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| *Title:* | Supporting the President's Arms Control and Nonproliferation Agenda: Transparency and Verification for Nuclear Arms Reductions |
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# Supporting the President's Arms Control and Nonproliferation Agenda: Transparency and Verification for Nuclear Arms Reductions

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## Introductory Observations

The President's arms control and nonproliferation agenda is still evolving and the details of initiatives supporting it remain undefined. This means that DOE, NNSA, NA-20, NA-24 and the national laboratories can help define the agenda, and the policies and the initiatives to support it.

This will require effective internal and interagency coordination. The arms control and nonproliferation agenda is broad and includes the path-breaking goal of creating conditions for the elimination of nuclear weapons. Responsibility for various elements of the agenda will be widely scattered across the interagency. Therefore an interagency mapping exercise should be performed to identify the key points of engagement within NNSA and other agencies for creating effective policy coordination mechanisms. These can include informal networks, working groups, coordinating committees, interagency task forces, etc. It will be important for NA-20 and NA-24 to get a seat at the table and a functional role in many of these coordinating bodies.

The arms control and nonproliferation agenda comprises both mature and developing policy initiatives. The more mature elements such as CTBT ratification and a follow-on strategic nuclear arms treaty with Russia have defined milestones. However, recent press reports indicate that even the START follow-on strategic arms pact that is planned to be complete by the end of 2009 may take significantly longer and be more expansive in scope. The Russians called for proposals to count non-deployed as well as deployed warheads.

Other elements of the agenda such as FMCT, future bilateral nuclear arms reductions following a START follow-on treaty, nuclear posture changes, preparations for an international nuclear security summit, strengthened international safeguards and multilateral verification are in much earlier stages of development. For this reason any survey of arms control capabilities within the USG should be structured to address potential needs across the near-term (1-4) years and longer-term (5-10) years planning horizons.

Some final observations include acknowledging the enduring nature of several key objectives on the Obama Administration's arms control and nonproliferation agenda. The CTBT, FMCT, bilateral nuclear arms reductions and strengthening the NPT have been sought by successive U.S. Administrations for nearly thirty years. Efforts towards negotiated arms control, although de-emphasized by the G.W. Bush Administration, have

remained a pillar of U.S. national security strategy for decades and are likely to be of enduring if not increasing importance for decades to come. Therefore revitalization and expansion of USG capabilities in this area can be a positive legacy no matter what near-term arms control goals are achieved over the next four years.

This is why it is important to reconstruct integrated bureaucratic, legislative, budgetary and diplomatic strategies to sustain the arms control and nonproliferation agenda. In this endeavor some past lessons must be taken to heart to avoid bureaucratic overkill and keep interagency policy-making and implementation structures lean and effective.

On the Technical side a serious, sustained multilateral program to develop, down select and performance test nuclear weapons dismantlement verification technologies and procedures should be immediately initiated. In order to make this happen the United States and Russia should join with the UK and other interested states in creating a sustained, full-scale research and development program for verification at their respective nuclear weapons and defense establishments. The goals include development of effective technologies and procedures for:

- Attribute measurement systems to certify nuclear warheads and military fissile materials
- Chain-of-custody methods to track items after they are authenticated and enter accountability
- Transportation monitoring
- Storage monitoring
- Fissile materials conversion verification

The remainder of this paper focuses on transparency and verification for nuclear arms and fissile material reductions.

## Transparency and Verification for Nuclear Arms Reductions

Verified nuclear arms reductions are one element of strategy that states undertake to improve their mutual security. In order to be effective in achieving that goal verified arms reductions must be:

- Tied to clear security objectives
- Integrated with other diplomatic and military efforts.
- Authorized by a clear and legitimate legal mandate
- Supported with sufficient human, technical and financial resources
- Conducted openly, rather than in secret so that the record of reductions can be monitored by the political leadership and public of the participating states and by the rest of the world.

Verified nuclear arms reductions can be successful only when there is a sustained commitment on the part of the participating states to reduce the burdens and risks of

military competition. However, it would be wrong to say that verified reductions are only possible **after** relations between states have improved. Rather, the activity of verified nuclear arms reductions can be a mechanism that contributes to improving trust and relations between states.

START follow-on

The ongoing U.S.-Russian strategic nuclear arms reduction negotiations may not be complete by the end of 2009. Already, issues regarding the counting and verification of warheads have surfaced that require new approaches to those in either START or SORT. Acceptance of new verification technologies and approaches will require both sides to work aggressively in a focused manner. There is an immediate need to identify what capabilities are needed to support the evolving treaty and, if required, establish bilateral technical working groups to develop the new technologies and procedures.

Nevertheless the achievements of current U.S.-Russian negotiations towards a START follow-on treaty are likely to be modest in terms of both numerical weapons reductions and political benefits. This is because the treaty objectives are evolutionary rather than transformational. Measures required to achieve truly deep reductions and changes in force posture reflecting reduced roles for nuclear arsenals in national security strategies lie outside of the current negotiating framework as described by government leaders from both sides. Even a successful START follow-on treaty will leave cold-war style nuclear triads in place in both nations with hundreds of strategic nuclear delivery vehicles and thousands of active and reserve nuclear warheads.[1]

Despite its limited objectives the conclusion of a START follow-on treaty will restore continuity to legally-binding, verifiable bilateral nuclear arms reductions and help both countries regain leadership of the global nuclear security and nonproliferation agenda. This outcome can strengthen bilateral security relations and set the stage for a successful 2010 review conference for the Treaty on the Nonproliferation of Nuclear Weapons (NPT). Moreover, Presidents Obama and Medvedev in April 2009 committed to a continuing process of step-by-step nuclear arms reductions beyond the next START treaty and to the eventual goal of a world free of nuclear weapons.[2]

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[1] The two Presidents agreed that: The subject of the new agreement will be the reduction and limitation of strategic offensive arms; the Parties will seek to record levels of reductions in strategic offensive arms that will be lower than those in the 2002 Moscow Treaty on Strategic Offensive Reductions, which is currently in effect; and the new agreement will mutually enhance the security of the Parties and predictability and stability in strategic offensive forces, and will include effective verification measures drawn from the experience of the Parties in implementing the START Treaty. http://www.whitehouse.gov/the_press_office/Joint-Statement-by-Dmitriy-A-Medvedev-and-Barack-Obama/ (June 2009)

[2] "As leaders of the two largest nuclear weapons states, we agreed to work together to fulfill our obligations under Article VI of the Treaty on Non-Proliferation of Nuclear Weapons (NPT) and demonstrate leadership in reducing the number of nuclear weapons in the world. We committed our two countries to achieving a nuclear free world, while recognizing that this long-term goal will require a new emphasis on arms control and conflict resolution measures, and their full implementation by all concerned nations. 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

Post START Follow-on

It is therefore clearly time to start considering the objectives of a round of negotiations following the next START treaty and to assess the technical and procedural capabilities that will be required for its effective verification. At least four main objectives stand out:

- Demonstrate commitment to the goal of a world free of nuclear weapons and to NPT Article VI obligations.
- 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.
- Establish procedures for the effectively verified storage and elimination of nuclear warheads and fissile materials from military stocks.

Setting these objectives for the round of negotiations beginning after a START follow-on agreement will help achieve several strategic goals shared by the United States and Russia. It would strengthen our bilateral pursuit of nonproliferation objectives by demonstrating the reduced role for nuclear weapons in U.S and Russian national security strategies and continuing progress toward nuclear disarmament. It would reduce the chances of nuclear terrorism by shrinking inventories of nuclear arms and fissile materials.

Additionally it would provide benefits for the U.S.-Russian strategic relationship such as abandoning Cold War nuclear postures, increasing transparency and reducing uncertainties in remaining areas of concern. Two such areas are Russian inventories of non-strategic nuclear weapons and U.S. inventories of reserve warheads that could be rapidly re-loaded onto delivery vehicles. Finally, a treaty achieving these objectives could be the final chapter in bilateral nuclear arms reductions.[3] Once Russia and the United States reached total nuclear weapons inventories in the 800-1,200 range they could justifiably set the stage for negotiations on elimination among all states possessing nuclear arms, thus achieving a major milestone on the path to global nuclear disarmament.

**Some Central Issues and Challenges**

Here are many issues and challenges that will remain after a START follow-on treaty. There are also great opportunities to truly transform the roles of nuclear weapons, reduce the dangers they present and shrink the footprint of nuclear weapons and fissile materials

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Press Release at: http://www.pbs.org/newshour/updates/white_house/jan-june09/usrussia_04-01.html (June 2009)

[3] This statement is made on the presumption that a global Fissile Material Cut-off Treaty would be successfully negotiated and implemented, verifying U.S. and Russian compliance.

that are potentially vulnerable to terrorists. A partial list of the challenges in no particular order of priority appears below.

*Accountable Items.* One central question is what items will be accountable under a post START follow-on treaty? It is likely that strategic nuclear delivery vehicles will again be reduced in a future treaty and they are well defined. But as the levels of deployed nuclear warheads move below 1,400 the stockpiles of reserve strategic warheads and non-strategic warheads in storage become more significant and are likely to be limited by a new accord.

*Stockpile Data Exchange.* Other treaty objectives could include exchange and verification of data on total nuclear warheads by type and location and of military stocks of fissile material and agreed procedures for monitored dismantlement of nuclear warheads. Potential stockpile data exchange categories include:

- Total quantity of fissile material in nuclear weapons program
- Quantity and form of fissile material determined to be excess to military needs
- Quantity of nuclear warheads awaiting dismantlement and schedule
- Quantity of nuclear warheads and fissile materials remaining in military stockpile
- Quantity, type and location of warheads in storage for enduring military use
- Quantity, type and location of operationally deployed nuclear warheads

The past attempt to exchange data in 1995 was more comprehensive and failed to receive Russian approval. One factor missing at that time was an agreement for nuclear cooperation that could facilitate the exchange of classified data. If the data above is exchanged it is in the interests of both states to declassify it, with the possible exception of location data.

*Nuclear Force Structure.* Another central issue for a post START follow-on is nuclear force structure. Once agreement is reached to reduce total nuclear warhead stocks to less than 1,500 or so then changes in the existing triad of nuclear delivery vehicles must be considered. Arguments and considerations for future forces structure are likely to be included in the Nuclear Posture Review due at the end of 2009.

*Non-strategic Warheads.* In addition the next treaty must include non-strategic nuclear warheads of which the U.S. has hundreds and Russia has thousands. The only meaningful way to impose limitations on non-strategic warheads is to verify their permanent storage or dismantlement. In this regard, developments in the joint technical work to demonstrate transparent warhead dismantlement are of vital importance. Russia will be reluctant to eliminate this asymmetry in force structure with the U.S. particularly if the latter does not accept significant, verifiable limitations on missile defenses.

*Dedicated Monitored Dismantlement Facilities.* Because both nations have retired warhead inventories in the thousands of weapons whose dismantlement will require 10-15 years they should consider segregating dismantlement and refurbishment operations. 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 Pantex.

*Rethinking Warhead Arms Control.* Another big question is "can confidence in nuclear stockpile reductions be achieved without verifying nuclear warhead dismantlement?" Warhead arms control may be too difficult at the present stage. An alternative concept could be to verify no new military fissile materials production and to simultaneously verify some periodic reduction in stocks of military fissile materials. A possible scheme for monitoring and verifying such material as it was converted to non-military forms is straightforward: sealed containers would be transported to facilities where the material would be converted and shorn of classified isotopics and chemical properties. Bilateral or IAEA monitoring would begin with the arrival of the classified material at the entry point to the conversion facility. A perimeter monitoring system would assure that only monitored containers, plus other nonweapons materials needed in the peaceful fuel, would be allowed in. All fissile material containers exiting the conversion facility would be measured using normal IAEA safeguards methods, and then seals would be applied to the containers for storage or transport to processing facilities where they would be converted to fuel for nuclear reactors. Ultimately, this verification plan, coupled with a verified FMCT would equate to nuclear arms reduction over time. This approach could sidestep the sensitivity of warhead verification until very low numbers (in the tens of weapons), were reached.

*Standards of Verification and Transparency.* How will effective verification be defined in future 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 to desires of other international partners and NNWS that reductions have taken place as declared.

*Technical and Institutional Resources.* Over the past decade there has been erosion of the technical and institutional base for verified nuclear arms reductions. This is a key issue with respect to the national labs and other DOE facilities. What institutional and laboratory structures have been lost and might be critical to reconstitute or create?

- One example could be working groups with key players to identify and discuss obstacles on the critical path to doing large scale experiments/demonstrations in the area of warhead dismantlement transparency and verification.

- Another example is the loss of TA-18 at LANL and the Superblock at LLNL which has significantly reduced our ability to:
    - Test new radiation measurement tools on suitable objects and materials
    - Demonstrate technology to USG personnel
    - Demonstrate technologies and procedures to international treaty partners.

- What new facilities can provide these capabilities? The Device Assembly Facility (DAF) is one possibility. Are there others? Is a dedicated facility needed/feasible?

**A Path Forward**

The most critical skill that needs to be developed for the next phase of nuclear arms reductions is the verified elimination of nuclear warheads and fissile materials. Authenticating that an item removed from a delivery vehicle is indeed a nuclear warhead subject to dismantlement under a treaty is a critical arms control challenge that has yet to be resolved.

A great deal of work has been done in this area, but only at the level of technology demonstration and prototype development. Nothing yet approaching first unit production of an efficient, reliable, cost effective and mutually acceptable system for verifying warhead dismantlement has yet been produced. However this objective seems well within the capabilities of the international technical community. Verifying the storage and non-use of warhead components and fissile materials is less challenging than warhead authentication and well with our grasp. But even these systems need further development and testing before they could enter production and be utilized for formal treaty verification.

Moreover, verification technology is only half the development challenge. The purposes for which these technologies are developed and the sensitive locations where they will be used, require that careful, detailed procedures for their safe and effective use be developed, tested and mutually agreed upon. To the greatest extent possible warhead verification systems must be cooperatively developed in an applied setting by the parties that will use them. No nation will permit its warheads to be examined by equipment developed solely by other states without certifying that it could not reveal any classified information about the inspected item or facility. Correspondingly no inspectors would trust the results of verification measurements performed by instruments that they did not help design and whose accuracy they could not independently verify.

The United States, Russia and the UK have maintained very modest programs for the development of verification technology over the past eight years with some limited progress, and the UK is working with Norway as well, but the level of effort is nowhere near what is required to make verified warhead elimination feasible in the short term.

Today only the UK has made a governmental commitment for intensified research and development in arms reduction verification and declared that its nuclear weapons establishment is ready to work with other nations on this challenge. A similar commitment, backed by action and resources on the part of all states possessing nuclear arms, and the United States and Russia in particular, is critical to global security in the long run.

In order to prepare for a post START follow-on treaty the following actions will be essential:

- Conduct a survey of technologies available for warhead monitoring and transparency and their maturity levels. What additional capabilities are needed?
- Assess all applicable government-to-government and lab-to-lab agreements that authorize joint work on nuclear weapon dismantlement verification/transparency and assess for scope, gaps, duration, roles and responsibilities etc.
- Determine the level of investment needed to bring prototype monitoring systems back into the field for exercises with both simulated and actual warheads/weapons components.

International Verification Development Centers

If a post START follow-on treaty is to be verified, including verification that warheads have been dismantled and not simply placed in storage (a desire publicly raised by Russia), then serious sustained program to develop, down select and performance test dismantlement verification technologies and procedures should be immediately initiated. This could include the establishment of international "test beds" for technologies and procedures for monitoring the deactivation, storage and dismantlement of nuclear warheads within the United States, Russia, the UK and other countries possessing nuclear arms that agree to their reduction.

This work would proceed in parallel with negotiations for reductions beyond the level of the Moscow Treaty. With luck, in 3-4 years a series of joint verification experiments (JVEs) on an expanding small number of warheads or quantities of military fissile materials could be conducted. Starting these activities on a small number of warheads or materials would limit the overall level of intrusiveness, locations affected, quantity of information exchanged, and cost. As the United States and Russia became more comfortable with warhead verification, the scope of joint verification experiments could be expanded gradually to cover additional warheads to be eliminated under the new treaty. Eventually the experiments would evolve into formal verification of treaty implementation.

An International Disarmament Demonstration?

A very bold proposal for verification technology demonstration would be for the United States and Russia to identify 50-100 nuclear warheads that they are willing to submit for internationally monitored dismantlement. A series of joint verification experiments would be conducted on various stages of the elimination of these warheads at various locations within each of the nations. Ultimately the fissile materials from the weapons could undergo monitored conversion into fuel rods for nuclear power reactors and

donated to a global fuel bank for NNWS who forego enrichment and reprocessing capabilities. In fact an opportunity might exist to announce such plans and describe some of the demonstrate verification technologies to be used at the 2010 NPT review conference.

A less ambitious plan for the short term would be for the United States, Russia, the UK and other interested states to create a full-scale research and development program for verification at their respective nuclear weapons and defense establishments. The goals of this program would include development of effective technologies and procedures for:

- Radiation measurements of warheads and fissile material signatures
- Information barrier systems to protect sensitive information, and solve the authentication problem – getting the inspecting party to trust measurements taken by equipment last in possession of the host (inspected) party
- Chain-of-custody methods to track items after they enter accountability
- Transportation monitoring
- Storage monitoring

**Conclusions and Recommendations**

If the technologies and procedures for verified nuclear dismantlement are not developed and implemented in nuclear arms reduction beyond the START follow-on treaty, then those reductions will not fully provide the strategic stability and non-proliferation benefits that both sides seek.

It will be difficult, for example, to prepare for the time when we are looking at a future verified multilateral nuclear arms reductions treaty whose goal may be the complete elimination of national nuclear arsenals. In addition, it will be difficult to claim that nuclear weapons have been reduced as opposed to simply placed in storage.

It will also be difficult to improve transparency on the total nuclear stockpiles as opposed to operationally deployed warheads and delivery vehicles. And as a result, it will be difficult to receive credit from the rest of the world for making meaningful progress towards Article Six commitments and the goal of a nuclear weapons-free world.

In designing verification and transparency measures for bilateral nuclear arms reduction beyond a START follow-on we should be mindful of the precedents that will be set and begin creating opportunities for greater international observation or participation in the process. It will also be important to consider new cooperative R&D projects supporting verification. These might include the establishment of joint technology centers at the national nuclear research centers of participating states.

## Appendix A

## Treaty Verification Annotated Bibliography

1. Kimball, Daryl, Hans M. Kristensen, and Greg Thielmann. "Next Steps in U.S.-Russian Nuclear Arms Reductions: The Start Follow-On Negotiations and Beyond." 27 April 2009. Arms Control Association. <http://www.armscontrol.org/node/3632>. (June, 2009)

This article is a transcript of a briefing hosted by the Arms Control Association. Ambassador Linton Brooks quotes recent diplomatic communiqués that give insight into the direction of START negotiations regarding ballistic missile defense. Ambassador Linton discuses lowering strategic arms below 2002 Moscow Treaty limits and utilizing verification measures drawn directly from the START I treaty. Greg Thielmann offers views on why comprehensive verification is critical to START success and what verification measures can be implemented to achieve this success. (20 Pages)

2. Bukharin, Oleg and Kenneth Luongo. "U.S. Russian Warhead Dismantlement Transparency: The Status, Problems, and Proposals." April 1999. PU/CEES Report No. 314. <http://www.ransac.org/new-web-site/pub/reports/transparency.html>. (June, 2009)

The authors outline the history of U.S.-Russian verification measures and observe problems in technology, intrusiveness, operational impact of weapons complexes, funding, and political constraints for future verification measures. The authors discuss ways to proceed with dismantlement through programs like START III, cooperative research, chain of custody arrangements, transparency agreements, and stockpile and fissile material declarations. Appendix A describes dismantlement transparency technologies and procedures in great step by step detail. (28 Pages)

3. **OUO DOCUMENT**: "Transparency and Verification Options: An Initial Analysis of Approaches for Monitoring Warhead Dismantlement" DOE Office of Arms Control and Nonproliferation. May 19, 1997.

This Department of Energy report discusses options for verifiable warhead dismantlement. The options are analyzed based of confidence, negotiability, classified information loss, operations impact, readiness of implementation, and inspection costs. It concludes: "transparency or verification can be achieved by implementing the monitoring activities identified in this report". The report suggests further analysis of warhead radiation signature measurement methods and the security and vulnerability issues surrounding these measurements, costs and impacts to dismantlement facilities, and options for irreversible warhead reductions. (168 Pages)

4. Fetter, Steve. "A Comprehensive Transparency Regime for Warheads and Fissile Materials." Arms Control Today 29. January/February (1999). <http://www.armscontrol.org/act/1999_01-02/sfjf99>. (June, 2009)

Fetter discusses the importance of warhead verification for reducing the US and Russia's ability to quickly increase the size of their strategic force by uploading and the importance of increased confidence between states with additional transparency measures. Fetter suggests several important requirements of a comprehensive transparency regime, including declarations of warhead and fissile material inventories, verification of this using tags or identifiers, inspections to verify the accuracy of declared inventories, the dismantling warheads with associated verification measures, disposition of fissile nuclear materials through the civilian power industry, and verification of the absence of nuclear weapons manufactured under IAEA type safeguards. (8 Pages)

5. Committee on International Security and Arms Control and National Research Council. Monitoring Nuclear Weapons and Nuclear Explosive Materials." 18 April 2005. National Academies of Sciences. National Academies Press, Washington, D.C. <http://www.nap.edu/openbook.php?record_id=11265&page=1>. (June, 2009)

This report focuses on the expansion of transparency and verification to include nuclear explosive material, weapons, and components. It covers possible steps to increase nuclear weapons inventory transparency for active, inactive, and nonstrategic weapons, and methods of confirming weapons elimination in dismantling facilities. The report analyzes definitions of the terms "nuclear warhead" and "nuclear weapon" and discusses the ambiguities of these definitions causing potential confusion for treaties. (250 Pages)

Acton, J. Brooks, L. and James Doyle. "Verification: common Ground and Emerging Controversies." Carnegie International Nonproliferation Conference, Washington, D.C. April 2009. <http://www.carnegieendowment.org/files/npc_verification2.pdf>. (June, 2009)

Ambassador Linton Brooks discussed political considerations of verification, focusing mainly on difficulties associated with access. He suggested revisiting the suggestion of having Russian inspections carried out by the Russian Academy of Sciences. James Doyle focused on technology, procedures, and institutions for verification. He stressed the need for states to maintain sustained commitments towards verification and the need for the "first unit production of an efficient, reliable, cost effective, and mutually acceptable system for verifying warhead dismantlement". He states the need for more coordinated research. James Acton discussed the problems associated with inspecting undeclared facilities as the amounts of weapons decrease and the political troubles associated with special inspections. (25 Pages)

Antonov, Anatoly and Rose Gottemoeller. "START Treaty Follow-On Talks." 24 April 2009. U.S. Embassy, Rome, Italy. <http://www.state.gov/t/vci/rls/123065.htm>. (June, 2009)

This is a short press release by Rose Gottemoeller, the Assistant Secretary of the Bureau of Verification, Compliance, and Implementation and Russian Ambassador Anatoly Antonov covering a preliminary meeting for START Treaty negotiations. Ambassador Anatoly expressed hope of creating a START draft treaty by the end of the year. He said a new treaty will help improve relations and promote confidence, but stated concern on Russian-US agreement over a "missile shield". He also stated "I hope that it will be a very impressive impulse to international movement regarding" the elimination of nuclear weapons. Assistant Secretary Gottemoeller was less forthcoming; her main statements revolved around rebuilding US-Russian relationships and confidence. (3 Pages)

Bunn, Matthew. "Securing the Bomb: Introduction: Monitoring Nuclear Stockpiles and Reductions." 28 October 2002. Nuclear Threat Initiative. <http://www.nti.org/e_research/cnwm/monitoring/index.asp>. (June, 2009)

In this section of "Securing the Bomb", Bunn discusses the increasing importance of warhead verification transparency to build international confidence in stockpile security and reductions. He suggests key initiatives for this transparency and how transparency increases warhead security. (7 Pages)

DeSutter, Paula A. "The New US Approach to Verification". Remarks at the Carnegie International Nonproliferation Conference "Sixty Years Later" Panel on the Future of Verification. Washington D.C. 7 November 2005. < http://merln.ndu.edu/archivepdf/wmd/State/57098.pdf>

DeSutter outlines the relationship between national security against nuclear attacks from rouge state and non-state actors and strong verification and compliance detection. She discusses problems with traditional verification measures when states break agreements, cheat, and fail to enforce rules. DeSutter identifies the difficulties associated with on-site inspections. She advocates changing the term "National Technical Means" to "National Means and Methods" as a way of recognizing states' individual roles in monitoring self-compliance. (3 Pages)

Doyle, James E. "Supporting the President's Arms Control and Nonproliferation Agenda, Inputs for Ed Fei, NA-24." LANL, May 2009.

Doyle explains the increasing importance of the "DOE, NNSA, NA-20, NA-20, the national laboratories, and NA-24" in creating innovative solutions to international nonproliferation concerns and the resulting need for increased interagency cooperation. He discusses difficulties with warhead verification, accounting, and the importance of US-Russian technical interaction. He outlines short and long term political and technical issues in weapons verification that need to be analyzed as the US and Russia progress with START negotiations. (11 Pages)

Gottenmoeller, Rose and Sergey I Kilyak. "Whither U.S.-Russia Relations?" Carnegie International Nonproliferation Conference, Washington, D.C. 6 April 2009. <http://www.carnegieendowment.org/files/npc_us_russia4.pdf>. (June, 2009)

Assistant Secretary Gottemoeller and Ambassador Kislyak discussed US and Russian relations without revealing much information on upcoming START treaty discussions. Gottemoeller stated that the new START treaty would not be a copy of START I but would instead build on START I principles. Ambassador Kilyak and Gottemoeller agreed that missile defense would be an important topic in negotiations. They both hinted to the political maneuvering that might play a part because of US-Iranian relationships. (15 Pages)

**OUO DOCUMENT**: "Joint DOE-DOD Integrated Technology Implementation Plan for START III, Mayak Transparency, and the Trilateral Initiative."

This joint DOE-DoD plan outlines the technology goals to support potential warhead verification needs of the arms control regime. It defines main areas of study: "Pantex/Y-12 radiation signatures measurements and analysis", "Pantex warhead and plutonium-containing component measurement and analysis", "Mayak transparency activities", analysis of information security, "NELA, JTA, and trainer measurements", and demonstration of technology to Russian and IAEA counterparts. The report finds eleven major work elements towards the above goals and gives a rough guideline for deliverables, funding, and deadlines for each element. (40 Pages)

Kimball, Daryl G. "START Anew: The Future of the Strategic Arms Reduction Treaty." 12 May 2008. Arms Control Association. <http://www.armscontrol.org/events/20080512_START_Anew>. (June, 2009)

Kimball discusses costs and benefits of START I and the SORT treaty and outlines the political difficulties resulting from the START treaty expiring without a similar replacement agreement. Kimball finds four "key objectives" to be met by the new START agreement: limiting the number of warheads and delivery systems, limiting the availability of non-deployed weapons, agreeing on a verification protocol similar to the original START, and accounting for weapons system changed from nuclear to conventional. (9 Pages)

Luger, Richard G. "Lugar Speech on Defense against Weapons of Mass Destruction." Conference on Defense against Weapons of Mass Destruction/venue of speech. Chantilly, Virginia. 30 January 2008.

In his speech, Lugar claims "significant setbacks" have occurred in recent years for the nonproliferation regime and states the importance of US-international cooperation to increase confidence in US leadership on these issues. He expresses disappointment in the lack of verification of the Moscow Treaty, stating; "Congress was told that efforts would be launched to add verification mechanisms to the Moscow Treaty". (4 Pages)

Norris, Robert S. and Hans M. Kristensen. "Nuclear Notebook: Russian Nuclear Forces, 2009". Bulletin of the Atomic Scientists. May/June 2009, vol 65, no. 3, pp 55-64.

Norris and Kristensen estimate Russian strategic and nonstrategic/defense weapons, specifically those associated with ICBMs, SLBMs, bombers/weapons, ABM/Air defense, land based air, and navel capabilities. They project reductions for ICBMs, SLBMs, and bombers through 2020. (10 Pages)

Persbo, Andreas, and Marius Bjørningstad "Verifying Nuclear Disarmament: The Inspector's Agenda". May 2008. Arms Control Association. < http://www.armscontrol.org/print/2979> (June 2009)

The authors discuss the difficulties associated with partial and total disarmament verification, including inspector access, legal issues stemming from utilizing non-weapons states inspectors, and protecting classified information. They propose several avenues for future research: creating a model process for disarmament, creating a "declaration standard", researching measurement technologies, address state security issues, and calculate the financial costs of dismantlement facilities.

Shea, Thomas E. "The Trilateral Initiative: A Model for the Future?" May 2008. Arms Control Association. <http://www.armscontrol.org/act/2008_05/PersboShea.asp%2523Sidebar1> (June 2009)

Thomas analyses the Trilateral initiative, a proposed system between Russia and the United States, utilizing IAEA assistance, to verifiably dismantle nuclear weapons. He discusses several verification levels and the difficulties associated with measurement systems. (5 Pages)

Thompson David B. A Guide to the Nuclear Arms Control Treaties. Los Alamos Historical Society, July 1999: 1-332. Report No. LA-UR-99-3173. Los Alamos National Laboratory Research Library, Los Alamos, New Mexico. <http://library.lanl.gov/cgi-bin/getfile?00416713.pdf>. (June, 2009)

This book offers a review of the role of verification in nuclear arms control treaties. Thompson discusses the START I, START II, and START III Treaty negotiation, requirements, and implementation, and includes an in-depth analysis of verification protocols for each treaty. Chapter 9 is of particular interest in our study as it discusses the implications and difficulties associated with including nuclear weapons materials controls and inventory verification in START III. (344 Pages)

## Appendix B

## Additional Sources for the Verified Dismantlement of Nuclear Weapons

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.

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# Status of Transparency and Verification Challenges for Nuclear Arms Reductions

| Challenge/ Objective | Proposed Solution | Status | Needed Development/ Capability |
|---|---|---|---|
| **Establish baseline stockpile data** | Stockpile data exchange (various categories) | 1995 US proposal rejected by Russia | Mutually acceptable categories for data exchange /agreement for sharing classified data |
| **Warhead authentication/ certification** | Various template and attribute measurement technologies with information barrier (IB) | In development, but greatly reduced effort since 2000 | Mutually agreed procedure for verification of original template/ authentication of IB |
| **Transportation Monitoring** | Monitored tags & seals/remote vehicle monitoring | In development, but greatly reduced effort since 2000 | Further technology demonstration, development and testing |
| **Storage monitoring** | Monitored tags & seals/remote real-time monitoring | In development, but greatly reduced effort since 2000 | Further technology demonstration, development and testing |
| **Verified Fissile material conversion** | Blend-down monitoring and attribute measurement systems | Blend-down systems in operation, attribute systems in development | Mutually agreed authentication procedures for attribute measurement systems |

# Status of Transparency and Verification Challenges for Nuclear Arms Reductions (cont.)

| Challenge/ Objective | Proposed Solution | Status | Needed Development/ Capability |
|---|---|---|---|
| **Distinguish warheads from warhead-like objects or other weapons grade fissile materials** | Conduct measurement campaign to baseline and compare signatures | Proposed activity for Pantex under 2000 Integrated Plan, largely dormant | Re-evaluate need and consider plans for joint development |
| **Guarantee that inspection technologies cannot reveal classified data on U.S. or Russian weapons** | Various certification, analysis, red-teaming and information barrier (IB) development programs for proposed inspection technologies | Proposed activity under 2000 Integrated Plan, largely dormant | Tech demos, performance testing and down-selection of candidate technologies |
| **Develop measurements approaches for HEU and high explosives (HE)** | Various: attribute measurements for HEU, HPGe and NaI detectors, chemical detection of HE | Much R&D in last decade but not focused on nuclear weapons | Assess advances in technology, propose new system design, tech demo |
| **Develop and exercise security procedures for reciprocal visits to deployed weapons sites and dismantlement facilities** | Threat assessment, Security plan design, red-teaming, mock visits and inspections | Proposed activity under 2000 I-Plan, largely dormant | Resume efforts to permit reciprocal on-site inspections of sensitive facilities, explore the use of trusted agents |