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Nuclear Weapons: Monitoring Warhead Dismantlement

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Summary

Concerned about the security of nuclear warheads in the former Soviet Union, the Clinton Administration sought ways to verify the elimination of non-deployed Russian warheads. One approach, directed by the U.S. Department of Energy, is to develop technologies to monitor the dismantlement of these warheads. Two constraints shape these technologies. Monitoring technologies must give inspectors sufficient confidence that a warhead is actually dismantled and that its components are not reused for new nuclear weapons. Yet, to protect nuclear weapon design information, inspectors must not be able to directly observe the disassembly of warheads or to conduct measurements on warheads that would reveal classified information. This report describes technologies for a possible nuclear warhead dismantlement regime between the United States and Russia. The report will be updated as appropriate.

Background

With the breakup of the Soviet Union in late 1991, many U.S. analysts and politicians became concerned about the security of nuclear warheads and fissile material in the Newly Independent States. Loss or theft of these warheads or their nuclear components could threaten U.S. security.[1] Beginning in 1993, Clinton Administration officials sought ways to reduce these risks. Its fissile material initiatives included the purchase of 500 metric tons of highly enriched uranium from dismantled Russian warheads and support for the construction of a fissile material storage facility at Mayak, Russia. Nuclear warhead initiatives focused on implementing the Strategic Arms Reduction Treaty (START I) and on monitoring the destruction of non-deployed warheads. In 1994, the United States began to urge Russia to enter into negotiations about the dismantling of nuclear warheads. In January 1994, Presidents Clinton and Yeltsin agreed to establish a joint working group,

[1]Graham T. Allison et al., *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material* (MIT Press, 1996).

whose tasks included the consideration of "steps to ensure the transparency and irreversibility of the process of reduction of nuclear weapons."[2] In 1994 and 1995, the joint working group discussed political and technical parameters for a possible warhead dismantlement regime.[3]

These efforts introduced a new element into the U.S.-Russian arms control agenda. While the strategic arms reduction treaties START I and START II had focused on the reduction of delivery systems, the Clinton Administration urged Russia to negotiate the dismantlement and elimination of nuclear warheads themselves.[4] In this effort, the Administration was supported by the Senate, which in October 1992 gave its advice and consent to the START I treaty, subject to a number of conditions and declarations. One condition, introduced by Senator Biden, instructed the Executive to include in any future strategic arms control agreement measures to specifically monitor nuclear warheads.[5]

Transparency and Irreversibility

Two concepts guided U.S. policy on a possible warhead dismantlement regime with Russia: transparency and irreversibility.[6]

- "Transparency" refers to measures that provide confidence that a declared arms control activity is taking place.[7]

- "Irreversibility" refers to measures that provide confidence that fissile materials from dismantled warheads cannot be used again for nuclear weapons.

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[2] "Joint Statement on Non-Proliferation of Weapons of Mass Destruction and the Means of Their Delivery," White House Press Release, January 14, 1994. The group became known as the Joint Working Group on Nuclear Safeguards, Transparency and Irreversibility.

[3] James Goodby, "Transparency and Irreversibility in Nuclear Warhead Dismantlement," in Harold A. Feiveson et al., *The Nuclear Turning Point* (The Brookings Institution, 1999), pp. 171-192

[4] See: Amy Woolf, *The START and START II Arms Control Treaties: Background and Issues*, CRS Report 93-617F, June 30, 1993; Amy F. Woolf, *Arms Control and Nonproliferation Activities: A Catalog of Recent Events*, CRS Report RL30033, January 4, 1999; Amy Woolf, *Nuclear Arms Control: The U.S.-Russian Agenda*, CRS Issue Brief IB98030, updated September 10, 1999.

[5] "Protocol to the Treaty with the Union of Soviet Socialist Republics on the Reduction and Limitation of Strategic Offensive Arms — Treaty Doc. No.102-32," *Congressional Record* (October 1, 1992), p. S15955; Michael R. Gordon, "Senate Calls for Monitoring of the Warheads in Russia," *New York Times*, July 3, 1992.

[6] For a history of warhead dismantlement transparency proposals see Oleg Bukharin and Kenneth Luongo, "U.S.-Russian Warhead Dismantlement Transparency: The Status, Problems, and Proposals," Princeton University, Center for Energy and Environmental Studies, Report No. 314 (April 1999) [www.princeton.edu/~ransac/reports/transparency.html]

[7] For a discussion of the relationship between "transparency" and "verification" see Joseph F. Pilat, *Verification and Transparency in Future Arms Control*, Los Alamos National Laboratory Report LA-UR-96-2618 (1996).

As part of the suggested transparency and irreversibility measures, the two countries considered an exchange of information about the number, safety, and security of their nuclear stockpiles as well as reciprocal monitoring of fissile material storage facilities to ensure the irreversibility of the dismantlement process.[8] Despite progress by the joint working group, Russian officials discontinued these government-to-government discussions in 1995, citing the need for further internal reviews of Russia's transparency and irreversibility policies.[9] The talks have not been resumed. However, during their March 1997 summit in Helsinki, Presidents Clinton and Yeltsin reaffirmed their commitment to pursue "measures relating to the transparency of strategic nuclear warhead inventories and the destruction of strategic nuclear warheads ... [and] to promote the irreversibility of deep reductions including prevention of a rapid increase in the number of warheads."[10]

At the same time, technical discussions about how to monitor warhead dismantlement had continued between U.S. and Russian national laboratories. In 1996 the U.S. Department of Energy initiated the Russian Lab-to-Lab Warhead Dismantlement Transparency Program to facilitate Russian warhead dismantlement and to identify and evaluate transparency techniques. This program engages Russian experts in an unclassified dialogue about technical approaches towards a verified dismantlement and elimination of nuclear warheads.[11] Thirty-six "Lab-to-Lab" contracts had been signed by mid-1999, with additional contracts under negotiation.[12]

Technologies for a Warhead Transparency Regime

The remainder of this report presents a description and analysis of the major technologies for transparency. The goal of monitoring dismantlement is to provide confidence that dismantlement is actually taking place. For that purpose inspectors aim at monitoring the process as closely as permitted by the host country. Currently, neither the United States nor Russia allow foreign inspectors to observe dismantlement directly because it could reveal classified information. Neither country is likely to permit such close monitoring in the foreseeable future. However, inspections must ensure that a warhead is actually dismantled inside the facility, without any possibility of diverting the warhead or its material. Ideally, inspectors should be able to account for the exact location and status of every warhead during the dismantlement process.

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[8]"Joint Statement on the Transparency and Irreversibility of the Process of Reducing Nuclear Weapons," White House Press Release, May 10, 1995.

[9]For an analysis of why Russian officials decided to end the talks see Goodby, "Transparency and Irreversibility in Nuclear Warhead Dismantlement."

[10]"Joint Statement On Parameters On Future Reductions In Nuclear Forces," White House Press Release, March 21, 1997.

[11]Andrew Bieniawski, "Russian Lab-to-Lab Warhead Dismantlement Transparency Program," DOE briefing, July 20, 1999; U.S. Department of Energy, Office of Nonproliferation and National Security, "Warhead and Fissile Material Transparency Program: Strategic Plan," May 1999.

[12]DOE,"Warhead and Fissile Material Transparency Program: Strategic Plan," 13-15; Andrew Bieniawski, "Russian Lab-to-Lab Warhead Dismantlement Transparency Program," DOE briefing, July 20, 1999.

To do so, a warhead would have to be continuously monitored. Monitoring would begin when the warhead is removed from a missile, a deployment site or a storage site, and then sealed into a canister for transport to the dismantlement facility. Monitoring would continue during transport and during the various steps inside the dismantlement facility. Finally, after the warhead is disassembled, its components would be monitored during transport to storage sites, where they would await final disposition.[13]

DOE laboratories have developed monitoring systems based on three main technologies: radiation measurements, tamper-indicating devices, and remote monitoring.

Radiation measurements.[14] A nuclear weapon contains a few kilograms of fissile material, either highly enriched uranium (U-235) or weapons-grade plutonium (Pu-239), or both. These materials emit a characteristic radiation, either spontaneously or induced by an external radioactive source. This radiation is partly absorbed and altered by other materials composing the warhead, but a characteristic radiation spectrum can be measured, even if the warhead is sealed in a metal container. The warhead's "radiation signature" can be compared with the radiation from nuclear components leaving the disassembly facility. If the two signatures correlate, the inspectors can be confident that the components stem from the original warhead and that the warhead has been successfully dismantled.[15]

The three leading radiation signature technologies were developed by U.S. National Laboratories. Sandia National Laboratory created the Radiation Identification System (RIS), a low-resolution measurement system that is used routinely to identify plutonium warhead components. Brookhaven National Laboratory's Controlled Intrusiveness Verification Technology (CIVET) includes a high resolution measurement system and a special computer without permanent memory to prevent storage of classified information. Oak Ridge National Laboratory developed the Nuclear Weapons Identification System (NWIS), which is used at Oak Ridge for the verification of nuclear weapons components in storage containers.[16]

In late 1997 and early 1999, DOE experts tested these technologies on actual U.S. nuclear weapons and warhead components. The experts concluded that the radiation

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[13]Zachary Davis, *Nuclear Weapons: Disposal of Surplus Weapons-Usable Plutonium*, CRS Report RL30170, May 13, 1999.

[14]For an introduction to radiation measurement techniques used in the detection of nuclear warheads see Steve Fetter et al., "Detecting Nuclear Warheads," in Frank von Hippel and Roald Z. Sagdeev, eds., *Reversing the Arms Race* (Gordon and Breach, 1990), 265-368.

[15]Gerald P. Kiernan et al., "Interim Technical Report on Radiation Signatures for Monitoring Nuclear-Warhead Dismantlement," in U.S. Department of Energy, Office of Arms Control and Nonproliferation, *Transparency and Verification Options: An Initial Analysis of Approaches for Monitoring Warhead Dismantlement* (May 19, 1997), pp. 135-145. OFFICIAL USE ONLY.

[16]Bukharin and Luongo, "U.S.-Russian Warhead Dismantlement Transparency," p. 12; Michael J. Newman, "Warhead Radiation Signatures: Report on the Nov-Dec 1997 Pantex Demonstration Measurements," DOE Briefing, March 16, 1998; on the NMIS see J.T. Mihalczo et al., *Physical and Mathematical Description of Nuclear Weapons Identification System (NWIS) Signatures*, Oak Ridge National Laboratory report Y/LB-15,946 R2 (September 26, 1997).

signature technologies allow, for example, an effective discrimination by type of warhead and a correlation of type of warhead with dismantled nuclear components.[17]

Tamper-Indicating Devices.[18] Inspectors can use tamper-indicating devices, such as special tags and seals, to determine if someone tried to gain unauthorized access to a storage site, a building, or a canister containing a nuclear warhead. Tags and seals have been used domestically and internationally for many years to safeguard fissile materials. Both U.S. and Russian national laboratories have developed and extensively tested tamper-indicating devices especially for arms control applications. However, some scientists have pointed out that most tags and seals are not tamper-proof.[19] Current research to improve tamper-indicating devices is conducted at DOE's National Laboratories, including Los Alamos, Lawrence Livermore, Oak Ridge, Pacific Northwest, and Sandia.

Remote Monitoring. Various remote monitoring techniques can be applied to ensure that a specific item is not removed or otherwise clandestinely altered. Standard technologies such as video surveillance can be used to monitor the interior of a storage site, doors of a building, or a facility's fence line.

Transparency and Verification Options at Pantex

In the fall of 1996, DOE began to study various monitoring systems that could be implemented at the Pantex plant in Amarillo, Texas, the nation's warhead assembly and disassembly facility. DOE officials expect that the lessons learned from monitoring the U.S. dismantlement process will be useful in designing a future monitoring system at Russian facilities. DOE identified four monitoring options, which differed primarily in their level of intrusiveness and in the confidence they provided to inspectors that dismantlement has taken place.

In general, DOE officials contend that more confidence can be gained by using more intrusive monitoring measures. More intrusive measures, however, would be more disruptive of normal stockpile operations at Pantex, would be more difficult to negotiate with the Russians, and would entail more risk of losing classified information. The least intrusive option considered was to monitor warheads and their components in the storage area and to follow the warheads to the gate of the dismantlement area, but not to allow access to this area. The most intrusive option considered was additional monitoring within the dismantlement area and direct observation or remote monitoring of the physical dismantlement of the warhead.

DOE concluded in a 1997 report that transparency of warhead dismantlement could be achieved in principle. While the least intrusive option would provide only low to

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[17]Newman, "Warhead Radiation Signatures"; Andrew Bieniawski, "Overview of DOE START III Activities," DOE Briefing, July 20, 1999.

[18]For a technical report on tags and seals see P.R.V. Horton and I.G. Waddoups, *Tamper-indicating devices and safeguards seals evaluation test report*, volume 2, Sandia National Laboratory report SAND93-1726/2 (released August 1995).

[19]Chad Olinger et al., *Technical Challenges for Dismantlement Verification*, Los Alamos National Laboratory report LA-UR-97-2812 (1997).

moderate confidence that dismantlement has taken place, the most intrusive option could provide moderate to high confidence. However, intrusive measures might require exchanges of certain classified data with Russia under a nuclear cooperation agreement.[20]

In 1997, DOE also identified areas that required additional research and analysis such as testing the leading warhead radiation signature technologies, in-depth cost and impact analysis, and an evaluation of techniques for tracking non-nuclear components. According to the DOE's Office of Nonproliferation and National Security, most of the additional research has been completed or was near completion as of mid-July 1999.

Budget and Recent Legislative Initiatives

The Department of Energy's Warhead and Fissile Material Transparency Program is the focal point of U.S. efforts to support transparent and irreversible nuclear warhead reductions. The program is part of DOE's Office of Nonproliferation and National Security, which is funded through the Energy and Water Development Appropriations Bill. In FY1997 the program received $6.5 million, in FY1998 $12.5 million, and in FY1999 $9.5 million.[21] For FY2000, DOE requested $16.01 million for promoting transparent and irreversible nuclear reductions as part of a $296 million budget request for various activities related to arms control and nonproliferation. The House recommended reducing this budget item to its FY1999 level of $256.9 million (H.Rept. 106-253), while the Senate recommended an increase of $20 million to $316 million (S.Rept. 106-58). In conference Congress agreed to support these activities with $281 million (H.Rept. 106-336). President Clinton signed the bill into law (P.L. 106-60) on September 30, 1999.

Issues and Options

Some analysts suggest that technologies developed for transparency measures are ready to be implemented. They believe the major problem in negotiating a warhead dismantlement transparency regime is not technical but political in nature. For example, at this time it is not clear whether such a regime would focus on strategic warheads alone, or whether it would include tactical and reserve warheads as well. Others argue that more federal money should be spent on the development of warhead transparency technologies. They may suggest that added funds for these technologies will result in more confidence that Russia is actually and irreversibly dismantling warheads. Some analysts may be concerned that a warhead dismantlement regime would be essentially unverifiable despite highly sophisticated monitoring technologies. Yet others may argue that such a regime could affect the normal operations at DOE nuclear weapons facilities and thereby impair U.S. security. Policymakers may closely watch DOE's warhead transparency initiatives to determine to what extent monitoring technologies benefit U.S. national security and how much federal support is appropriate for these initiatives.

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[20]DOE, *Transparency and Verification Options*, p. 15.

[21]DOE, "Warhead and Fissile Material Transparency Program: Strategic Plan," 21-23.