I. OVERVIEW

There is increasing interest in both the United States and the Russian Federation in further nuclear warhead reductions beyond START I and START II as well as in the need to monitor nuclear warhead inventories, nuclear warhead dismantlement, and fissile materials resulting from warhead reductions. This interest was evidenced by the Joint Statement issued by Presidents Clinton and Yeltsin at their March 21, 1997, Helsinki Summit, as follows:

> "Once START II enters into force, the U.S. and Russia will immediately commence negotiations on a START III agreement, which will include *inter alia:*
>
> - *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."*

Any treaty involving the monitoring of nuclear warheads, nuclear warhead dismantlement, and stockpiles of fissile materials will have a significant impact on DOE. By Presidential order, DOE has the nation's responsibility to maintain a safe, secure, and reliable nuclear warhead stockpile and to ensure that excess nuclear warheads are dismantled safely in accordance with arms control requirements.

In anticipation of such an agreement requiring further warhead reductions and the monitoring of warhead dismantlement, the DOE Office of Arms Control and Nonproliferation commissioned a technical study in the Fall of 1996 to determine what transparency and verification options could be implemented at DOE facilities to monitor warhead dismantlement. This report provides the results of that study. This study was not intended to answer all of the possible questions associated with a START III monitoring regime but rather to initially focus on the following key questions related to warhead dismantlement monitoring options at DOE facilities:

- *How can the rate of dismantlement be monitored in the event that a START III treaty requires that a specific quantity of warheads be dismantled in a specific period of time?*

- *Does a warhead dismantlement monitoring regime require an Agreement for Cooperation to exchange Restricted Data (RD) and Formerly Restricted Data (FRD)?*

- *Can the dismantlement of a specific type of warhead be confirmed and can the dismantlement of a strategic versus tactical warhead be confirmed by implementing monitoring measures only at DOE facilities, or must Department of Defense (DoD) facilities be involved as well?*

To assist in this study, DOE established a Dismantlement Study Group that included technical experts from the Office of Arms Control and Nonproliferation, the Office of Defense Programs, the Office of Security Affairs, Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Pacific Northwest National Laboratory, Sandia National Laboratories, the Pantex Plant, and the Oak Ridge Y-12 Plant. The list of participants in the Dismantlement Study Group is provided in Appendix A.

A nuclear warhead generally consists of an assembly containing a "pit," a Canned SubAssembly (CSA), high explosive (HE), and other non-nuclear components. As defined by DOE, the warhead dismantlement process, which includes activities that occur at the Pantex and Y-12 facilities, involves the storage of nuclear warheads, onsite transportation, warhead disassembly, plutonium (Pu) and highly enriched uranium

(HEU) component storage, and non-nuclear component disposition. A warhead is considered to be fully dismantled when the HE is removed from the "pit." After dismantlement takes place, the "pits" are stored at Pantex in Zone 4 and the CSAs are shipped to the Oak Ridge Y-12 Plant for disassembly and storage. The "pits" stored at Pantex await future disposition, which is beyond the scope of this study.

This study focused on potential warhead dismantlement monitoring procedures that could be implemented in the DOE nuclear weapons complex, particularly at the Pantex Plant and the Oak Ridge Y-12 Plant. The study group concluded that there may be some significant advantages in using a dedicated dismantlement facility such as the Device Assembly Facility (DAF) at the Nevada Test Site as a means of minimizing both the disclosure of sensitive information and the impact on stockpile surveillance and maintenance activities at Pantex. Therefore, the study group concluded that a separate, in-depth analysis should be performed to fully evaluate the cost, schedule, and impact issues associated with the use of a dedicated dismantlement facility.[1]

The study addressed both ***transparency*** and ***verification*** options that could be implemented in the DOE nuclear weapons complex. For the purposes of this study, transparency and verification are distinguished as follows:

- **Transparency:** measures that provide *confidence* a declared activity is taking place.
- **Verification:** measures that *confirm* a declared activity is *actually* taking place.

The study did not focus on potential monitoring procedures that could be implemented at Department of Defense (DoD) facilities, where nuclear warheads declared to be excess and awaiting dismantlement are stored prior to being transported to Pantex. However, the study group concluded that an analysis of potential monitoring procedures at DoD facilities should be undertaken as part of any follow-on work.

This study also did not address in detail potential monitoring procedures that could be implemented at Russian facilities. The study group concluded that it was prudent to first determine the options for warhead dismantlement monitoring in the U.S. before analyzing potential warhead dismantlement monitoring options that could be implemented in the Russian nuclear weapons complex. Having completed an evaluation of options for warhead dismantlement monitoring in the U.S. nuclear weapons complex, the study group concluded that a follow-on study should be undertaken to address the issues associated with implementing a warhead dismantlement monitoring regime in Russia. Such a follow-on study should particularly address the significant asymmetries that exist between the U.S. and Russian nuclear weapons programs.

In considering the possible monitoring options or scenarios, many of the monitoring *activities* are largely facility-independent—that is, the options might employ, for example, monitoring of weapons receipt and storage areas, or weapons disassembly areas, which in general terms would be common to either a U.S. or Russian dismantlement facility. It is the *implementation* of the warhead dismantlement monitoring options that would be facility-specific.

The study group identified ten (10) key activities listed below that could be used as part of a warhead dismantlement monitoring regime. They are general in nature and may be applied to the monitoring of warhead dismantlement at a U.S. dismantlement facility, to the disassembly of CSAs at the Oak Ridge Y-12 Plant, or to the monitoring of warhead dismantlement at a Russian dismantlement facility. For illustration, these ten activities are referenced to the applicable Pantex Plant zones in parentheses.

[1] The December 1993 Wilson Report (see Appendix C) concluded that the use of a dedicated dismantlement facility such as the DAF could reduce the risk of disclosing sensitive information and the impact on non-dismantlement operations. Since 1993, DOE has accomplished a significant amount of work in completing the DAF construction and the DAF is scheduled to have its Operational Readiness Review in the Summer of 1997. Given these changing circumstances, an updated report on the use of DAF in a START III transparency regime should be undertaken.

The ten monitoring activities are:

- Declarations of dismantlement schedules, warheads, and components resulting from the dismantlement process;
- Spot checks of the weapons receipt and storage areas and component storage areas to confirm the declarations, including the use of radiation signatures of the weapons and components (*Zone 4 at Pantex*);
- Remote monitoring of the weapons receipt and storage areas and component storage areas (*Zone 4 at Pantex*);
- Chain-of-custody of warheads and components from the storage areas to the dismantlement areas (*from Zone 4 to the gate of Zone 12 at Pantex*);
- Portal Perimeter Continuous Monitoring (PPCM) to inspect every item that passes in and out of a segregated portion of the dismantlement area (*inside Zone 12 at Pantex*);
- Chain-of-custody of warheads and components within the dismantlement area (*inside Zone 12 at Pantex*);
- Sweeping or sanitizing a disassembly bay or dismantlement cell periodically before and after dismantlement (*inside Zone 12 at Pantex*);
- Remote monitoring or direct observation of the dismantlement process (e.g., during the disassembly of the physics package and during the removal of the high explosive from the pit) (*inside Zone 12 at Pantex*);
- Chain-of-custody of nuclear components from the dismantlement areas to the component storage areas after dismantlement (*from the gate of Zone 12 back to Zone 4 at Pantex*); and
- Monitoring of the disposition of the nonnuclear components of the warhead, such as the high explosive and warhead electronics, after dismantlement.

After careful consideration of the details of current Pantex and Y-12 operations, and as a result of the significant cultural changes regarding openness at the DOE and at the Pantex and Y-12 Plants during the past four years, the study group concluded that all of the ten monitoring activities listed above could be applied at either the **Unclassified to Confidential National Security Information (U to C/NSI)** level or at the **Restricted Data (RD)/Formerly Restricted Data (FRD)** level. The monitoring activities cannot be completely implemented on the unclassified level because some of the activities include monitoring the movement of weapons and components. Under current classification guidelines, dates and times of movements of weapons and components outside a protected area are classified as C/NSI. The study group also concluded that the confidence in each monitoring activity would depend critically on which classification level was chosen, with higher classification levels generally yielding higher confidence in warhead dismantlement.

In addition, the study group concluded that, ***assuming the item arriving at the dismantlement facility is a nuclear weapon***, either warhead dismantlement transparency or verification ***can be achieved*** through various combinations of the ten monitoring activities, with confidence that increases at higher classification levels.

The study group identified four options for discussion based on the ten monitoring activities listed above, ranging from monitoring only the warhead and component storage area (Option 1), to highly intrusive monitoring of the actual dismantlement process in the dismantlement area (Option 4). Each option is general and may be applied to the monitoring of warhead dismantlement at a U.S. dismantlement facility, to the disassembly of CSAs at the Oak Ridge Y-12 Plant, or to the monitoring of warhead dismantlement at a

Russian dismantlement facility. For illustration, the four options are stated here in terms of application to Pantex. Application to a Russian facility would require additional information concerning the Russian nuclear weapons program. The four options chosen for discussion are:

Option 1: Monitoring of warheads and components in the storage area (*Zone 4 at Pantex*) and chain-of-custody monitoring to and from the gate to the dismantlement area (*Zone 12 at Pantex*).

Option 2: Option 1 *plus* portal perimeter continuous monitoring (PPCM) of a segregated portion of the dismantlement area (*inside Zone 12 at Pantex*) dedicated to monitored dismantlement.

Option 3: Option 1 *plus* further chain-of-custody procedures to monitor warheads and components within a segregated portion of the dismantlement area (*inside Zone 12 at Pantex*) and to and from the disassembly bays and dismantlement cells (without PPCM).

Option 4: Option 3 *plus* direct observation or remote monitoring of the dismantlement process (*inside Zone 12 at Pantex*).

Each of the four options was evaluated against the following seven evaluation criteria:

- **Level of confidence**—the level of confidence that dismantlement has taken place provided by each option.
- **Negotiability**—a judgment of the relative ease with which the transparency or verification option may be accepted by the Russian Federation.
- **Inadvertent loss of classified information**—the possibility that a Russian inspector, by being present at a dismantlement facility, could either accidentally or intentionally gain access to classified information not intended to be shared with the inspectors.
- **Impact on operations**—the disruption to ongoing operations at Pantex or Y-12 unrelated to the dismantlement of excess nuclear weapons, such as stockpile surveillance and maintenance activities.
- **Operational readiness**—the time needed to be ready for Pantex or Y-12 to host inspections, including the time required for construction and physical modifications, if needed.
- **Cost to prepare for and host the first inspection**—including any physical or procedural modifications that would need to be made to prepare for and host the first inspection.
- **Routine cost of hosting each inspection**—the recurring cost of each routine inspection after the initial inspection.

ASSUMPTIONS

Several general as well as specific assumptions were made by the study group. However, it should be noted that the four options listed above were designed to be flexible enough to accommodate changes to the specific assumptions described below. If—as part of the U.S. interagency deliberations—it became necessary to change the specific assumptions so that, for example, the duration and number of inspections per year were increased, the model that was developed would be able to generate a revised analysis of the impacts of the new assumptions on the overall cost, level of confidence, etc. Thus, even though we have hypothesized for purposes of analysis that, for Options 1, 3, and 4, there would be twelve inspections per year, these assumptions can easily be varied to accommodate changes in U.S. policy.

General Assumptions

- For the purposes of this study, it is ***assumed*** that the object arriving at Pantex to be dismantled is ***actually*** a nuclear warhead.
- Warhead dismantlement monitoring procedures would only be applied to warheads declared to be *excess* to national security requirements, and no longer required as part of the existing nuclear warhead stockpile.
- Issues associated with the ***"irreversibility"*** of the fissile materials in storage and the disposition of fissile materials are beyond the scope of this study.
- The problem of the ***"initialization"*** of the size of U.S. and Russian stockpiles of warheads and fissile material is beyond the scope of this study.
- Stockpile surveillance activities and other activities required to maintain the enduring stockpile would ***not*** be subject to monitoring procedures.
- Segregated, dedicated magazines in Zone 4 at Pantex and segregated, dedicated disassembly bays and dismantlement cells in Zone 12 at Pantex will be used for the storage and dismantlement of excess warheads and components covered in a START III treaty. (Facilities represented in the graphics illustrating the options which follow are included for cost estimating purposes only. The actual magazines, bays, cells, etc. used in a warhead dismantlement monitoring regime may differ from those illustrated.)

Specific Assumptions

The following specific assumptions were used ***only*** for the purposes of generating cost estimates. A complete listing of all specific assumptions used for cost-analysis purposes is included in Appendix F.

- Options 1, 3, and 4 would allow a discrete number of inspections per year (e.g., up to 12 inspections per year).
  - Each inspection would have a relatively short duration (e.g., up to 5 working days).
  - Each inspection team would consist of a relatively small number of inspectors (e.g., up to 10).
- Options 2, 3, and 4 would be applied in the same segregated, dedicated portion of the dismantlement area (Zone 12 if implemented at Pantex).
- Option 2 would require that inspectors be continuously present at the dismantlement facility.

DESCRIPTION OF OPTIONS

Option 1: Monitored Storage

Option 1 involves declarations of the dismantlement schedule and inventories of warheads and components resulting from dismantlement as well as spot checks to confirm those declarations. Option 1 would be applied to monitoring the storage of warheads and components coming from dismantled warheads in the Zone 4 storage area at Pantex and HEU from CSAs if implemented at the Oak Ridge Y-12 Plant. This *monitored storage option* is designed to be a minimally intrusive option that includes following the warhead to the gate of the dismantlement or disassembly area (Zone 12 at Pantex) but does not provide access to the dismantlement area itself, where actual dismantlement of the warhead takes place. This option provides the lowest confidence level of all four options considered in this report that dismantlement has taken place, since the other options build upon this one. Figure 1 shows the areas in red that inspectors would have access to under Option 1 if implemented at Pantex.

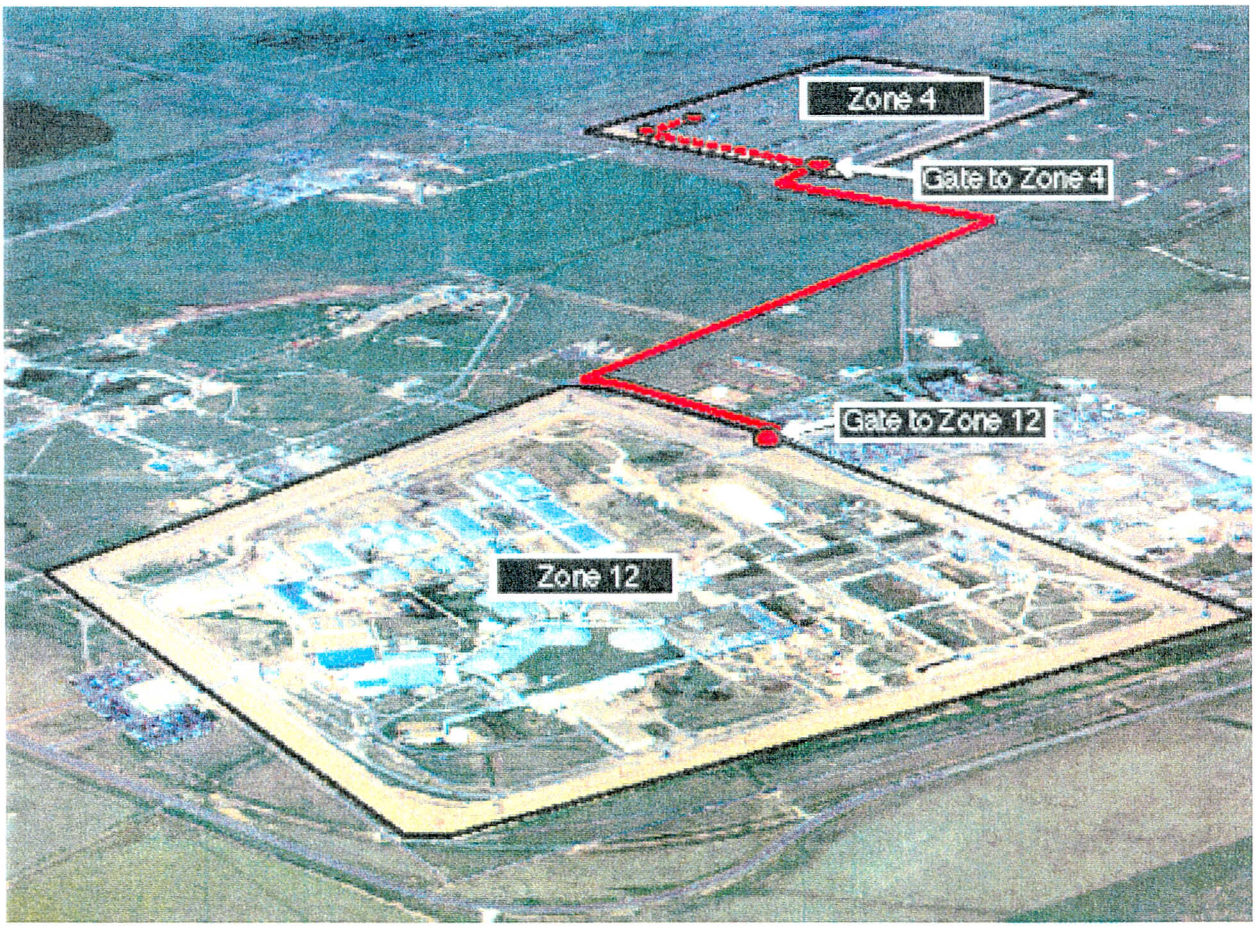

Figure 1: Pantex Access Areas Covered under Option 1.

Option 2: Option 1 *Plus* Portal Perimeter Continuous Monitoring

Option 2 is intended to produce higher confidence in dismantlement than Option 1 but without direct observation of the dismantlement process (Option 4) or the need for chain-of-custody within the dismantlement area (Option 3). In addition to monitored storage, Option 2 would establish Portal Perimeter Continuous Monitoring (PPCM) of a segregated portion of the dismantlement area (inside Zone 12 at Pantex) dedicated to monitored. The study group considered establishing PPCM around the entire dismantlement area but concluded—as did previous studies—that this would be extremely intrusive and costly because it would require that ***all*** items entering and leaving the dismantlement area would be subject to search. This would result in an unintentional loss of information regarding the enduring stockpile because warheads returned to Pantex and CSAs returned to Y-12 for retrofitting or testing as part of the Stockpile Stewardship Program would be subject to inspection and potential radiation measurements. Implementation of PPCM around a segregated, dedicated portion of the dismantlement area (inside Zone 12 at Pantex) would have a significant impact on current Pantex and Y-12 operations, and would require a one-time investment for facility modification of $12 million or more. Following the initial significant impact on plant operations of segregating and dedicating an area, Option 2 would provide a moderate to high level of confidence that dismantlement is taking place, depending on the classification level chosen, at a relatively low impact on normal operations both in the segregated, dedicated portion of the dismantlement area and in the remainder of the dismantlement area. Figure 2 shows the areas in red to which inspectors would have access under Option 2 if implemented at Pantex.

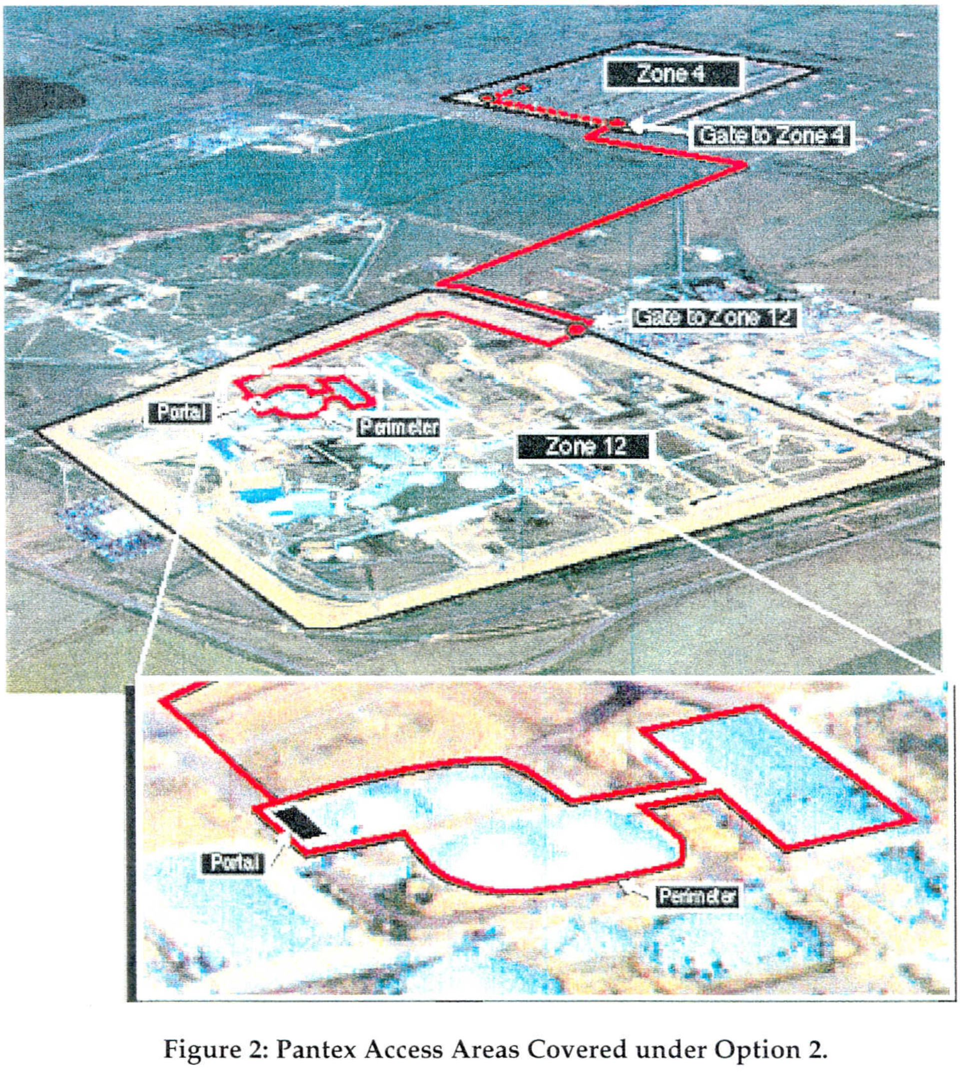

Figure 2: Pantex Access Areas Covered under Option 2.

Option 3: Option 1 *Plus* Chain-of-Custody from Monitored Storage to and from the Dismantlement Bay or Cell

In addition to declarations and spot checks to monitor the warhead receipt and storage area and the component storage area (as in Option 1), Option 3 provides a direct and continuous chain-of-custody from arrival and storage of the warhead at Pantex (or CSA at Y-12) in the storage area to and from dedicated dismantlement bays and cells in the dismantlement area. Option 3 does **NOT** include PPCM as does Option 2. Instead, in Option 3, the warhead can be followed up to a dedicated bay for mechanical disassembly and then to a dedicated dismantlement cell where the physics package is taken apart and the high explosive is removed from the pit (at Pantex) or to the area where CSAs are separated into components (at Y-12).

In Option 3, inspectors would have the right to sweep or sanitize the bays and cells before and after disassembly to determine there are no nuclear components or undeclared entrances and exits in the bay or cell. In addition, inspectors would have the right to examine the declared warhead or CSA in the staging area outside of the bay or cell and confirm that it is the object of inspection using radiation signatures and tags and seals. The warhead is then taken into the bay or cell to be taken apart and separated into its key parts (pit, CSA, high explosive, and other non-nuclear components), or the CSA is taken into an area without inspectors present and disassembled. When the nuclear and non-nuclear components are removed from the bay or cell, the inspectors could perform additional radiation measurements on each container leaving the cell to confirm the absence or presence of fissile material, and/or conduct radiation signature measurements to determine whether the components are actually *from* the declared warhead or CSA. Figure 3 shows the areas in red that inspectors would have access to under Option 3 if implemented at Pantex.

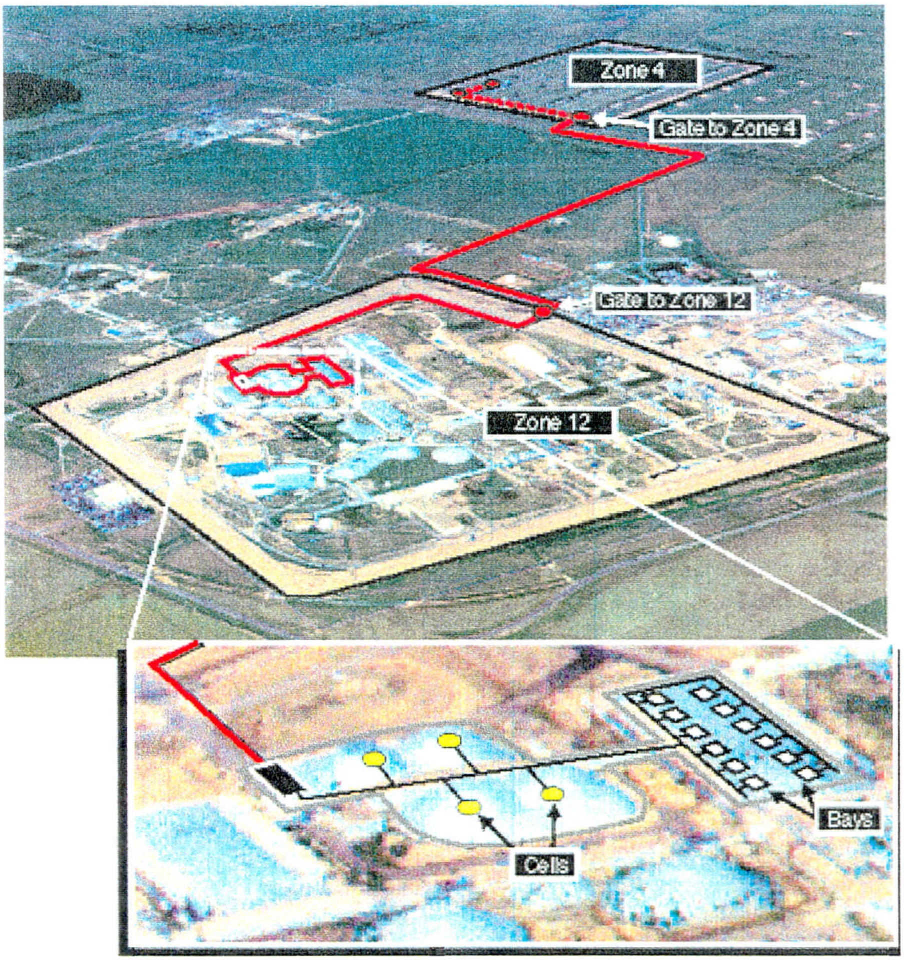

Figure 3: Pantex Access Areas Covered under Option 3.

Option 4: Option 3 *Plus* Direct Observation or Remote Monitoring of the Dismantlement Process

Option 4 includes all of the steps in Option 3 but also allows direct observation or remote monitoring of the dismantlement process in the bays and cells. In some special cases, such as the case of the gravity bombs (e.g., B61), observation of the mechanical disassembly process in a *bay* at Pantex (when the warhead is separated into three parts: front section, center section, and rear section) could be performed at the Unclassified to C/NSI level, with some masking of the disassembly process. However, for all warheads, observation of the disassembly of the physics package in a *cell* is classified as Restricted Data, unless extensive and costly masking of classified information and parts is done to allow unclassified observation of the dismantlement process. Similarly, observation of the actual disassembly of a CSA at Y-12 is classified as Restricted Data without extensive masking.

Direct observation of the dismantlement process, therefore, would generally reveal Restricted Data information and would require an Agreement for Cooperation, assuming the U.S. and the Russian Federation were willing to exchange such sensitive information with each other. However, remote observation of the dismantlement process by using a video camera could, in principle, be done at the unclassified level if classified details are masked. Figure 4 shows the areas in red to which inspectors would have access under Option 4 if implemented at Pantex.

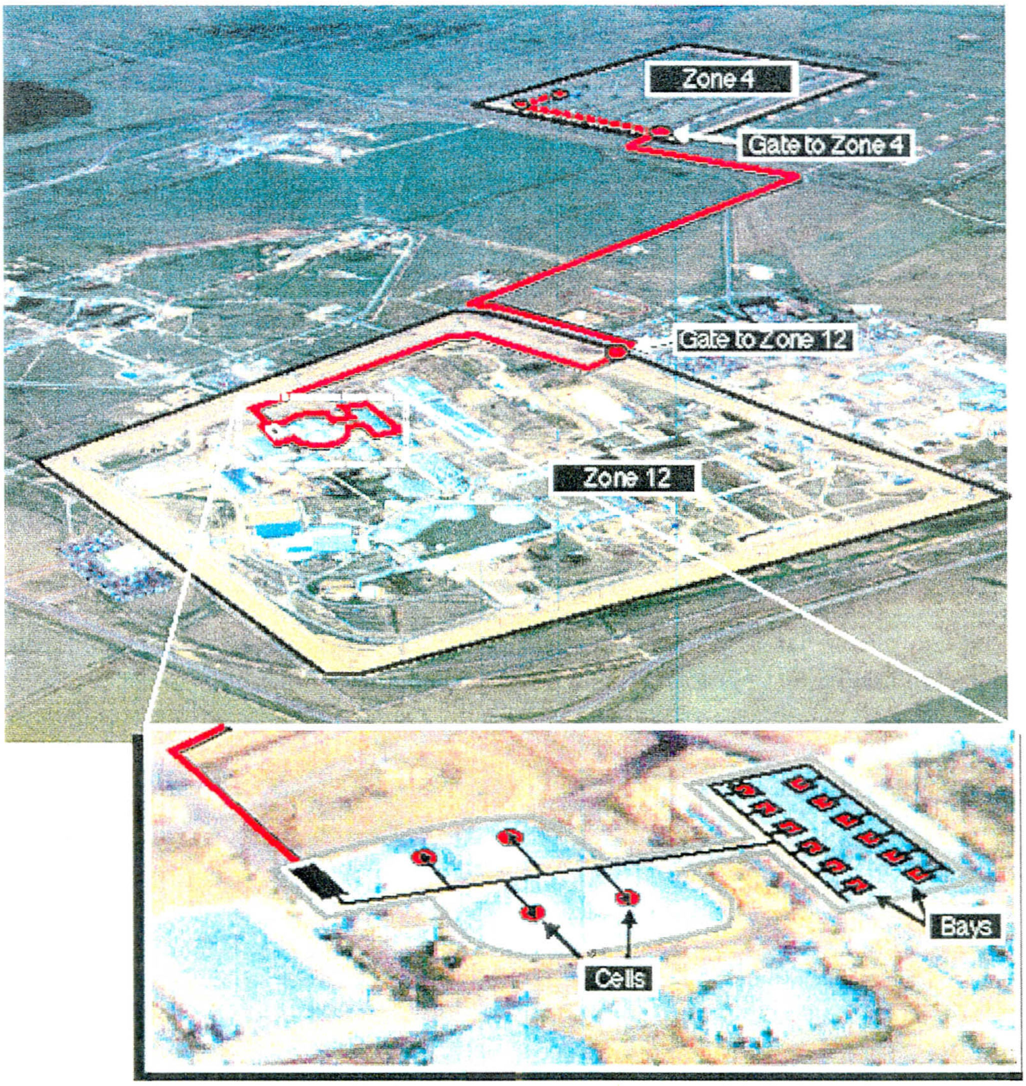

Figure 4: Pantex Access Areas Covered under Option 4.

Each of the four warhead dismantlement monitoring options was evaluated against the seven criteria previously mentioned. With the exception of three of the criteria—operational readiness, cost to prepare for the first inspection, cost of hosting routine inspections—a qualitative, as opposed to quantitative, analysis was conducted for the purposes of this report. An analysis of the other four criteria—level of confidence, negotiability, inadvertent loss of classified information, impact on operations—is essentially subjective. For criteria evaluated on a qualitative or subjective basis, the analysis includes either a low, moderate, or high rating. In some limited cases, an intermediate assessment of either low-to-moderate or moderate-to-high was used. The results of the analysis of the four dismantlement monitoring options considered in this report are summarized in Table 1.

Table 1. Summary of Options and Criteria

Option 1: Monitored storage
Option 2: Option 1 *plus* portal perimeter continuous monitoring of a portion of the dismantlement area
Option 3: Option 1 *plus* chain of custody from monitored storage to and from the dismantlement bay or cell
Option 4: Option 3 *plus* direct observation or remote monitoring of the dismantlement process in the bay or cell

		Confidence in Dismantlement	*Negotiability*	*Inadvertent Classified Information Loss*	*Impact on Operations*	*Operational Readiness* [1]	*Cost of First Inspection* [2]	*Routine Inspection Cost* [2,3]
Option 1	C/NSI	Low	High	Low	Low	1 year	$2.5 M	$0.12 M
	RD/FRD	Moderate	Low–Mod.	Low–Mod.	Low	1 year	$2.5 M	$0.12 M
Option 2	C/NSI	Moderate	Low	Low–Mod.	Moderate	2 years	$12.0 M	N/A[4]
	RD/FRD	High	Low	Moderate	Moderate	2 years	$12.0 M	N/A[4]
Option 3	C/NSI	Moderate	Moderate	Moderate	Moderate	1.5 years	$6.5 M	$0.2 M
	RD/FRD	Mod.–High	Low–Mod.	Mod.–High	Moderate	1.5 years	$6.5 M	$0.2 M
Option 4	C/NSI	Moderate	Low	High	High	2 years	$6.5 M	$0.2 M
	RD/FRD	High	Low	High	High	2 years	$6.5 M	$0.2 M

1 Operational readiness refers, for example, to the time required for construction and physical modifications. The time required for the SS-21 process would have to be incorporated into the declared dismantlement schedule.
2 Cost estimates are planning estimates only for Pantex and do not represent official estimates for budget purposes.
3 Routine inspection costs are shown for one inspection, but several such inspections would likely be performed each year.
4 Option 2 assumes permanent presence of inspectors at a cost of $5.5 million per year.

CONCLUSIONS

The following general conclusions were reached by the DOE study group:

- Any treaty involving the monitoring of nuclear warheads, nuclear warhead dismantlement, and stockpiles of fissile materials will have a significant impact on the DOE nuclear weapons complex.
  - Pantex is DOE's primary—and currently only—plant for performing warhead operations that support both the enduring stockpile and the dismantlement of excess warheads.
  - Consistent with Executive priorities, operations that support the enduring stockpile are given the highest priority while warhead dismantlements are performed in a safe, timely and efficient manner consistent with available resources.

- Both the requirement to dismantle additional warheads under a START III regime and the requirement to allow Russian inspectors to monitor, the dismantlement process will affect ongoing stockpile surveillance and maintenance activities.
  - The U.S. will therefore need to plan carefully to ensure that implementation of the START III requirement does not adversely affect the Presidential requirement to maintain a safe, secure, and reliable U.S. nuclear weapons stockpile.
- **Assuming that the item arriving at Pantex is a nuclear warhead**, either warhead dismantlement ***transparency*** or ***verification*** can be achieved by implementing the monitoring measures considered in this study.
- Determining that an item to be dismantled is ***actually*** a nuclear warhead is very difficult.
  - Radiation measurements (such as an x-ray or radiograph) of the container to confirm that the nuclear material in a storage container is in a configuration fully consistent with a nuclear warhead is highly intrusive and would reveal highly classified nuclear-weapons design information.
  - Such measurements would be too sensitive to be performed even if an Agreement for Cooperation were in place allowing the exchange of Restricted Data and Formerly Restricted Data with Russian inspectors because such measurements would reveal possible system vulnerabilities and/or advanced design technology.
- Determining that an item to be dismantled is ***actually*** a nuclear warhead may require both chain-of-custody procedures from DoD facilities (e.g., from a delivery vehicle, deployment site, or weapons storage depot) to the dismantlement facility and the use of warhead radiation signatures, other than an x-ray or radiograph, to determine a unique template of the warhead.
- As a result of the new openness that Pantex, Y-12, and DOE have experienced over the past four years, ***transparency*** measures for monitoring warhead dismantlement can be applied at Pantex with up to a moderate level of confidence that dismantlement has taken place if implemented at the Unclassified to C/NSI level.[2]
- V***erification*** of warhead dismantlement will likely require the exchange of Restricted Data or Formerly Restricted Data under an Agreement for Cooperation in order to confirm that dismantlement has taken place.
  - However, if warhead radiation signatures and templates are successful in correlating signatures from weapons and their components, it may be possible to confirm warhead dismantlement without needing an Agreement for Cooperation.[3]
  - As in the case of the November 1996 demonstration to the Russians at Oak Ridge on classified U.S. HEU weapons components, even though the actual template generated for each weapon or component is classified, it may be possible to compare a classified radiation signature of a warhead or component to that of a classified template of an identical warhead or component in an unclassified manner.
  - This can be done by comparing ***only the relative differences*** in each template or by normalizing the results of each measurement without actually revealing the details of the classified templates.

[2] Transparency measures cannot be implemented completely on the unclassified level because all options include monitoring the movements of weapons and components. Under current classification guidelines, dates and times of movements of weapons and components are classified as C/NSI.

[3] Under START I, the U.S. and Russia exchanged C/NSI data by having the President of the United States sign the treaty, in effect giving the treaty the force of an Executive Order. A START III treaty could use a similar mechanism to exchange C/NSI without requiring an Agreement for Cooperation.

- However, there will need to be extensive red-teaming of any candidate technologies to ensure that such measurements or comparisons do not reveal classified design information and to ensure that such measurements cannot be easily spoofed.
- Should the inadvertent loss or compromise of classified warhead information lead to identification of potential vulnerabilities associated with the existing stockpile, the loss in dollars would be significant and that loss could be coupled with significant safeguards and security concerns.
- Additional analysis will need to be conducted to address the problem of "authenticating" the measurement system to have confidence that what is being measured is actually a nuclear warhead.
- One approach to addressing the "authentication" problem could include performing measurements on unclassified plutonium and highly enriched uranium shapes and displaying the unclassified templates to Russian monitors to provide confidence in the integrity of the measurement methods.
- In the case of warheads mounted on delivery vehicles, it may be possible to ameliorate the "authentication" problem by validating the template when the warhead is in the custody of the DoD.
- Additional demonstrations on actual U.S. warheads should be performed to provide further empirical data to determine whether warhead radiation signatures can be applied in a warhead dismantlement regime.[4]

- The technical readiness or maturity of the technologies that would support the monitoring of warhead dismantlement is essentially the same for all four options considered in the study because all options include the use of radiation measurements.
  - As a result, technical readiness was not a discriminating criterion included in the analysis of the options.
  - The time needed to be ready to use radiation measurement technologies, including warhead radiation signatures, is at least one to two years.

- Transparency measures for monitoring warhead dismantlement can be applied at the Unclassified to C/NSI level with up to a moderate level of confidence that dismantlement has taken place for all of the weapons types currently scheduled for dismantlement in the near term, which include the following weapons programs:

- B53	- W56
- B61, Mod 5	- W69

- To meet the Helsinki Summit requirement to establish new, lower aggregate levels of 2,000–2,500 strategic nuclear warheads, dismantlement of strategic warheads currently in the U.S. active stockpile will need to take place. This could include dismantlement of some of the following strategic warhead systems:

- B61, Mod 7 and 11	- W76
- W78	- W80
- B83	- W87
- W88	

[4] In 1988, the Nuclear Weapons Identification System (NWIS) was demonstrated on a B83 warhead at Pantex to explore the concept of confirming dismantlement by correlating the signature of the warhead with that of its components. The Controlled Intrusiveness Verification Technology (CIVET) was demonstrated on three current warhead systems at a U.S. Air Force installation in 1994.

- If additional weapon reductions include elimination of an entire warhead type (e.g., the B83), then we can still reach the same conclusion that warhead dismantlement transparency measures can be implemented at the Unclassified to C/NSI level with up to moderate confidence that dismantlement has taken place.
  - By eliminating an entire warhead type, the security concerns posed to the enduring stockpile by performing radiation measurements may be reduced because the entire type will be dismantled.
  - However, the DOE study group strongly recommends that, due to potential design commonalities in various warheads, a thorough red-team and vulnerability analysis should be conducted to ensure that the risks associated with such measurements are fully understood.

- In the event that the provisions in a START III treaty require that the dismantlement of a portion of a particular warhead type remaining in the active stockpile be monitored (e.g., dismantle 50% of the W76s but retain the other 50% of the W76s as part of the enduring stockpile), then—
  - Transparency measures can still be implemented that provide up to moderate confidence that dismantlement has taken place on the Unclassified to C/NSI level.
  - Verification procedures involving the exchange of Restricted Data or Formerly Restricted Data could only be performed on such weapon types after a thorough security and vulnerability analysis has been conducted.
  - Under the condition that warheads in a monitored dismantlement regime represent warheads in the enduring stockpile, sharing Restricted Data would significantly increase the risk that potential vulnerabilities might be unintentionally revealed.
  - Members of the DOE study group expressed serious concerns that unless such measurements were thoroughly red-teamed, information could inadvertently be released that might identify potential vulnerabilities of these systems.

- In the event that the monitoring provisions in a START III treaty require that a specific quantity of nuclear warheads be dismantled, the rate of dismantlement and the number of warheads dismantled can be monitored by all four options because the accumulated data from declarations, spot checks, and confirmatory measures would allow the number of warheads and components resulting from dismantlement to be determined.
  - However, under Option 1, the rate of dismantlement and the number of warheads dismantled can only be determined if warhead radiation signature methods are successful in correlating warheads going into the dismantlement area and components coming out. This would detect the possible introduction of pre-existing components, which might be stored inside the dismantlement area, into the dismantlement stream.
  - The confidence in the quantity of warheads dismantled increases as the number of inspections per year increases, and is highest when the permanent presence of inspectors is allowed.

- Dismantlement of a specific type of warhead can only be verified in conjunction with collateral information obtained outside of Pantex.
  - Once a weapon arrives at Pantex for dismantlement, it may be possible that Pantex can provide a declaration of the specific type of warhead and allow a unique signature or template to be made of that ***declared*** type of warhead, assuming that such templates prove to be feasible.
  - However, the combination of these two measures is not sufficient to ***confirm*** that the declared warhead is in fact a weapon of that type.
  - Determination of a specific warhead type will require that the weapon be monitored before it arrives at Pantex for dismantlement (e.g., at a point of DoD custody).

- Similarly, a determination of strategic versus tactical nuclear warheads can only be made before the warhead arrives at Pantex for dismantlement.
  - Because strategic and tactical warheads are typically distinguished by warhead type, delivery system, and employment purpose, a determination of "strategic versus tactical" is linked to when the determination of a specific warhead type is made.
  - Because a determination of a specific warhead type can only be made in conjunction with collateral information obtained outside of Pantex, a distinction between strategic and tactical can only be made when the warhead is in DoD custody.