II. CONTEXT

Before discussing in detail the factors that have changed over the past several years, it is useful to briefly summarize the conclusions contained in previous dismantlement transparency and verification studies. This dismantlement-monitoring study is not the first detailed analysis of various warhead dismantlement transparency and verification options. In fact, there is a rich history of studies addressing the issue of monitoring warhead dismantlement. The study group thought it useful to extract the key conclusions from these previous studies as a means of providing not only a background for the current study but also to ensure that any valuable conclusions previously reached are carried forward.

SUMMARY OF PREVIOUS WARHEAD DISMANTLEMENT TRANSPARENCY AND VERIFICATION STUDIES

For this report, we reviewed seven major studies published since 1990 relating to warhead dismantlement transparency and verification. Three of the studies—the President's 1991 Report to Congress on "Verification of Nuclear Warhead Dismantlement and Special Nuclear Material Controls" (the Section 3151 Report), the 1991 Joint U.S.–Russia Report on "Verifying the Dismantlement of Nuclear Warheads," and the 1993 JASON Report on "Verification of Dismantlement of Nuclear Warheads and Controls on Nuclear Materials"—scoped the larger issues of controlling all special nuclear material, accountability of U.S.–Russian nuclear material, breakout and cheating scenarios, and the ability to effectively monitor or verify activities related to the above.

The other four studies focused more closely on the impacts and issues for the DOE nuclear weapons complex if the U.S. government decided to implement a regime for warhead dismantlement monitoring and safeguarding of special nuclear material. The key conclusions from the seven studies are summarized below. For summary purposes, we have highlighted only the most relevant conclusions, but Appendix C includes a complete bibliography and summary of each study.

- Any dismantlement verification regime would involve a high risk of disclosing sensitive information, and such disclosures could reveal potential vulnerabilities of our nuclear forces or reveal weapons-design information. As a result, measures will have to be taken to keep classified information from being placed at risk. (*3151 Report*)

- Determining the initial number of warheads that a side possesses at the time of entry into force of an agreement would be an extremely difficult problem. (*3151 Report*)

- National Technical Means (NTM) are not effective at verifying dismantlement. (*3151 Report*)

- The verified destruction of the non-nuclear parts of the dismantled warheads would have little arms control significance by themselves because these parts could be reconstituted in a clandestine manner with only modest costs. (*3151 Report*)

- The most important step in the verification of dismantlement occurs at the beginning, when a weapon is first declared to be a weapon and officially entered into the system. (*JASON Study*)

- Although DOE facilities such as Pantex and Y-12 were not designed to accommodate monitoring procedures, implementation of a variety of dismantlement monitoring and cooperative measures at DOE dismantlement facilities is feasible. (*Wilson Report*)

- The use of a dedicated dismantlement facility, such as the Device Assembly Facility (DAF) at the Nevada Test Site, could reduce the disclosure of sensitive information as well as the impact on nondismantlement activities. (*Wilson Report*)

- Monitoring the accumulating inventories of nuclear components and materials would provide strong indications that warheads are being dismantled, or at least that the inventory of warheads is being reduced. The confidence provided by monitoring inventories could be relatively high and would minimize the disruption to ongoing dismantlement activities. (*Wilson Report*)

- The cost of Portal Perimeter Continuous Monitoring (PPCM) would be high because of the need for continuous onsite presence and the need to make the necessary modifications to facilities to allow for accurate flow measurements. (*Wilson Report*)

- There are significant asymmetries between the U.S. and Russian nuclear weapons programs. These asymmetries include differences in the physical size of the nuclear production and storage complexes, inventory accountability, and, perhaps most important, the fact that Russia is still producing new nuclear weapons. (*JASON Study*)

RECENT CHANGES

Many activities have taken place over the past several years that require an update of the previous warhead dismantlement transparency and verification studies. These include the beginning of START I inspections, planning for potential START II inspections, and various transparency initiatives being negotiated with the Russian Federation.

START I Inspections

Arms control in the U.S. underwent a significant paradigm shift with the signing of the Chemical Weapons Convention in January 1993 and the ratification and entry into force of the START I Treaty in December 1994. For the first time, the U.S. was willing to allow inspectors representing a foreign country into U.S. facilities. Given the long history of differences in national-security concerns between the U.S. and the Soviet Union, and between the U.S. and Russia, the START inspections have gone remarkably well. Anomalies have been encountered, but the mechanism established to deal with them—the Joint Compliance and Inspection Commission—has by and large worked well.

Under START I treaty inspections, each country is given the right to verify that the declared number of Reentry Vehicles (RVs) or Reentry Bodies (RBs) assigned to each ballistic missile system has not been exceeded. For these and other inspections in the treaty, the sides negotiated an elaborate set of confidence-building and verification measures that include data exchanges, movement notifications, pre-inspection operational and movement restrictions, and onsite inspection (specific inspection-site selection, chain of custody, and visual viewing of shrouded RV/RB sections). These measures and associated procedures established by the Services have not fully satisfied the Russians except in the case of the Peacekeeper system. For this system, the front section of the missile is removed and transported back to the maintenance facility for shroud removal and viewing preparation. Thus, the Russians have full exposure to the warhead section, albeit with the individual warheads and the mounting platform appropriately covered. For both the Minuteman III and the Trident D-5 and C-4 systems, the Russians have registered concerns over covert warhead capability because the shrouding techniques and operational procedures utilized by the Services do not afford them the full exposure to the Minuteman III and Trident missiles or the undersides of the RV/RB platforms. In all cases, the procedures and measures utilized by the U.S. are determined to be treaty-compliant and have been implemented on an unclassified basis.

START II

Following the signing of the START I Treaty on January 31, 1993, the U.S. and Russia embarked on an intense set of negotiations to reduce strategic accountable force levels below the 6,000-warhead limit established in START I. Within an 18-month period, the U.S. and Russia negotiated and signed the START II Treaty which limited accountable warheads to between 3,000–3,500. This agreement also eliminated the entire class of

heavy ballistic missiles, prohibited multi-warhead land based ballistic missiles, and capped sea launched ballistic missiles at 50% of the total ballistic missiles allowed.

Anticipating rapid ratification of the START II Treaty and entry into force, the interagency conducted in early 1993 a review of what steps should follow START II. This review considered numerous options for lower strategic force levels, operational constraints on nuclear forces, objectives for the next round of discussions, and type of negotiations to be conducted. However, during this process, initial Russian concerns began to surface with START II, especially within the Duma and among anti-Yeltsin factions. Because of the uncertainty in Russian ratification, U.S. policy, as recommended by the interagency, focused on ensuring that START II was moved forward for ratification before entering into formal discussions on a follow-on START treaty.

START III

Consistent with this policy, at the March 21, 1997, Helsinki Summit, Presidents Clinton and Yeltsin issued a Joint Statement on Parameters on Future Reductions in Nuclear Forces. Specifically, Presidents Clinton and Yeltsin agreed that once START II enters into force, the U.S. and Russia will immediately begin negotiations on a START III agreement, which will include, among other things, the following basic components:

- Establishment, by December 31, 2007, of lower aggregate levels of 2,000–2,500 strategic nuclear warheads for each of the Parties; and,

- 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.

The Presidents also agreed that in the context of START III negotiations their experts will explore, as separate issues, possible measures relating to nuclear long-range sea-launched cruise missiles and tactical nuclear systems, to include appropriate confidence-building and transparency measures. Presidents Clinton and Yeltsin also agreed that the sides will consider the issues related to transparency in nuclear materials. A complete text of the Helsinki Summit Statement is provided in Appendix B.

SAFEGUARDS, TRANSPARENCY, AND IRREVERSIBILITY

At the January 1994 Summit Meeting, Presidents Clinton and Yeltsin agreed on the goal of ensuring the "transparency and irreversibility of the nuclear arms reduction process." A Joint Working Group on "Safeguards, Transparency and Irreversibility" (STI) was established in May 1994, with the mandate to build confidence and promote stability in the two countries' mutual security relationship. At their September 1994 Summit Meeting, Presidents Clinton and Yeltsin further directed their experts to pursue additional transparency and irreversibility measures and to report on their accomplishments during the summit scheduled for the spring of 1995. The Presidents also mandated that the U.S. and Russia negotiate an Agreement for Cooperation that would provide the legal basis for the exchange of classified and sensitive information necessary to support an STI regime.

In December 1994, the U.S. presented the Russians with a non-paper defining the objectives of the STI initiative and outlining the key elements of the U.S. STI approach. The December 1994 non-paper stated that the STI initiative should meet four key objectives:

- **Transparency:** *The measures that build each side's confidence in its understanding of the size of the other's stockpiles of nuclear weapons and fissile materials, and the rate of reduction in these stockpiles.*

- **Safeguards and Security:** *The measures should build each side's confidence that nuclear weapons and fissile materials are secure, and provide the information and openness needed to strengthen our mutual cooperation toward that end.*

- **Irreversibility:** *The measures should build each side's confidence that the nuclear arms reductions being carried out are irreversible, and in particular that fissile materials declared excess to military needs (including civilian weapons-usable materials) are not being used to build new nuclear weapons.*

- **Political Benefits:** *The measures should build public, legislative, and international confidence in the nuclear arms reduction process, supporting our mutual efforts to extend and strengthen the NPT regime, ratify and implement the START agreements, and consider further arms control measures.*

The key elements of the STI regime include:

- Reciprocal exchanges of detailed information on aggregate stockpiles of nuclear warheads and fissile material *(THE STOCKPILE DATA EXCHANGE AGREEMENT)*

- Mutual reciprocal inspections to confirm that ***excess*** Pu and HEU removed from nuclear weapons are not being returned to weapons *(MRI)*

- Cooperative measures to confirm the fissile material portion of the Stockpile Data Exchange Agreement *(SPOT CHECKS)*

- A cooperative arrangement to monitor warheads declared excess and awaiting dismantlement, to further confirm the dismantlement of these nuclear weapons *(LIMITED CHAIN-OF-CUSTODY)*

At the May 9–10, 1995 Summit Meeting in Moscow, Presidents Clinton and Yeltsin laid out a more detailed agenda to increase the transparency and irreversibility of the process of reducing nuclear weapons. Specifically, they agreed as follows:

- Fissile materials removed from nuclear weapons being eliminated and excess to national security will not be used to manufacture nuclear weapons;

- No newly produced fissile materials will be used in nuclear weapons;

- Fissile material from or within the civil nuclear programs will not be used to manufacture nuclear weapons;

- The U.S. and Russian Federation will negotiate agreements to increase the transparency and irreversibility of the nuclear arms reduction process that, *inter alia*, establish:

  - An exchange on a regular basis of detailed information on aggregate stockpiles of nuclear weapons, on stocks of fissile materials and on their nuclear security (*THE STOCKPILE DATA EXCHANGE AGREEMENT*);
  - A cooperative arrangement for reciprocal monitoring at storage facilities of fissile material removed from nuclear warheads and declared to be excess to national security requirements to help confirm the irreversibility of the process of reducing nuclear weapons *(MRI)*, recognizing that progress in this area is linked to progress in implementing the joint U.S.–Russian program for the fissile material storage facility at Mayak; and
  - Other cooperative measures, as necessary to enhance confidence in the reciprocal declarations on fissile material stockpiles *(SPOT CHECKS)*.

In June 1995, the U.S. tabled a Stockpile Data Exchange Agreement with the Russians which proposed that each side not only declare existing inventories of weapons and fissile material but also declare the number of nuclear weapons dismantled each year since 1980 and the quantity of fissile material produced by the Parties each year since 1970 by material type, amount, category of enrichment or grade and production location. Assistant Minister of Atomic Energy Vladislav Balamutov rejected the June 1995 version due to the fact that it was too comprehensive and inconsistent with a "step-by-step" approach to transparency.

By December 1995, the two sides had nearly completed the text of the Agreement for Cooperation providing the legal basis for exchanging classified nuclear information required to implement these initiatives. However, the Russian government then called a halt to these negotiations pending an internal Russian policy review. As a result, no negotiations on STI have taken place since that time, although technical discussions on MRI were conducted in the fall of 1996. Nevertheless, it is important to note that many of the specific activities that will increase the transparency and irreversibility of the nuclear weapons reduction process, such as Mutual Reciprocal Inspections (MRI) of facilities storing fissile material removed from dismantled nuclear weapons, declarations of nuclear weapons and fissile material stockpiles, and spot checks to verify these declarations, could become the building blocks for a warhead dismantlement monitoring treaty, if they are negotiated and implemented in the near term.

MUTUAL RECIPROCAL INSPECTIONS

With regard to the first element of the STI framework, on March 16, 1994, former U.S. Secretary of Energy O'Leary and Russian Minister of Atomic Energy Mikhailov issued a Joint Statement on Inspection of Facilities Containing Fissile Material Removed from Nuclear Weapons.

The Joint Statement required that the U.S. and Russia "...conclude an agreement on the means of confirming the plutonium and highly enriched uranium inventories from nuclear disarmament." Negotiations with the Russians to implement the O'Leary–Mikhailov Joint Statement initially focused on the technical means of monitoring plutonium inventories because of the relative ease in conducting radiation measurements on pits as opposed to canned subassemblies.

Plutonium Mutual Reciprocal Inspections

Significant progress on technical discussions relating to plutonium demonstrations continued through the summer of 1994 with reciprocal familiarization visits being conducted at the U.S. Rocky Flats Plant in July 1994 and at Seversk, Russia, in August 1994. During the Rocky Flats visit, the U.S. demonstrated to the Russians an unclassified sodium iodide (NaI) radiation measurement indicating the presence of plutonium in a sealed container containing an actual pit removed from a dismantled U.S. nuclear weapon. Similarly, at Seversk, the Russians demonstrated for the U.S. delegation an unclassified radiation measurement demonstrating the presence of plutonium in a sealed container declared to contain an actual pit removed from a dismantled Russian nuclear weapon. Subsequently, meetings took place in September and October 1994 in Moscow to finalize the plutonium demonstration techniques. At both the September and October 1994 meetings, the technical experts from both countries agreed that it would be necessary to exchange some classified, Restricted Data, in order to carry out an effective transparency regime.

Discussions with the Russians on plutonium measurements continued in November 1994 with a Russian visit to the Lawrence Livermore National Laboratory and the signing of a protocol on the technical means to carry out a plutonium mutual reciprocal inspection (MRI) demonstration agreement. This protocol led to a draft plutonium MRI Demonstration Agreement which was tabled with the Russians in January 1995. The draft Pu MRI Demonstration Agreement incorporated specific radiation measurement techniques in order to determine that the contents of a sealed container are consistent in isotopics, mass, and shape with a pit

removed from a dismantled nuclear weapon. Specifically, the January 1995 draft Pu MRI Agreement included the following three technical annexes:

- **Technical Annex 1:** *Radiation measurements to determine the presence and isotopics of plutonium in a sealed storage container*
- **Technical Annex 2:** *Neutron measurements to determine the approximate mass of plutonium in a sealed storage container*
- **Technical Annex 3:** *Gamma-ray scanning measurements to determine the shape and extent (size) of plutonium in a sealed storage container*

The draft Pu MRI Demonstration Agreement was discussed in February 1995 with the Russians and during the February negotiations they essentially accepted the procedural body of the draft agreement but made a counter proposal based on neutron measurements concerning the technical annex on the shape measurement (Annex 3). Formal negotiations with the Russians on the Pu MRI Demonstration Agreement have been stalled by the lack of progress of the Agreement for Cooperation. Completion of the Agreement for Cooperation is required since the technical annexes require certain classified information to be exchanged. Hence the fate of the O'Leary–Mikhailov Joint Statement and the Pu MRI Demonstration Agreement became bound up with the fate of the Agreement for Cooperation allowing the sharing of classified and sensitive information. However, technical discussions on the Pu MRI Demonstration Agreement *annexes* have continued while the U.S. and Russia discuss the issues associated with the Agreement for Cooperation at a higher level.

In September 1996, U.S. and Russian technical experts met in Moscow to continue technical discussions associated with the Pu MRI Demonstration Agreement. At the September 1996 meeting, U.S. and Russian technical experts confirmed that the technical procedures in Annex 1 (for the determination of the presence of weapons-grade plutonium) and Annex 2 (for the determination of the mass of Pu) were agreed. However, the sides also confirmed that there are differing views regarding the technical procedures in Annex 3 (for the determination of the shape). In order to evaluate the merits of the proposed Russian neutron isotropy technique and the U.S. gamma ray scanning technique, a Russian delegation, headed by Deputy Assistant Minister of the Russian Federation for Atomic Energy Nikolai Voloshin, visited the Lawrence Livermore National Laboratory in November 1996 to conduct joint measurements on unclassified plutonium sources in sealed storage containers. Based on the November 1996 LLNL meeting, the U.S. and Russian technical experts agreed that they now have sufficient technical information to evaluate the merits of the different techniques to measure the shape of plutonium in a sealed storage container. In addition, the sides agreed to meet in the near future to discuss the results of the joint measurements and work towards completing the MRI Demonstration Agreement, including a limited Agreement for Cooperation that would allow the sides to exchange only that classified data necessary for a one-time Pu MRI demonstration.

Highly Enriched Uranium Mutual Reciprocal Inspections

Because the March 16, 1994, O'Leary–Mikhailov Joint Statement also required that inventories of highly enriched uranium be monitored, the Department of Energy Office of Arms Control and Nonproliferation held a number of technical meetings, and sponsored a series of measurements, in early 1995 to determine how to conduct highly enriched uranium mutual reciprocal inspections (HEU MRI). The conclusions from these meetings were presented to the Russians in June 1995 in the form of a non-paper. The non-paper proposed two different HEU MRI regimes:

- For Canned Sub-Assemblies (CSAs) or secondaries, the use of tags and seals, the weighing of CSAs, and "chain-of-custody" techniques were proposed to track HEU in sealed storage containers.
- For other forms of HEU (metal, oxide, or right circular cylinders), measurements to determine the approximate mass and enrichment of uranium in sealed containers would be performed.

Based on this approach, in November 1995, DOE and MINATOM agreed that HEU MRI would be implemented on an unclassified level. This decision paved the way for the U.S. and Russia to conduct unclassified reciprocal familiarization visits to each other's HEU storage facilities. In November 1996, a Russian delegation visited the Oak Ridge Y-12 Plant for a highly enriched uranium transparency familiarization visit. During the Russian visit to Y-12, procedures extracted from the HEU MRI non-paper were demonstrated to the Russians to support the transparency measures associated with the U.S.–Russian HEU Purchase Agreement. Specifically, Russian experts observed a demonstration of the U.S. procedures for receiving HEU components in sealed containers from Pantex, recording the unique identifier, and weighing the sealed shipping container containing an actual HEU weapons component. Russian technical experts also observed radiation measurements being performed on U.S. HEU weapons components in sealed storage containers to confirm the presence of HEU. Two types of radiation measurements were demonstrated to the Russians on actual HEU weapons components from dismantled U.S. nuclear weapons. First, the U.S. demonstrated portable sodium iodide (NaI) non-destructive assay equipment to confirm the presence of HEU in a sealed storage container holding a HEU weapon component removed from a dismantled U.S. nuclear weapon. Second, the U.S. side successfully demonstrated, on sealed storage containers holding HEU weapons components removed from dismantled U.S. nuclear weapons, the Nuclear Weapon Identification System (NWIS) to confirm that the contents of a sealed storage container containing a U.S. HEU weapon component are identical to the contents of another sealed storage container containing a similar HEU component.

In December 1996, U.S. technical experts visited Seversk (Tomsk-7) for a reciprocal familiarization visit. In particular, the Russians demonstrated a sodium iodide (NaI) radiation measurement to measure the enrichment of a Russian HEU weapons component from a dismantled Russian nuclear weapon in a sealed storage container.

HEU PURCHASE AGREEMENT TRANSPARENCY MEASURES

On February 18, 1993, the U.S. signed an agreement with Russia to purchase up to 500 metric tons of highly enriched uranium from dismantled former Soviet nuclear weapons. The HEU Government-to-Government Agreement also required that transparency measures be implemented in the U.S. and Russia to provide confidence that the arms control and nonproliferation objectives of the Agreement were met. Specifically, transparency measures were required to provide confidence that:

- Highly enriched uranium was extracted from dismantled Russian nuclear weapons;
- Highly enriched uranium was blended down to low enriched uranium in Russia; and,
- Low enriched uranium shipped to the United States was fabricated into fuel assemblies for use in commercial power reactors.

To date, fifteen technical transparency annexes that govern the monitoring activities at U.S. and Russian facilities have been signed over the course of five Transparency Review Committee meetings. At the fifth session of the Transparency Review Committee in Moscow in December 1996, the Russians agreed to significantly expand U.S. monitoring activities at the three Russian facilities subject to the Agreement.

As a result, at the Siberian Chemical Enterprise (SChE) at Seversk, U.S. technical experts currently have the right to:

- observe HEU weapons components in sealed containers, that are shipped to Seversk from Russian dismantlement facilities, being received and stored
- request and observe nondestructive assay (NDA) measurements being performed on sealed containers of Russian HEU weapons components to independently confirm the enrichment of uranium
- request and observe NDA measurements being performed on sealed containers of HEU metal shavings from weapons components
- request and observe NDA measurements being performed on HEU oxide containers prior to shipment to the Russian blending facilities at Novouralsk and Zelenogorsk.
- obtain copies of relevant shipping and material control and accounting documentation.

Thus, the U.S. currently has the right to routinely observe *unclassified* radiation measurements being performed on HEU weapons components in sealed containers at Seversk. The NDA equipment is commercially available Canberra equipment that includes a sodium iodide detector. The U.S.-supplied NDA equipment has been licensed and certified for use at Seversk by Russian authorities. Such unclassified radiation measurements on HEU weapons components could be an important element or building block of a warhead dismantlement transparency or verification regime.

PANTEX PLANT MEDIA DAY

One of the most significant changes that has taken place over the past several years is the cultural change with regard to openness at the Pantex Plant. Prior to 1993, Pantex was very limited in its public declarations of functions and missions. However, because of former Secretary of Energy O'Leary's openness initiative, Pantex significantly changed its relationship with the public in 1993. Since 1993, Pantex has conducted an annual event called "Media Day," where members of the press are invited to tour the facility and are briefed on plant operations. In 1994, Media Day became "International Media Day" and representatives from all U.S. national broadcast and print media as well as representatives from the foreign media were invited to participate. In addition to Media Day, Pantex has also conducted public tours of limited areas of the plant. These public tours were conducted weekly from January 1993 until October 1996 for the public who were citizens of the United States. In September 1995, Pantex also had its first ever family day where family members of Pantex workers were invited to visit the plant.

During Media Day, tours are given of a linear accelerator facility, gas analysis laboratory, Zone 4, a bay and a cell in Zone 12, the high-explosive firing site, the DOE Transportation Safeguards Division Pantex operations, and a windshield tour of the facility. However, it is important to note that current regulations require that normal operations at Pantex be shut down during such tours. During these tours the media are presented information on and have access to unclassified information related to:

- Radiographic procedures used to check the condition of weapon components before disassembly
- Leak-check procedures, also used to check the condition of weapon components
- Several different types of weapons trainers
- Representative steps in the disassembly of a weapon, using a weapon trainer
- Pit packaging
- A demonstration of the Stage Right system for storage of pits in Zone 4

AGREEMENT FOR COOPERATION

One of the other most significant changes over the past few years is that the United States and Russia now have the legal mechanism by which to exchange sensitive and classified information for the purpose of arms control and nonproliferation. In 1994, Congress acknowledged the difficulty imposed on further transparency and arms control agreements by the necessity to discuss classified, and in particular Restricted Data, information. As a result, Congress amended the Atomic Energy Act of 1954 to allow the reciprocal sharing with a treaty partner, under an Agreement for Cooperation, of Restricted Data information for the purpose of arms control and nonproliferation. An Agreement for Cooperation has yet to be completed with the Russian Federation. However, the possibility for such an agreement in itself has significantly altered the possible approaches to warhead dismantlement transparency and verification.

SUMMARY

All of these recent activities in the arms control policy arena contributed to the decision to undertake the current study of the options for warhead dismantlement monitoring and their effect on the DOE weapons complex. The three most significant changes that have taken place over the past several years are:

- *unclassified* radiation measurements are routinely performed on Russian HEU weapons components in sealed containers as part of the expanded HEU transparency measures;
- the greatly increased level of openness in U.S. dismantlement activities at the Pantex Plant; and,
- a new legal mechanism to exchange classified information to support arms control and nonproliferation initiatives with the Russian Federation.

As a result of these changes, an update of previous warhead dismantlement monitoring studies was required in order to prepare the U.S. for a possible warhead dismantlement monitoring regime as part of a START III treaty.