

# Towards Nuclear Zero: Comprehensive Accounting Arrangements for Warheads and Fissile Materials

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U.S.-Soviet/Russian efforts to limit and reduce nuclear forces largely have ignored the nuclear warheads themselves, and the fissile materials—plutonium and high-enriched uranium—necessary for their construction. Arms control has instead focused on limiting deployed delivery vehicles and launchers: ballistic missiles and their silos, mobile launchers, or submarines; and long-range bombers.

The focus on delivery vehicles is understandable. They are much easier to count and far more difficult to hide than warheads or fissile materials. Delivery vehicles are also expensive, typically costing 10 times more to produce and maintain than the nuclear warheads they carry. In addition, the number and characteristics of a nation's delivery vehicles are more accurate measures of the operational potency of its nuclear arsenal than are the size of its warhead or fissile-material stockpiles.

In the future, however, it will become increasingly important to complement limits on delivery vehicles with restrictions on warhead and fissile-material stockpiles, for several reasons.

First, limits on warheads and fissile materials would make arms reductions far more difficult and time-consuming to reverse. Large stockpiles of non-deployed warheads or fissile materials create the potential for rapid and large-scale breakout from treaty obligations. The United States plans to maintain over 5,000 strategic warheads (and nuclear components to build another 5,000 warheads) in storage after START II is fully implemented, in addition to the 3,500 deployed warheads permitted by the treaty. This has generated concern in Russia that the United States could increase the size of its strategic force very rapidly by simply replacing warheads that had been removed from missiles and bombers under START II.

At the high force levels permitted by START I and START II, the break-out problem is not acute. But as the number of deployed warheads moves from 3,500 to 1,000 or less, as we hope it soon will, uncertainties about the total number of warheads—and the amount of fissile material available to make new warheads—

would loom much larger. Intelligence estimates of warhead inventories are highly uncertain. For example, a CIA official testified in 1992 that Russia had 30,000 nuclear warheads, “plus or minus 5,000.” Subsequent statements by Russian Minister of Atomic Energy Victor Mikhailov that the Russian stockpile peaked at 45,000 warheads in 1986 cast doubt on the CIA estimate. When the U.S. and Russia get below 1000 warheads, it will be essential to have in place a system for limiting total stockpiles. The time to begin building that system is now.

Second, unlike strategic weapons, most tactical warheads lack unique delivery vehicles or launchers. Verified limits on warheads are the only way to build confidence that commitments to reduce tactical nuclear weapons have been implemented. Limits on tactical warheads will become more important as the number of strategic warheads is reduced, because the distinction between “strategic” and “tactical” warheads is hazy. For example, U.S. B61 tactical bombs are nearly identical to the B61 strategic bomb, and the W80 warhead on the tactical sea-launched cruise missile is nearly identical to the W80 warhead on the strategic air-launched cruise missile. If strategic warheads are limited, their tactical counterparts should be limited as well. The United States is concerned about the fate of Russia’s huge stockpile of tactical warheads and about Russia’s increased reliance on tactical nuclear weapons to offset the conventional forces of NATO and China. Russia is worried about the deployment of U.S. tactical warheads in an expanded NATO.

Third, limits on warhead and fissile-material stockpiles and associated transparency measures could help reduce risks of theft or unauthorized use. Transparency measures would build confidence that warheads and fissile materials are secure. If security is lacking, transparency measures would help identify shortcomings and facilitate cooperation toward improving safeguards.

Finally, an accounting system for warheads and fissile materials would lay an essential foundation for the prohibition of nuclear weapons. Prohibition would require confidence that nuclear arsenals had been eliminated, and that timely warning would be available of an attempt to build nuclear weapons. It is important to begin verifying declarations as far in advance of a disarmament agreement as possible. As the number of nuclear weapons falls into the hundreds, states would be far more likely to have confidence in a declaration whose accuracy had been verified for years and for tens of thousands of nuclear warheads, than one whose verification had begun recently and only after thousands of warheads had been dismantled.

The need to begin to build a regime for warheads and fissile materials is recognized in 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.”

### **Building a Comprehensive Regime**

A comprehensive regime would have several components, including initial and ongoing declarations; inspections to gain confidence in the accuracy and completeness of the declarations; and measures to confirm the dismantling of warheads and the disposition of warhead components.

**Declarations.** The first element in a transparency regime would be an initial declaration of nuclear warhead and fissile-material inventories, updated at agreed intervals. In June 1995, the United States proposed exchanging data with Russia 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.”

Although the June 1995 proposal represents a useful starting point, declarations ultimately would have to be considerably more comprehensive to achieve the goals set out above. The information to be exchanged should include the location, type, and serial number of every nuclear device, the location and serial number of each fissile component recovered from a dismantled warhead, total inventories of plutonium and high-enriched uranium, and a detailed inventory for each facility for bulk fissile materials. For stored warheads or warhead components, the location would be a particular storage facility; for deployed warheads, it would be the corresponding launcher.

To provide confidence that the declaration is accurate and complete, it would be helpful to also have information on the history of warhead and fissile-material stockpiles and the facilities used to produce them. For warheads, one could begin by exchanging data on the aggregate number of warheads produced and dismantled

each year, or, better still, the date of assembly or disassembly of each device. For fissile materials, the annual production and consumption of plutonium and high-enriched uranium by facility would be useful. A detailed description of the warhead-production complex would be valuable in this context, and would help in designing transparency measures to validate the declaration.

The U.S. Department of Energy took an important step toward increased transparency by publishing a report summarizing U.S. plutonium production and use from 1944 through 1994. The report provides a comprehensive accounting of plutonium inventories at each DOE facility, including the sum of the quantities of plutonium in the U.S. nuclear weapons stockpile and in pits at the Pantex warhead assembly/dismantling facility in Texas. It also provides a summary of the production of plutonium at DOE sites, small acquisitions of foreign plutonium and removals of plutonium from the stockpile. A similar report on the production and use of U.S. HEU is in preparation.

**Inspections.** Declarations are a good start, but eventually there must be inspections to confirm the accuracy and completeness of the declaration. There would be no need to count warheads deployed on strategic missiles, since these would be covered by the START agreements. Nearly all other warheads are in storage, so inspections would mostly involve visiting a particular storage facility and checking that the declared number of warheads is present—no more, no less.

The use of unique identifiers or “tags” would have three key advantages in this regard. First, tags make it easier to certify the completeness of a declaration, because the discovery of an untagged warhead or canister would constitute an unambiguous violation.

Second, it would not be necessary to inspect or count each and every controlled item to gain confidence in the accuracy of the declaration. Instead, inspectors could randomly select a small number of warheads for inspection and verify that their serial numbers matched those listed in the declaration. If a random sample of 20 or 30 warheads turned up no undeclared or bogus warheads, then one could be highly confident that the declaration was accurate.

Third, tags would allow a chain of custody in which individual warheads could be tracked from deployment sites to storage bunkers to dismantlement facilities. Similarly, canisters containing warhead components could be tracked from dismantlement facilities to storage sites to facilities for the civil use or disposal of the material.

A tagging scheme could make use of existing surface features (at sufficiently high magnifications all surfaces have a unique “fingerprint”) or several different kinds of applied tags, such as bar-coded labels or plastic holographic images overlaid by a tamper-proof tape. Tags are used by UNSCOM in Iraq to log and track items which could be used both for civilian and military purposes, by the IAEA to safeguard civilian nuclear materials, and by the U.S. military to track weapons. These tags require that inspectors have physical access to the tag, but it is possible to imagine tags that could be authenticated outside of a container or at a distance. The use of tags for verification, while not yet applied to warheads, is provided for in the START Treaty. Although certain technical issues would have to be worked out, there should be no problem in instituting an effective tagging system for canisters containing warheads, warhead components, or fissile materials.

There are, however, two key problems in confirming the declaration. The first is knowing that an object which is declared to be a warhead of a certain 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 confirm 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 and center of gravity; the relative strength of neutron emissions or gamma-ray emissions at certain points; or heat output. A fingerprint of this type would be extremely difficult to spoof. To protect 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?” A similar system is being developed by the U.S. and Russian laboratories to confirm the authenticity of plutonium pits placed in a U.S.-funded storage facility near Chelyabinsk.

A second problem is demonstrating that the declaration is complete—in other words, that there are no hidden or undeclared stockpiles or fissile material. Challenge, suspect-site, or anytime-anywhere inspections are often mentioned as one way to detect undeclared stockpiles if they exist, but a well-designed plan to hide warheads or materials would give few clues about where to look. A better approach is to exchange detailed historical information on the nuclear stockpiles as part of the initial declaration. These records could be examined for internal consistency, for consistency with the current stockpile declaration, and they could be compared to archived intelligence information.

In some cases, inspections might be able to confirm the completeness of the declaration. For example, measurements of isotope ratios in the permanent structural components of plutonium-production reactors can verify, at least approximately, declarations of the total production of plutonium at that reactor. Knowing the amount of plutonium produced would, in turn, validate declarations about the production of warheads.

**Dismantling.** Once a baseline warhead inventory is established, agreed reductions can be achieved by confirming that a certain number of warheads have been dismantled. This could be accomplished rather easily by demonstrating that the warhead had been removed from the stockpile and that the corresponding fissile components—in particular, the plutonium pit—had been placed in a monitored storage facility. For example, Russia could verify that a U.S. 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 described above could be used to show 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. 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.

Another method would use 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. A third method would track the warhead and its components through the dismantling process. Although this is often considered excessively intrusive, it may be possible to protect sensitive information. The monitoring party could, for example, track the warhead up to the disassembly cell, track 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.

**Manufacture.** It also would be important to have confidence that new warheads or fissile materials are not being produced. Gaining confidence that

additional warheads are not being manufactured will be difficult, since warhead maintenance and remanufacture will continue as long as nuclear weapons exist. Transparency measures on fissile materials provide assurance that a large number of additional warheads could not be produced without detection. Additional confidence could be obtained by requiring a strict balance between the number of warheads and pits entering and exiting a warhead maintenance or remanufacturing facility.

A ban on the production of fissile materials could be verified by applying IAEA-type safeguards to plutonium-production reactors, reprocessing facilities, and uranium-enrichment plants. Indeed, the United States favors such measures as part of a multilateral agreement to end the production of fissile material for weapons or outside of safeguards—the so-called fissile-material cut-off treaty proposal now before the UN Conference on Disarmament.

**Disposition.** If reductions are to be truly irreversible, a comprehensive transparency regime must also provide confidence that components from dismantled warheads and other excess fissile materials would not be available to rebuild nuclear arsenals. The goal should be to render these materials at least as unattractive for use in nuclear weapons as is fresh or spent civilian reactor fuel.

In the case of HEU weapons components, transparency measures have already been negotiated to provide confidence that the low-enriched uranium that the United States is purchasing from Russia for civilian reactor fuel is derived from dismantled warheads.

Disposing of plutonium will be more difficult. The plutonium could be used to fabricate mixed-oxide fuel elements for civilian reactors, but the resulting fuel would be more expensive than uranium fuel, and neither country has facilities to fabricate plutonium fuels. Alternatively, the plutonium could be mixed with vitrified high-level radioactive wastes. In either case, IAEA-type safeguards could provide assurance that no plutonium had been diverted.

## **Conclusions**

A comprehensive transparency regime for nuclear warheads and fissile materials would have a number of important advantages. A transparency regime would build confidence that agreed reductions in strategic and tactical nuclear forces are irreversible, lay the foundation for much deeper reductions in nuclear forces, and would facilitate efforts to reduce the risks of theft or unauthorized use of nuclear warheads and fissile materials.

Although a comprehensive transparency regime will present numerous challenges, the task is manageable if both sides do the necessary technical work and negotiate in good faith. This work should begin immediately. We cannot afford to wait until negotiations begin, or until political agreement has been achieved, to work out the details of verifying declarations or the dismantling of warheads. Unlike past arms control agreements, which were discrete events, we should think of increased transparency as a continuous process, in which we constantly increase the exchange of more detailed information and find ways to corroborate that information. This process is an essential component of a long-term program to reduce the size and salience of nuclear arsenals, as well as a vital element of the effort to improve U.S.-Russian relations.