History of Dismantlement Studies

A. Bibliographic list

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Report to Congress, "Verification of Nuclear Warhead Dismantlement and Special Nuclear Material Controls (U)", Report Classification SRD, Department of Energy, DP-5.1-7375, July 1991, pp.90 (the 3151 Report).

"Verifying the dismantlement of nuclear warheads", Federation of American Scientists, Report Unclassified, June 1991, pp. 58.

C. Olinger, W.D. Stanbro, D.A. Close, J.T. Markin, M.F. Mullen and K.E. Apt, "Potential Transparency Elements Associated with Warhead Disassembly Operations at the Pantex Plant", Report Unclassified, Los Alamos National Laboratory, LA-CP-93-355, December 1992, pp.28.

S. Drell (Chairman) et.al., "Verification of Dismantlement of Nuclear Warheads and Controls on Nuclear Materials", Report Unclassified, JASON/MITRE, JSR-92-331, January 1993, pp.119 (the Jasons' report).

Rodney K. Wilson (editor), "Analysis of Potential Measures for Monitoring U.S. Nuclear Warhead Dismantlement (U)", Executive Summary, Volume II and Volume III, Report Classification SRD, Sandia National Laboratories Draft Report Numbers VST-049 and VST-050, October 1993, pp.6 (Executive Summary), pp.52 (Vol. II), pp.116 (Vol. III) (the Wilson report).

Rodney K. Wilson and George T. West, "Cooperative Measures for Monitoring U.S. Nuclear Warhead Dismantlement", Report Unclassified, Sandia National Laboratories, VST-051, July 1994, pp.90.

Summary of Previous Studies

1. "Nuclear Dismantlement Center (NDC) Alternatives Study (U)", Unclassified Summary of the Brown Report, PNL, November 1990.

In November, 1990, the Pacific Northwest Laboratory (PNL) led a multi-lab team (PNL, LLNL, SNL) that produced this report for the Division of Policy and Technical Analysis of DOE's Office of Arms Control. The report is classified and consists of two volumes and a separate executive summary. Volume 1 (168 pages) is the complete report and Volume 2 (322 pages) is a series of appendices that provides the background support for the analysis and conclusions in the report.

The purpose of the report was to identify and analyze potential issues important to the DOE should the President determine that future arms control agreements require the dismantlement of nuclear weapons. It

was not designed to identify dismantlement verification options. Issues identified and analyzed in the report include: 1) verification and monitoring; 2) safeguards and security; 3) risks to human health and safety; 4) economics; 5) public acceptance, institutional, and regulatory risks; and 6) co-location vs. separate dismantlement facilities.

Issues are identified for the six topical areas as functions of dismantlement approaches and dismantlement steps. Dismantlement approaches evaluated in the study include: 1) field demilitarization at the DoD site; 2) no action (business as usual); 3) declaratory; 4) bonded storage; 5) Intermediate-Range Nuclear Force (INF)-type; 6) dismantlement; and 7) SNM disposition.

The scope of the study is limited to the identification and analysis of key issues confronting DOE should the President determine that nuclear warhead dismantlement be included in future international agreements. The study does not address the question of whether U.S. policy should endorse nuclear warhead dismantlement or issues relating to warhead and SNM stockpile initialization.

The report's major conclusions are as follows:

- Verification/Monitoring - Sensitive information will be at risk for all verification approaches examined. Therefore measures will have to be taken to keep the classified information from being placed at risk by the arms-control-mandated process. The level to which this information is potentially revealed is strongly dependent on the dismantlement approach. Declaratory dismantlement and chain-of-custody approaches have the lowest risk, while direct observation and radiographic examination have a much greater risk.

- Safeguards and Security - Incremental risks to DOE's safeguards and security program will result from any of the proposed approaches. Current DOE safeguards and security programs need to be re-evaluated if warhead dismantlement becomes an accountable activity.

- Human Health and Safety - Potential incremental risks fall into three groups. There are risks associated with: 1) accidental nuclear detonation, 2) spread of plutonium, and 3) release of other hazardous substances. The incremental risks are due mostly to increased warhead handling, increased dismantlement operations, and increased warhead transportation.

- Economics - Cost factors are strongly dependent on the dismantlement approach and the details of the arms control agreement. Key factors affecting this analysis include time from agreement to implementation and use of current vs. dedicated facilities. Management of hazardous wastes generated by a large-scale dismantlement program must also be thoroughly evaluated.

- Public Acceptance, Institutional, and Regulatory Analysis - Public acceptance will likely depend on the type of facilities and operations, and can be greatly affected by the process used to select sites. Some dismantlement approaches will require resolution of regulatory issues involving NRC, EPA, and others.

- Co-location of Facilities vs. a Dedicated Dismantlement Center - This is a key issue. The decision made on this issue affects most of the others. The two key factors favoring co-location are short response time and low cost. The two key factors favoring a dedicated facility are lower security risks and an increased public perception of, and commitment to, arms control and nonproliferation.

The report provides a set of integrated recommendations for the next five years (now expired). Key recommendations included:

- Collect information regarding DOE's ability to respond to a treaty that mandates warhead dismantlement.

- Develop a site selection strategy.
- Develop a site-asset inventory for at least several DOE-owned sites.
- Determine special requirements, if any, that may exist with the tagging of nuclear warhead parts.
- Develop criteria for certifying that an accountable unit is indeed a real nuclear warhead.
- Continue to support development of methodology to assess the risks of disclosure.

2. "Verification of Nuclear Warhead Dismantlement and Special Nuclear Material Control, Executive Summary", Report to Congress, July 1991 (the 3151 report)

This is an unclassified executive summary of the report, with the same title, that was prepared in order to meet the requirements of Section 3151 of the National Defense Authorization Act of 1991, which mandates a report to the Congress on the on-site monitoring techniques, inspection arrangements, and national technical means (NTM) of verification that the United States could use to verify the actions of other nations with respect to:

- Dismantlement of nuclear warheads in the event that a future agreement between the US and the Soviet Union should provide for such dismantlement to be carried out in a mutually verifiable manner,
- A mutual US-Soviet ban, leading to a multilateral, global ban, on the production of additional quantities of plutonium (Pu) and highly-enriched uranium (HEU) for nuclear weapons,
- The end-use or ultimate disposal of any Pu and HEU recovered from the dismantlement of nuclear warheads

This report addresses on-site monitoring techniques, inspection arrangements, and NTM of verification that could be used to attempt to monitor compliance if a decision to pursue such arms control measures were made. The status, role, potential use, and possible further development of these verification techniques and inspection arrangements are examined. The report also identifies other impacts including the risk of compromising sensitive, nuclear-weapon-related information.

This report does not address the policy issue of whether it would be in the US national security interest to seek agreements with either the Soviet Union or other nations that would require the dismantlement of nuclear weapons, the disposition of the returned nuclear materials, and /or controls on the production of plutonium or HEU that could be used to build additional nuclear weapons. That issue can only be decided on the basis of strategic, military, and political judgments, including a net assessment of the objectives and capabilities of other nations relative to US security, which lie beyond the scope of this report.

This report, in keeping with the Congressional charter, emphasizes the technical monitoring and NTM techniques, and does not address in detail vulnerability of verification technology to cheating, potential cheating scenarios, etc.

The report points out, that if a proposed agreement provides for dismantlement of specified numbers of weapons or for specified reductions of Special Nuclear Materials (SNM) inventories, the following verification issues would need to be addressed:

- Actual and appropriate nuclear weapons are dismantled,
- Nuclear materials recovered from dismantled weapons are not used for prohibited purposes,
- Existing facilities and processing facilities are not used to produce prohibited materials or warheads,
- Clandestine/prohibited production and processing facilities do not exist.

Aside from the summary and introductory discussions, the main body of this Report to Congress is divided into a section covering general verification measures, and then three sections covering the primary topics of interest: verification of dismantlement, SNM controls/cutoff, and material disposition.

The report states that the warhead dismantlement process can be represented as three separate processes from a verification point-of-view.

- Warhead Identification - confirmation that the unit to be dismantled, in fact, is or contains a nuclear warhead (and perhaps a specific type of nuclear warhead) rather than a surrogate.
- Chain-of-Custody - verification that the unit identified as containing a warhead remains intact during transport from the site where identification took place to a dismantlement site and during any temporary storage. There must be assurance that the warhead was not removed and replaced by a surrogate during the transport and any temporary storage process.
- Dismantlement - disassembly of the warhead-containing system to the degree required.

The key observations made by this report concerning verification of warhead dismantlement are as follows:

- There is a high risk in disclosing sensitive information and such disclosures could reveal potential vulnerabilities of our nuclear forces or reveal design information.
- Determining the initial number of warheads that a side possesses at the time an agreement would enter into force would be an extremely difficult problem due to the ease of concealment and the paucity of external observables. Uncertainties in initial inventories would become more important as the size of the warhead stockpiles decreases.
- It might be possible to develop techniques that offer improvements in warhead identification with reduced risks of disclosing sensitive information.
- Chain-of-custody arrangements offer the possibility of verifying dismantlement with a lower risk of divulging sensitive information. For these possibilities, evasion scenarios must be carefully and thoroughly evaluated.
- In order to segregate new warhead production functions from dismantlement functions, modified or dedicated facilities, as well as new processes or procedures for carrying out warhead dismantlement in on-site inspection regimes, might have to be provided.

- The verified destruction of the non-nuclear parts of the dismantled warheads would have little arms control significance, since these parts could be reconstituted in a clandestine manner with only modest efforts and costs.

The key observations from this section of the report on the verification of SNM production control/cutoff are listed below:

- It would be extremely difficult to verify, without a significant margin of error, the size of the SNM stockpile that a side possesses at the time an agreement would enter into force.
- An integrated civilian/military material production complex, such as in the Soviet Union and other countries, would complicate the verification of the initial inventories of material available for weapons.
- In any agreement to limit production of SNM, verification would require monitoring of appropriate elements of the civilian fuel cycle.
- Tritium production reactors would also need to be monitored to foreclose the possibility of prohibited Pu production as well as the monitoring of other production and use of SNM.
- It would be very difficult to detect and identify production from undeclared uranium enrichment plants.
- The potential of new technology would open up significant new opportunities for SNM production with minimal observables.
- Benefits that could arise from monitoring of SNM include the opportunity for US on-site presence at Soviet facilities and an opportunity of strengthening commitments to the Non-Proliferation Treaty (NPT).

The key observations from the section of the report on the verification of SNM disposition are listed below:

- Most disposition options would be reversible at some cost.
- Down-blending HEU to LEU would significantly reduce the weapon utility of the material.
- The weapon utility of Pu can be significantly reduced by denaturing with other materials or by incorporating the material in a glass matrix. Both processes would require additional investments in costs and time for recovery and reuse.
- Options that return the SNM to non-weapons programs could cause an enlargement of the monitoring task and introduce concerns regarding protection of sensitive information.
- Long-term storage of material would likely be possible to monitor using standard safeguards technologies. The form and location of the material is critical in this disposition scenario, since the materials could be reused for military purposes in a short time.

3. "Ending the production of fissile materials for weapons. Verifying the dismantlement of nuclear weapons - the technical basis for action", Federation of American Scientists, June 1991

This study represents a joint effort between the Federation of American Scientists, the Committee of Soviet Scientists for Global Security and the Center for Program Studies of the USSR Academy of Sciences. Their objective was to outline the technical basis for a Soviet - US agreement to halt the production of fissile material for weapons and to verifiably eliminate retired warheads. Their underling concerns focus on two issues:

- Warheads associated with START and INF treaty eliminated nuclear delivery systems, and the fissile material that they contain are not constrained by treaty or agreement; therefore, there is great uncertainty about their disposition which may undermine the possibility of future reduction agreements. These warheads could be stored for possible rapid re-deployment or be recycled to increase the number of warheads available for uncontrolled or difficult-to-verify systems.

- The small but finite possibility that stored intact warheads might become targets for unauthorized use or subject to accidents.

Key study assumptions include:

- Both the US and Russia share a common interest in a bilateral agreement for a verified cutoff of the production of plutonium and highly enriched uranium for weapons.

- That an agreement on verifiable nuclear warhead dismantlement and disposal of associated fissile material would be ineffective if new fissile material production for weapons were unconstrained.

- Uncertainties in Russian and US knowledge about the sizes of each other's stockpiles are considerable but need not prevent either a halt in the production of fissile materials for warheads or a first round of stockpile reductions.

- In order to go beyond the first cuts of 50 percent or so, Russia and the US will want to have an improved idea of the sizes of each other's nuclear stockpiles.

The study's primary focus was on:

- A verified halt in the production of new fissile material for warheads. In this section, the study highlighted that verification would require reassurance that military production facilities are converted to safeguarded non-weapon uses or are shutdown, tritium production and naval propulsion reactors are not used to produce plutonium for weapons and the enriched uranium in their fuel cycles is not diverted to weapon use, and none of the enriched uranium or plutonium in the fuel cycles of civilian nuclear reactors is diverted to weapon production. In addition, the study addressed possible verification regimes for shutdown production facilities, the difficulties of effectively safeguarding naval reactor fuel cycles without releasing classified information about the fuel and reactor designs, highlighted the differences in the US/Russian civilian nuclear facilities and the strengths and weaknesses of the IAEA safeguards as related to verification, and attempted to dilute the concerns over clandestine production and breakout potential.

- Verified dismantlement of nuclear warheads and the safeguarded storage or non-weapon use of the highly enriched uranium and plutonium. Three basic approaches to stockpile reduction were proposed:

  — The verified dismantlement of agreed numbers and types of warheads and the placement of the recovered fissile material under safeguards for non-weapon use or disposal.

  — Transfer of agreed quantities of HEU and plutonium out of the control of the weapon complexes to safeguarded facilities for agreed uses or disposal.

  — A combination of both approaches.

For effective verification the study proposed tags and seals, portal-perimeter monitoring and intrinsic "fingerprints" of warheads, and safeguarding fissile material. Important to note is that dismantlement "would be done in privacy by the owning country in its own facilities." The study points out that the most difficult problem encountered in this approach would be to devise mutually acceptable approaches to verify the authenticity and intactness of the warheads being submitted for dismantlement.

Study recommendations are as follows:

- implement the joint Russian/US technical studies and demonstration projects that have been proposed by the US Congress,
- the placement of warheads to be retired in sealed, tagged containers,
- the verification of the shutdown status of plutonium production reactors and the placement under IAEA-type safeguards of key civilian nuclear facilities,
- warheads that are to be subjected to verified dismantlement should be stored at the likely location of the dismantlement facility and in a manner such that the integrity of the tags and seals can be periodically checked,
- elimination of unnecessary secrecy relating to past and present nuclear-weapon production activities especially by the Russian government.

It must be noted here that this study reaches the opposite conclusions regarding verification of the respective nuclear stockpiles and the concern over clandestine production as the "3151 Report."

4. "Potential Transparency Elements Associated With Warhead Disassembly Operations at the Pantex Plant", LANL, December 1992.

The objective of this Los Alamos study was to provide DOE with information necessary for policy formulation on the future course of transparency within the US nuclear weapons complex by identifying potential "transparency" elements that reflect nuclear warhead dismantlement operations at the Pantex Plant and assess the impact the elements would have on plant operations and the potential for loss of information. The main assumptions of this report are:

- The impact of transparency elements on plant operations (including environment, safety, and health, security, and dismantlement schedules) should be minimized,

- That limits will remain on the extent of sensitive information that might be declassified or accessed for transparency purposes.

The study addressed four broad categories of transparency elements and then performed an analysis using confidence, intrusiveness, impact on plant operations and costs as the evaluation criteria. The first category, Declaratory Elements, includes initial declarations, notifications and update declarations, hosted demonstrations, and access to management data bases, reports, and documents. Limited Independent Observations, the next category, limits either the amount of information revealed by observation or the frequency of observation. Elements include perimeter and physical plant infrastructure observations, monitoring the dismantlement support services such as training exercises, examination of disassembly products, and high explosive deliveries. The third category, Limited Independent Measurements, includes elements like independent portal monitors, SST loading, pit calorimetry, infrared imagery, aerial surveys, and analysis of effluent from High Explosive burning. The last and most intrusive category, Comprehensive Independent Observations or Measurements, would include short-notice inspections, independent intrinsic radiation measurements and direct observation of the dismantlement process. The general conclusions of the study are as follows:

- Declaratory transparency elements can reveal a broad scope of dismantlement activities while limiting risk; however information is not likely to be taken at face value due to ease of falsification,

- Limited independent observations and measurements could be designed to prevent or limit loss of sensitive information. However, they only reveal a fraction of the dismantlement process and in some cases they do not provide enough fidelity to distinguish between dismantlement and other operations,

- Comprehensive independent observations or measurements could provide high transparency but at increased risk and costs,

- No single transparency element would provide high confidence that dismantlement is occurring without disclosing significant sensitive information or severely limiting the dismantlement schedule,

- Any specific transparency system architecture incorporating more than one transparency element must be carefully designed and evaluated to prevent unintended loss of information,

- Once a coherent system is designed, individual transparency elements could be phased in incrementally.

One of the shortcomings of this report, noted by the authors, is that it addresses only individual transparency elements that could be incorporated into a transparency system and does not address what a system architecture might look like. The authors believe that before a specific architecture can be developed policy decisions regarding the extent and type of information that will be shared with inspectors, the costs each party will incur, and the desired level of confidence are needed.

5. "Verification of Dismantlement of Nuclear Warheads and Controls on Nuclear Materials", JASON Study, January 1993.

This study addressed the question of verification of future agreements with respect to dismantlement and destruction of nuclear warheads, bans on the production of additional quantities of plutonium and highly enriched uranium for nuclear weapons and agreements on the end use or ultimate disposal of special nuclear materials. Key assumptions included:

- There exist new opportunities for reducing arsenals of nuclear warheads and inventories of SNM that are beyond the usual framework of formal treaties and their elaborate frameworks for monitoring activities and verifying compliance,

- A bilateral agreement between the US and Russia would call for one or more of the following: a limited agreement ensuring that nuclear warheads removed from delivery systems eliminated under treaties or under matched unilateral statements are not available for reuse; an agreement of a similar nature as above but requiring full destruction of a specific number of warheads and secure storage for associated SNM; an agreement to retain all, or some of the weapons grade SNM now in national stockpiles in secure storage as an interim measure pending further agreement on ultimate disposition; an agreement establishing a verified bilateral cutoff on production of new HEU and plutonium, and an agreement not to manufacture new nuclear warheads,

- The US and Russia will retain nuclear weapons at a level that is significant in comparison to the overt nuclear states and maintain viable nuclear weapons complexes.

In general the study attempted to highlight the potential means of verification and assess their strengths and weaknesses. In particular the study measured the different verification regimes against two critical objectives:

- Ability to detect significant strategic Russian violations

- Ability to detect leakage of only a few weapons or kilograms of SNM to other countries

The primary focus was on National Technical Means, enhanced Open Skies sensors , data exchanges, perimeter portal monitoring, on-site inspection, tags/seals, emplaced sensors, and radiation monitoring. The study also addressed the issues associated with warhead totals and inventories of HEU and plutonium. Here they offer a number of possible measures to help narrow the uncertainty in the stockpile and HEU/ plutonium production; however, they recognized that "one can never count on finding clandestine warheads".

When addressing the issues of disassembly and destruction, the study emphasized that speed of action is more important than waiting for the best of facilities to proceed, and that "the most important channel of information for verifying dismantlement is to have inside knowledge of the day-to-day operation of the Russian weapons-handling bureaucracy". They clearly would "prefer to have inspectors with legal access to the main weapon production sites rather than to an isolated dismantlement facility." The study divided the flow of weapons to be dismantled into three phases, exclusive of the dismantlement itself;

- The movement of weapons from wherever they are to the dismantlement building entrance,

- The passage through the building to the exit where weapon components appear in separately packaged or batched containers,

- The movement of component packages from the dismantlement building exit to final disposal, storage, or destruction.

Within this breakout, the study highlighted that "the most crucial 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. The study also used this construct to evaluate each of the verification measures in a range from "adequate, good, better, to best". Other areas considered in the study included SNM cutoff and storage and disposal of SNM.

The general conclusions of the study are as follows:

- NTM alone are inadequate for verification of warhead dismantlement and SNM production. However, they are very valuable for monitoring the shutdown of declared facilities and as a part of a larger verification system,
- Open Skies with multi-spectral sensors can provide an overt signal of suspicious activities. Additional sensors that collect air samples for gas and particulate analysis will increase its value in identifying clandestine activities,
- We face a tension in setting verification standards and requirements for monitoring caused by our desire for information versus what we are willing to give up.

Study recommendations:

- Continue strong R&D support for spaced-based sensors and systems for monitoring activities and changes,
- Develop and support a strong R&D program for identifying and characterizing source signatures and multi-spectral optical, IR, LIDAR, SAR, and air-sampling sensors for Open Skies,
- Develop an effective monitoring system that integrates cooperative procedures with Open Skies and NTM without requiring unnecessary and unwanted intrusive and comprehensive procedures.

6. "An Analysis of Potential Measures for Monitoring U.S. Nuclear Warhead Dismantlement", Volume 1: Unclassified Executive Summary of the Wilson Report, SNL, December 1993.

This report is an unclassified summary of the classified report by the same title. Agreements to reduce the number of nuclear weapons by both the US and the Russian Federation could result in externally-imposed monitoring and inspection of the DOE nuclear weapons complex and operations as means of assuring that nuclear warheads are being dismantled.

As a result, this study was initiated with two primary objectives:

- Evaluation of the potential impact of procedures for monitoring nuclear warhead dismantlement on the DOE nuclear weapons complex.
- Identification of cooperative measures that could both demonstrate dismantlement and enable the DOE to meet its legal obligations to protect sensitive information under the Atomic Energy Act of 1954 and Nuclear Non-Proliferation Act of 1978.

The study focused on three facilities in the DOE nuclear weapons complex:

— Pantex Plant, Amarillo, Texas

— Y-12 Plant, Oak Ridge, Tennessee

— Device Assembly Facility (DAF), Nevada Test Site, Nevada

The Pantex Plant and Y-12 Plant are the principal DOE facilities for the production, test, maintenance, and dismantlement of nuclear weapons and components. The DAF was used as a model of a dedicated dismantlement facility because it is a modern facility where nuclear warheads could hypothetically be disassembled.

The study had several sections that included the following areas:

- Descriptions were obtained of facilities and the dismantlement process at each facility.
- A set of scenarios for monitoring dismantlement was developed that spanned the possible range of intrusiveness (and corresponding level of confidence that weapons were being dismantled).
- A set of criteria for evaluating the impact of the various monitoring procedures on dismantlement facilities was developed and values (high, medium, low, none) for each on these impact criteria were assigned for each of the scenarios.
- Cooperative measures could substitute for externally-imposed monitoring procedures and inspections.

The classified report that was produced as a result of this study developed several dismantlement monitoring scenarios at each of the three facilities. Thirteen scenarios were developed for Pantex, eight for Y-12, and seven for DAF. At each facility dismantlement scenarios fell into four categories:

- Scenarios that involved intrusive monitoring of the warhead disassembly process for all or some of the weapons being dismantled.
- Scenarios that involved procedures for monitoring inventories of weapons, components, or special nuclear material (SNM).
- Scenarios that involved portal perimeter monitoring procedures at area and plant boundaries to monitor the flow of SNM.
- Declarations (e.g., of information related to facilities, processes, schedules, and inventories) which, in some cases, could be supplemented by invitations to visit or inspect facilities.

In order to evaluate the impact on operations the study considered several criteria:

- The effort required to protect different types of sensitive information and the risk of inadvertently disclosing such information. The sensitive information was of several types: facility security procedures, weapon design information, equipment, stockpile vulnerabilities and effectiveness, non-dismantlement activities, and other stockpile information.
- Facility security concerns such as the requirements to modify security systems or procedures.
- Impacts on nuclear explosive safety.
- Impacts on other environmental, safety, and health requirements.
- The likelihood and relative magnitude of disruptions and delays to dismantlement schedules caused by monitoring procedures.

- The final criterion addressed the impact on facility resources and included the cost and impact of modifications to facilities and procedures that might be required, the magnitude of requirements for additional personnel to support or accommodate monitoring procedures, and requirements for additional fiscal resources.

Principal Results and Conclusions

Although DOE facilities were not designed to accommodate monitoring procedures, implementation of a variety of dismantlement monitoring and cooperative measures at DOE dismantlement facilities is feasible. The report concluded that the analysis of each category of monitoring procedures produced different and widely varying results. The results in the individual categories are given below.

Monitoring the Disposition of Components and Materials from Warhead Dismantlement

For the above category one can demonstrate that weapons are being dismantled and measures can be undertaken at low cost and without disrupting ongoing dismantlement activities. Monitoring the inventory of nuclear components and materials would provide strong indications that warheads were being dismantled. The confidence provided by monitoring inventories could be relatively high, but will depend on the equipment, procedures, and standards used to identify components and materials which, in turn, will depend on the requirements to protect sensitive information.

Direct Observation of Warhead Disassembly

Observation of the dismantlement process would provide direct evidence that nuclear weapons were being disassembled. Continuous pit inventory monitoring would be required to assure that warheads were not being re-assembled. Extensive changes in facilities and operations that are required to segregate dismantlement from other activities would cause an increase in costs and would also impact safety and security.

Protection of Sensitive Information

Intrusive measures for monitoring dismantlement could compromise various types of sensitive information. The impact of disclosing sensitive information would depend on the inspecting party.

Portal Perimeter Monitoring (PPM)

PPM could provide direct evidence of the flow of nuclear warheads and nuclear warhead components into and out of a facility. However, it would not provide direct evidence of dismantlement. Furthermore, PPM procedures would need to be applied differently at dismantlement facilities than in other verification regimes. Monitoring components as they move from place to place would be difficult for reasons such as, small sizes of components from dismantled nuclear warheads, large volumes of components, and the need to protect sensitive information during normal operations at the facility. The cost of PPM would be high because of the need for continuous on-site presence to make the necessary modifications to facilities to allow for accurate flow measurements while still protecting sensitive non-dismantlement information.

Use of a Dedicated Dismantlement Facility

The advantages of using a dedicated dismantlement facility like the DAF are limited and are primarily related to reduced risk of disclosing sensitive information and the reduced impact on non-dismantlement operations. The report estimates that using an existing facility like the DAF would still require an investment of up to hundreds of millions of dollars and several years to develop the environmental, safety, health assessments, nuclear explosive safety studies and reviews, security inspections and evaluations and operational readiness reviews.

The report details the requirements for implementing monitoring procedures that would need to be followed by DOE and the facility. The following actions will be required:

- Further technical analysis and planning will be necessary to address such issues as methods for detecting the presence of Pu or HEU that do not reveal sensitive information.
- A review of classification issues will be necessary to determine whether information disclosed by a monitoring procedure or cooperative measures is classified or proliferation-sensitive.
- Readiness plans would need to be developed at each facility.
- A commitment of resources to plan and implement monitoring and cooperative measures will be necessary.

From the analysis of potential monitoring procedures for Pantex and Y-12 in the report, four options were identified for further analysis.

- Declarations of nuclear weapons stockpiles, dismantlement facilities, processes and schedules, and inventories of weapons and SNM at dismantlement facilities.
- Combination of declarations of dismantled weapons and components with procedures to inspect non-SNM parts derived from those weapons and components.
- Combination of periodic declarations of dismantlement activities with procedures to monitor the inventory of SNM components (pits) and materials (HEU) derived from nuclear weapon disassembly.
- Combination of declarations of flow of weapons and components with PPM procedures at plants or area boundaries to monitor the flow of SNM in and out of nuclear dismantlement facilities.

7. "Cooperative Measures for Monitoring U.S. Nuclear Warhead Dismantlement", SNL, VST-051 Report Summary, July 1994:

Based on an earlier analysis of potential measures for monitoring nuclear warhead dismantlement at U.S. nuclear weapons dismantlement facilities, four types of cooperative measures were identified

- Declarations and site visits,
- Monitoring the disposition of components and materials from dismantled nuclear warheads,
- Monitoring inventories of pits from dismantled nuclear warheads,
- Portal perimeter monitoring at weapon and component storage areas.

This report presents the results of a more detailed analysis of these cooperative measures. The analysis identifies the requirements to implement dismantlement procedures at the Pantex Plant. The results provide a comparison of the cooperative measures based on their impact and the confidence they provide about the transparency and irreversibility of dismantlement in the United States.

Declarations and site visits

As a result of the analysis, the study found, regardless of whom the inspecting party may be, that:

- The DOE has made significant declarations of activities and allowed visits to dismantlement facilities upon which confidence-building and cooperative measures for demonstrating nuclear warhead dismantlement can be built. Further declarations and more extensive site visits are not necessary at U.S. facilities to establish other cooperative measures for building confidence that warheads are being dismantled. However, declarations related to specific cooperative measures may be necessary.

- With specific regard to the Russian Federation (or other nations with which a bilateral agreement might be considered), further declarations and site visits are necessary to determine whether other, reciprocal cooperative measures for monitoring nuclear warhead dismantlement are feasible. This conclusion is consistent with one of the key findings in the Office of Technology Assessment report on dismantlement (OTA-O-572, Sept.1993). It may be more desirable to share sensitive information with the Russians under a cooperative bilateral arrangement rather than by declassifying information.

Monitoring the disposition of components and materials from dismantled nuclear warheads

The disposition of parts and components from dismantled U.S. warheads could be monitored as a means of demonstrating dismantlement. The type of components and parts chosen primarily would depend on whether they contained sensitive information that would be disclosed during inspection and whether their destruction or other disposition could be monitored. Generally, the components providing the strongest evidence that warheads were dismantled are those that contain unique identifiers that can be compared to records. The components most easily inspected would be those that are non-nuclear, non-hazardous, and do not contain sensitive information. However, monitoring of these parts would provide less assurance regarding warhead dismantlement than would other, classified parts.

The greatest challenge in implementing procedures to inspect parts and monitor their disposition at Pantex would be in creating an environment in which to conduct the monitoring and inspection activities without compromising sensitive information and with a minimal impact on the dismantlement rate or other non-dismantlement activities.

The confidence (that weapons were being dismantled) provided by monitoring the disposition of parts is not easily assessed, but is expected to be lower than the confidence provided by monitoring the inventory of pits or by PPM. If parts critical to the warhead, such as nuclear components or critical electrical components, are monitored, the confidence will be greater than if the parts are commercially available. Finally, if the destruction of the parts can be confirmed, confidence will be greater.

Monitoring inventories of pits from dismantled nuclear warheads

It is feasible to provide access to pit inventory data and procedures at Pantex to provide a relatively high degree of confidence, albeit indirect evidence, that warheads are being dismantled, and a high degree of confidence (direct evidence) that SNM is under control and not being used to reassemble warheads. Furthermore, the cost of providing access, relative to PPM monitoring or other intrusive measures, will be relatively low and primarily related to the cost of providing security escorts.

Protection of sensitive information and other security requirements place limitations on the amount of information related to inventory procedures that can be provided to observers. Since the schedule for conducting inventories can be made well in advance, the suspension of activities involving weapons should not be a concern (unless short-notice inspections are permitted).

Under the Stage Right procedures for the interim storage of pits, the inventory process itself can be observed without revealing any classified information. All Stage Right inventory information will be collected using remotely controlled equipment; the data will be stored in a computer. There may not be high confidence to the observers that the items being inventoried are pits.

In this case, it might be desirable to allow confirmatory measurements to be made by the inspectors.

The cost of monitoring pit inventory data and procedures is much less than the cost for portal perimeter monitoring and other intrusive measures. The initial costs do not include any costs for the development and acquisition of radiation measuring equipment used to make independent measurements on pits by inspectors.

The concern over radiation exposure to workers and visitors as a result of these monitoring measures will be no greater than it would be during regular operations, unless it is necessary to retrieve a pit from a magazine and allow observers to make independent measurements.

Portal perimeter monitoring (PPM) at weapon and component storage areas

With the requirements to protect sensitive information, and recognizing the realities of the existing nuclear weapon complex where both dismantlement and non-dismantlement activities occur in a concurrent and co-located manner, three options were examined for PPM at Pantex in this report:

- No Segregation; No Disclosure of Sensitive Information,
- Certain Sensitive Information is Shared with Inspectors,
- Sensitive Information is Not Disclosed; Dismantlement and Non-Dismantlement Items and Activities are Segregated
    - — Segregation of Zone 4 West
    - — Use of Zone 4 East for Staging

PPM measures can be implemented in a number of ways at Pantex to provide varying degrees of confidence that warheads being dismantled as part of stockpile reductions are not reassembled. Protection of sensitive information and other security requirements place limitations on the means by which PPM could be implemented.

Option 1, in which PPM is applied within the current configuration of Pantex and without permitting the sharing of sensitive information, results in a situation in which little more is done than vehicle counts. Option 1 would involve significant recurring annual costs relative to the very low confidence that it provided.

The cost of Option 2 is significantly less than all variations of Option 3, but requires that sensitive non-dismantlement information be shared. Option 2 provides higher confidence than the other options that weapons are being dismantled and not reassembled because all shipments (inbound and outbound) can be inspected.

Of the options involving segregation, Option 3a (segregate the existing staging area) has the least initial cost. However, segregating Zone 4 could disrupt current Pantex operations.

Alternatively, to modify Zone 4 East (Option 3b) could require a number of safety and security assessments and reviews.

Options involving segregation also will require that a number of weapons and perhaps pits be moved from their current locations. To comply with security requirements, these moves could require a significant amount of time to complete and, particularly for Option 3a, could result in a loss of weapon staging flexibility (i.e., capacity). This would affect both DOE's transportation safeguards system and the DoD.

Finally, a difficult problem that remains for the PPM option is determining a way to differentiate between a weapon and a pit.