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# Scenarios for Exercising Technical Approaches to Verified Nuclear Weapons Reductions

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## Background

Presidents Obama and Medvedev in April 2009 committed to a continuing process of step-by-step nuclear arms reductions beyond the new START treaty that was signed April 8, 2010 and to the eventual goal of a world free of nuclear weapons.1 In addition, the US Nuclear Posture review released April 6, 2010 commits the US to initiate a comprehensive national research and development program to support continued progress toward a world free of nuclear weapons, including expanded work on verification technologies and the development of transparency measures.

It is impossible to predict the specific directions that US-RU nuclear arms reductions will take over the 5-10 years. Additional bilateral treaties could be reached requiring effective verification as indicated by statements made by the Obama administration. There could also be transparency agreements or other initiatives (unilateral, bilateral or multilateral) that require monitoring with a standard of verification lower than formal arms control, but still needing to establish confidence to domestic, bilateral and multilateral audiences that declared actions are implemented.

The US Nuclear Posture Review and other statements give some indication of the kinds of actions and declarations that may need to be confirmed in a bilateral or multilateral setting. Several new elements of the nuclear arsenals could be directly limited. For example, it is likely that both strategic and non-strategic nuclear warheads (deployed and in storage), warhead components, and aggregate stocks of such items could be accountable under a future treaty or transparency agreement. In addition, new initiatives or agreements may require the verified dismantlement of a certain number of nuclear warheads over a specified time period. Eventually procedures for confirming the elimination of nuclear warheads, components and fissile materials from military stocks will need to be established.

This paper is intended to provide useful background information for establishing a conceptual approach to a five-year technical program plan for research and development of nuclear arms reductions verification and transparency technologies and procedures.

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[1] "We agreed to pursue new and verifiable reductions in our strategic offensive arsenals in a step-by-step process, beginning by replacing the Strategic Arms Reduction Treaty with a new, legally-binding treaty." See the White House Press Release at: http://www.pbs.org/newshour/updates/white_house/jan-june09/usrussia_04-01.html (June 2009). At the signing of the New START Treaty in Prague in April 2010 President Obama said "While the New START treaty is an important first step forward, it is just one step on a longer journey. As I said last year in Prague, this treaty will set the stage for further cuts. And going forward, we hope to pursue discussions with Russia on reducing both our strategic and tactical weapons, including non-deployed weapons." http://www.whitehouse.gov/the-press-office/remarks-president-obama-and-president-medvedev-russia-new-start-treaty-signing-cere

**New START Follow-on Possibilities**

It is clearly in the interest of the US national security community to assess the technical and procedural capabilities that will be required for the safe, secure and effective verification of future nuclear arms reduction treaties or transparency agreements. At least three main possible objectives stand out:

- Exchange effectively verifiable data on *total* inventories and locations of nuclear warheads in several categories, i.e. deployed, stored, strategic and non-strategic.
- Establish significantly lower limits for nuclear delivery systems and *total* stocks of nuclear warheads including lower agreed limits on operationally deployed warheads and lower limits on non-deployed and non-strategic warheads once they were defined and declared.
- Establish procedures for the effectively verified storage and elimination of declared nuclear warheads, (of all three types i.e. deployed, non-deployed and non-strategic) and fissile materials from military stocks.

**Some Possible New Tasks**

In order to exchange verifiable data on total inventories of nuclear warheads or confirm the reductions of non-deployed or non-strategic nuclear warheads, definitions would be needed for the following:[2]

- Operationally deployed strategic nuclear warhead
- Non-deployed strategic nuclear warhead
- Non-strategic nuclear warhead

Declarations regarding these items might include their location, and for non-deployed warheads, whether or not they are in a stored stockpile reserve or retired and awaiting dismantlement.

In addition, procedures would have to be established for confirming that an item is what it was declared to be and is then subsequently dismantled or otherwise eliminated from military stocks. Procedures needing to be defined and agreed include:

- Inspection, authentication and accounting procedures for declared warheads of various types
- Procedures for confirming the non-deployed status of a nuclear warhead
- Procedures for confirming the dismantlement or elimination from military stocks of various warhead types, warhead components and fissile materials.

**Central Issues and Challenges**

*Re-establishing a Robust U.S. Technical Infrastructure for Arms Control Verification R&D.* In the field of nuclear arms reductions verification, there was a period of relative activity during the late 1990s, followed by a sharp decline in investments and R&D. As a result, physical as well as human capital vital

[2] This list is illustrative and not comprehensive

to progress in arms control verification technologies declined. Careful planning is required to effectively and efficiently re-constitute and sustain U.S. capabilities in this area. NA-22 and other USG agencies will need to collaborate with the full range of partners in the nuclear weapons complex, national laboratories, Department of Defense and interagency. Cooperation with foreign allies and partners, international organizations and universities will also be beneficial.

*Understanding Current Verification and Transparency Activities.* A wide variety of verification and transparency activities relating to nuclear arms reduction are underway. These include START data exchange and verification, transparency arrangements for CTR and MPC&A assistance to Russia and other states, and transparency measures for the U.S.-Russia HEU purchase agreement. Other activities exist as well that offer proven approaches, technologies and operational experiences vital to development of new verification capabilities.

*Choosing Standards of Verification and Transparency.* How will effective verification be defined in follow-on arms reductions agreements? It is likely that the United States and Russia might be satisfied with transparency rather than verification for the next round of reductions. On the other hand there are nonproliferation benefits to satisfying the desires of other international partners and NNWS that reduction has taken place as declared. Advantages could result from designing technologies and approaches that can provide a range of confidence from transparency to strict verification. This will involve trade-offs in time, cost and levels of intrusiveness with respect to inspections and operational impacts.

*Selecting Verification Experiment Parameters.* As mentioned it is impossible to predict the specific political conditions or treaty structure under which future reductions will take place. What is known by each nation with nuclear weapons are the detailed phases of the weapons life-cycle from production to dismantlement. It is prudent to design verification technologies and procedures that could confirm the completion of several of these key life-cycle stages. In figure 1 below blue arrows indicate possible monitoring or verification points.

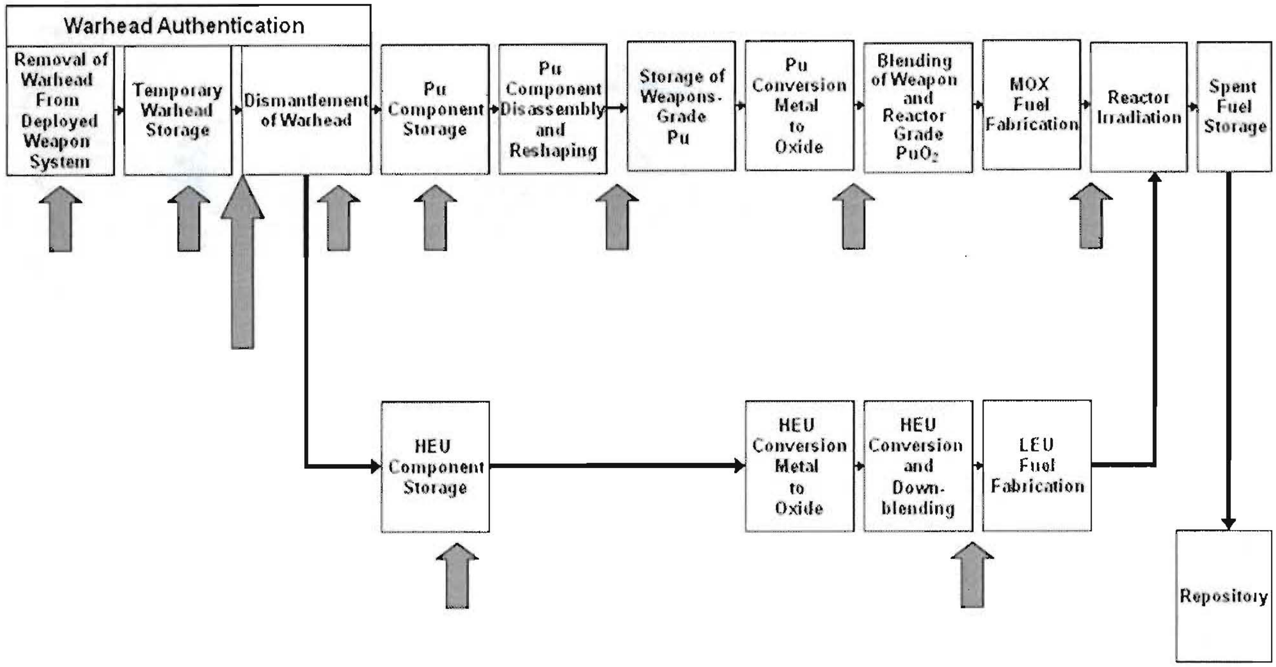


Figure 1. Notional Warhead Life-Cycle

*Creating Positive Exercise Conditions.* Even though established approaches exist to verifying or monitoring several stages of the nuclear weapon life cycle, these are in the conceptual design phase and have not been extensively tested in operational settings. R&D activities should be designed to encourage innovation and solicit feedback from a diverse audience including multinational observers and participants. A set of permanent activities should parallel occasional experiments and technology demonstrations. These might include working groups that look for ways to reduce the costs of verification or identify key data that, if exchanged or declassified, could greatly assist effective verification.

*Managing Operational trade-offs.* When designing verification experiments many decisions will need to be made involving various desired objectives and their potential costs and risks. There far more issues and concerns than can be mentioned in this brief report but several stand out:

- *Field vs. lab* - while much can be done at experimental facilities, verification technologies and procedures need eventual field testing with real weapons at operational facilities.

- *Intrusiveness vs. operational impact and security risk* – Generally speaking, more intrusive verification procedures can provide higher confidence that arms control agreements are being implemented as required. However the measures one side enjoys for confirming compliance must be accepted by other parties to the agreement as well. More intrusive inspections have a higher risk of interfering with nuclear stockpile operations and disclosing sensitive or classified information.

- *Fidelity vs. cost* – The more accurately an exercise scenario matches real operations the more likely it is to provide useful information for assessing real inspections. However using real nuclear materials with elaborate simulations of other operational infrastructure, or conducting verification experiments at operational facilities will clearly raise cost and require more time.

- *Multinational participation vs. cleared US personnel only* – The advantages of permitting only cleared US personnel at verification experiments include shortened timelines and lowered requirements for site preparation and operational security. However, the ultimate objective of verification and transparency activities is to reassure foreign partners and the general public that treaties and agreements are implemented as required. This means eventually acquiring experience with the presence of foreign nationals at technology demonstrations. In fact, there is a growing consensus that verification equipment and procedures will only be acceptable if they are jointly developed by treaty partners. This would make their participation essential in many R&D activities.

*Verification Synergies with other National Technical Means and Open Source Information.* When designing verification and transparency scenarios thought should be given to the potential advantages of integrating data from on-site inspections with other available sources such as imagery and other spectra from national technical means. Fused data, including from open source analysis can increase the confidence level in data acquired through on-site inspections and may provide efficiencies that can reduce the burden of inspections.

*Dedicated Monitored Dismantlement Facilities.* Because both Russia and the United States have retired warhead inventories in the thousands of weapons whose dismantlement will require 10-15 years they might consider segregating dismantlement and refurbishment operations, to facilitate verification of dismantlement. Russia has plans to shut down the warhead assembly plants in Penza-19 and Arzamas-16. One or both could be dedicated to verified warhead dismantlement. In the United States, treaty-limited dismantlement operations could be carried out at the Device Assembly Facility (DAF) on Nevada Test Site, some alternative facility, or a dedicated area at the Pantex Plant. Given the cost and timelines, the pros and cons of dedicated dismantlement facility require careful consideration.

*Program Milestones/Metrics* . When planning a complex multi-year R&D program for verification technologies that includes development, test and evaluation and demonstration it will be important to define some overall objectives. Progress towards these objectives need to be measured to ensure that early stages make appropriate progress and successfully lead toward desired results. Because these technologies are ultimately interned for use in a multinational activity, some notion of their acceptability to foreign partners could be important evaluation criteria for program success

**Potential Scenarios**

Scenario 1: Mock Inspection to Verify Baseline Declaration

To establish a meaningful baseline for reductions, this declaration should include the number of each type of weapon that is deployed, is not deployed (whether in an active or inactive reserve), and in the inventory for dismantlement. A mock inspection would include identification of a deployment or storage facility, declaration of the type and number of items at the facility and some procedure for confirming the declaration. Data exchanged could include:

- Site diagrams for a facility, indicating the location of all deployed delivery vehicles and storage bunkers or other locations at which nuclear weapons were (or might be) present.
- The number of warheads in each delivery vehicle, bunker or storage facility
- The serial number or other unique identifier on each declared warhead or its container.

The primary needed procedure is how to verify that items are what they are declared to be and how they are counted in a manner that allows periodic checks.[3]

Scenario 2: Removal of warheads from operational strategic missiles

This scenario could simulate the removal of warheads from any type of strategic ICBM or SLBM, for example, the U.S. Minuteman III ICBM and the Russian SS-24 ICBM. Procedures for observing the removal of the warheads from the missile and confirming that no items emitting radiation remained in the silo or missile headspace would need to be established. Monitoring of the transportation of the warheads on a special truck to a weapon service area will also be needed as well as a radiation measurement and final tagging of the storage or transportation container containing the declared warhead.[4]

Scenario 3: Continuous monitoring of stored nuclear warheads

Procedures and technologies for monitoring stored warheads may be the most mature among the range of systems for verifying various stages of the warhead life-cycle. Nevertheless additional testing of prototype systems is necessary. Several approaches to storage monitoring have been tested and/or employed in the past, including manned perimeter-portal monitoring systems, periodic inspections of tagged items, and unattended systems with continuous monitoring of the exterior and interior of storage facilities. Remote monitoring systems include a variety of sensors including video, motion detection, monitored seals and other technologies that would detect in real time any attempt to enter

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[3] For more on monitoring declarations see "Verifying a Prohibition on Nuclear Weapons," by Steven Fetter and Ivan Oelrich in *Elements of a Nuclear Disarmament Treaty,* Edited by Barry Blechman and Alex Bollfrass, The Henry L. Stimson Center, 2009.

[4] For a detailed description of this activity at an operation base see Oleg Bukharin and James Doyle, "Transparency and Predictability Measures for US and Russian Strategic Arms Reductions," *The Nonproliferation Review,* vol. 9, no. 2, Summer 2002, pp. 82-100.

or remove the contents of a sealed storage weapons magazine. Live data from these surveillance systems can be exported and viewed remotely. As long as the observers are assured that the data is authentic, they do not have to visit the storage facility to have confidence that its contents have not been tampered with or removed.

Scenario 4: Monitored Warhead Dismantlement

Another series of experiments could be aimed at methods and technologies for building confidence that nuclear warheads had been dismantled. For example, the joint development of inspection systems using passive and active radiation measurements to determine the presence or absence of weapons-grade fissile material and high explosives in a sealed container offers one possible element of a procedure for authenticating declared items as nuclear warheads. Other systems that combine tags, seals and live video data could be developed to provide remote monitoring of the actual warhead dismantlement process. Used in combination with observations at warhead deployment sites and methods for monitoring transportation, these measures may provide adequate confidence that warheads had been dismantled in a manner consistent with declarations

Scenario 5: Verification of Weapons Transportation

Current approaches to monitoring items during transportation include the application of tags and seals that are inspected prior to and following transportation. Because, given sufficient time and resources, most tags and seals are vulnerable to defeat, new and more robust approaches are needed to developing confidence that sealed warhead containers have not been tampered with during the significant periods of transportation. One approach could be to provide the inspecting party with live sensor data on the status and integrity of the containers without revealing the precise location of the shipment. (For safeguards and security purposes, the precise location of a warhead transport is kept secret both in the United States and in Russia.) Additional R&D effort is needed to develop and implement such transportation monitoring technologies.

Scenario 6: Verified Conversion of Weapons-Grade Fissile materials

Key technology challenges for monitoring the conversion of weapons-usable materials into non weapons-usable forms include demonstrating continuity of knowledge during the transition from item accountability to bulk processing and back to item accountability. In the case of plutonium, monitoring technologies are needed to confirm that weapons components comprising declared quantities of Pu metal are converted to oxide and then fabricated into mixed-oxide (MOX) fuel assemblies for burning in reactors. Plutonium components, if determined excess to defense requirements, would be eventually sent to the DOE's Savannah River Site (SRS) facility for conversion to plutonium oxide and disposition. The HEU components would be converted to metal ingots and stored at the Y-12 Plant pending downblending at the BXWT HEU processing facility in Lynchburg, VA. Once in non-weapons forms the IAEA could assume responsibility for monitoring former weapons materials.