called for by the Joint Statement of the Presidents just one month earlier. The proposed agreement called for exchanging data, on a confidential basis, on total current inventories of nuclear weapons and fissile materials, as well as the total number of nuclear weapons dismantled each year since 1980, and the type and amount of fissile material produced each year since 1970. Unfortunately, Assistant Minister of Atomic Energy Balamutov reportedly rejected the proposal as too comprehensive. It is difficult for me to understand why such information should still be considered sensitive in today's political and strategic environment. Perhaps this is something we could discuss.

Declarations would be valuable even without transparency measures, and we should begin exchanging this data before we've worked out all the verification provisions. Early declarations would build confidence, and would stimulate both governments to ensure that their accountancy systems are accurate and understandable. In the case of historical information, such as the rates of production of nuclear weapons or fissile materials many decades in the past, it is important to assemble this information today, while the personnel who were involved and in charge of these operations are still available.

Baseline inspections. But the real value in declarations would come with their verification, and the second element of a transparency regime would be baseline inspections to verify the accuracy of the declaration. There would be no great need, at least initially, to verify the number or status of deployed strategic warheads, since these warheads are covered by the START agreements. Since all tactical warheads are in storage, the baseline inspections would mostly involve warheads in storage bunkers.

For example, inspectors could visit a particular bunker and verify that the declared number of warheads is present—no more, no less. Alternatively, inspectors could select, at random, a small number of warheads for inspection, and

could verify that the serial numbers or tags on the warheads matched those listed in the declaration.

I would prefer the second approach because it could greatly reduce the number of warheads that are examined. For example, a random sample of just 30 warheads would provide 95 percent confidence that the number of warheads at declared sites is no more than 10 percent higher than the declared number.[2]

There are, however, two key problems in verifying a warhead declaration. The first is knowing that an object which is declared to be a warhead of a particular type really is a warhead of that type. This could be dealt with by developing "fingerprints" or templates of warhead types, and using random sampling to verify that a particular warhead is an authentic warhead of the declared type. For example, Russia could present one or more SS-18 warheads for fingerprinting, or warheads could be selected from a deployed missile by U.S. inspectors. A set of agreed characteristics could be measured: length and diameter; mass; the relative strength of neutron emissions or gamma-ray emissions at certain points; or heat output. Such a signature could be extremely difficult to spoof. If these measurements would reveal sensitive weapon-design information, an automated system could be devised to give a simple "yes" or "no" answer to the question, "Is this an SS-18 warhead?"

Of course, we will have to balance our desire for transparency against the cost, complexity, and intrusiveness of inspections and our desire to protect sensitive information. During the Cold War, both countries usually erred in the direction of secrecy when trying to find the proper balance. But today the balance of risks has shifted decisively in favor of greater transparency. It is difficult to believe that either country could gain a significant military advantage by exploiting the information it might glean from such inspections about the design of the other country's nuclear weapons, given that both countries have committed themselves to a comprehensive nuclear test ban. In any case, I am optimistic that procedures could be devised to protect truly sensitive information while providing an adequate degree of transparency.

A second, more severe, problem in verifying declarations is knowing that they are complete. How could the United States and Russia be confident that the other

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[2] Let F be the fraction of undeclared warheads (in this example, f = 0.1), N be the number of warheads sampled, and P be the probability that at least one of the sampled warheads is undeclared; then $P = 1 - (1 - F)^N$. (This is valid only if the total number of warheads is large compared to N; otherwise, it underestimates the probability P.)

had not hidden a few hundred or even a few thousand warheads? Warheads are so small and need so little attention that we will never be sure that there are no hidden warheads. We can, however, substantially reduce uncertainties and, over time, develop confidence in the declaration.

Challenge or anytime-anywhere inspections are often mentioned as one way to detect undeclared warheads, if they exist, but I am pessimistic about this because a well-designed plan to hide warheads would give few clues about where to look. So even if the other country was not cheating, the fact that the other country could do challenge inspections wouldn't by itself give much confidence that there were no hidden warheads.

A better approach is to exchange historical information on the nuclear stockpiles as part of the initial declaration. For example, we could exchange information on the history of every nuclear device ever manufactured, including the dates and locations of assembly and disassembly and movement between various storage and deployment facilities. In addition, data could be exchanged on the production of fissile materials and warhead components. Information about the location, design, and operation of facilities involved in the production of warheads and fissile materials also should be exchanged. These records could be examined for internal consistency, for consistency with the current stockpile declaration, and they could be compared to archived intelligence data. In some cases, on-site inspections might be able to confirm the accuracy of the declaration. For example, measurements of isotope ratios in the permanent structural components of plutonium-production reactors might verify, at least approximately, declarations of the total production of plutonium at that reactor.

The point isn't that uncertainties in the completeness of the declaration can be eliminated, but that current uncertainties could be reduced substantially. Unclassified U.S. government estimates of the number of warheads in the Russian stockpile are said to uncertain by plus or minus 5,000 warheads, and Minister Mikhailov has been quoted as giving widely divergent estimates for the size of the warhead and fissile-material stockpiles. Unless these uncertainties are reduced through a program of declarations and transparency measures, it may be difficult to sustain a cooperative program to reduce the risks posed by nuclear weapons.

Dismantling. If we can establish a baseline inventory of nuclear warheads, we can proceed to verifiably dismantle them. Although some have proposed verifying the dismantling of nuclear warheads as a separate measure, I believe that it makes more sense as part of a comprehensive regime to limit the number of nuclear weapons. After all, what would be gained by verifying the elimination of a few

selected types of warheads, if other warheads in the stockpile could take their place, or if new warheads could be produced to replace them?

There are three main methods for verifying the dismantling of warheads. The first is simply to verify that a nuclear warhead had been removed from the stockpile, and that the corresponding nuclear components—in particular, the plutonium pit—had been placed in a monitored storage facility. In the case of the United States, Russia could verify that a warhead had been removed from the storage area and delivered to the dismantling area at Pantex, and that some days later a pit had been placed in the storage area. The "fingerprinting" procedures mentioned earlier could be used to assure that the object to be dismantled was an authentic warhead of a given type. Intrinsic gamma-ray signatures might also be used to verify that the pit which is subsequently placed in storage was taken from a warhead of that type. It may even be possible to determine whether the pit was taken from a particular warhead (for example, by irradiating the warhead with a burst of neutrons and measuring the fission-product gamma-ray signature of the pit some days later). Again, sampling could be used to minimize the number of warheads or pits that are subjected to detailed examination.

A second method would be perimeter-portal monitoring at the dismantling facility. The portal would be equipped with a system to verify the authenticity of warheads entering the facility, and to detect fissile materials exiting the facility. Components containing plutonium or uranium would be stored pending their ultimate disposition under mutual monitoring; other components could be destroyed or recycled, as agreed by the parties.

A possible complication is the fact that warhead maintenance and remanufacturing activities might still be occurring at the facility. To deal with this, it might be best to segregate these activities. For example, Pantex could designate a certain area for maintenance and remanufacturing, and another area for dismantling. It would be necessary, of course, to verify that the maintenance facility wasn't being used to increase the stockpile, but this could be done by requiring a strict balance between the number of warheads and pits entering and exiting the maintenance facility.

Some people worry that, by observing maintenance and remanufacturing activities, the monitoring party might learn of vulnerabilities in the force. If, for example, Russia observed that all the W-76 Trident warheads were being rebuilt, it might conclude that that system had a major reliability problem. Even so, it is difficult to see how that knowledge would confer a significant and usable military advantage. U.S. policy is to maintain a mix of warheads in the stockpile, so that the

failure of any one system would not cripple the deterrent capability of the overall force.

A third method would be to track the warhead and its components through the dismantling process. Although this is often considered to be excessively intrusive, it may be possible to protect sensitive information. The monitoring party could, for example, track the movement of warhead up to the disassembly cell, track the movement of the fissile components from the disassembly cell to the storage area, and verify that the disassembly cell contained no warheads or warhead components both before or after the disassembly procedure. Monitoring could be done by on-site inspectors, or remotely using secure video links or radio beacons.

Disposition. The final component of a comprehensive warhead transparency regime would be the disposition of the warhead components. In the case of HEU components, transparency measures have already been negotiated to verify that material from dismantled warheads is being converted into LEU. As regards plutonium components, we must await decisions by the governments about the final disposition of weapon plutonium, either in reactor fuel or in radioactive waste.

Conclusion

I would like to conclude by emphasizing that an agreement to verifiably dismantle nuclear warheads should be seen as just one component of a more comprehensive and integrated effort to reduce nuclear risks. I hope that the two countries can develop a comprehensive plan, rather than deal with individual measures in a piecemeal fashion. Finally, I would like to emphasize the importance of implementing the initial phase of this plan—an exchange of data on warhead and fissile-material stockpiles—as soon as possible. Thank you.