U.S.-RUSSIAN WARHEAD DISMANTLEMENT TRANSPARENCY: THE STATUS, PROBLEMS, AND PROPOSALS

Oleg Bukharin and Kenneth Luongo

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Center for Energy and Environmental Studies
School of Engineering and Applied Science
Princeton University
Princeton, NJ 08544-5263
www.princeton.edu/~CEES

Oleg Bukharin is a member of the research staff at Princeton University's Center for Energy and Environmental Studies (CEES). Kenneth Luongo is the director of the Russian-American Nuclear Security Advisory Council and a visiting research collaborator at Princeton University. Mailing address: CEES E-Quad, H-101, Princeton University, Princeton, NJ 08544; fax: 609-258-3661; e-mail: bukharin@princeton.edu and kluongo@princeton.edu.

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I. INTRODUCTION

During the past 30 years of the U.S.-Russian nuclear arms control process, the focus of negotiations has been to limit the number and deployment of nuclear-warhead delivery systems. The focus has not been on limiting or eliminating nuclear warheads. With the political transition of Russia from Communism, it now has become possible for the two countries to discuss placing limits on warheads and verifying their elimination. The U.S. and Russian governments have indicated their support for a warhead elimination regime in official documents and government statements. However, the difficulties of extending the arms control regime to cover warheads are numerous.

Warhead design, production, and management operations are among the most closely guarded secrets of the nuclear-weapons states. Greater openness in these areas will be required for a warhead regime. Also, the confirmation of warhead elimination will pose new verification challenges since warheads are too small to be monitored from space or by most other standard national technical means. In addition, there has been no exchange of official information on warhead stockpiles, raising additional verification questions. For example, the United States has only been able to make very rough and indirect estimates of Russia's nuclear stockpile. The level of uncertainty quoted in published estimates is a staggering 5,000 warheads.[1]

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[1] In May 1992, for example, CIA's Lawrence Gershwin stated that Russia had 30,000 warheads and that "the uncertainty [of this estimate] is plus or minus 5,000." (Lawrence Gershwin, NIO for Strategic Programs, CIA, Testimony before the House Appropriations Committee, "*DOD Appropriations for 1993, Part 5*," May 6, 1992, GPO, p. 499.) More recently, General Habiger stated that "the gross numbers of tactical nuclear weapons

Given the array of challenges posed by a transparent warhead dismantlement regime, it is clear that new levels of trust and transparency in the U.S.-Russian nuclear security relationship will have to be achieved. Such openness would have been unthinkable during the Cold War but may be achievable in the coming years. There have already been many transparency breakthroughs in the 1990s and the challenges involved no longer appear insuperable, though they remain formidable.

Aside from addressing the technical aspects of verifying warhead dismantlement another major issue is the conflicting objectives the U.S. and Russian governments have for this regime. Moscow desires the verified elimination of the U.S. “hedge” stockpile of warheads. These warheads remain in ready reserve and would allow the United States to upload its missiles and bombers with twice the number of warheads allowed by START II. Concerns about the U.S. capability to break out of START II in this manner have been a major obstacle to ratification of the treaty by the Russian Duma. The United States, for its part, would like to be able to verify that Russia’s stockpile of substrategic nuclear weapons is being irreversibly eliminated. Russia’s substrategic warhead holdings may be on the order of 10,000-20,000 warheads or ten-twenty times more than the U.S. substrategic stockpile. Later on, if the U.S. and Russian nuclear-warhead stockpiles are reduced below about one thousand warheads each, it is likely that the United States and Russia would require other nuclear weapons states to join in these transparency arrangements.

Some steps have already been taken to structure a warhead dismantlement regime. Joint U.S.-Russia “lab-to-lab” research is being conducted on technical approaches to verification that would instill confidence that warhead dismantlement was being carried out but would not reveal weapon design information considered sensitive. The two countries also have implemented

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that are in Russia today … – depending on who you talk to within the Intelligence community – [are] from 17,000 to 22,000 nuclear weapons.” (*Hearings before the Committee on Armed Services, United States Senate, 105th Congress*, Second Session on S.2057. Part 7, Strategic Forces, US GPO, Washington, DC, 1998, p. 492.)

unprecedented transparency measures as part of their contract to have Russia blend down and sell to the United States up to 500 metric tons of excess weapon-grade uranium from dismantled warheads.

These steps have helped create a good foundation for additional warhead transparency activities. And, this new work could have corollary benefits. For example, if structured correctly, a warhead transparency initiative could become an important source of funding to help Russia eliminate its excess nuclear warheads. It also could lead to opportunities to strengthen safeguards and security of nuclear materials and warheads in the warhead production infrastructure, which is the part of the Russian nuclear complex that has benefited least from U.S.-Russian cooperation.

However, despite positive first steps, it must be realized that creating a meaningful and effective warhead transparency regime will not be easy, and will be affected by continuing Cold War suspicions within the security establishments, and a multitude of other political and technical problems.

II. HISTORY

The history of proposals for transparent warhead dismantlement dates back at least a decade, to the days of Perestroika and Glasnost in the Soviet Union (see Appendix 1). In 1989 the Russian government allowed a U.S. group of non-governmental scientists to conduct measurements of neutron and gamma radiation of a nuclear warhead aboard the Russian ship “Slava.” The U.S. Congress then raised the issue of warhead dismantlement periodically in the early 1990s in relation to the ratification debate of START I. The U.S. Executive Branch, however, did not become interested in the subject until the coming to power of the Clinton administration.

Key developments toward the creation of a warhead transparency regime during this period occurred during 1994-95 and 1996-98. In the first period the official government-to-government dialogue dominated the subject. In the latter period, and up to today, the laboratory-to-laboratory process has been the primary vehicle for progress.

The Safeguards, Transparency and Irreversibility Initiative

The first U.S.-Russian nuclear warhead and materials transparency effort was launched at the January 1994 Summit when the two presidents agreed on a goal of "ensuring the transparency and irreversibility of the process of reduction of nuclear weapons." The initiative, dubbed the "Safeguards, Transparency, and Irreversibility (STI)" initiative, was largely designed to ensure that fissile materials from eliminated warheads would not be recycled into new weapons. In May 1994, an STI Joint Working Group was established to work on the following five issues: Agreement for Cooperation, stockpile data exchange agreement, spot checks to increase confidence in fissile material declarations, Mutual Reciprocal Inspections (MRI), and Limited Chain of Custody (LCC).[2]

The objective of the stockpile data exchange procedures was to create an exchange of information regarding stockpiles of fissile materials and nuclear warheads that could to some extent be confirmed through spot checks. Such exchanges, it was thought, would replace stockpile estimates with facts and serve as the basis for a future transparency regime. However, despite the creation of a detailed list of stockpile information to be exchanged, the discussions on this issue were quickly stalled.

In the area of MRI, the proposed activity was to have U.S. and Russian technical experts develop non-intrusive techniques of

[2] A.Czajkowski, A.Bieniawski, C.M.Persival "*Status of the United States – Russian Federation Safeguards, Transparency and Irreversibility (STI) Initiative for Nuclear Arms*

confirming that, at the end of the dismantlement process, a declared fissile material container contains a weapon-grade plutonium or highly-enriched uranium (HEU) object the shape and mass of which (in the case of a warhead pit) are consistent with those of a warhead component.[3] During 1994 and 1995, Russian and U.S. experts developed and demonstrated some promising MRI techniques but no consensus was reached on the scope of fissile material measurements or specific MRI procedures.

The limited Chain of Custody measures envisioned following specific excess warheads or fissile materials recovered from dismantled warheads by placing tags and seals on containers, and, possibly, by using additional remote monitoring techniques such as TV surveillance.[4] The LCC discussions during the STI initiative did not advance to specifics.

The Agreement for Cooperation was to be the legal instrument that would allow the United States and Russia to exchange sensitive and classified information. The agreement was required in the United States by the Atomic Energy Act. It was believed that such an agreement was critical for data exchange or plutonium MRI. The two countries generally agreed on the level of protection of sensitive and classified information that

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Reductions," paper presented at the 37th Annual Institute of Nuclear Materials Conference, July 28 – August 1, 1996, Naples, FL.

[3] For example, at the 14-23 November 1994 meeting at the Lawrence Livermore National Laboratory, U.S. and Russian experts demonstrated an inspection technique based on the use of a narrow region (630-670 keV of the plutonium gamma-ray spectrum taken with a high-purity germanium detector. The measurement was to determine the grade of plutonium (based on a Pu-240/Pu-239 ratio) as well as to estimate the minimum mass of plutonium necessary to produce the observed gamma-ray intensity. (Zachary Koenig et al, "*Plutonium Gamma-Ray Measurements for Mutual Reciprocal Inspections of Dismantled Nuclear Weapons*," paper presented at the 36th Annual Institute of Nuclear Materials Conference, July 1995.) According to U.S-Russian technical discussions in 1995, plutonium MRI procedures would involve a) radiation measurements to determine the presence and isotopics of plutonium, b) neutron measurements to determine its approximate mass, and c) gamma-ray scanning to determine the shape and size of plutonium in a sealed container. For HEU secondaries, MRIs would be based on the use of chain-of custody (including application of tags and seals) procedures, weight measurements, and radiation measurements to confirm HEU presence. HEU MRI procedures can be implemented on an unclassified level. In 1996, HEU MRI techniques were demonstrated during reciprocal familiarization visits to the Oak Ridge Y-12 plant and Tomsk-7.

[4] A full chain of custody implies monitoring of a warhead from the moment of its separation from the delivery vehicle, through dismantlement, and through the disposition of the resulting fissile materials. A limited chain of custody focuses on excess warheads entering and fissile materials exiting the dismantlement process and it excludes the monitoring of the disassembly process. (G.Kiernan, M.Percival, L.Bratcher "*Transparency in Nuclear Warhead Dismantlement – Limited Chain of Custody and Warhead Signatures*," paper presented at the 37th Annual Institute of Nuclear Materials Conference, July 28 – August 1, 1996, Naples, FL.)

might be exchanged under an Agreement for Cooperation.[5] However the difficult negotiation of this centerpiece document soon became an obstacle to progress of the STI initiative.

As a result, the entire STI initiative collapsed in the fall of 1995 when, following an internal interagency policy review, the Russian government stopped all STI discussions. Participants in the negotiations and outside observers attribute this failure to a combination of the following factors: distractions and uncertainties created by Russia’s presidential elections; inadequacy of the Russian interagency process; lack of interest on the part of the Russian Ministry of Atomic Energy (Minatom); resistance from the Russian Federal Security Service (FSB); and a lack of a consistent high-level political attention in the United States.

Still, official, high-level support for verified warhead dismantlement did not entirely collapse after 1995. The issue was resurrected at the March 1997 Presidential Summit in Helsinki when Presidents Yeltsin and Clinton agreed that the proposed START III agreement would include “measures relating to the transparency of strategic nuclear warhead inventories and the destruction of strategic nuclear warheads and any other jointly agreed technical and organizational measures, to promote the irreversibility of deep reductions including prevention of a rapid increase in the number of warheads.” However, this statement was met with some confusion as to its actual meaning in the U.S. bureaucracy and resistance to warhead transparency in some portions of Russia’s bureaucracy remained despite the statement.

In the meantime, the U.S. and Russian governments have been quietly negotiating and implementing some elements of a fissile material transparency regime under the HEU purchase agreement, the agreement to stop the production of plutonium for weapons,

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5 Progress and problems of the STI negotiations are reviewed, for example, in J.Goodby “START III: A Transitional Phase in Arms Control.” (In *Nuclear Turning Point*, ed. by Harold Feiveson and Frank von Hippel, Brookings Institute, 1999.)

and the U.S.-Russian-International Atomic Energy Agency (IAEA) trilateral initiative to monitor fissile materials that have been declared an excess to national defense requirements (see Appendix 2). Bilateral work on verified and irreversible dismantlement of nuclear warheads, however, has shifted away from the government-to-government channels and into more technical exchanges between the national nuclear laboratories.

The Laboratory-to-Laboratory Program

After the collapse of the official STI negotiations, the Department of Energy provided approval for a quiet process of U.S.-Russian national laboratory cooperation on the technical aspects of verified warhead dismantlement. This lab-to-lab work built on the relationships and mutual trust that had been created in the U.S. Department of Energy funded cooperative lab-to-lab fissile material protection, control and accounting (MPC&A) program. The Russian and U.S. national nuclear labs have the requisite technical expertise in this area and the U.S. labs had already conducted internal studies of various aspects of the problem. For example, DOE's warhead dismantlement study group prepared a report, *Transparency and Verification Options: An Initial Analysis of Approaches for Monitoring Warhead Dismantlement*, (May 1997). This report, which has never been made public officially but has been widely distributed to interested experts, has become a roadmap for both the U.S. domestic- and U.S.-Russian lab-to-lab analyses of warhead-transparency issues. While it is assumed that Russian institutes have also conducted internal assessments of this issue, there does not seem to be a comparable, comprehensive study similar to that done by the U.S. laboratory study group.

Once the decision to initiate lab-to-lab cooperation had been made, the first discussions on transparency were started in late 1995 at an arms-control workshop in Chelyabinsk-70. This workshop paved the way for a 1996 contract between Chelyabinsk-70 and the Sandia National Laboratories to conduct a cooperative study on warhead dismantlement transparency. This initial effort was funded at about $400,000 and was intended to sustain a technical dialogue on warhead dismantlement with Russian specialists; create knowledgeable advocates for dismantlement transparency in Russia’s nuclear weapons design community; and develop a bilateral understanding of the technical foundations for transparency.

The success of the first lab-to-lab warhead transparency project helped to overcome an initial skepticism that existed in Minatom’s headquarters and, in 1996 – 1998, new contracts were negotiated, additional meetings took place, and participation in the program expanded. November 1997 meeting in Chelyabinsk-70, for example, was attended on the Russian side by representatives from Arzamas-16, Chelyabinsk-70, the Institute of Automatics, the Institute of Impulse Technologies, the four warhead dismantlement plants, and Minatom. On the U.S. side, the meeting was attended by representatives from the Sandia National Laboratories, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Pacific Northwest National Laboratory, Oak Ridge Y-12 plant, Pantex plant, and U.S. Department of Energy.

Because of the continuing sensitivity of the subject, lab-to-lab work focuses only on hypothetical dismantlement scenarios, technical transparency measures, and table-top (a scaled-down mock-up) and computer models of the dismantlement process. The overall plan envisages four phases of work: 1) preliminary studies, 2) advanced studies, 3) laboratory-scale technology demonstration, and 4) technology demonstration at a dismantlement facility. Ideally, the process will yield a joint approach to warhead dismantlement transparency that could be presented to policy-makers in the two countries and incorporated into future arms control treaties.

As of 1998, the process has reached the third phase and DOE’s annual budget has increased to $10 million. At April and May 1998 workshops in Chelyabinsk-70 and Arzamas-16, Russian experts demonstrated proposed technologies for fissile-component radiation measurements, detection and disposition of high explosives, and elimination of warhead casings. A table-top model of the dismantlement process also was completed. It was hoped that deployment of a prototype transparency system would occur in 1999.

The Clinton-Yeltsin agreement at the Helsinki summit has changed the dynamic of the laboratory-to laboratory effort, however, by bringing this fairly obscure cooperative R&D effort to the attention of political leaders and security specialists. In November 1998, the Russian security services first interrupted and then slowed down the implementation of the lab-to-lab warhead transparency contracts pending an interagency review of the program. As of early 1999, the review has not been completed.

PROBLEMS

Aside from the difficulties that the warhead dismantlement regime has faced to date, there are a number of detailed and interrelated technical, operational, and political problems that must be resolved in coming years if a regime is to move beyond conceptual studies into practical implementation. Specifically, the parties must confront questions of technology readiness, dangers of revealing sensitive warhead-design information, the operational impact of warhead-dismantlement inspections on co-located stockpile maintenance activities, asymmetries of the warhead complexes and arsenals, interchangeablility of certain strategic and tactical warheads, Russia's potential inability to finance verified warhead-dismantlement activities, the mixed record of past transparency efforts, and political resistance that often stems from seemingly unrelated U.S.-Russian difficulties.

Technology

As of the summer of 1998, many U.S. and Russian experts were reportedly favoring warhead transparency approaches based on the use of chain-of-custody- and radiation-template technologies (see Appendix 3). The leaderships of the lab-to-lab transparency program believed at that time that there were no major technical obstacles to this approach, and should a policy decision be made, the technology could be ready for deployment within 12 months.

A primary technology that would be used in the chain-of-custody procedures is tamper-indicating devices (tags and seals). These have been employed extensively for domestic safeguards and international verification purposes for many years, and the U.S. and Russian national laboratories have a considerable expertise in developing and evaluating these devices. There is a wide range of tags and seals that have been developed specifically for arms control applications or that are available commercially.

However, questions have been raised about the effectiveness of tags and seals in a warhead dismantlement transparency scenario. According to Los Alamos experts, “most tags and seals are highly vulnerable to tampering when they are not being monitored. In one study, every seal tested was defeated within five minutes (if the seal was not under some form of monitoring). This study demonstrated that without careful considerations as to selection of which tags and seals to use, the establishment of procedures for their application, removal, and autopsy, and monitoring of seals between application and removal, tags and seals may be of limited value in maintaining the chain-of-custody of an item.”[6] Additional technologies and procedures to monitor seals might therefore have to be developed for warhead-transparency applications.

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[6] Chad Olinger et al “*Technical Challenges for Dismantlement Verification*,” paper presented at the 38th Annual Institute of Nuclear Materials Conference, July 20-24, 1997, Phoenix, AZ.

The effectiveness of radiation template methods, which rely on measurements of spontaneous and stimulated radiation from nuclear weapons and their components and the use of radiation "templates" for comparing the energy, time and correlation patterns of this radiation with library reference patterns, has also been questioned. Radiation templates are already used at U.S. warhead dismantlement facilities for domestic safeguards purposes to confirm that returned warheads are intact and that random samples of warhead component containers hold specified fissile material components. The low-resolution gamma-spectrometry method (Radiation Identification System, RIS system) is employed at Pantex for measurements primarily on plutonium pit components. The nuclear materials identification system (NMIS, until recently the Nuclear Weapons Identification System, NWIS)) is used at the Y-12 plant in Oak Ridge to track HEU secondaries. There is, however, little operational experience in using these systems for measurements on both intact warheads and HEU and plutonium components as it is envisaged in the proposed transparency regime. A high-resolution gamma-spectrometry (CIVET system) could be used for such measurements, but this system has not been tested operationally.[7]

It is believed that no radiation template measurements are used at the Russian dismantlement plants on a routine basis. According to a U.S. arms control expert, “Russians will resist any unproven [verification] technology, and will stress low-cost and low-tech approaches.”[8] This assessment has been borne out as some Russian experts have already expressed reservations regarding the template approach and raised questions about its ability to protect sensitive information.

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7 The RIS, NMIS, and CIVET systems are most mature technically and at present are considered leading candidates for warhead transparency applications. There is a number of other promising radiation detection methods, such as the LANL-developed Thermal Neutron Multiplicity Counter or Neutron/Gamma-Ray Fingerprint System, that could potentially be used to authenticate nuclear warheads and components. Additional analysis and development, however, would be required before these techniques will become available for warhead transparency applications. (*Warhead Identification Measurements*, Briefing materials, Los Alamos National Laboratory, December 15, 1998)

8 Sandia National Laboratories expert, remarks at Institute of Nuclear Materials Management’s workshop, April 1994, Washington, DC.

In the proposed transparency regime, radiation-template technologies would be used to satisfy inspectors concerning the identities of warheads and their fissile components without allowing them to derive sensitive warhead-design information.[9] However, according to U.S. national laboratory experts, “Analyses of the efficacy of these [template] measurements both in protecting design information and authenticating warheads are still preliminary.”[10] Further development and validation of information barrier technologies is needed before radiation template methods could be used to verify warhead elimination.

Additional joint laboratory experiments will likely be required to satisfy cautious security officials and production managers. A final judgement on whether the technology is ready for deployment and whether the parties are comfortable with a particular technical solution will likely require demonstration and extensive testing (initially with unclassified, well-characterized objects) at the actual dismantlement facilities where the transparency measures are to be implemented.

Intrusiveness

The requirement of the U.S. and Russian governments that warhead dismantlement transparency technologies not allow very sensitive warhead design information to be revealed poses a significant challenge to the development of this new regime. The use of radiation measurements and their comparison with templates and threshold values for quantities of fissile material and other variables, using computers which give only a "yes" or "no"

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9 Under most verification scenarios, radiation measurement technologies would require some sort of an “information barrier”. Each of the leading candidates offers some level of information protection. The RIS system, although used for domestic safeguards applications, is designed to give a Yes or No answer without displaying template or signature information. The CIVET system has been designed specifically for arms control verification purposes. The NMIS system, which utilizes a time and frequency analysis of induced or passive radiation from nuclear components, is considered to be relatively less intrusive because of difficulties associated with extracting warhead design information from time and frequency analysis data.

10 Chad Olinger et al “*Technical Challenges for Dismantlement Verification*,” paper presented at the 38th Annual Institute of Nuclear Materials Conference, July 20-24, 1997, Phoenix, AZ.

answer, will make it possible to conduct inspections at mostly unclassified level.[11] Restrictions on direct access to the dismantlement process while classified components are exposed and masking of any specialized dismantlement equipment which reflects design information could allow the parties to avoid disclosure of any weapon design information that is considered classified by their national laws.

However, classified-level inspections would greatly enhance confidence in the transparency measures and would possibly be simpler and cheaper to organize. Because of the high level of weapon design expertise in both countries, there should be little concern about exchanging currently classified information related to general nuclear physics and warhead design principles. Still, exchanges of even trivial classified information would require an Agreement for Cooperation, which the U.S. and Russia have thus far failed to negotiate.

And certain information could not be shared even on a classified level because of fears of revealing advanced warhead design features or vulnerabilities.[12] Even small snippets of information could be of concern when collated with intelligence data received from other sources and analyzed using computer models for reverse-engineering. There are reports, for example, that the Russian security apparatus was unhappy about the 1989 Black Sea experiment in which U.S. NGO organizations were able to measure the complete gamma-ray spectrum from a Russian cruise missile warhead.[13]

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[11] In the United States, activities including monitoring of movements of weapons and components cannot be completely implemented on the unclassified level because dates and times of such movements are classified as confidential national security information (C/NSI). (James Morgan "*Transparency and Verification Options*," paper presented at the 37th Annual Institute of Nuclear Materials Conference, July 28 – August 1, 1996, Naples, FL.)

[12] Advanced design information might relate to the features that have enabled the United States to achieve yield-to-weight ratios in its warheads which are believed to be somewhat higher than those of Russia. Vulnerabilities could relate to security features that have been designed into modern U.S. warheads or their sensitivity to nearby nuclear explosions.

[13] Bukharin's interviews with Minatom officials, 1991.

An additional complication arises when the proposed bilateral transparency regime is extended to international monitoring, as is contemplated under the trilateral initiative, because it is absolutely essential that international inspectors do not derive any classified weapons-design information.

Operational impact

The presence of foreign inspectors at national dismantlement plants would have a significant impact on facility operations such as warhead evaluation, modernization and re-furbishing, which support the remaining nuclear stockpile. It is currently a requirement at the Pantex plant, for example, that all operations stop during a visit by foreigners. This problem might be particularly serious for the Russian weapons production complex, which is believed to maintain a relatively higher warhead re-manufacturing rate because of much shorter life-times of Russian warheads.[14]

Proper timing of stewardship activities, and masking and segregating transparent warhead dismantlement activities within isolated areas would moderate this impact. Segregation could even be carried to the point where the dismantlement of treaty-limited warheads was isolated in dedicated facilities. The Russian government, for example, has decided 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, which is no longer needed for its original purpose of assembling nuclear warheads for testing. This option is already being evaluated by the U.S. DOE, but preliminary analysis has indicated

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[14] Assuming an average warhead lifetime of 10-15 years for current-generation Russian warheads, and a START III stockpile of 4,000 deployed and reserve strategic and tactical warheads, the remanufacturing requirements would be 270-400 warheads per year. In contrast, the lifetime of U.S. warheads is approximately 30 years. For a stockpile of the same size, approximately 130 warheads might therefore be remanufactured each year in the United States.

that the DAF would require significant additional investment to be made ready for this activity.

Asymmetry of the warhead complexes

One of the most difficult problems for negotiating and implementing a warhead transparency regime is likely to be the significant asymmetry between the warhead production complexes and dismantlement operations in the United States and Russia (see Figures 1 and 2). In the United States, the dismantlement of intact warheads and storage of plutonium pits take place at only one plant, the Pantex facility outside of Amarillo, TX. Another facility, the Y-12 plant in Oak Ridge, TN manages and disassembles HEU secondaries, which were removed from the warheads at Pantex, as well as HEU-only gun-type warheads.

Russia has four “serial production” (assembly-disassembly) facilities located at Arzamas-16, Sverdlovsk-45, Zlatoust-36, and Penza-19. (However, according to the Nuclear Complex Reconfiguration Program, adopted by the Russian Government in 1998, warhead dismantlement work will cease at Arzamas-16 and Penza-19 by 2003.[15]) In addition, management and storage of HEU and plutonium components takes place in Chelyabinsk-65 and Tomsk-7. The difficulties arising from the difference in the number of Russian and American facilities involved in warhead dismantlement are further complicated by the fact that each of the Russian serial production plants may have its own area of specialization. It has been reported, for example, that the Sverdlovsk-45 plant makes physics packages for most strategic missile systems (in addition to producing tactical weapons of certain types) that are subsequently sent to Zlatoust-36 which builds them into ICBM/SLBM reentry vehicles.[16]

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15 Remarks by Minatom’s Deputy Minister Lev Ryabev at the 7th Carnegie Endowment Nonproliferation Conference, January 11-13, 1999, Washington, DC.

16 Some have suggested that Arzamas-16 specializes on tactical as well as certain types of strategic weapons and Penza-19 manufactures only electronic and automatic components and subassemblies. This latter assumption, however, might be incorrect and the Penza-19 facility might be involved in “true” warhead dismantlement. For example,

These questions about the process of warhead dismantlement in Russia have a direct impact on the ability to reach a rapid agreement on the inclusion of warhead dismantlement transparency as part of a START agreement. If, in fact, treaty-limited strategic warheads are dismantled in more than one location, it will be difficult, without major modifications and re-tooling of the Russian complex, to designate any single facility for the verified dismantlement of warheads. As a consequence, transparency monitoring might require access to a larger number of facilities in Russia than in the United States. On the other hand, if a larger number of Russian facilities are required to be monitored because consolidation is infeasible, a Russian insistence on reciprocity may require that the U.S. compensate Russia with greater access in other areas.

Another difference between U.S. and Russian procedures is in the greater role that the military plays in the Russian warhead management and dismantlement process. In the United States, the Department of Defense's (DOD) involvement in warhead management operations ends after DOE's safe-secure trailer picks up a weapon at a military base to deliver it to Pantex for dismantlement. In Russia, prior to dismantlement, warheads are kept in staging areas that are located near the dismantlement plants but are controlled by the 12th Main Directorate of the Ministry of Defense (MOD). Representatives of the 12^{th} Directorate also reportedly observe the process of dismantlement. U.S. inspectors therefore would have to deal with both Minatom and the Ministry of Defense. The Russian interagency process has been a problem in the past and is likely to remain a complication in the future. This raises questions about the ability to smoothly implement the new regime.

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declassified U.S. Corona Satellite Imagery of Penza-19 (probable; mission 1116-2, 6 May 72; photo courtesy of C.Vick, FAS) reveals high-explosives storage magazines and bermed structures that could be associated with operations with nuclear warheads and/or their high-explosive components.

Asymmetry of production capacities

In addition to the asymmetries in the number of facilities where warhead dismantlement occurs, there are also differences between the United States and Russia in nuclear warhead production. The U.S. industrial infrastructure for mass-production of nuclear warheads has shrunk considerably since the late 1980s. Many warhead production and management activities have been consolidated and a number of manufacturing facilities have been shut down.

Most notably, there has been no industrial-scale production of plutonium pits since 1989, when the Rocky Flats Plant in Colorado was shut down because of environmental and safety concerns. The Los Alamos National Laboratory, the only U.S. facility with complete plutonium handling capabilities, is expected by 2007 to reach a manufacturing capacity of 20 pits per year. Eventually, it would be able to produce 50 pits per year. (This capability is generally viewed as sufficient to maintain the U.S. stockpile.) There also has been no production of completely new warheads at Pantex since 1992.[17] (But the capability for large-scale production has been preserved. Such large-scale production would have to use stored pits.) New production is scheduled to resume in 1999 but at a limited level.

Recently, the production of new warheads in Russia has also dropped to less than ten percent of its 1990 level.[18] The Russian complex, however, remains capable of producing thousands of new warheads per year.[19]

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17 At present, approximately 60 warheads are disassembled and re-assembled annually for modification and evaluation purposes at Pantex. (*The Bulletin of the Atomic Scientists*, July/August 1998, p. 71.)

18 Remarks by Minatom's Deputy Minister Lev Ryabev at the 7th Carnegie Endowment Nonproliferation Conference, January 11-13, 1999, Washington, DC.

19 Assuming an operational Soviet stockpile of 35,000 warheads and a warhead life-time of 10 years, one can estimate that the Soviet complex was manufacturing and refurbishing 3,500 warheads per year in the mid-1980s. It is unlikely that the Russian complex is capable today, however, of producing new warheads at the Cold-War levels. The workforce at the warhead production complex has declined and the manufacturing infrastructure has deteriorated. Over 80 percent of the workforce of the pit-production plants in Chelyabinsk-65 and Tomsk-7 are involved in processing HEU under the U.S.-

Russia has to maintain a relatively high production capacity, in part, because of manufacturing and technology problems that limit the life-time of the current-generation warheads to 10-15 years.[20] By comparison, U.S. warheads have a service life of 30 years. Russia therefore has to re-manufacture two-to-three times as many warheads to maintain a nuclear arsenal of the same size. (Russia, however, has reportedly launched a program to improve its warhead manufacturing techniques to extend warhead lifetimes to 25 years.)

The United States and Russia also have different stockpile maintenance approaches. The U.S. stockpile stewardship plan emphasizes science-based surveillance and evaluation of warheads to detect potential defects due to aging. In contrast, "the Russians ensured stockpile reliability through conservative warhead designs that included lavish use of fissile material and high-explosives and by remanufacturing nuclear weapons before age-related problems appeared."[21]

Technical factors alone, however, do not justify the Cold-War size of the Russian weapons complex and Minatom is currently seeking ways to downsize the production complex. In January 1999, Minatom's Deputy Minister Lev Ryabev announced Russia's plans to consolidate warhead assembly work in Sverdlovsk-45 and Zlatoust-36 by 2000, to end production of HEU and plutonium components at one out of two sites, and to cut the number of defense program personnel in the closed cities from 75,000 to 40,000 by 2005.[22] The Russian government is also downsizing Minatom's non-nuclear

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Russian HEU agreement. And Minatom has announced plans to shut down two of its four serial production plants.

[20] Reportedly, some problems of aging for Russian warheads relate to instabilities of high-explosive components and corrosion and swelling of (presumably, fissile material) components. (See, for example, *Stenographic Records of the Parliamentary Hearings "Safety and Security Problems at Radiation-Hazardous Facilities,"* November 25, 1996, Moscow.)

[21] Harold Smith, Jr. and Richard Soll "Challenges of Nuclear Stockpile Stewardship under a Comprehensive Test Ban," *Arms Control Today*, March 1998, pp. 3-6.

[22] Remarks by Minatom's Deputy Minister Lev Ryabev at the 7th Carnegie Endowment Nonproliferation Conference, January 11-13, 1999, Washington, DC. (According to Mr.Ryabev, the total number of workers in the ten closed cities is approximately 150,000.)

weapon component manufacturing facilities.[23] To date, the downsizing process has been largely stalled because of the difficulties of redirecting excess personnel to productive non-weapons work. The creation of economic opportunities for former weapons production workers is the objective of the U.S.-Russian Nuclear City Initiative.[24]

The asymmetries in the U.S. and Russian warhead production capabilities have raised significant concerns, particularly in the United States. Some U.S. critics of the proposed warhead transparency regime could be anticipated to use the production capacity asymmetry to construct the following two arguments: First, Russia could use its excess production capacity to secretly produce new warheads to compensate for verifiably dismantled warheads. Such secret production would be facilitated and masked by legitimate stockpile-maintenance activities. Senator Helms, chairman of the Senate Foreign Relations Committee, has already put this argument forth, stating that, "Russia could be expected simply to replace dismantled older warheads with newer models, while the United States foots the bill for destruction."[25]

The second argument of critics is that Russia could quickly reconstitute its warhead arsenal in a break-out scenario during a period of increased international tension. This surge-production argument, while technically accurate, may not have the serious implications for toppling the strategy balance that there might seem at first reading. The United States is planning to retain large stockpiles of hedge and reserve warheads, and fissile material components, which number in the thousands. Also, secret or break-out production of new strategic warheads would make

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[23] For example, defense production has been virtually stopped at the Molnia plant in Moscow, which in the past was producing bomb casings, and it has been reduced at other facilities of the warhead production complex. (Remarks by Lev Ryabev, deputy minister of Minatom, Russian-American Nuclear Security Council Workshop, Moscow, May 24, 1997.)

[24] As of 1998, Arzamas-16 was the only city targeted by the Nuclear City Initiative that contains a warhead assembly/disassembly plant (as well as a warhead design center VNIIEF). The other two targets – Chelyabinsk-70 and Krasnoyarsk-26 – are homes to a warhead design institute (VNIITF) and a plutonium production facility (the Mining and Chemical Combine) respectively.

little sense if Russia had already eliminated the associated delivery vehicles.[26] In any case, both the clandestine- and surge production scenarios are certainly questionable given the current state of Russia’s economy. In fact, without near-term economic improvements, a rapid deterioration of the technical infrastructure and workforce attrition (due to the lack of replacement of retired personnel and younger workers finding jobs outside of the weapons complex) will further erode Russia’s warhead production capability.

The production asymmetry concerns also could be reduced by cooperative transparency measures. Initially, such transparency measures could include warhead stockpiles and manufacturing declarations, and monitoring of the production facilities that no longer manufacture new warheads. Eventually, transparency arrangements could be implemented at the remaining active warhead production facilities as well.

Asymmetry of dismantlement schedules and in sizes and compositions of the stockpiles

Related to the issue of warhead production asymmetries is the problem posed by the differences in the dismantlement schedules and the sizes of the stockpiles in the United States and Russia. In 1999-2000, the United States expects to complete the dismantlement of warheads that have become excess under the START I treaty.

However, the United States plans not to dismantle a significant number of the warheads removed from deployment under the START II treaty. Instead, in 1994, a policy decision was made to configure its START II forces in a manner that would make possible a rapid deployment of twice the treaty-permitted number of strategic warheads (this known as the "up-load hedge") on Minuteman III and

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25 Senator Helms’ letter to the Secretary of Energy Federico Pena, September 16, 1997

26 Some of strategic air-launched warheads probably could be deployed with medium-range bombers for sub-strategic missions.

Trident II missiles and B-1 strategic bombers in case of a resumption of the Cold War nuclear confrontation. According to current U.S. plans, the START II hedge stockpile would contain approximately 2,500 fully operational warheads. A separate inactive reserve would contain an additional 3,000 warheads without tritium supplies – up from 2,000 as of the end of September 1998.[27] It is, in fact, this large hedge stockpile that is driving Russian interest in a warhead dismantlement regime. Russian leaders would like to see a substantial irreversible reduction in this stockpile as deployed warheads are limited in the future.

With START III reductions the number of warheads outside of the operational stockpile will grow even larger. Assuming a START III stockpile of 2,000 warheads and a combined hedge and inactive stockpile of 2,500 warheads, then approximately 4,000 warheads could become excess and available for dismantlement in the United States.[28] If no steps are taken to verifiably dismantle these warheads, it may increase Russian concern about giving strategic nuclear advantage to the United States and raise further potential difficulty for the struggling strategic arms control process.

On the other hand, because Russia maintained a larger nuclear stockpile during the 1980s, it may still have to dismantle several thousand additional strategic warheads and many thousand tactical warheads to catch up with the United States (see Tables 1 and 2). Assuming that START III will enter into force around the year 2000 and dismantlement rates of 1,500 warheads per year in both countries, Russia would be several years behind the United States in completing the dismantlement. This lag could raise potential concerns in the United States about Russia’s intentions. And, if a warhead dismantlement regime is instituted

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[27] Thomas B. Cochran, "*Disposition of Fissile Material from Nuclear Weapons*," paper presented at the Isodarco Conference, Shanghai, October 29-Nov. 1, 1998.

[28] The actual number of U.S. excess warheads would be determined by a political decision and arms control negotiations and could be less. Only 2000 warheads or so would be available for dismantlement, for example, if the United States were to retain its

during this period of inequity, it could result in much more U.S. inspection of Russian warhead dismantlement than *vice versa*.

Strategic versus tactical weapons

Another complication for the creation of a warhead dismantlement regime is the uncertainty surrounding the number of strategic and tactical warheads in the U.S. and Russian arsenals. This issue is of particular concern to the United States. In part, the U.S. interest in a warhead dismantlement regime is driven by a desire to get accurate information on the number of Russian tactical weapons and to see them eliminated. But, from the perspective of creating a strategic warhead elimination regime, as anticipated in START III, further problems arise. For certain weapon systems, such as gravity bombs and cruise-missile warheads, there is little difference between tactical and strategic warheads. In the United States, for example, variants of the B-61 bomb are assigned tactical and strategic roles and one is assigned both roles.[29]

Extending the limited chain of custody to military sites in order to associate warheads with their delivery vehicles could help. However, as a result of the 1991 reciprocal, unilateral Bush-Gorbachev initiatives, most tactical nuclear weapons have been removed from front-line units and are presently stored inside containers at central locations. In some cases, strategic and non-strategic warheads are kept side by side, in the same bunker.[30] Telling treaty-limited strategic warheads from tactical ones under these circumstances could be a challenging task.

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inactive stockpile and to keep most of the gravity bombs and ALCM warheads, which could not be deployed under START III, in the hedge stockpile (Table 3).

29 The B-61 is an intermediate yield thermonuclear weapon. The B-61 Mod 3, 4, and 10 bombs are tactical; the Mod 7 bomb is strategic; and the Mod 11 bomb is both tactical and strategic.

30 According to General Habiger, who visited the national nuclear weapons storage site Sierra 1050 (located near Saratov, 30 km from the Engels bomber base), “we went...to Saratov, to a national nuclear weapons storage site, where I saw not only strategic weapons, but tactical weapons” (Gen. Habiger Press Briefing/ *USIS Washington File*, 24 June 1998).

Funding

The deteriorated economic condition of the Russian nuclear weapons complex is well known and the cost of the creation of a warhead dismantlement regime is of concern to Russian and U.S. officials. The United States has been effectively paying for warhead-transparency technology development in both countries through its lab-to-lab contracts. It has also been indirectly supporting the dismantlement work by purchasing uranium derived from HEU from dismantled weapons. However, implementation of transparency measures would require additional funding if dismantlement activities are to be rearranged to separate monitored from unmonitored activities, and to shield sensitive information from the view of inspectors.

DOE estimates that hosting an initial inspection at Pantex could cost $6 million, and subsequent hosting costs would amount to $2.5 million per year (under the inspection scenario outlined in Appendix 3).[31] These initial costs would include the cost of building fences and portals around a segregated disassembly area, masking sensitive activities, and security personnel. In addition, the On-Site Inspection Agency would spend an estimated $200,000 per year to provide escorts and logistical support to inspectors. Hosting Russian inspectors at the Y-12 plant in Oak Ridge would likely double the cost.

The cost of facility preparations and inspections could be higher in Russia because of the greater number and larger size of its facilities and larger numbers of warheads being dismantled.[32]

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[31] The annual cost estimates assume 12 routine inspections per year. It was assumed that inspections would be 5-days long and an inspection team would consist of 10 inspectors. Permanent presence of inspectors at a dismantlement facility would be more expensive. The cost estimates do not account for the cost of inspection equipment.

[32] For example, the dismantlement area of the Pantex plant (Zone 12) is approximately 1 km wide; and the warhead and pit storage area (Zone 4) is located approximately 1 km north-west of the Zone 12 (Mocrosoft TerraServer Image Page; terraserver.microsoft.com.) In contrast, the Sverdlovsk-45 dismantlement facility is approximately 4 km in size; its railterminal is located 3-4 km south-west of the industrial area; and the military storage facility is located approximately 10 km west of the plant. (Declassified U.S.Corona Satellite Imagery; mission No. 1111-1, 24 July 1970; photo courtesy J.Handler.)

Such expenses might be a serious disincentive to implement transparency at Russia’s dismantlement facilities.

If Russia's economic situation continues to deteriorate, it may even have trouble maintaining its dismantlement rates. According to Minister of Atomic Energy Adamov, as of September 1998, the Ministry of Defense has “not [been] allocating a ruble to the nuclear industry over the past two months.” [33] Funding shortfalls might have already reduced Russia’s dismantlement rates and caused a slippage in dismantlement schedules.[34] The prospects of funding for the dismantlement program are likely to remain bleak for some time. To keep both warhead dismantlement and transparency on track, the United States and perhaps other countries may have to share some of Russia's dismantlement costs.

Mixed record for the past transparency efforts

The activities related to warhead dismantlement transparency are just the latest in a string of efforts to implement transparency in U.S.-Russian nuclear security cooperation activities. Others include: the HEU blend-down and purchase agreement; the Mayak high-security fissile-material storage facility; the Trilateral Initiative, which would place excess U.S. and Russian fissile materials under IAEA safeguards; the plutonium-production reactor conversion agreement; and plutonium disposition. These initiatives have met with varying degrees of success and could hold lessons for the successful implementation of a verified warhead dismantlement regime.

- The HEU transparency regime, the most successful transparency effort so far, focuses on verifying the weapons-origin of the blended-down HEU being purchased by the United States. The regime began with limited transparency but has developed over time. The United States is now able to verify that the material originated as HEU metal, but does not have complete confidence that the metal was derived from dismantled warheads

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33 Russian nuclear scientists picket ministry, (*BBC Monitoring Newsfile*; 09/08/98).

as required by the agreement. The addition of the key transparency arrangements in 1995 was undoubtedly helped by linkage to $100-million cash advances when the Russian Ministry of Atomic Energy found itself in an acute cash crisis, raising the question of whether similar linkages could pay transparency dividends in the future.

- Construction of the Mayak storage facility has been largely funded by the United States but, despite years of negotiation, the United States has not thus far succeeded in getting Russian agreement to a verification regime that would provide confidence that the fissile material to be stored there was derived from dismantled weapons. In part, the problem is in Russia's insistence on reciprocal transparency from the United States.[35] In 1998, to facilitate long-term storage of plutonium, Minatom initiated a program to recast pits into 2-kg solid plutonium spheres. Without transparency measures at the point of this conversion at the chemical and metallurgical plant in Chelyabinsk-65, the pit destruction process will further complicate efforts to establish the weapons origin of plutonium.[36]

- The Trilateral Initiative would place stored U.S. as well as excess Russian fissile materials stored at the Mayak facility under IAEA safeguards. In this case, the requirement is not to verify the weapons origin of HEU and plutonium but to assure that the material is not used in the production of new weapons. However, progress on these transparency measures has been slow, both because they overlap with the U.S.-Russian negotiations on Mayak transparency and because there is concern about protecting sensitive information from international inspections.

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34 General Igor Valynkin, *Stenographic Records of the Parliamentary Hearings "Safety and Security Problems at Radiation-Hazardous Facilities,"* November 25, 1996, Moscow.

35 The United States has proposed to implement threshold measurements (plutonium isotopics, mass, symmetry and size) on Russian pits to verify the weapons origin of the material. The Russian government, however, has been rejecting this proposal.

36 As of fall 1998, approximately 200-container worth of plutonium was recast into solid spheres.

- Transparency negotiations in connection with the U.S. deal to assist in converting Russia's plutonium production reactors to a new fuel have been completed. The objective of the agreement is to end the production of weapon-grade plutonium in Russia soon after the turn of the century. The transparency provisions focus on ensuring that the weapon-grade plutonium produced in the interim is not used in weapons. Regular inspections are expected to begin in 1999.

- Negotiations on plutonium disposition are just beginning. Here again, the United States is offering assistance – initially to convert the plutonium in excess Russian "pits" into unclassified forms.

In the past, U.S. negotiators have found their Russian counterparts to be generally quite reluctant to engage in transparency negotiations (even on a reciprocal basis) unless the financial incentives for progress are real. The Russian government agrees that their resources are too limited to be spent on transparency and verification activities. A warhead transparency regime could be even a greater challenge because the Russian government reportedly has made a decision to keep the serial production plants outside of the sphere of U.S.-Russian cooperative activities. Whether this decision can be reversed by offering Russia reciprocity, as well as substantial financial and arms control incentives remains to be seen.

Political constraints

It is clear that the technical obstacles to the creation of a warhead dismantlement regime are formidable, but the political considerations regarding this regime will determine whether or not any substantial progress is made. The first problem is the stalled START II ratification process in Russia. And the challenges here are great. Under Clinton administration policy there is a limit on how much further the lab-to-lab process can go without START II entering into force. Also, Russian officials have indicated that for security reasons further lab-to-lab cooperation on warhead transparency should be governed by a formal agreement between the two countries. Russian military and the security establishment are very uneasy about this cooperation.

It has been stated that the official STI negotiations were cut short because of fear of security breaches and lack of sufficient incentives. The initiation of the lab-to-lab effort effectively dealt with the incentive issue for the Russian weapons design institutes. Financing was provided to support the participation of Russian specialists in this process. The security fears, however, still remain and are now leading to security-service imposed delays on the progress of the lab-to-lab program. Managing these security fears has been difficult, in part, due to the lack of coordination between various parts of the Russian Government and outdated security and classification guidelines. Addressing those issues is another major challenge

Russia’s principal interest in warhead transparency appears to be a verified elimination of the U.S. hedge stockpile. Any such proposal, however, is likely to be resisted by the U.S. Executive Branch, which has unanimously supported the decision to establish and maintain the hedge stockpile.

A negotiated agreement on verified warhead dismantlement would probably take the form of a treaty – perhaps a portion of the START III Treaty. In this case, it would have to be endorsed by the national legislative bodies. Getting such an endorsement could be an uphill battle.

There are mixed signals from the U.S. Congress. On the one hand, Senator Joseph Biden sponsored a condition on the U.S. Senate's START I ratification resolution which calls for warhead and fissile materials declarations and elimination in future arms control agreements (see Appendix 1). On the other hand, Senator Jesse Helms has made clear his skepticism about verified warhead elimination by writing to the then-Secretary of Energy Federico

Pena that he does "not favor [dismantlement of all U.S. and Russian nuclear warheads to be withdrawn from deployed strategic nuclear delivery vehicles pursuant to a START III Treaty] … because … (1) Such a measure would be completely unverifiable. … (2) The Russian Federation's track record of arms control violations provides scant assurance that they would act in good faith."[37] More generally, since the 1994 change of control of the Congress from the Democrats to the Republicans, there is much less Congressional support for this agenda.

In Russia, the Communist-dominated Duma has also been consistently hostile to the notion of transparency, considering it a cover for U.S. intelligence-gathering.

IV. A PATH FORWARD[38]

At present there are no formal or informal on-going warhead-transparency negotiations between the United States and Russia. Virtually all of the work that is occurring is under contracts between the U.S. and Russian nuclear laboratories. Almost all of these contracts focus on general technical and conceptual aspects of a possible regime because of extreme security and classification concerns surrounding the issue.

In order for warhead transparency to become a reality, the United States and Russia will have to make linked advances on both the technology and policy fronts. The two countries have to address major policy issues related to arms control, financial assistance for Russian warhead dismantlement, and warhead complex and stockpile asymmetries. While it is difficult in the near-term to resolve completely these fundamental policy issues, the United States and Russia could take a number of first steps with regard to technology and operational aspects of verifiable warhead

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37 Senator Helms' letter to the Secretary of Energy Federico Pena, September 16, 1997

38 This discussion of possible future initiatives is based, in a significant part, on the *Conclusions from a Workshop on Warhead Transparency (Washington, DC, November 9-10, 1998)* (See Appendix 4).

dismantlement and expand gradually the scope of the existing transparency measures.

Major policy issues

There is no immediate answer to the policy issues discussed below but they need to be analyzed and resolved before any meaningful warhead dismantlement transparency regime can be completed.

ARMS-CONTROL OBJECTIVES

The Russian government has a strong motive in seeing that the warheads downloaded from strategic missiles under START II and III are eliminated under a dismantlement regime. This elimination of the U.S. upload capability, its hedge stockpile, appears to be Russia's principal interest in warhead dismantlement transparency. As outlined previously, a decision to include the hedge stockpile in a warhead dismantlement regime would constitute a major policy change for the U.S. and could require substantial debate and analysis.

For its part, the United States would like to see verifiable reductions of Russia's remaining stockpile of tactical nuclear weapons down to a level comparable to that of the United States (about 1000 warheads). According to former head of the U.S. Strategic Command, General Habiger

> "It is time to get serious about the number of tactical nuclear weapons. Following a series of unilateral declarations by President Bush, the United States withdrew and dismantled the majority of its non-strategic nuclear stockpile. The Russians have not reciprocated. There is currently a huge disparity between the number of tactical weapons in Russia and the number we hold. As we reduce the number of strategic weapons in parallel with the Russians, their huge stockpile of tactical weapons becomes destabilizing. We must ensure we parlay this issue into

> START III negotiations, and I have every expectation that we will."[39]

Some Russian analysts suggest, however, that Russia will be interested in warhead transparency for tactical nuclear weapons only if NATO makes a binding agreement not to deploy nuclear weapons in new member countries and the United States withdraws its nuclear weapons from Europe, a decision that NATO has indicated that it is unlikely to take.

Russia, however, may be forced by the currently relatively short service life of Russian warheads (10-12 years) to drastically reduce the size of its tactical stockpile in any case. Since Russia has not been manufacturing new warheads on a significant scale since the late 1980s, its current substrategic stockpile, estimated at approximately 5,700 warheads,[40] may be reduced to as little as several hundred warheads after the year 2000.

RECIPROCAL TRANSPARENCY AND FINANCIAL ASSISTANCE FOR RUSSIAN WARHEAD DISMANTLEMENT

The economic crisis in Russia has raised questions about its ability to maintain warhead dismantlement rates and implement a transparency regime. The funding requirements of Russia's dismantlement program do not seem exorbitant in comparison to the scale of funding that the United States has been already providing for weapons reduction activities in Russia (see below). According to DOD's Franklin Miller:

> "The Russians have in the past confirmed that they face warhead dismantlement costs comparable to a U.S. figure of approximately $100,000 per warhead. Separately, they have said that they are dismantling about 2,000 warheads a year. Together, this would

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39 Questions Submitted by Senator Jeff Bingaman, March 13, 1998, *Hearings before the Committee on Armed Services, United States Senate, 105th Congress*, Second Session on S.2057. Part 7, Strategic Forces, US GPO, Washington, DC, 1998, p. 534.

40 Anatoli Diakov and Yevgeni Myasnikov "A Solution to the Impasse: Confidence Building Measures Could Accelerate the Nuclear Weapons Reduction Process," *Moscow Nezavisimoye Voyennoye Obozrenie* (in Russian), 11-17 September 1998, pp. 1, 4.

> suggest that warhead dismantlement has been costing the Russians about $200 million US annually."[41]

The actual costs may be less. The budget for all Minatom defense programs in 1998 was about $400 million.[42] Even at $100,000 per warhead, however, the total cost for the irreversible dismantlement of 10,000 Russian warheads over five years would be only $1 billion. This would be extraordinary value in comparison to the costs of other U.S. defense programs and in comparison to U.S. costs if Russia's nuclear complex collapsed and weapons, components, and fissile materials leaked to the black market.

The simplest mechanism for U.S. financial support of Russian warhead dismantlement would be to pay a fee for every irreversibly eliminated warhead. The Russian-U.S. HEU deal is, in part, already helping Russia finance the dismantlement of its excess nuclear warheads, because Russia is being paid for the uranium that is removed from the warheads. Assuming an average HEU content of 20 kg per warhead, Russia receives approximately $500,000 gross for recovering and downblending HEU from each dismantled warhead.[43] However, information concerning how much of the HEU money is allocated to the dismantlement activities is not publicly available.

There are two additional options for using the HEU purchase agreement to facilitate verifiable dismantlement. In exchange for reciprocal warhead dismantlement transparency arrangements, the United States could provide to Russia a partial pre-payment (e.g. 20 percent) of its expected total payment for each year's delivery of blended HEU. The United States also could provide an additional payment at the end of

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41 *Hearings before the Committee on Armed Services*, United States Senate, One hundred fifth session on S.936. Part 7, Strategic Forces, February 27, March 5, 12, 19, April 16, 1997. USG Printing Office, Washington, 1998, pp. 98-99. For comparison, Pantex has 3400 employees and an annual operating budget of $265 million ($80,000 per employee). The cost per warhead dismantled in a 1500-warhead year is therefore about $200,000.

42 The 1998 budget for Minatom's military programs was 2,095M ruble, corresponding to approximately $400M (at the exchange rate of 5 rubles per dollar). ("On the 1998 Federal Budget," *Rossiyskaya Gazeta*, March 31, 1998 pp 3-6.

43 At the initially negotiated prices, Russia is projected to receive $12 billion for LEU derived from 500 t 90-percent HEU. HEU revenues, however, could be less because of decreased prices for natural uranium and enrichment services and difficulties with selling the natural uranium component of the HEU-derived low-enriched uranium.

each year if the warhead dismantlement and HEU blend-down rate is higher than required by the HEU deal.[44]

In the context of reciprocal warhead transparency, support for warhead dismantlement could also be provided through the U.S. Department of Defense's Cooperative Threat Reduction (CTR) program or from DOE funds. The original objective of the CTR program, when it was launched in 1991, was to expedite the elimination of Russia’s nuclear warheads. Indeed, the program’s initial name was the Safe and Secure Dismantlement Program. The CTR program has since been funded at a level of approximately $400 million per year. However, most of the funding has been dedicated to the elimination of missile silos, submarines and missiles. Only a small fraction has related to the destruction of warheads themselves – and that only for increasing the security of the transport and storage activities taking place before and after actual warhead dismantlement, not for actual warhead dismantlement activities.[45]

Direct support for Russian warhead dismantlement has not been possible because of the combination of Russian secrecy requirements and U.S. accountability requirements for the expenditure of CTR funds. A warhead transparency regime could help resolve this impasse. These transparency arrangements would, however, need to differ from other CTR audit arrangements because Russian inspectors would have reciprocal access to the U.S. dismantlement process, and it is unlikely that U.S. auditors would have unlimited access to warhead dismantlement plants.

The United States also could support the separation of Russian warhead dismantlement and maintenance/remanufacturing activities by financing the re-tooling of one or more of the dismantlement plants to be a dedicated facility whose sole mission would be the verifiable and irreversible dismantlement of treaty-limited warheads. The United States could then share the cost of dismantlement at this facility on a

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44 The acceleration of the HEU purchase schedule would require an additional investment to expand Minatom’s HEU down-blending infrastructure.

45 CTR projects in these categories include: warhead transportation safety and security, warhead transportation containers, emergency response capabilities in case of a transportation accident resulting in plutonium dispersal, fissile material containers, and the fissile material storage facility at Chelyabinsk-65.

per-warhead cost-reimbursement basis and help re-direct excess workers to new civilian missions.

In the meantime, the U.S. DOE should maintain a strong and diverse cooperative warhead-transparency R&D program involving personnel from the nuclear-weapon laboratories and military establishments of both countries. This program would help to sustain core expert groups in both the United States and Russia. Otherwise, because of the lack of funding and the imminent downsizing of the Russian nuclear infrastructure its expert groups involved in the warhead-transparency effort may not survive.

RELEVANCE OF ASYMMETRIES IN THE WEAPONS PRODUCTION AND MAINTENANCE COMPLEXES, AND IN SECRECY REQUIREMENTS

In order to fully achieve the security objectives of both sides in pursuing a warhead transparency regime, a number of asymmetries between the two warhead complexes and their contexts must be dealt with. The United States is concerned about differences in nuclear-weapons-production capacities, and warhead and weapons-usable material stockpiles. Russia is concerned about differences in financial resources, upload capacities, and dangers to the security of its nuclear facilities. Additionally, the development of a transparency regime could be impeded by differences in the sizes of nuclear-weapon-production infrastructures, weapon remanufacturing rates, and dismantlement operations and schedules. As a first step, each country should list the asymmetries which concern it, along with an explanation of why they are of concern. Then consideration should be given to how to apply transparency and other measures (such as U.S. assistance to Russia in downsizing its nuclear complex) in a way that can mitigate political and perception problems, minimize operational impacts, and reduce worries about possible breakouts.

First steps

In the near term, the United States and Russia could undertake a number of activities that would expand the scope of the existing lab-to-lab technical projects and government-to-government transparency measures. These practical steps would help to jump-start the currently stalled warhead transparency discussions and facilitate the development of a workable transparency regime.

FACILITY-SPECIFIC STUDIES

The immediate task for U.S. and Russian technical experts is to complete the technology development stage and to think through how transparency measures could be applied to specific stages of the warhead dismantlement process and at specific facilities.

The United States has carried out a detailed study on how to protect sensitive information and how activities related to transparent warhead dismantlement might be segregated from activities relating to maintenance of the enduring nuclear stockpile. Russia should do the same. To facilitate this work, the United States may have to fund Russian analyses whose results cannot be entirely shared with the United States – for example a study of possible implementation arrangements at specific Russian facilities, development of information protection techniques, and red team evaluation.[46] In such cases, the Russian experts could provide the United States with unclassified summaries of the classified reports. If necessary for accounting purposes, additional evidence of work could be requested. (This type of auditing has already been used for the implementation of material-security upgrades at sensitive facilities to which U.S. access is currently not allowed.[47])

46 Red team evaluation is intended to identify and eliminate security vulnerabilities that could allow foreign inspector to acquire, intentionally or unintentionally, sensitive information. In the United States, the responsibility for red-team evaluation is assigned to more skeptical experts in the DOE national laboratories. The results of their evaluation are then sent for review to DOE and DOD security specialists who might ask laboratory experts to provide additional clarifications.

47 At present, U.S. auditing methods at a sensitive facility may include a combination of: director-signed act that certain equipment is accepted for operation; documents from the accounting office confirming that equipment is accepted "on facility’s balance"; video/photo evidence; statistical information regarding equipment’s operation; and auditing by a Russian institution.

COOPERATIVE RESEARCH WITH THE RUSSIAN MINISTRY OF DEFENSE AND U.S. DEPARTMENT OF DEFENSE ON POSSIBLE CHAIN-OF CUSTODY ARRANGEMENTS FOR WARHEADS

Another opportunity for the technical experts is to extend their analysis "upstream" to the nuclear-warhead storage sites of the U.S. Department of Defense and the 12th Directorate of Russia's Ministry of Defense where excess warheads are stored before being transported to the respective facilities of the Department of Energy and Ministry of Atomic Energy for dismantlement. This work would complement the lab-to-lab process and get the military establishments more involved in the cooperation. This could ultimately decrease security concern about the implementation of the regime.

An ideal starting point for this cooperation would be research on a possible transparent chain-of-custody arrangement for warheads as they move from active field deployment to dismantlement. This could involve tagging warheads or their containers at military storage sites or, in some cases, even at deployment sites when the warheads are downloaded from missiles.

This will require cooperation from both the Russian Ministry of Defense and the U.S. Department of Defense. A possible partner for the United States in the development of this dimension of transparency could be the 12th Directorate's Central Technical-Physical Institute in Sergiev Posad (formerly Zagorsk).

CLASSIFICATION REQUIREMENTS

U.S. and Russian technical and security specialists should compare the relevant classification requirements of the two countries to arrive at a mutual understanding of the types of information that can and cannot be shared. Discussions regarding a contract to evaluate differences in classification requirements have already been initiated between the Sandia National Laboratories and Chelyabinsk-70.

AN EXCHANGE OF DIAGRAMS SHOWING LAYOUTS AND WARHEAD FLOWS THROUGH DISMANTLEMENT FACILITIES

The United States has proposed an unclassified exchange of visits to a Russian dismantlement plant and the U.S. Pantex plant in order to familiarize each side with the flow of the dismantlement process. (Journalists have already been offered such tours of the Pantex plant.) The United States offered to host the first visit at Pantex if the Russian government could reciprocate by inviting U.S. experts to a functionally equivalent facility of Zlatoust-36 or Sverdlovsk-45.[48] However, this idea has not been accepted by the Russian government.

A possible first step in this direction would be for each country to unilaterally draw up, on paper, an unclassified description of activities at its dismantlement plants and a schematic diagram of how warheads flow though the dismantlement processes. It could constitute a confidence building first step toward the reciprocal "walk-throughs" that the U.S. has been seeking, and lead to demonstration of warhead transparency measures and procedures at the dismantlement facilities in both countries first on unclassified objects, and, ultimately, on actual warheads.

TECHNOLOGY DEVELOPMENT CENTERS

The United States and Russia also could establish technology development and demonstration centers at actual dismantlement facilities that are (or will be) not operational. The planned phase-out of weapons work at the Avangard plant in Arzamas-16 may present the best chance for a demonstration in Russia. Avangard is in the same closed city, Arzamas-16, as the Institute of Experimental Physics, one of Russia's two leading nuclear-weapons-design institutes, which plays a major role in the lab-to-lab warhead transparency program. Alternatively, technology development and testing could be carried out at one of the pilot weapons production plants associated with the weapons design institutes in Chelyabinsk-70 or Arzamas-16. In the United States, a similar center could be established at the recently built state-of-the-art Device Assembly Facility at the Nevada Test Site.

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48 A non-paper regarding unclassified reciprocal visita to dismantlement facilities was handed by the former Secretary of Energy Pena to former Minister Mikhailov in 1994. Such proposed visits would be designed to improve the understanding of the site layouts and operational flowcharts and would involve a briefing on facility’s activities, and a walk-through its storage areas and dismantlement bays and cells.

MONITORING THE SHUT-DOWN OR CONVERTED STATUS OF EXCESS WARHEAD PRODUCTION CAPACITY, AND NON-PRODUCTION OF NEW WARHEADS

Warhead production and refurbishing activities in Russia will be phased out at two (or, possibly, three) out of four existing facilities. Monitoring the shut-down or converted status of these facilities would help to address the U.S. concern regarding the asymmetry in production capacities. (Russia could verify non-production at the DAF complex at the Nevada Test Site.) A first step could be a lab-lab study on possible non-production transparency methods at a former warhead assembly plant.

A TRANSPARENCY AGREEMENT ON PIT-CONVERSION

Russia has already begun recasting plutonium pits to solid metal spheres at Chelyabinsk-65 and might start similar activities at Tomsk-7 in the future. The United States plans to convert its excess plutonium pits to plutonium oxide powder at a new Pit Disassembly and Conversion Facility (PDCF) to be built at the Savannah River Site in South Carolina.[49] The two countries should negotiate reciprocal transparency arrangements at the point in the process where the plutonium pits are being changed from their classified shapes, after the weapons have been disassembled.

DECLARATION OF WARHEADS ELIMINATED AND REMAINING TO BE ELIMINATED UNDER THE 1991 BUSH-GORBACHEV INITIATIVES

In 1991, Presidents Bush and Gorbachev each unilaterally committed their countries to eliminate certain classes of nuclear weapons. These are the only warheads both countries have officially agreed to eliminate. As a result, the obstacles to increased transparency could be lowest when dealing with these weapons. The two countries could start by declaring how many of these warheads have been dismantled and how many remain to be disassembled. A follow-on initiative could include declarations of the plutonium pits recovered from these warheads, as well as bilateral monitoring of pits and any plutonium recovered from them.

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49 The PDCF could be brought into operation by 2005. (*Status of the Pit Disassembly and Conversion Facility (PDCF)*, briefing materials, Los Alamos National Laboratory, November 12, 1998.)

DECLARATION OF TOTAL STRATEGIC WARHEAD AND FISSILE MATERIALS STOCKSPILES

Declarations of warhead and fissile material stockpiles is an important confidence-building measure. They also are an essential element of building a comprehensive transparency regime and irreversible reductions process.

The United States has already released current and historical data regarding its warhead stockpile, production and dismantlement (but not the number of currently operational warheads).[50] The United States has also made public data related to its total stocks, production, acquisition and use of plutonium. A similar effort is currently underway to prepare and release information on its HEU stocks. Russia has not released stockpile information.

In January 1995, the United States proposed an exchange of detailed information regarding the warhead and fissile material stockpiles, the number of warheads dismantled each year since 1980, and the quantity of fissile materials produced each year since 1970 (by material type, amount, enrichment level or grade, and production location). The proposal was rejected by Russia apparently because of the amount of detail requested. A declaration of aggregate strategic warhead stocks could be a more acceptable first step.

In part, Russia has not been able to declare its fissile-material holdings due to the lack of funds to undertake such a project. A lab-to-lab contract to support this effort in Russia would be a useful step towards irreversible stockpile reductions.

CONCLUSION

The United States and Russia are closer to initiating warhead transparency than ever before. But there remain substantial technical and political challenges that could keep the regime

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50 For an analysis of the U.S. data see, for example, T.Cochran “*Transparency Associated with the Process of Eliminating Nuclear Warheads*,” presented at Pugwash meeting 241, London, November 6-8, 1998,

from becoming a reality and possibly even roll back the progress that has been made to date. In order to strengthen the chances for successful implementation of a warhead transparency regime, the United States and Russia must in the short term address five key questions:

1) Will there be sufficient arms control and financial incentives provided to Russia to overcome the political resistance of its military and security agencies?

2) If cooperation is maintained at the lab-to-lab level, will the United States and Russia agree to move beyond cooperation on generic concepts to demonstrations in actual warhead dismantlement facilities?

3) Will the two countries be able to put in place the legal framework for a warhead dismantlement regime (including Russian ratification of START II and agreements required to maintain cooperation at the lab-to-lab level and for the exchange of classified information)?

4) Will greater public and political attention to this issue increase or decrease the barriers to progress?

5) Finally, in the longer term, can the focus of the dismantlement regime extend beyond warheads declared excess and be expanded to include those warheads that the Russian government (U.S. hedge stockpile) and the U.S. government (Russia tactical stockpile) see as the rationale for becoming involved in the creation of this regime? If not, progress will almost surely grind to a halt as concerns increase about possible imbalances of the residual stocks.

Table 1: Warhead stockpile estimates

	U.S strategic/tactical (total)	Russia strategic/tactical (total), end 1997
active and reserve	9,000/1,000 (10,000)[51]	8,295/5,700 (13,995)[52]
waiting for dismantlement	(1,500[53])	2,300/4,000 (6,300)[54]
eliminated	10,512[55] (FY1990-97)	2,000/9,000 (11,000) (from early 1990s)

Table 2: Projected dismantlement requirements

	RUSSIA		UNITED STATES	
	Stockpile (s/t)	To be dismantled (cumulatively)	Stockpile (s/t)	To be dismantled (cumulatively)
Early 1998	8,295/5,700 (A+R)	6,300	9,668/1913 (A) 350 (I)	1,179
START II (2000+)	4,000/1,000 (A)** 1,000 (R)	8,000+6,300-2x1,500=11,300*	3.488/892 (A) 5,096 (H+I)	none
START III (2,000+)	2,000/1,000 (A) 1,000 (R)	13,300	2,000/950 (A) 2,500 (H+I)**	4,026

s/t – strategic/ tactical warheads
A - active stockpile
R - reserve stockpile
H - hedge stockpile
I - inactive stockpile
* - It is assumed that the Russian active tactical stockpile will be reduced by natural attrition around the year 2000 and that the dismantlement rate will be maintained at 1,500 warheads per year.
** - It is assumed that under START III the U.S. hedge and inactive stockpile will be cut in half, proportionally to the operational stockpile.

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51 *The Bulletin of the Atomic Scientists*, July/August 1998, p. 71.

52 Anatoli Diakov and Yevgeni Myasnikov “A Solution to the Impasse: Confidence Building Measures Could Accelerate the Nuclear Weapons Reduction Process,” *Moscow Nezavisimoye Voyennoye Obozrenie* (in Russian), 11-17 September 1998, pp. 1, 4.

53 *The Bulletin of the Atomic Scientists*, July/August 1998, p. 71.

54 Anatoly Diakov, presentation at the RANSAC workshop, April 1998.

55 DOE Albuquerque Operations Office, Response to a FOIA request, March 8, 1998.

Table 3: U.S. START II and III notional force structures and hedge stockpiles

Weapons system	START II				START III			
	Laun-chers	Depl/ upload Ws per laun-cher	Total depl Ws	Total hedge	Laun-chers	Depl/ upload Ws per laun-cher	Total depl Ws	Total hedge
Minuteman III	500	1/2	500	1000	300	1/2	300	600
Trident II	336	5/3	1680	1008	240	4/4	960	960
B-2	20	16/0	320	0	20	16/0	320	0
B-52H*	53 18	12/0 20/0	636 360	206 0	35	12/8	420	280
B-1	95	0/16	0	430**	95	0/16	0	430
Total deployed and hedge stockpiles			3496	2644			2000	2270

* - B-52H is the only bomber capable of carrying ALCms and ACMs. The total number of ALCM/ACM warheads (W80-1) is 1000.

** - There are total 750 B61-7/11 strategic bombs that could be carried by B-2 and B-1 bombers.

APPENDIX 1: WARHEAD TRANSPARENCY CHRONOLOGY

1987. During the debate on the ratification of the INF Treaty, Reagan administration officials stated that the elimination of warheads could not be verified without unacceptable sharing of warhead design information.[56] A joint technical study on verification of nuclear warhead elimination was launched by the U.S. Federation of American Scientists and the Committee of Soviet Scientists for Peace and Against the Nuclear Threat which first developed many of the approaches later incorporated into the lab-to-lab proposals.[57]

1989. Russian Academician Velikhov arranged with the U.S. non-governmental group, the Natural Resources Defense Council, for a U.S.-Soviet demonstration of measurements of gamma and neutron radiation emitted by a Soviet warhead on the ship “Slava” in the Black Sea.[58]

1991. Under the START I treaty, the United States and Russia agreed to monitor the maximum number of reentry vehicles on strategic missiles (RV On-Site Inspections, RVOSI). RVOSI inspections include a visual counting of shrouded reentry vehicle shapes from above the open missile launcher after the missile nose cone has been removed or after escorted removal of the warhead section of the missile to an inspection facility. Inspectors also conduct radiation measurements to confirm that no nuclear-armed cruise missiles are present at bomber bases that have been declared non-nuclear.

1992. The Russian Federation and Ukraine signed an Agreement on the Procedure for Movement of Nuclear Munitions from the

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56 The INF Treaty, *Hearings before the U.S. Senate Committee on Foreign Relations*; see, e.g.: Part I, January 25, 1988, Secretary of State George Shultz, p. 59; January 26, 1988, U.S. INF Negotiator Maynard W.Glitman, pp. 121-122; Part II, February 1, 1989, secretary of Defense Carlucci, p. 8; and *Report of the Committee*, April 14, 1988, pp. 58-59.

57 *Reversing the Arms Race: How to Achieve and Verify Deep Reductions in Nuclear Weapons,* co-editor with Roald Z. Sagdeev, New York: Gordon and Breach Science Publishers, 1990, 432 pp.

Territory of Ukraine to Central Pre-Factory Bases … for the Purpose of Dismantling and Destroying Them, which gave Ukraine the right to send three-man observer teams to each of the serial production facilities in Russia to monitor the process of dismantlement of warheads removed from Ukraine. Under the agreement, Ukrainian observers are to be provided by MOD’s 12 Main Directorate with records on nuclear warheads to be dismantled. Observers “control step by step the dismantling of nuclear munitions into their component parts and their destruction, the extraction and dismantling of the charge [physics package].”[59]

February 1992. Russian Foreign Minister Kozyrev, in a speech to the Conference on Disarmament in Geneva, agreed to open the door to a U.S.-Russian exchange of nuclear stockpile information. Kozyrev, who read Yeltsin's message to the U.N. Disarmament Conference, “proposed that the five acknowledged nuclear powers -- Britain, China, France, Russia and the United States – exchange data on the number and type of their warheads, the amount of fissionable material they have and installations where nuclear weapons are produced, stored and destroyed”.[60]

October 1992. The U.S. Senate adopted the Biden condition to the ratification of START I which calls for “(A) the exchange of detailed information on aggregate stockpiles of nuclear warheads, on stocks of fissile materials, and on their safety and security; (B) the maintenance at distinct and secure storage facilities, on a reciprocal basis, of fissile materials removed from nuclear warheads and declared to be excess to national security requirements for the purpose of confirming the irreversibility of the process of nuclear weapons reduction; and (C) the adoption of

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58 S.Fetter et al “Measurements of Gamma Rays from a Soviet Cruise Missile”; *Reversing the Arms Race*, pp. 379-398.

59 *Annex to the Protocol to the Agreement*; translated by the U.S. Department of State’s Office of Language Services. According to the Annex, all observers are “designated from among the officer corps having practical work experience with nuclear munitions.”

60 “Russia Urges End of Nuclear Arms Alerts”, *Los Angeles Times*, February 13, 1992.

other cooperative measures to enhance confidence in the reciprocal declarations on fissile material stockpiles.”[61]

January 1994. Presidents Clinton and Yeltsin agreed “to establish a joint working group to consider: steps to ensure the transparency and irreversibility of the progress of reduction of nuclear weapons, including the possibility of putting a portion of fissionable material under IAEA safeguards. Particular attention would be given to materials released in the process of nuclear disarmament, and to steps to ensure that these materials would not be used again for nuclear weapons.”[62]

May 1995. Presidents Clinton and Yeltsin issued a Safeguards, Transparency and Irreversibility statement calling for “concrete agreements on transparency and irreversibility [of] the process of reduction of nuclear weapons. The presidents “confirmed that both sides seek to strengthen mutual confidence and regularly exchange detailed information about the overall stock of nuclear warheads and fissile materials, their security and safety.”[63]

Fall 1995. The U.S. Department of Energy initiated a low-profile laboratory-to-laboratory R&D collaboration on the means of assuring transparent warhead dismantlement in line with the Clinton-Yeltsin May statement.

March 1997. In their Helsinki Summit statement, Presidents Clinton and Yeltsin called for "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

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61 Text of the Committee Recommended Resolution of Advice and Consent, Executive Reports of Committees (Senate – December 15, 1995), Executive Report 104-10.

62 Joint statement by Clinton and Yeltsin on nonproliferation, ITAR-TASS news agency (World Service), Moscow, in Russian 1242 gmt 14 Jan 94, The British Broadcasting Corporation, January 15, 1994, SECTION: Part 1 Former USSR; SPECIAL SUPPLEMENT; MOSCOW SUMMIT; SU/1896/S1.

63 YELTSIN-CLINTON SUMMIT; Joint statements issued after summit; ITAR-TASS news agency (World Service), Moscow, in English 1830 gmt 10 May 95; BBC Summary of World Broadcasts, May 12, 1995, Friday, SECTION: Part 1 Former USSR; RUSSIA; SU/2301/B.

rapid increase in the number of warheads" to be included in a START III agreement.[64]

APPENDIX 2: U.S.-RUSSIAN FISSILE MATERIAL TRANSPARENCY MEASURES

Under the U.S.-Russian highly-enriched uranium purchase agreement, the parties have established a system of permanent and special monitoring of the HEU down-blending process at the Russian facilities. U.S. monitors have a right to see all relevant material accounting data, observe the technological processes after the HEU metal has been chopped up, and request and observe HEU isotopic measurements.

Under the Reactor Shutdown Agreement, U.S. inspectors are to verify that plutonium newly-produced at the three Russian plutonium-production reactors that are still in operation to produce heat and electricity for nearby populations, is placed in storage and is not used for weapons purposes.[65]

The United States and Russia also have begun working on transparency measures for the high-security storage facility for excess fissile materials from dismantled weapons that is being constructed with U.S. assistance in Chelyabinsk-65. For its part, the United States has placed 10 t of HEU and 2 t of plutonium under IAEA safeguards and invited the IAEA to monitor the blending down of its excess HEU.

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64 *Joint Statement on Parameters on Future Reductions in Nuclear Forces*, The White House Office of the Press Secretary, March 21, 1997.

65 U.S. monitors are to visit the plutonium facilities twice a year and conduct NDA measurements on randomly selected containers to compare the Pu-240/Pu-239 and Am-241/Pu-241 ratios to the agreed threshold values. Such visits are expected to commence in 1999. A maximum Pu-240/Pu-239 ratio of 0.1 is set to verify that reactor-grade plutonium has not been substituted for weapon-grade plutonium. The Am-241/Pu-241 ratio makes it possible to verify when the plutonium was chemically separated (Pu-241 decays into Am-241 with a 14.4-year half-life). Additionally, U.S. inspectors are to have access to the records for every plutonium container (container ID and location, plutonium mass, and PuO2 production date).

APPENDIX 3: DISMANTLEMENT TRANSPARENCY TECHNOLOGIES AND PROCEDURES

The general approach to warhead dismantlement transparency being explored by U.S. and Russian laboratory experts would involve warhead and fissile-component monitoring in storage before and after the dismantlement process, plus a "chain-of-custody" approach to associate the fissile components that emerge from the dismantlement process with the warheads that went in (see Table A2.1 and Fig. A2.1).[66]

Transparency and monitoring measures under this approach would start at a military deployment site or upon receipt of a warhead at the warhead-storage area at the dismantlement site. Wherever the first inspection took place, a treaty-limited warhead in a container would be identified by the characteristic energy spectrum of spontaneous gamma radiation from the fissile material it contains or by its pattern of gamma or neutron emissions stimulated by irradiation by a small neutron source.[67] The warhead container would then be tagged and sealed. Subsequent checks of these tags and seals, along with random rechecks of the canister radiation signatures, would then be able to verify that the warhead had not been tampered with prior to its delivery to a specific area in the dismantlement facility.

Prior to dismantlement, inspectors would sweep this disassembly area with radiation detectors to ensure that it did not contain undeclared warheads or fissile materials. The use of these detectors would allow the facility operators to shroud any equipment whose design might

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[66] This description corresponds to Option 3 in the DOE Warhead Dismantlement Study. Option 1 involves “Monitoring of warheads and components in the storage area … and chain-of-custody monitoring to and from the gate to the dismantlement area.” Option 2 is “Option 1 plus portal [and perimeter] continuous monitoring [PPCM] of segregated portion of the dismantlement area … dedicated to dismantlement of treaty-related weapons.” Option 3 is “Option 1 plus further chain-of-custody procedures to monitor warheads and components within a segregated portion of the dismantlement area … and to and from the disassembly bays and dismantlement cells (without PPCM).” And Option 4 is “Option 3 plus direct observation or remote monitoring of the dismantlement process.”

[67] The passive gamma spectrum reflects the structure of the nuclear warhead due to the fact that gamma rays with different energies are absorbed to different degrees in their passage through the fissile material and the structure that surrounds it. The radiation stimulated by neutron irradiation is mostly due to induced fissions. Each fission releases multiple neutrons and the time and angular correlation between these neutrons reflect the distribution of the fissile material within the warhead. Because of the design information that could potentially be inferred from these characteristic

reveal warhead-design information. The inspectors would not stay to observe the disassembly process. However, they would be permitted to carry out radiation measurements on all containers entering and leaving the disassembly area to confirm that no fissile materials are secretly introduced to or removed from the disassembly area. After the disassembly process was completed, they would once again sweep the area to verify that all the fissile material had been removed. This would associate the materials in the fissile material containers leaving the disassembly area with the original warhead. This process would be repeated more than once as the warhead and its components went through successive stages of dismantlement. The containers holding the stripped down fissile components would then would be tagged, sealed and sent to a monitored storage facility pending final disposal of fissile materials. To increase confidence, the inspectors could audit the facility's records and track to destruction non-nuclear components such as warhead casings and high-explosive components.

Verifying the dismantlement of every excess warhead might require a continuous presence of inspectors at a dismantlement facility. This would not be unprecedented. Under the verification arrangements of the INF Treaty the United States and Russia each maintain full-time portal-perimeter surveillance at the facilities at which each formerly produced intermediate-range ballistic missiles. Also, under the HEU Purchase agreement the U.S. and Russia have established permanent monitoring offices in the blend-down sites at Sverdlovsk-44 and Portsmouth, OH.

Radiation measurements are at the heart of the proposed technical transparency measures. As already noted, radiation signatures would identify the warhead type and identify the fissile material components coming out of the dismantlement process. As of summer 1998, the list of promising candidate technologies included passive gamma-radiation fingerprinting (the RIS and CIVET systems), and the active interrogation nuclear material identification system (NMIS).

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radiation signatures, inspectors would have access only to information that had been sanitized through a jointly programmed computer.

A gamma-radiation fingerprint involves a full-spectrum analysis of gamma-ray spectra (possibly with degraded spatial and spectral resolution). It has been demonstrated that the method can be used to confirm that two objects are of the same design. In a practical application, a library of “templates” would be established for treaty-limited assembled warheads and their fissile material components. Warhead and component signatures would then be checked against the existing set of templates. Because the templates are highly sensitive, both radiation measurements and signature comparison would be done automatically, with inspectors receiving only the answer Yes or No.

The RIS system, which is currently used on plutonium pits at Pantex for the domestic safeguards purposes, is based on low-resolution measurements and statistical analysis. The CIVET system is based on high-resolution gamma measurements the results of which are processed by a special computer without permanent memory to prevent disclosure of classified information. The CIVET computer could also be used with any other system to protect classified information.

The Nuclear Materials Identification System is routinely used at the Y-12 plant for verifying and tracking HEU warhead components. This is an active interrogation technique in which an object is irradiated by a neutron source (californium-252). (With plutonium, which has a relatively high spontaneous neutron background, the system is capable of working in a passive mode.) The induced fission neutrons and gamma-rays are then detected and correlated with each other and with the incident neutrons from Cf-252. This produces a characteristic signature for a warhead or HEU- or plutonium-containing component.

Table A2.1: Warhead dismantlement and fissile material monitoring

Dismantlement steps	Monitoring activities
Warhead shipment from a deployment site or warhead receipt at a dismantlement site staging area	Warhead identification at a deployment site or storage area and initiation of LCC - Tagging and sealing of warhead container - Measurement of warhead radiation and comparison with template
Prior to disassembly	- Sweep of disassembly area to confirm that no fissile material is present
Warhead transfer to the disassembly area	- Measurement of radiation signature (possibly) - Check of container tag and seal
Warhead dismantlement	- Check with radiation detectors of incoming and outgoing packages declared not to contain fissile materials
After disassembly	- Measurement of radiation signatures of packages declared to contain fissile warhead components and template analysis - Application of tags and seals to fissile material containers - Sweep of dismantlement area to confirm that all fissile material has been removed - Tracking of key non-nuclear components such as outer casings, re-entry shields, and high-explosives to destruction (possibly)
Fissile material components storage and disposition	- Fissile material transparency measures

APPENDIX 4

December 12, 1998

Conclusions from the
RUSSIAN-U.S. WORKSHOP ON WARHEAD TRANSPARENCY
hosted by the Federation of American Scientists,
Washington D.C., November 9-10, 1998

The purpose of the workshop was to explore the current state of the Russian-U.S. discussion of a possible warhead transparency regime and to identify actions that could facilitate progress. The workshop participants consisted of Russian and American non-governmental experts, and governmental experts participating in a non-official capacity (see list at end). In the view of a core group of non-governmental participants (Bukharin, Bunn, Diakov, Luongo and von Hippel), the meeting identified possible activities in two areas:

a) Clarifying major policy issues; and

b) Possible first steps forward.

A. MAJOR POLICY ISSUES

These are issues for which there is no immediate answer, but which need to be analyzed and resolved before any meaningful warhead dismantlement transparency regime can be completed.

1. THE U.S. UP-LOAD HEDGE AND RUSSIAN AND U.S. TACTICAL NUCLEAR WARHEADS

In 1994, the U.S. made a policy decision to configure its START II forces in a manner that would make possible an increase in the number of U.S. deployed strategic warheads back to roughly twice the treaty-permitted number. (This is known as the "up-load hedge.") This upload capability is of concern to the Russian Government and addressing it appears to be the principal motive for Russian Government's interest in the transparent elimination of warheads. Russia therefore has a strong interest in seeing that the warheads downloaded from strategic missiles under START II and III are eliminated under a dismantlement regime.

The U.S. Government, for its part, is very concerned about the possibility of a large number of remaining Russian tactical nuclear warheads. It would like to have transparency in tactical nuclear-warhead stocks and, if Russia's stock is much larger than that of the U.S., to see substantial reductions.

The Russian Government objects to including tactical nuclear warheads in the START III negotiations and the United States has been reluctant to agree to dismantle its up-load hedge warheads. During the workshop, some American participants suggested that an obvious compromise would include transparent reductions in the U.S. upload hedge in return for transparent reductions in excess Russian tactical nuclear weapons. Russian participants, however, took the view that Russia will be interested in warhead transparency for tactical nuclear weapons only if NATO makes a binding agreement not to deploy nuclear weapons in new member countries and the U.S. withdraws its nuclear weapons from Europe.

2. RECIPROCAL TRANSPARENCY AND FINANCIAL ASSISTANCE FOR RUSSIAN WARHEAD DISMANTLEMENT.

The economic crisis in Russia has raised questions about the maintenance of warhead dismantlement rates. The Russian-U.S. Highly Enriched Uranium (HEU) deal is, in part, already helping Russia finance the dismantlement of its excess nuclear warheads, because Russia is able to sell the uranium that is removed from the warheads.

Four options to provide additional funds to facilitate the financing of warhead dismantlement in a context of reciprocal warhead transparency were raised at and after the workshop: 1) the U.S. could provide to Russia a partial pre-payment (e.g. 20 percent) of its expected total payment for each year's delivery of blended HEU; 2) the U.S. could provide an additional payment at the end of each year if the HEU blend-down rate exceeds that required by the HEU deal; 3) Cooperative Threat Reduction [CTR] program funds could be used to modernize and re-tool one of Russia's dismantlement plants to create a facility dedicated solely to the mission of transparently and irreversibly dismantling warheads that are declared excess, either unilaterally or pursuant to an international agreement; and 4) CTR or similar funds could be used to pay part of the costs of Russian warhead dismantlement in return for transparency to confirm that this dismantlement is taking place. Transparency would be implemented on a reciprocal basis at U.S. dismantlement facilities as well.

3. RELEVANCE OF ASYMMETRIES IN THE WEAPONS PRODUCTION AND MAINTENANCE COMPLEXES, AND IN SECRECY REQUIREMENTS

In order to fully achieve the security objectives of both sides in pursuing a warhead transparency regime, a number of asymmetries between the two warhead complexes and their contexts must be dealt with. The U.S. is concerned about differences in nuclear-weapons-production capacities, and warhead and weapons-usable material stockpiles. Russia is concerned about differences in financial resources, upload capacities, and about possible security dangers arising from the compromise of secret information about its facilities. Additionally, the development of a transparency regime could be impeded by differences in the sizes of nuclear-weapon-production infrastructures, weapon re-manufacturing rates, and dismantlement operations and schedules. As a first step, each country should list the asymmetries which concern it, along with an explanation of why they are of concern. Then consideration should be given to how to apply transparency measures in a way that can mitigate political and perception problems, minimize operational impacts, and reduce worries about possible breakouts.

B. POSSIBLE FIRST STEPS TOWARD A NEW REGIME

At present there are no formal or informal on-going negotiations between the U.S. and Russia on the issue of a warhead-transparency regime. Virtually all of the work that is occurring is under contracts between the U.S. and Russian nuclear laboratories. Almost all of these contracts focus on technical and conceptual aspects of a possible regime because of the extreme security and classification concerns surrounding the issue. Listed below are some suggestions put forth at the workshop for first steps that could be taken to
facilitate the movement toward a comprehensive warhead transparency regime.

1. A TRANSPARENCY AGREEMENT ON PIT-CONVERSION.

Moving directly into the monitoring of warhead dismantlement activities at a warhead assembly/disassembly plant is a highly unlikely first step. However, an early agreement might be possible on reciprocal transparency at the point in the warhead-elimination process where plutonium pits are changed to unclassified shapes. These activities are scheduled to be undertaken by both countries and are likely to occur at the Mayak plant in Russia and at either Savannah River or Pantex sites in the U.S.

At present the U.S., Russia, and IAEA, under the Trilateral Initiative, are negotiating arrangements to monitor that excess weapon material sent to the Mayak storage facility (where re-cast plutonium from Russian pits will be stored) is not returned to weapon programs. The U.S. and Russia are engaged in separate bilateral negotiations on monitoring arrangements. However, these discussions continue to be at an impasse because of differences over how to provide assurance that the plutonium to be stored in the storage facility is of weapons-origin.

The U.S. proposes limited chain of custody arrangements, starting with threshold measurements (plutonium isotopics, mass, symmetry and size) on Russian pits in their canisters before they are converted to unclassified forms. A U.S. offer to implement identical transparency measures on a reciprocal basis at its planned pit-conversion facilities might help resolve this difference and build confidence to support the creation of a broader regime. CTR funds could be used to help ease operational bottlenecks in the Russian pit-conversion process if this proposal were adopted.

2. A DECLARATION OF WARHEADS ELIMINATED AND REMAINING TO BE ELIMINATED UNDER THE 1991 BUSH-GORBACHEV INITIATIVES

In 1991, Presidents Bush and Gorbachev each unilaterally agreed to eliminate certain classes of nuclear weapons. These are still the only warheads both countries have officially agreed to eliminate. As a result, the obstacles to increased transparency could be lowest when dealing with these weapons. Both countries could declare how many of these warheads have been dismantled and how many remain to be disassembled. A follow-on initiative could include declarations of the plutonium pits recovered from these warheads and bilateral monitoring of them, and any plutonium recovered from them.

3. FACILITY-SPECIFIC STUDIES

The U.S. has carried out a detailed study on the costs and impacts of specific approaches to activities related to transparent warhead dismantlement if implemented at specific U.S. facilities. This study includes an analysis of how activities related to transparent warhead dismantlement might be segregated from activities relating to maintenance of the enduring nuclear stockpile -- perhaps even in entirely separate dedicated facilities. Russia should carry out a similar detailed study -- perhaps with support from the lab-lab program.

4. AN EXCHANGE OF DIAGRAMS SHOWING LAYOUTS AND WARHEAD FLOWS THROUGH THE DISMANTLEMENT FACILITIES

The U.S. has proposed an exchange of unclassified tours of the U.S. Pantex plant of and a Russian dismantlement plant in order to familiarize each country with the flow of the dismantlement process in the other country. (Journalists have already been offered such tours of the Pantex plant.) The U.S. has offered to host the first visit at Pantex if the Russian government could reciprocate. However, this idea has not yet been accepted by the Russian government. The benefits of implementing this idea, and the means to do so without compromising secrets on either side, were discussed at some length at the workshop.

A possible first step in this direction put forth at the workshop envisions that each country would unilaterally draw up, on paper, an unclassified description of activities at its dismantlement plants and a schematic diagram of how warheads flow though the dismantlement processes. This could constitute a confidence-building first step toward reciprocal "walk-throughs" and then unclassified demonstrations of warhead transparency measures and procedures at the dismantlement facilities in both countries.

5. ARRANGEMENTS FOR VERIFYING THE SHUT-DOWN OR CONVERTED STATUS OF EXCESS WARHEAD-PRODUCTION CAPACITY, AND NON-PRODUCTION OF NEW WARHEADS

A particular interest of the U.S. will be to gain assurance that shut-down or converted warhead dismantlement plants in Russia are not covertly producing new nuclear warheads. There are also questions about how the re-manufacturing of weapons could be distinguished from new warhead production. A first step should be a lab-lab study on possible transparency measures to address these issues.

6. COOPERATIVE RESEARCH WITH THE RUSSIAN MINISTRY OF DEFENSE AND U.S. DEPARTMENT OF DEFENSE ON POSSIBLE CHAIN-OF CUSTODY ARRANGEMENTS FOR WARHEADS

The Russian Ministry of Defense plays a greater role in the Russian warhead dismantlement process than the Department of Defense does in the U.S. For example, warhead storage at Russian dismantlement sites is under the control of the MoD's 12th Directorate. To date, however, no cooperation under the lab-to-lab program has been initiated with the MOD.

An ideal starting point for this cooperation would be research on a possible transparent chain-of-custody arrangement for warheads as they move from active field deployment to dismantlement. This could involve tagging warheads or their containers at military storage sites or, in some cases, even at deployment sites when the warheads are downloaded from missiles. Such approaches could turn out to be the only reliable means to distinguish strategic from tactical warheads, should the two sides agree on limitations that apply differently to the two types of warheads, as suggested in the Helsinki Summit statement.

This will require cooperation from both the Russian Ministry of Defense and the U.S. Department of Defense. A possible partner for the U.S. in the development of this dimension of transparency could be the 12th Directorate's Central Technical-Physical Institute in Sergiev Posad (formerly Zagorsk).

7. DECLARATIONS OF TOTAL WARHEAD STOCKS

In September 1994, President Clinton and President Yeltsin agreed to an exchange of data on each country's stockpiles of nuclear warheads, plutonium, and highly-enriched uranium. In January 1995 the United States put forward a specific proposal for stockpile declarations by both nations. This proposal was rejected by Russia -- apparently because of the amount of detail proposed in the information exchange. A simpler declaration of aggregate warhead stocks -- perhaps divided into strategic and tactical weapon categories -- could be a more acceptable first step. If the United States declassified its aggregate stockpile information, as it has done for plutonium, then implementation of such an exchange would not require an Agreement for Cooperation under the U.S. Atomic Energy Act.

8. DECLARATIONS OF TOTAL PLUTONIUM AND HEU STOCKS.

The U.S. has already made public its total stockpile of plutonium by isotopic grade and site (with Pantex and all warhead sites lumped into a single warhead/pit "site"), along with the history of U.S. production, acquisition and disposition of separated plutonium. The United States is expected soon to release similar information on its HEU stockpile.

Russia has not released information on either of its fissile-material stockpiles. Russian officials and laboratory experts have indicated that Russia does not currently have funds available to pull together the information in a form comparable to what the United States has released on its plutonium stockpile. A useful step would be to undertake a lab-to-lab contract in which the United States would pay the cost of preparing an inventory of Russia's plutonium stockpiles in return for receiving information at the same level of detail as the United States has already released. If this worked well for plutonium, a similar approach could be taken for Russia's HEU stockpiles once the United States has released its data. These further declarations would support agreements for deep cuts in the warhead stockpiles.

WORKSHOP ATTENDEES

RUSSIA

Anatoli Diakov (Moscow Institute of Physics and Technology)
Gennady Kruglov (Chelyabinsk-70/Princeton)
Igor Markov (Chelyabinsk-70/Princeton)
Petr Romashkin (Staff, Defense Committe, Russian State Duma)
Vladimir Rybachenkov (Ministry of Foreign Affairs)

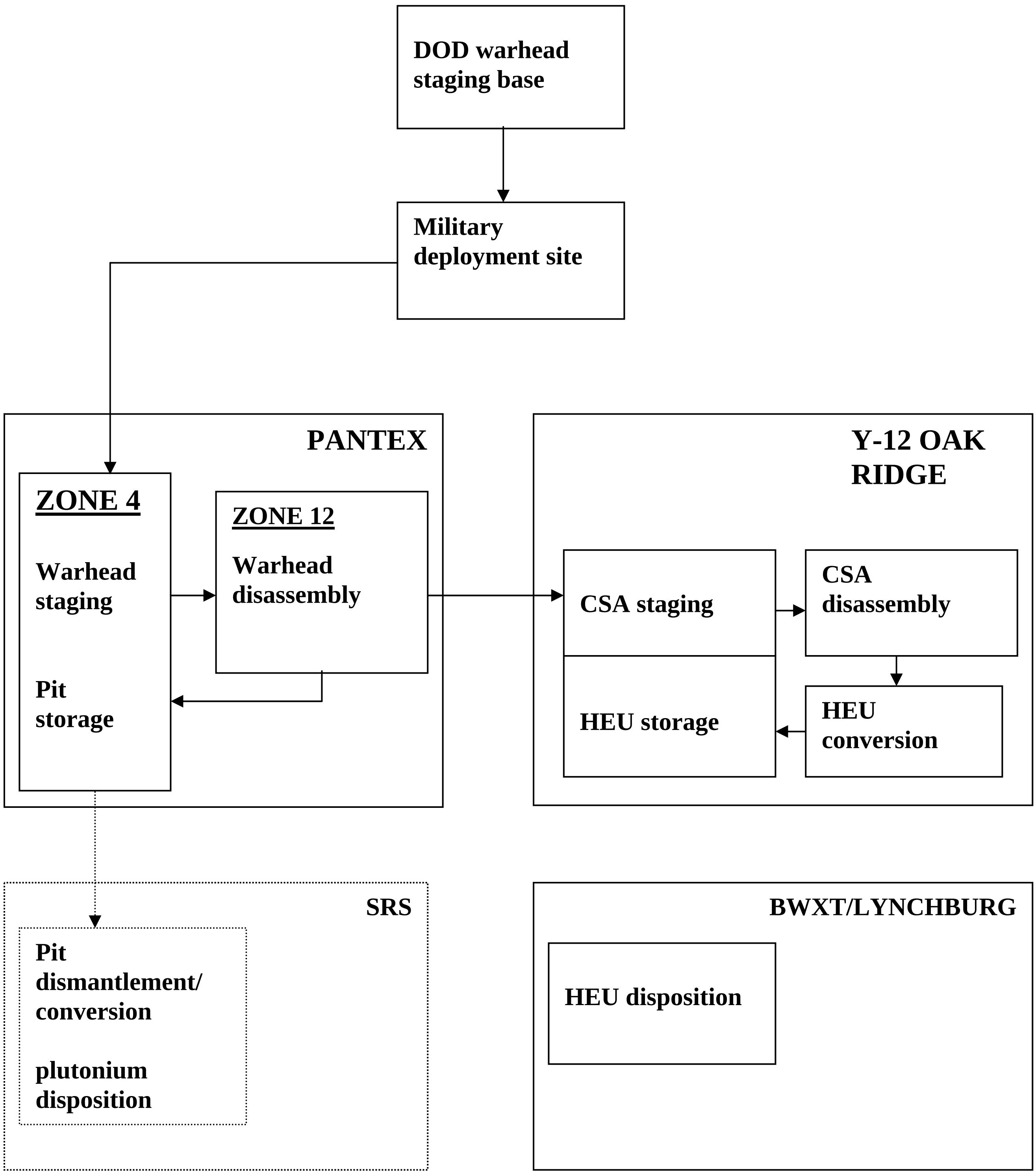
UNITED STATES

Oleg Bukharin (Princeton University)
Matthew Bunn (Harvard University)
Charles Ferguson (FAS)
Steve Fetter (University of Maryland/CISAC)
Ambassador James Goodby
Joshua Handler (Princeton University)
Bill Hoehn (RANSAC)
Ken Luongo (RANSAC)
Frank von Hippel (Princeton University)

Andrew Bieniawski (DOE)
Geoffrey Forden (CBO)
Robert Gromoll (ACDA)
T.R.Koncher (DOD/ LLNL)
Denny Jones (DOS)

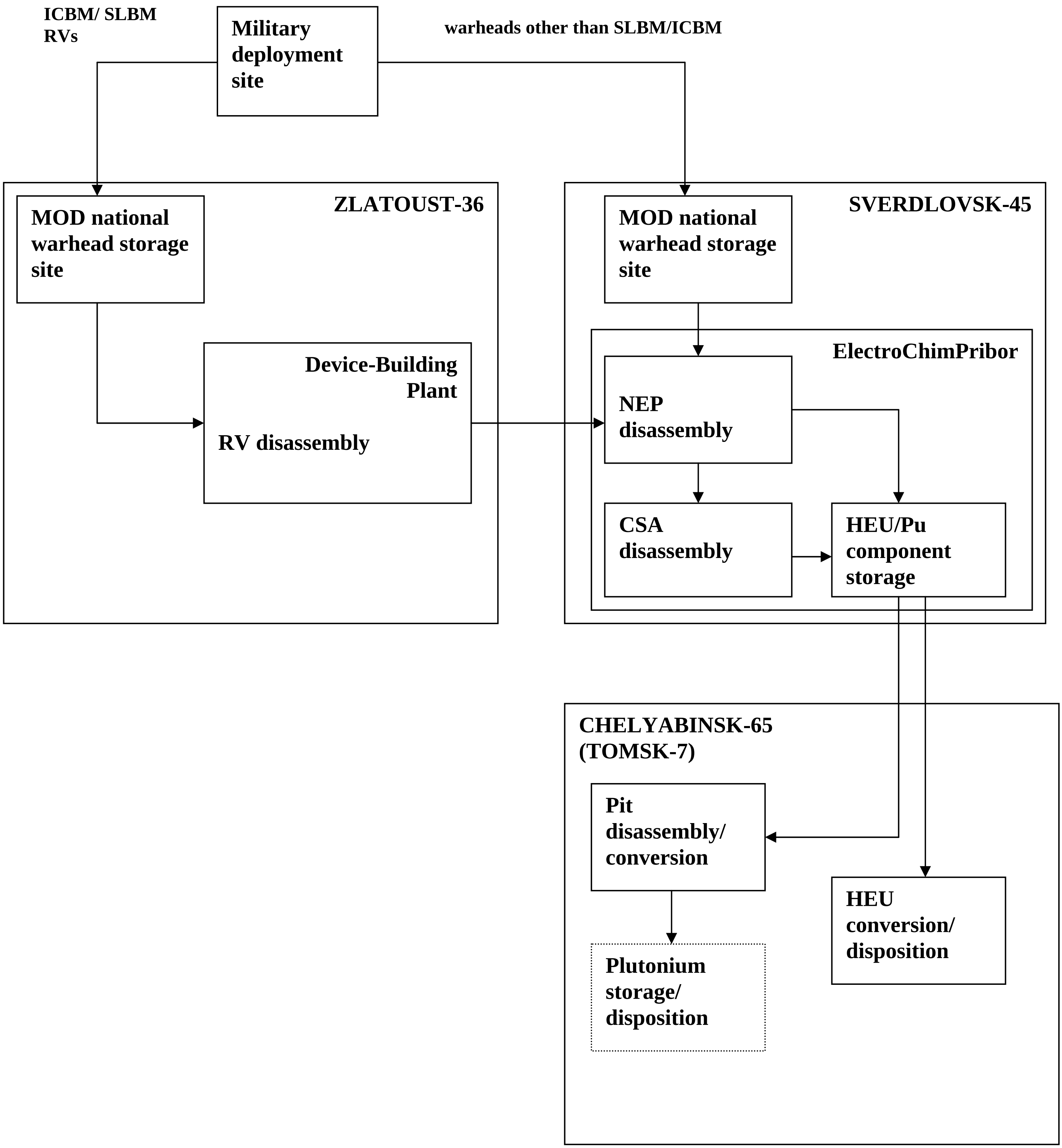
Col. Guy Lunsford (DOD)
David Mosher (CBO)
Michael Newman (DOE)
Michael Olmsted (JCS)
Kurt Sieman (DOE)
Michael Stafford (DOS)

Warhead dismantlement in the United States



CSA – Canned Secondary Assembly (HEU secondary)

A HYPOTHETICAL SCENARIO OF WARHEAD DISMANTLEMENT IN RUSSIA



WARHEAD DISMANTLEMENT SEQUENCE