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VI. EVALUATION OF OPTIONS

In order to determine the relative merit of the options for warhead dismantlement monitoring, a set of criteria with which to evaluate these options was developed. After considerable discussion, the study group established the following seven criteria with which to evaluate the four dismantlement monitoring options:

- Level of Confidence
- Negotiability
- Inadvertent Loss of Classified Information
- Impact on Operations
- Operational Readiness
- Cost to Prepare for and Host the First Inspection
- Routine Cost of Hosting Each Inspection

These criteria cover the major points in determining the applicability of the various options to the problem of warhead dismantlement monitoring. A brief discussion of each of the evaluation criteria considered in this study follows.

A. DESCRIPTION OF EVALUATION CRITERIA

Level of Confidence

The first evaluation criterion is the level of confidence that dismantlement has taken place produced by each option. The level of confidence that a particular monitoring option provides that warhead dismantlement is actually occurring depends on the level of information obtained from that particular option and the ease with which that option can be spoofed. Short of direct observation or remote monitoring of dismantlement (Option 4), evaluation of confidence levels will always be somewhat subjective. However, the extended continuous application of any monitoring regime would result in an accumulation of data amenable to statistical analysis.

Negotiability

Negotiability is a judgment of the relative ease with which the transparency or verification option may be accepted by the Russian Federation. The evaluation of this criterion was based on knowledge of what the Russians have been willing to negotiate in recent agreements. Based on this experience, some elements of a monitoring regime, such as use of radiation measurements, may be easier to negotiate as part of a START III treaty, since they are already an accepted element of other U.S.-Russian agreements. However, some elements may be more difficult, such as continuous presence of inspectors and the exchange of sensitive nuclear weapons design information (such as Restricted Data), which the Russians have strongly resisted in previous negotiations. Exchange of such information would require an Agreement for Cooperation, and negotiation of such an Agreement could affect the time required for implementation of a warhead dismantlement monitoring regime.

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Inadvertent Loss of Classified Information

Each of the monitoring options discussed in the previous chapter can be conducted at the C/NSI or RD/FRD levels. The sharing of NSI with foreign inspectors could be accomplished under a General Security of Information Agreement or Executive Order. Under START I the treaty itself served as the instrument allowing the exchange of NSI. RD or FRD can only be shared with another country under an Agreement for Cooperation. In 1994 Congress amended the Atomic Energy Act of 1954 to allow an Agreement for Cooperation to be concluded with another country for the purpose of arms control and nonproliferation or for the verification of a treaty. Such an Agreement for Cooperation is under negotiation with the Russian Federation, but has not yet been concluded.

If the legal mechanism for the exchange of classified information were in place with the treaty partner, classified information could be exchanged as a result of the declarations that are a necessary part of each option, or during the monitoring process itself. Classified information could be exchanged in the form of written information related to dismantlement process descriptions, written records of process activities or inventories of warheads and components, or data obtained from measurements performed during spot checks, chain of custody radiation measurements, or portal perimeter monitoring inspections, etc. Classified information could also be exchanged by visual observation of classified aspects of the dismantlement facility, classified warheads and components, and classified activities during the dismantlement process.

It is important to distinguish between this intentional sharing of classified information and the unintentional, inadvertent loss of information not intended to be shared with the inspectors. Even the least intrusive monitoring options will have inspectors present at the U.S. dismantlement facilities, Pantex and Y-12. This presence, by its very nature, provides the possibility for the inspectors to gain classified information, either accidentally or by intentional acts of the inspectors. When inspectors are allowed access to an area that is used to perform classified operations or store classified material, or to observe a classified operation such as warhead dismantlement, the chance for the inadvertent disclosure of classified information exists. Inadvertent classified information loss could be limited by a thorough Red Team assessment of the proposed measures, extensive training of escorts and careful preparation of areas containing classified information for inspection.

Impact on Operations

The financial cost of altering operations at Pantex and Y-12 to accommodate warhead dismantlement monitoring activities is included in the cost analysis in Appendix F. However, it is important to consider the effect of the inspections in terms of the impact on all operations at the sites. It is anticipated that the major impact on operations will occur at Pantex, where inspections have the potential to affect not only the disassembly of warheads covered by a treaty, but activities related to maintaining the U.S. enduring stockpile as well. Therefore, the U.S. will 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 nuclear weapons stockpile. The impact on Y-12 operations of warhead dismantlement monitoring may be less than at Pantex, depending on the rate of disassembly of canned subassemblies at the time a treaty enters into force. As with inadvertent loss of classified information, it is difficult to quantify the impact on operations.

Operational Readiness

Operational readiness refers to the time that it would take to actually implement each warhead dismantlement monitoring option. It includes any facility modification or new construction which might be required, developing software to produce the appropriate declarations from the Pantex and Y-12 data bases, conducting the applicable nuclear weapon safety and security studies, training of site personnel, etc. The metric used for the evaluation of the operational readiness of each option is the time required, following entry into force of a monitoring agreement, to prepare a site to receive the first inspection. New construction

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to support the permanent presence of inspectors, as assumed for Option 2, is estimated to require two years from authorization of such construction. Direct or remote observation of dismantlement, as in Option 4, would require changes in the SS-21 (Seamless Safety for the 21st Century) procedures, which would also require a minimum of two years. Similarly, beginning dismantlement for a warhead type currently in the enduring stockpile would require at least two years for the SS-21 process before dismantlement could begin. However, the time period required for the SS-21 process, which is needed for every new type of warhead to be dismantled, would be built into the dismantlement schedule, and therefore is not included in the estimate of the time needed to be operationally ready for inspections.

Cost

The evaluation criteria applied to the warhead dismantlement monitoring options include the 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, and the routine cost of hosting each inspection—the recurring cost of each routine inspection after the initial inspection has taken place. The approach taken in this study to estimate the costs for each option was to use the Inspection Cost Analysis Model (ICAM). ICAM was developed by the DOE Office of Arms Control and Nonproliferation to assist in the planning and design of on-site inspection regimes and has been used extensively to prepare for Russian visits to DOE facilities, including the recent Russian visit to the Oak Ridge Y-12 Plant in November 1996. For the purposes of this study, both Pantex and Y-12 provided the necessary input data needed for ICAM to generate the cost estimates for each option. A detailed discussion of the cost analysis methodology for the warhead dismantlement monitoring options is included in Appendix F to this report.

B. ANALYSIS OF OPTIONS

Each of the 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 7 at the end of this section. A brief discussion of the evaluation of each of the options individually is provided below.

Option 1. Monitored Storage

		<i>Confidence in Dismantlement</i>	<i>Negotiability</i>	<i>Inadvertent Classified Information Loss</i>	<i>Impact on Operations</i>	<i>Operational Readiness</i>	<i>Cost of First Inspection</i>	<i>Routine Inspection Cost*</i>
Option	C/NSI	Low	High	Low	Low	1 year	\$2.5 M	\$0.12 M
1	RD/FRD	Moderate	Low-Mod.	Low-Mod.	Low	1 year	\$2.5 M	\$0.12 M

* Routine inspection costs are shown for one inspection, but several such inspections would likely be performed each year.

Option 1 is designed to have the least effect on the operations of the Pantex and Y-12 facilities. Monitoring activities at Pantex are limited to Zone 4 and up to the gate to Zone 12. Activities at Y-12 are limited to the receipt and storage areas for secondaries in building 9720-5 and to monitoring the right circular cylinders of HEU in tube vaults in building 9720-5. As a result of these limitations, the impact on Pantex and Y-12 operations is minimal, but Option 1 only provides a low level of confidence that warhead dismantlement is

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taking place at the C/NSI level, and a moderate level of confidence that warhead dismantlement is taking place if implemented at the RD/FRD level.

At the RD/FRD level, MRI-like measurements would be conducted in Option 1 on components in storage in Zone 4 coming from dismantled nuclear warheads. Since the MRI-like measurements will confirm that the contents of a sealed storage container are consistent in mass, isotopics, and shape with plutonium removed from dismantled nuclear warheads, the level of confidence increases over time from low to moderate as the quantity of components being monitored increases, if Option 1 is implemented at Pantex at the RD/FRD level.

The negotiability of the C/NSI version of Option 1 is high since it corresponds to a regime very close to those suggested by the Russians in other contexts. Negotiability falls to moderate or low for the RD/FRD version. In the past the Russians have shown a marked aversion to exchanging sensitive weapons design information and RD. However even with this reluctance to exchange RD the Russians would probably find a classified Option 1 preferable to any of the more intrusive options.

Because Option 1 is limited only to Zone 4 and terminates at the gate to Zone 12, the inadvertent loss of classified information is considered to be low at the C/NSI level. The possibility of loss of information increases to moderate at the RD/FRD level due to the possible loss of design information while making classified radiation signature measurements. The inadvertent loss of information as a result of radiation measurements being performed on warheads and components can be minimized by thoroughly red-teaming the proposed measurements in advance.

At all levels, the time needed for operational readiness is estimated to be only one year for Option 1. It is estimated that approximately six months are needed to generate the required declarations of warheads and components as well as the delivery and dismantlement schedules. However, up to one year is required to perform the necessary red-teaming activities, including the security and vulnerability analysis. Since Option 1 is confined to Zone 4 the impact on operations was considered to be low.

Option 2. Portal Perimeter Continuous Monitoring of a Dedicated Portion of Zone 12

		<i>Confidence in Dismantlement</i>	<i>Negotiability</i>	<i>Inadvertent Classified Information Loss</i>	<i>Impact on Operations</i>	<i>Operational Readiness</i>	<i>Cost of - First Inspection</i>	<i>Routine Inspection Cost</i>
Option 2	C/NSI	Moderate	Low	Low-Mod.	Moderate	2 years	\$12.0 M	N/A*
	RD/FRD	High	Low	Moderate	Moderate	2 years	\$12.0 M	N/A*

* Option 2 assumes permanent presence of inspectors at a cost of \$5.5 million per year.

Option 2 provides increased confidence that dismantlement is taking place without providing access to Zone 12 or allowing direct observation or remote monitoring of the actual dismantlement process. A highly effective regime of portal perimeter monitoring gives the inspection team the ability to monitor everything that enters or leaves the segregated area in Option 2. In addition, the segregated area of Zone 12 would be initialized by inspectors who are allowed to sweep the dedicated portion of Zone 12 one time at the inception of PPCM to ensure that a clandestine stockpile of components does not exist inside the dedicated area.

After initialization, the level of confidence that warhead dismantlement is taking place within this area is then tied directly to the intrusiveness of the measurements that the inspectors are allowed to make at the portal. Even when the inspectors are restricted to unclassified measurements, such as monitoring only the presence of weapons-grade plutonium and highly enriched uranium in warheads entering the portal and in containers exiting the portal, combining these measurements with the cumulative information gained from Option 1 produces a moderate level of confidence in Option 2 that warheads are being dismantled. At the RD/FRD level, by using MRI-like measurements to determine the isotopics, mass, and shape of the pits, the level of confidence increases over time from moderate to high as the quantity of components being monitored increases.

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Since PPCM requires the continuous presence of inspectors at the Pantex facility, the likelihood of the inadvertent loss of classified information is higher in Option 2 than for Option 1. Thus the likelihood of the inadvertent loss of classified information in Option 2 is low-to-moderate at the C/NSI level. This is due to the fact that, depending on the measures taken to minimize the loss of classified information, observation at the portal may reveal information concerning stockpile activities, such as retrofits or stockpile maintenance. Segregating a dedicated portion of Zone 12 would considerably reduce the risk of such inadvertent information loss. As with Option 1, the possibility of the inadvertent loss of additional classified information increases to moderate at the RD/FRD level due to the possibility of the loss of design information in the radiation signatures measurements. The probability of information loss is no higher in Option 2 than in options which introduce inspectors within the Zone 12 perimeter on a regular basis, such as Options 3 and 4.

Option 2 would have a larger impact on operations at Pantex than does Option 1 since a dedicated or segregated area within Zone 12 would need to be established. However, once the segregated area of Zone 12 is functional, the remaining activities at Pantex could continue in a relatively unimpeded manner. After segregation is complete, activity at Pantex can develop into a new "normal," with monitored dismantlement taking place in the segregated area and regular stockpile surveillance operations taking place in the rest of Zone 12. Thus, the impact on Pantex operations for all classification levels is considered to be moderate for Option 2, once the one-time transition to a dedicated dismantlement area for TLIs is accomplished.

Significant physical modifications of Zone 12 would be required to implement Option 2. Specifically, construction to segregate a portion of Zone 12, including the need to construct a fence around the segregated area, and the need to adjust internal routings within Zone 12, would be required. It is estimated that it would take up to two years to implement these physical modifications at Pantex.

Since the Russians have been very reluctant in the past to negotiate agreements which include permanent presence, the negotiability of Option 2 is considered to be low. Even though the Russians have agreed to such permanent presence arrangements previously, both at Votkinsk (now in Ukraine) for INF and at Novouralsk for the HEU purchase agreement, these negotiations were very difficult and required high-level intervention at the secretarial level on several occasions in order to ensure that the commitments to have permanent presence were implemented. It is anticipated that negotiating permanent access at the relevant Russian dismantlement facilities, which are considered to be among their most sensitive facilities, would likely be rejected by the Russian government, particularly by the Foreign Service Bureau (FSB).

Option 3. Chain-of-Custody from Storage to and from Dismantlement Bay or Cell

		<i>Confidence in Dismantlement</i>	<i>Negotiability</i>	<i>Inadvertent Classified Information Loss</i>	<i>Impact on Operations</i>	<i>Operational Readiness</i>	<i>Cost of First Inspection</i>	<i>Routine Inspection Cost*</i>
Option	C/NSI	Moderate	Moderate	Moderate	Moderate	1.5 years	\$6.5 M	\$0.2 M
3	RD/FRD	Mod.-High	Low-Mod.	Mod.-High	Moderate	1.5 years	\$6.5 M	\$0.2 M

* Routine inspection costs are shown for one inspection, but several such inspections would likely be performed each year.

In addition to monitoring the weapons receipt area and 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. Both before and after disassembly and dismantlement, inspectors have the right to sweep the bay and cell to ensure that there are no clandestine components in either the bays or cells. In some limited cases (such as during disassembly of the B-61s), inspectors would be allowed to observe the mechanical disassembly at the unclassified level in the dedicated bays with some minor shrouding of classified components. In addition, before a warhead enters the bay or cell, inspectors would have the right to perform radiation signature measurements to ensure that the warhead entering the bay or cell is the same warhead that left Zone 4.

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Following dismantlement, inspectors would have the right to conduct radiation measurements to correlate the signature of the components exiting the cell to that of the warhead that entered the bay or cell.

In both Option 1 and Option 3, the warhead and the components resulting from its dismantlement are followed through a limited chain of custody—to and from the entrance to the dismantlement area in Option 1, and to and from the dismantlement bay or cell in Option 3—and the available monitoring methods (e.g., radiation measurements, tags and seals) are much the same. The key difference between Option 1 and Option 3 is the ability of the inspectors, in Option 3, through sweeping of the bay or cell, to confirm that pre-existing components which might be stored inside the dismantlement facility are not inserted into the dismantlement stream. This addition to the preponderance of evidence indicating that dismantlement is taking place increases the confidence in dismantlement in Option 3 relative to Option 1.

Because inspectors would have access to Zone 12, Option 3 presents a higher risk of the inadvertent loss of classified information. Even with careful training of escorts and technical staff, as well as careful red teaming and attention to pathways and routings, it is estimated that the risk of inadvertent loss of information at all classification levels for Option 3 would be at least moderate. Again considering the higher risk associated with RD signature measurements the level of risk of information loss may rise to high for the RD/FRD level implementation of Option 3.

The types of measurements the inspectors are allowed to conduct as well as the level of information contained in the various declarations would depend on the classification level for Option 3. As a result of the recent openness initiatives and declassification rulings, monitoring of warhead dismantlement can be performed at the Unclassified to C/NSI level with a moderate level of confidence through the use of chain-of-custody and radiation measurement techniques. At the RD/FRD level, the level of confidence that dismantlement has taken place is considered to be moderate-to-high for Option 3.

It is estimated that about 1-1/2 years would be needed to operationally prepare Pantex to implement Option 3 because segregation of bays and cells, and possibly some physical construction, would be needed.

Similar to Option 2, Option 3 would have an initial impact on operations at Pantex because a dedicated or segregated area within Zone 12 would need to be established. However, once the segregated area of Zone 12 is functional, the remaining activities at Pantex can continue in a relatively unimpeded manner. Thus, the impact on Pantex operations for all classification levels is also considered to be moderate for Option 3.

Negotiability of Option 3, the relative ease of having the Russians accept this option, ranges from moderate for the Unclassified to C/NSI level to low-moderate for the RD/FRD level. Although the Russians would probably not want to allow U.S. inspectors in the Russian dismantlement areas they might find this option preferable to permanent presence.

Option 4. Direct Observation or Remote Monitoring of Dismantlement

		<i>Confidence in Dismantlement</i>	<i>Negotiability</i>	<i>Inadvertent Classified Information Loss</i>	<i>Impact on Operations</i>	<i>Operational Readiness</i>	<i>Cost of First Inspection</i>	<i>Routine Inspection Cost*</i>
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

* Routine inspection costs are shown for one inspection, but several such inspections would likely be performed each year.

Option 4 provides the highest level of confidence that nuclear warheads are being dismantled. However, it also results in the highest degree of intrusiveness. Option 4 encompasses all of the procedures in Option 3, with the exception that since there will be direct observation or remote monitoring of the dismantlement process, it is not necessary to sweep the bays and cells before and after dismantlement in Option 4.

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Since inspectors are allowed direct observation or remote monitoring of the actual dismantlement procedure, the possibility of the inadvertent release of classified information is high for Option 4 at all classification levels. This is particularly the case if remote viewing of the dismantlement process by television camera is conducted at the unclassified level. Although it is technically possible to distort the view enough to conceal the classified aspects of the dismantlement process, a thorough security review would need to be performed to ensure that the aggregate information revealed as a result of remote viewing of the dismantlement process is in fact unclassified.

The operational readiness of Option 4 is estimated to be approximately 2 years in order to implement any facilities modifications, such as installation of the remote monitoring equipment, as well as the training of dismantlement technicians. Also, it is estimated to take up to 1 year to conduct a thorough security review and fully assess the risk of allowing direct observation or remote monitoring of the actual dismantlement process. Finally, the impact on dismantlement operations at Pantex would be high because Option 4 allows direct observation of the disassembly and dismantlement process, which could affect operations in the bays and cells. Such intrusive monitoring could adversely impact both the process time and cycle time required to dismantle each warhead (see Table 5), which in turn would reduce the overall dismantlement rate at Pantex.

Negotiability of Option 4 is considered low for either classification level, given the anticipated Russian desire to protect sensitive warhead design information.

Table 7 presents a complete summary of the evaluation of the four options at the various classification levels.

Table 7. Evaluation of Warhead Dismantlement Monitoring Options

Option 1: Monitored storage

Option 2: Option 1 Plus Portal Perimeter Continuous Monitoring of a portion of Zone 12

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 Observation 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 RD/FRD	Low	High	Low	Low	1 year	\$2.5 M	\$0.12 M
		Moderate	Low-Mod.	Low-Mod.	Low	1 year	\$2.5 M	\$0.12 M
Option 2	C/NSI RD/FRD	Moderate	Low	Low-Mod.	Moderate	2 years	\$12.0 M	N/A ⁴
		High	Low	Moderate	Moderate	2 years	\$12.0 M	N/A ⁴
Option 3	C/NSI RD/FRD	Moderate	Moderate	Moderate	Moderate	1.5 years	\$6.5 M	\$0.2 M
		Mod.-High	Low-Mod.	Mod.-High	Moderate	1.5 years	\$6.5 M	\$0.2 M
Option 4	C/NSI RD/FRD	Moderate	Low	High	High	2 years	\$6.5 M	\$0.2 M
		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, and 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.

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