Summary 1

During the Cold War, both the United States and the Soviet Union built and maintained large stockpiles of nuclear weapons. Over the past 2 years, the leaders of these nations have pledged to withdraw tactical weapons and sharply reduce the size of the strategic weapons arsenal. Both nations have begun to retire thousands of weapons and to dismantle the nuclear warheads-the part of the weapon that contains its massive destructive power. Reducing the nuclear arsenals of both nations presents a unique opportunity and a challenge. The opportunity is to eliminate large numbers of warheads and reduce the threat of nuclear war. The challenge is to devise feasible and practical means of dismantling them and managing the constituent nuclear materials without causing new environmental, safety, or security problems. Still needed are decisions, policies, and plans to guide both the short- and the long-term goals of this effort.

Treaty agreements, such as the Intermediate Range Nuclear Forces (INF) and the Strategic Arms Reduction (START) treaties, negotiated to date require that weapons be retired from deployed status and that the means of delivering them be removed or destroyed. They do not require that warheads be dismantled or that warhead parts and materials be destroyed. However, the United States has undertaken to remove certain weapons from the stockpile, return warheads to the facilities that assembled them, dismantle the warheads, and store or dispose of their components, parts, and key nuclear materials. Substantial disassembly work is ongoing. The specific plans and schedules, however, are not available to the general public. Nor is the ultimate scope of this effort.

"Successful dismantlement and disposition of the weapons materials may be the single most important public health, environmental, and social challenge we face."

Public health expert participating at OTA panel meeting

"Current dismantlement can either be done well and set a foundation for future progress, or it can be done badly, leaving so much unaccounted for, so much room for uncertainty, so much inequity that it will set back, if not destroy, future possibilities."

Local citizen's group reviewer of OTA report

The Office of Technology Assessment (OTA) has analyzed the present U.S. approach to this undertaking and concludes that current Federal efforts are insufficient to the challenge because they are scattered and lack uniform objectives; they are not based on a clear mission; the public distrusts the responsible Federal agencies, and fears that the environmental and health impacts may be no better than past performance; and there has been little informed public debate to establish national goals. In essence, the Nation has no coordinated, comprehensive national policy on nuclear warhead dismantlement, and current overall management of the task is weak.

Neither the United States nor Russia has developed a technically and politically feasible plan to dismantle warheads and dispose of the nuclear materials from them. Policies for nuclear warhead dismantlement and materials control are important to both U.S. and international security. While recent pronouncements and agreements by national leaders may set goals for reduction of the weapons stockpile, they do not, by themselves, eliminate nuclear warheads. Although nuclear weapons can be rendered less threatening by destroying the means of delivering them (as recently negotiated treaties require), destroying warheads and their constituent nuclear materials safely and effectively is a very difficult task. Many of the most dangerous materials will need careful management for generations.

OTA's analysis of the dismantlement program makes clear that eliminating these warheads-or even destroying a portion of the stockpile of nuclear weapons that have been amassed-will be neither simple nor painless. The difficulties of weapons retirement and warhead dismantlement should not be underestimated. Plans for long-term storage or disposition of nuclear materials must be resolved, and difficult decisions regarding these matters must be made at the highest levels of government.

THE CHALLENGE

Tens of thousands of nuclear weapons are still deployed in the United States, Russia, and other nations (i.e., ready for use or deliverable). Others, although not deployed, are part of what is called —in the United States—the "reserve" stockpile, meaning they are maintained as "backups" for deployed weapons. Still other weapons are removed from both the active stockpile and the inactive reserve, and "retired.' The warhead portions of the retired weapons are eventually returned to a Weapons Complex plant for dismantlement.[1]

The Strategic Arms Reduction Treaty, START II, which awaits ratification, provides for some warheads that are presently deployed to be separated from delivery vehicles or otherwise placed in a status in which they are not deliverable or ready for use. START II does not impose any requirements to actually dismantle the warheads that are removed from deployed status. Neither START agreement calls for dismantling any warheads that are now in the reserve stockpile or that may be added to it in the future.

Potential political instability in the former Soviet Union raises concern that control over some weapons will diminish and they will fall into the hands of revolutionary regimes or terrorist groups. The potential proliferation of nuclear weapons poses a serious threat to international security. There is also the possibility that a weapon may detonate accidentally or pose other types of safety problems. Accidental explosions are a concern if groups with limited technical capability and resources have control of these weapons.

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[1] Dismantlement means the removal of **all** nonnuclear components, including the chemical high explosive that surrounds the nuclear materials. Dismantlement also includes waste management and disposal of other parts and materials. It does **not,** however, include destruction of the key nuclear materials or even of the major nuclear subassemblies.

For these and other reasons, the criteria against which options for dismantlement, storage, and disposition of components from nuclear warheads must be assessed differ significantly from those that applied to warhead production. In the past, national security was accorded much more prominent attention than environmental risks. Today, however, there is a need for responsible stewardship of the long-lived nuclear materials that are bequeathed to future generations, and safeguards will be required to protect the safety and health of the public and of the workers who carry out dismantlement.

New technologies may offer solutions or partial solutions to some of the problems associated with either safe disposal or utilization of materials whose radioactive half-lives are measured in many thousands of years. Yet few proven technologies are readily available. Nonproliferation concerns will affect decisions about technologies because of the pressure to come up with options that reduce the risks of nuclear materials being easily diverted into new warheads.

Dismantlement of nuclear warheads is proceeding at a time when trust of government in general, and DOE in particular, is--at best--fragile. The culture of secrecy and insularity embraced by the Department of Energy (DOE) and its predecessor agencies has had a corrosive effect on relations between the Department and the communities neighboring nuclear weapons facilities. The United States begins with the handicap of widespread public mistrust of its own institutions charged with these responsibilities because of their previous failures to safeguard the environment and health. Thus, one of the first tasks is to rebuild institutional credibility.

To do this, the priorities and characteristics of the institutions that supported warhead production will have to be carefully rethought. Greater attention to environmental, safety, and health impacts is essential. If the United States is to successfully carry out nuclear warhead dismantlement and materials management and disposition, and to engage in cooperative efforts with Russia, new institutional capabilities and management approaches are essential. These institutions will be expected to devote much more attention to the environmental impacts of proposed ways of handling nuclear materials than was given when warhead production was the primary concern.

THE OFFICE OF TECHNOLOGY ASSESSMENT STUDY

This study addresses the challenge of eliminating thousands of nuclear warheads. It traces the U.S. process within the responsible Federal agencies, with particular attention to factors that may affect realization of the national goal of safe and secure stockpile reduction in a reamer that protects human health and the environment. The report also reviews related work in Russia, focusing on the ability of the United States to influence a safe, secure, and environmentally sound process there.

If the United States wishes to develop and implement policies leading to substantial nuclear arms reduction worldwide, as well as to substantial reduction of the nuclear materials with which to make new warheads, certain actions are important and probably more urgent than generally realized. This report discusses the following major activities involved in the unprecedented enterprise to achieve nuclear stockpile reduction:

- the process for retiring weapons from active deployment in the military and returning their nuclear warheads to the facilities that manufactured them; and dismantlement of the warheads, and subsequent handling of the parts and materials from them; and
- the storage, control, and ultimate disposition of key nuclear materials (plutonium and highly enriched uranium) from the warheads.

Box I-A-Key Findings

- Ongoing Federal program and plans within the Departments of Defense and Energy for retirement and dismantlement of nuclear weapons are currently treated as a short-term modification of existing practice rather than a change in focus from past missions of production and stockpile maintenance.
- Numbers of weapons in the active stockpile, and numbers to be retired and dismantled, are contained in classified documents not available to the general public, Existing and pending international agreements do not require that any warheads be dismantled, only that they be removed from delivery systems. The nation's massive nuclear stockpile is now partly dismantled, partly in temporary storage, partly in transition, and partly deployed.
- Environmental, safety, and health problems continue in the operation of the DOE Weapons Complex, and certain aspects of current dismantlement activities---the use of old facilities, additional sources and generation of waste, and slow adoption of modern health and safety practices---may affect the success of dismantlement programs.
- A continuing lack of public credibility may have a *major* impact on progress in dismantlement and on implementing key operational decisions. Public interest groups have obtained a legitimate voice in influencing DOE operations through environmental legislation and their political power. Despite new public participation initiatives, the major DOE sites have yet to ensure adequate communication with the public, to understand public concerns, or to involve the public in critical decisions.
- it is likely that significant portions of the highly enriched uranium and plutonium recovered from dismantled warheads will need to be stored for decades regardless of the ultimate disposition option chosen for them. Significant time will be required for making disposition decisions and formulating policies; for planning, designing, funding, building, and testing even the most available technology; for gaining regulatory and public acceptance; and for actually processing quantities of materials.
- The use of surplus plutonium from weapons as fuel for U.S. commercial reactors is unlikely because of economic factors, the concerns of U.S. utilities about regulatory constraints and public acceptance, and the need to evaluate U.S. policies that discourage commercial plutonium use.
- if the policies articulated urge expeditious processing or conversion of plutonium to less weapons-usable forms, it may be best to pursue the most available near-term technologies. OTA finds that a process to immobilize it directly in some form such as vitrified glass or, with appropriate poisons, to decrease its proliferation risk and a Government-built and operated dedicated light-water reactor that uses mixed plutonium and uranium fuels are two such near-term technologies.
- it is impossible to fission plutonium completely (and thus "destroy" all of it), but certain new developments may be able to convert it to different radionuclides at a much more efficient rate than existing technologies. However, the research required to develop such advanced reactors and converters would be costly, and would require times on the order of decades.
- The U.S. program to assist Russia with nuclear warhead dismantlement has initiated important cooperative work but has not addressed the broader issues of mutual goals and interests in stockpile and materials reduction or control, nor has it had a significant effect on Russian dismantlement.
- The United States has not verified specific warhead dismantlement activities and accomplishments in Russia, and has no direct cooperative process for developing accurate information about Russian dismantlement status and capabilities.
- Efforts to integrate U.S. warhead dismantlement plans with programs to assist Russia have not received substantive attention. There is little linkage between Russian economic, environmental, or social needs and U.S. programs to assist and encourage Russian dismantlement a related activities.
- While the United States views expeditious Russian warhead dismantlement and materials disposition as vital to its national security, Russia's agenda is dominated by economic and political issues that could relegate dismantlement to a low priority.

The following sections summarize the status of ongoing dismantlement activities, OTA's findings, and an analysis of the policy issues involved and the initiatives proposed.[2] The key OTA findings listed in box 1-A summarize the major points discussed in this report. The findings address U.S. warhead dismantlement and materials management, and U.S. cooperation with Russia regarding the disposition of weapons in the former Soviet Union.

Box 1-B lists issues related to the process of nuclear warhead dismantlement and materials management. These issues are presented in the form of questions and relate to the major decisions that the United States will have to make to facilitate dismantlement both here and in the former Soviet Union.

Finally, box 1-C presents the key policy initiatives developed by OTA in this report. These initiatives are intended to offer possible approaches to improve Government programs and enhance their chances of success. They could be adopted either through legislative initiatives or by the Administration with congressional encouragement. The options can be pursued either individually or as a group. They are presented in the order in which they are discussed in chapter 7.

DISMANTLEMENT OF NUCLEAR WARHEADS

Status

According to a long-standing administrative procedure for management and control of nuclear weapons within Federal agencies and the military services, dismantlement begins with a presidential decision approving the annual Nuclear Weapons Stockpile Plan. Retired weapons are then transferred to a military base within the continental United States, where the warhead is usually separated from the delivery system and returned to the DOE facility that assembled it. DOE retains custody until it is dismantled and its components have been disposed of. In recent years, thousands of U.S. nuclear weapons have been put on retirement status: many of these have been returned to DOE for dismantlement; others are in storage at military bases, waiting their turn in the dismantlement process. In FY 1993, the United States expects to dismantle about 1,400 warheads, but plans for the total number of weapons to be retired and disassembled, as well as the future size of a reduced warhead stockpile, are not available for public release.

Warheads returned from the Department of Defense (DOD) to the Department of Energy for dismantlement are transported to the DOE Pantex Plant near Amarillo, Texas, where they were built. Several Department facilities are currently engaged in warhead dismantlement and related work, with major activities centered at Pantex, Y-12 (in Oak Ridge, Tennessee), and Savannah River (in Aiken, South Carolina). At Pantex, plutonium pits (the primary explosive parts) are removed from warheads, placed in containers, and stored in bunkers. Other parts and wastes are characterized, stored, and disposed of in a variety of ways. Nuclear warhead "secondaries" and highly enriched uranium (HEU) are shipped to the Y-12 Plant at Oak Ridge for further storage or disassembly. Tritium gas canisters are shipped to the Savannah River Plant for storage or processing.

The United States has recently announced that it will no longer produce weapons-grade plutonium or highly enriched uranium for warheads. In practice, these activities ceased some years ago, and production facilities have not been operating. Thus, the United States plans to store some of the materials extracted from disassembled warheads

[2] The analyses in this report are based on unclassified information. Thus, certain data such as weapons types, numbers of weapons, retirement schedules, warhead designs, materials shapes, and some processes are discussed only in general terms. OTA did have access to classified information in the course of the study and has prepared a classified annex to this report, which contains more detailed information regarding the nuclear weapons stockpile, future plans with respect to nuclear weapons, and related data.

Box I-B–Issues Related to Weapons Dismantlement and Materials Management

U.S. WEAPONS DISMANTLEMENT AND MATERIALS MANAGEMENT

Policy and Strategy

How many U.S. warheads are to be retired and dismantled?

How much weapons-grade plutonium and highly enriched uranium (HEU) from already dismantled weapons and from weapons planned for dismantlement will not be required for stockpile purposes, and can thus declared surplus?

Should information about numbers of weapons to be dismantled and amounts of **surplus materials from dismantled** weapons be made public?

Should surplus plutonium pits from U.S. warheads be stored indefinitely or disposed of as waste?

Should surplus HEU from U.S. warheads be stored indefinitely or converted for use in commercial power reactors?

Should U.S. surplus materials be made amenable to monitoring or inspection under a bilateral arrangment with Russia?

Operations and Management

When will dismantlement of retired weapons or weapons planned to be retired be completed?

What additional measures should be taken to manage the dismantlement mission so as to protect the environment, as well as public and worker health and safety?

How long should plutonium pits from dismantled warheads be retained in temporary storage at Pantex--and the HEU from dismantled warheads in storage at Y-12?

What type of processing facility is needed to maintain the plutonium pits?

What type of facilities are needed for long-term storage of plutonium and HEU (pending some future use or disposal), and where could such facilities be located?

What type of technologies should be used if plutonium is deemed to be a waste, and what facilities are needed to implement disposal plans?

Should the surplus materials from dismantled warheads be stored separately from materials needed for weapons stockpile requirements?

To what extent can and should operational information be made available to the public, and how can public participation best be ensured?

Through what process will a site or sites be chosen for facilities required to carry out ultimate disposition options including long-term storage, conversion to fuel, or disposal as waste?

Organizational Structure

Should responsibility for management and disposition of surplus materials from warheads be retained in the Department of Energy's Defense Programs, or given to a new organization within DOE or another existing agency, or should a new organization be created for this purpose?

How should the transition be made between the present organizational structure and a potential future one?

How can external oversight and enforcement be strengthened-what agencies should be engaged, and what mechanisms should be developed?

RUSSIA'S NUCLEAR WEAPONS DISMANTLEMENT AND MATERIALS MANAGEMENT

How can the United States best encourage and aid Russia in dismantling warheads, and in the management and disposition of materials from them, and how should those efforts be structured?

Should the United States propose or enter into reciprocal arrangements with Russia involving information exchange, transparency, and inspections?

Should the United States encourage or promote any role by an international organization wit h respect to Russian weapons and nuclear materials?

Should the United States enter into joint study projects or provide technical assistance to Russia for processes leading to ultimate disposition of plutonium?

for possible future military use. The facilities that were used to recycle old warhead parts such as plutonium pits have been shut down, largely for environmental and safety reasons.

Plutonium pits from recently dismantled warheads are being stored at the Pantex Plant, where warhead disassembly takes place. DOE is running out of storage space for plutonium pits at Pantex and wants to change the storage configuration in existing bunkers to accommodate more pits, but the specific plan has not been approved yet. HEU from disassembled warheads is now being stored at the Y-12 facility, and there are no current plans to store it elsewhere.

Findings

The Nation's massive nuclear stockpile is now partly dismantled, partly in temporary storage, partly in transition, and partly deployed. Whereas past dismantlement activities were geared to maintaining the weapons stockpile, present and future activities are intended to permanently reduce it. Since fewer new weapons will be made, most of the materials recovered from dismantled warheads will no longer be recycled for use in other weapons. More plutonium and HEU will have to be stored and managed for long periods of time, and international factors may have significant impacts on materials management decisions. Yet, Federal programs and plans within DOD and DOE for retirement and dismantlement of nuclear weapons are currently treated as a short-term modification of existing practice, rather than a change in focus from the past missions of production and stockpile maintenance.

Existing and pending international agreements require only the removal of warheads from delivery systems. Preparation for long-term institutional custody of warheads and their nuclear materials lacks direction. DOE does not have comprehensive and accurate estimates of the total current or future annual costs of this enterprise, but available information indicates that DOE expenditures for dismantlement activities at all sites could be approaching $1 billion annually.

Thus far, there have been few if any serious problems with respect to dismantlement, but some process difficulties and logistical problems have caused schedule changes. One potential stumbling block is the storage of plutonium pits from warheads. Although DOE has stated that it needs to change the storage configuration in its World War II-vintage bunkers at Pantex to accommodate the anticipated number of pits coming from warheads, it has not yet produced the documentation required for approval. The State of Texas, community groups, and other experts have found DOE's environmental analysis to be deficient and have objected to the fact that DOE originally restricted access to the associated safety review. In addition, some citizen groups in Texas are concerned that although DOE says the pits will remain in "temporary storage" for 6 to 10 years, Pantex could turn into a de facto long-term storage site, and the pits may

Box 1-C--Summary of Policy Initiatives

Congress could implement---or the Administration could undertake to implement-the following policy initiatives:

Initiative 1—A National Dismantlement Policy

Develop and announce a national policy that sets goals for warhead dismantment and materials management, and specifies the amount of plutonium and highly enriched uranium from dismantd warheads that will not be needed to support future stockpile requirements.

Initiative 2-Strengthening DOE Management

Implement a DOE management system that gives priorit y to protecting the environment, health, and safet y; expand and strengthen external oversight of DOE dismantment and materials management activities by independent outside entities,

Initiative 3---Nuclear Materials Storage

Establish an interagency task force that includes Federal agencies with expertise in regulatory, international, and public involvement matters to recommend a plan for safe, secure storage of nuclear materials, and to develop a process acceptable to the interested public for siting new or modified storage facilities.

Initiative 4---Nuclear Materials Disposition

Create a national commission to recommend goals, policies, and programsforuitimate disposition of surplus plutonium and HEU from warheads, and to provide a basis for developing an ultimate disposition policy for these materials.

Initiative 5--A New Materials Management Organization

Create a new organization outside DOE to manage surplus materials from warheads, or establish a new organization for this purpose within DOE or some other existing agency.

Initiative 6--Information Access

Review and possibly revise the existing legal basis for restricting access to information in light of today's post-Cold War national security objectives, and accelerate efforts to increase access to information relevant to warhead dismantment and materials disposition.

Initiative 7-Cooperation with Russia

Strengthen the relationship between U.S. assistance to Russia for materials disposition and other programs in which assistance is desired by Russia; develop a means for joint assessment of plutonium disposition technologies; and negotiate mutual disclosure of information and reciprocal materials monitoring arrangements.

deteriorate before alternative storage arrangements are available.

Another stumbling block is DOE's poor record with respect to environmental and safety matters at its Nuclear Weapons Complex in the past, which has led to concerns among the interested public and affected communities about future DOE activities at those sites. Recent process difficulties during dismantlement at Pantex have caused the public to continue to question health and safety practices. Lack of public trust and credibility could adversely affect prospects for successful conduct of dismantlement and materials management activities.

While DOE is working on improvements to its environmental, health, and safety programs at the

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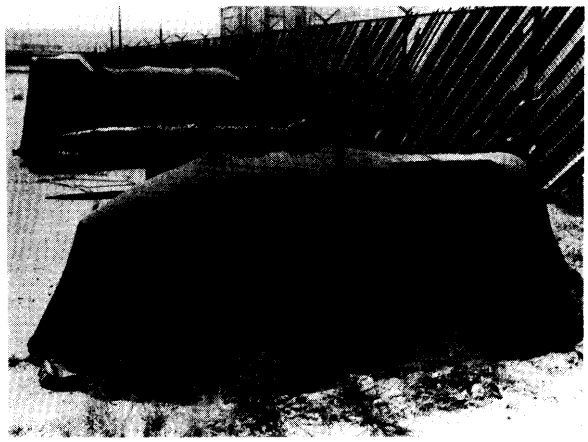


Dismantlement means more than putting weapons under wraps like these "extinct" bombs at the National Atomic Museum in Albuquerque.

Nuclear Weapons Complex, current dismantlement activities still face problems, such as the use of old facilities, waste generation, and the slow adoption of modern worker health and safety practices. DOE's lack of public credibility could also have a negative impact on prospects for making key operational decisions regarding dismantlement and management of materials from warheads. Despite DOE's efforts to develop better public participation initiatives, the major dismantlement sites have yet to ensure adequate communications with the public, address public concerns, or involve the public in making decisions about dismantlement and materials management that could affect surrounding communities. In addition, considerable work remains to develop a national consensus around dismantlement goals and to ensure the protection of human safety, environmental integrity, and international security.

Policy Issues and Initiatives

Although present efforts to dismantle warheads and manage warhead materials are being treated by DOD and DOE as business as usual, these activities should be viewed as constituting a new mission with different challenges than in the past. Failure to effectively carry out the new mission here could adversely affect similar efforts abroad, with harmful consequences for international security and the global environment.

A NATIONAL DISMANTLEMENT POLICY

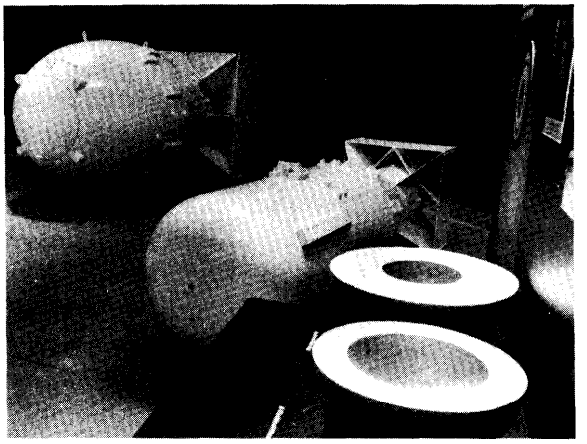
To define the new mission, and guide the agencies in implementing it, the Nation could establish a policy that sets forth the long-term goals and rationale for dismantlement. As part of that policy, decisions about the number of weapons to be retired and dismantled, as well as the time frame for dismantlement, would be made public. The Administration will also have to decide on the amount of plutonium and HEU currently available from dismantled warheads that is not needed to support nuclear weapons stockpile requirements and could be declared surplus to military needs. To aid this process, Congress could direct that an unclassified report containing such information be prepared and updated annually. This initiative would facilitate understanding of the rationale and goals of dismantlement; help ensure the public that future actions are consistent both with safety and protection of human health and the environment, and with U.S. strategic needs; and signal the international community that the United States is serious in its intent to dismantle warheads.

STRENGTHENING DOE MANAGEMENT

Although DOE is attempting to establish new guidelines for protecting the environment, health, and safety in its dismantlement and nuclear materials management activities, these matters require continuing attention. It is critical for DOE to develop a management system at all levels of its organization that is strongly committed to environmental, safety, and health improvements, and that effectively integrates this commitment into its operations. To help ensure that this occurs, external oversight of DOE's dismantlement and materials management program and plans should be strengthened. One way to accomplish this is for Congress to provide the Defense Nuclear Facilities Safety Board with the necessary re-

sources and personnel (and any additional authority required) for this purpose. To assure communities around the sites that activities are being conducted properly, the Board-as well as DOE-could provide greater opportunity for public involvement than in the past. In addition, the Occupational Safety and Health Administration (OSHA) could be given jurisdiction over DOE worker health and safety.

In general, Congress could insist that DOE upgrade and strengthen its management systems to adopt and maintain high standards of worker health and safety, public health, and environmental protection.



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Models of World War II nuclear weapons Fat Man and Little Boy at the Bradbury Science Museum in Los Alamos, New Mexico. Conventional explosive hemispheres that surround the plutonium pit in a nuclear warhead are shown in the foreground.

MANAGEMENT OF NUCLEAR MATERIALS

Status

The two principal nuclear materials in warheads are plutonium and highly enriched uranium. Together or separately, they can be made into new warheads; thus there is a need to keep these materials safe and secured. Because of their radioactive half-lives, these materials will continue to pose some level of risk to human health and the environment for many thousands of years. OTA has thus focused on plutonium and HEU, although the disposition and disposal of many other materials from dismantled warheads are of concern.

A few hundred tons of plutonium and more than a thousand tons of HEU (exact numbers are classified) were produced worldwide for warheads. Today, this stockpile exists either in intact warheads or weapons, in forms ready to be made into warheads, or as pits and other forms removed from retired weapons. The United States and Russia have by far the largest portion of these materials. Both plutonium and uranium are also found in various forms and quantities in the nuclear industry worldwide, along with other industries that use nuclear materials. Some weapons-grade HEU is used in naval and research reactor fuel. Some plutonium that has been separated from commercial spent fuel could also be used in warheads even though it was not made for such use.

Nuclear materials taken from dismantled U.S. warheads, including plutonium pits placed in the bunkers at the Pantex Plant and HEU housed at the Oak Ridge Y-12 Plant, are considered to be in temporary or interim storage. Although DOE has stated its intention to store plutonium pits in temporary bunkers at Pantex for the next 6 to 10 years, it has not announced any plans to provide safe storage for the pits beyond that time. DOE also has not indicated its long-term storage plans for HEU.

Long-term or permanent solutions to the disposition[3] of these materials await policy decisions by the President and Congress. DOE has not declared any of this material to be surplus. However, recent DOE-sponsored studies have

[3] In this report, the term "disposition" means the spectrum of possibilities about what to do with these materials beyond weaponry-frost to store them in a safe, secure facility; perhaps to destroy some portions if technically feasible and practical; perhaps to utilize them to produce civilian energy, if security is adequate and if the technology and economics prove sound; and finally to dispose of them as waste if technology and national policies permit.

focused on options for plutonium disposition through the use of various fuels containing plutonium in existing or advanced nuclear reactors. Within these reactors the plutonium would be irradiated and some of it converted to other radionuclides and fission products, possibly with the generation of electricity. Other studies have addressed plutonium storage for moderate to long-range time frames and techniques for turning plutonium into a form suitable for disposal as waste. Debate over these options is based largely on whether plutonium is viewed as a valuable asset whose beneficial uses are to be explored or a major liability to be disposed of in the safest and most secure way.

It is extremely difficult to convert significant amounts of plutonium into a substance that would be nonradioactive or harmless to health and the environment. Existing reactor technologies can be used to consume it as fuel, that is, to irradiate it and transform portions of it over time. Mixed-oxide (plutonium and uranium) fueled reactors are an example of existing technology that maybe modified or adapted for plutonium disposition. Advanced reactor or converter technologies could be developed to achieve a large degree of plutonium transformation (and perhaps also to produce energy). However, available information indicates that their development would require significant time and resources, and it is uncertain how effective they would be. Alternatively plutonium could be disposed of more directly by using available technologies to embed it in other materials that make it difficult to recover (such as vitrified waste).

Some processing of nuclear materials is required to convert them into forms appropriate for many of the disposition options that have been proposed, including preparing them for disposal as waste. Processing of plutonium and uranium has historically raised environmental and public health concerns, as well as concerns about occupational health and safety. Regardless of the technology or disposition approach selected, radioactive waste will be generated and require long-term management.

Findings

Storage of plutonium and HEU from dismantled warheads will be required for one to several decades, regardless of what choices are made for ultimate disposition of these materials. DOE will present some approaches for a long-term storage facility as part of its Weapons Complex reconfiguration (in conjunction with the preparation of a Programmatic Environmental Impact Statement under the National Environmental Policy Act), and there are expected to be opportunities for public comment in that process.

Since the Administration has not made an official determination as to whether any plutonium and HEU from warheads will be declared surplus (e.g., not needed for future weapons), as yet there has been no comprehensive Federal planning process for the ultimate disposition or management of surplus materials. Discussions in and out of Government of plutonium disposition reveal little support for the use of surplus U.S. plutonium from warheads as fuel for U.S. commercial reactors. Some factors contributing to the lack of enthusiasm for this option are concerns of U.S. utilities about regulatory, public acceptance, and economic issues, as well as the fact that the United States has in the past discouraged commercial plutonium use because of proliferation concerns. DOE and certain private firms have expressed interest in the construction of special plutonium-fueled reactors at Federal sites to eliminate portions of weapons plutonium while also generating electricity.

Decisions about the fate of plutonium from U.S. weapons could influence similar decisions in Russia and other nations that may be planning to use plutonium in reactors. To reduce the world stockpile of plutonium that is readily available for weapons, actions need to be taken to discourage future production and to facilitate controlling the

existing materials and making them unusable for weapons.

With respect to HEU from U.S. warheads, it is unlikely that this material will ever be considered waste. Technology is available to convert it for use as reactor fuel. However, current plans for introducing uranium extracted from Russian warheads into commercial U.S. power plants will probably precede any similar program for U.S. material. Thus, storage of HEU for several decades is a likely outcome, and safe, secure means for long-term storage must be planned.

Policy Issues and Initiatives

Eventually, the United States will have to decide what it ultimately wants to do with the stored plutonium and highly enriched uranium from its dismantled warheads. If none of it is declared surplus, presumably the plan would call for storage for an indefinite period or until it is needed for weapons. If some of the nuclear material from warheads is declared surplus, possible disposition options would include storing it indefinitely, converting it for use in existing or future reactors, or disposing of it as waste (not likely for uranium).

NUCLEAR MATERIALS STORAGE

Regardless of the ultimate disposition of plutonium and HEU from warheads, safe storage of these materials for several decades will have to be planned as soon as possible. There are many controversial and difficult issues that will take much time and effort to resolve. These include finding the most effective way to ensure safe and secure long-term storage of these materials, determining g how such facilities should be regulated, and considering whether and how storage facilities can be made amenable to any bilateral or international inspections that may be agreed to in the future. Gaining public acceptance for the location of any new or modified facilities will be difficult. Because some of the issues that need to be addressed are not within the purview or expertise of DOE, it may not be desirable to confine the planning process to DOE. A broader planning process involving government agencies in addition to DOE could help identify, anticipate, and resolve key issues.

One way to provide such a process is for Congress or the President to establish an interagency task force to make recommendations about the best way to achieve safe and secure storage. The task force can also examine the feasibility and consequences of storing surplus plutonium and highly enriched uranium separately from materials reserved for stockpile requirements, and determine what type of arrangement would facilitate potential bilateral or international inspections. Also, because settling upon a suitable and acceptable location for nuclear materials storage will be a problem, the task force should consult with the public and attempt to develop a facility siting process that is agreeable to the potentially affected communities.

NUCLEAR MATERIALS DISPOSITION

In the longer term, a process will be needed to determine the ultimate disposition of surplus plutonium and HEU from warheads. So far, discussions of options have been carried on largely by technical experts and there is no consensus about most matters.

National policy on these issues is just beginning to be discussed, and the criteria against which options can be evaluated are only beginning to be considered. To help determine how nuclear materials are to be dealt with over the long term, a means should be developed to provide the President and Congress with a comprehensive basis for making the policy decisions necessary before long-term disposition of U.S. nuclear materials can begin. A preliminary step might be to obtain a broad range of governmental and nongovernmental views about what national policies, and the key criteria for evaluating them, should be. One mechanism for doing this is for the President or Congress to create a national commission that would evaluate the technical, institu-

tional, and economic issues, and recommend goals, policies, and programs relevant to the ultimate disposition of nuclear materials from warheads.

A NEW MATERIALS MANAGEMENT ORGANIZATION

Whatever the outcome of decisions about storage and ultimate disposition of surplus plutonium and HEU, the present organization charged with this responsibility (DOE's Office of Defense Programs (DP)) may not be well suited to carry out the new nonmilitary mission of managing materials from warheads. Historically, its activities have been subject to minimal regulation, its operations have been conducted in secret, and it has not sought or welcomed public involvement or been concerned about the international implications of its actions. Its priorities continue to be maintaining the warhead stockpile.

In contrast, the mission of storing and dealing with surplus materials is essentially civilian in nature, and potentially subject to extensive domestic regulation and to scrutiny by the international community. It may be best to have an organization that is structured from the start to do this job in a way that gives priority to ensuring safety and protecting human health and the environment, operating in an open reamer, involving the public more effectively, responding to public concerns, and being constantly aware of the international implications of its activities. Such an organization could be created within DOE. Alternatively, Congress could create an organization outside DOE (perhaps in some existing agency) to carry out activities related to the disposition of surplus nuclear materials from dismantled warheads.

INFORMATION ACCESS

Status

The institutional framework for making decisions about nuclear warhead dismantlement and materials disposition is essentially the same as it was throughout the Cold War. The decisionmaking structure has historically been characterized by lack of regulation or outside oversight, restricted public access to information, and little if any public involvement. Current restrictions on access to information relevant to nuclear warhead dismantlement and materials disposition are based on legislative requirements generally intended to protect national security during the Cold War.

Findings

The executive branch has undertaken some reviews of various Federal agency procedures related to classification and declassification of information, but those efforts are typically slow and may not address public concerns about the lack of information access in warhead dismantlement and materials management matters, particularly with respect to environmental, health, and safety issues.

Many of the restrictions on information enacted to meet the Cold War situation may no longer be necessary to preserve national security, although certain types of information about warhead design and manufacture must still be withheld because of potential terrorist activities and other security concerns. However, a great deal of information relevant to warhead dismantlement and materials management could be made more accessible, particularly data having to do with the environment, health, and safety.

Policy Issues and Initiatives

In light of the increased authority of the States and of the public in activities at the Nuclear Weapons Complex, DOE will have to plan and conduct its dismantlement and materials management activities in a more open manner that will permit more public involvement. To facilitate public access to relevant information, legislative and administrative restrictions on information access should be evaluated to determine what changes are needed to suit the new circumstances of the post-Cold War era and enhance public

involvement. Although the Administration is reviewing some of these matters, more attention could be devoted to efforts to revise current standards and procedures for access to information specifically related to warhead dismantlement and materials management. Also, Congress could review the Atomic Energy Act and other pertinent laws, or request that the Administration conduct such a review, and recommend changes to facilitate public access to appropriate data relevant to nuclear warhead dismantlement and materials management.

COOPERATION WITH RUSSIA

Status

Russia has announced plans to retire and dismantle a substantial portion of its nuclear weapons stockpile over the next decade or more. The United States has pledged several hundred million dollars for technical assistance in this connection, but only a small portion has been spent.

The Russians have indicated that a lack of storage for their nuclear materials, especially plutonium, is impeding their ability to dismantle warheads. After a series of discussions, the United States and Russia have agreed that Russia will design its own storage facility for special nuclear materials from warheads, with design assistance from the United States provided through the U.S. Army Corps of Engineers. The Russians plan to begin site preparation for this storage facility within a year, but many political, technical, and financial obstacles could hinder its successful completion in the near term.

U.S.-Russian agreements have also been reached on U.S. provision of, or assistance with, specific items such as armored blankets, warhead storage containers, emergency response systems, and secure rail cars to enhance the safe transport of weapons. However, these efforts have not had any significant effect yet on Russian warhead dismantlement—an objective that requires continuous emphasis at the highest levels of U.S. Government and by the several agencies designated to conduct the Russian assistance program.

With respect to the HEU from Russian weapons, the United States and Russia entered into an agreement in February 1993 (subject to terms not yet finalized) whereby 500 metric tons of the material would be converted to low-enriched uranium (LEU) in Russian facilities and then purchased by the United States. At least 10 metric tons would have to be converted in each of the first five years and 30 metric tons in each of the following years (for a total of 20 years). A final purchase agreement has yet to be executed, however.

An implementing agreement would specify price, certain conditions, and a method of sharing proceeds among other former Soviet republics. The contract is intended to provide for participation by both the U.S. private sector and Russian enterprises; it is also intended to establish 'transparency measures" for materials control and accounting.

Findings

While the United States views expeditious Russian warhead dismantlement and materials disposition as vital to its national security, Russia's agenda is dominated by economic and political issues that could diminish the priority given to dismantlement. U.S. efforts to assist Russia with nuclear warhead dismantlement have initiated an important cooperative process but have not yet had a significant effect on the Russian dismantlement program. And they have not been carried out in a manner that addresses the broader issues of mutual goals and interests in stockpile reduction and materials management.

The U.S. purchase of Russian HEU from warheads is nearing final agreement and will contribute to a reduction of the materials available for new nuclear weapons there. However, it will be decades before large portions of the total Russian inventory of this material are converted and transferred to the United States, and therefore

a significant risk of diversion will remain. The United States appears to have entered into this agreement without a fully articulated analysis of what further steps might be taken to improve the management and control of warhead materials to prevent their diversion.

The United States has not verified specific warhead dismantlement activities and accomplishments in Russia, and has no direct cooperative process for developing accurate information about Russian dismantlement status and capabilities. Further, the United States has not established a policy or approach to mutual dismantlement verification, warhead materials storage, or other materials management and control activities (including possible future production of warhead materials).

Efforts to integrate U.S. warhead dismantlement progress and plans with programs to assist Russia have not received adequate attention. There is also little linkage between Russian economic, environmental, or social needs and U.S. programs to assist or encourage Russian dismantlement and other related activities.

Policy Issues and Initiatives

The United States needs a plan for helping Russia's dismantlement and materials management process to proceed safely and without allowing warheads or warhead materials to get into the wrong hands. An important aspect of the plan is to increase coordination between the agencies responsible for U.S. materials management and disposition programs and those responsible for U.S. policy toward Russia. This is important because the United States must develop policies that utilize U.S. experience in its programs to assist Russia.

Because many problems and needs in Russia are unrelated to dismantlement, it is also important at this time to strengthen the link between U.S. assistance in nuclear materials disposition programs and other programs in which assistance is desired by Russia. It would help if there were cooperative efforts between the two nations in these matters.

To carry cooperative efforts further, an arrangement could be worked out with Russia whereby the United States would fired a 2-year joint study of materials disposition scenarios to be conducted by a U.S.-Russian multidisciplinary team based in Russia. To help ensure that dismantlement and materials disposition are proceeding safely and securely, the United States could also develop and negotiate with Russia an initiative for mutual disclosure of the amounts of weapons plutonium and highly enriched uranium possessed by each country.

An important issue is whether any storage or processing facilities used in connection with warhead dismantlement and materials management should be subject to international monitoring, inspections, or even control. In that regard, it remains to be seen whether the United States can realistically expect to verify, either directly or through international agencies, Russia's compliance with a specified rate of dismantlement-and its controlled storage of special nuclear material—without some reciprocal interest by Russia in verifying U.S. progress along the same lines. A high-level governmental process is needed to consider and address means to achieve reciprocal arrangements to verify the amounts and monitor the status of these materials in the future.

CONCLUSION

Reducing the nuclear weapons stockpile will not be simple, painless, or inexpensive. Although the work of retiring and disassembling weapons that are outdated or no longer needed in the stockpile is under way, the next critical steps in the process are uncertain because no national policy exists to guide future dismantlement and materials management activities in the United States. In addition, the United States has not developed an effective strategy for encouraging and assisting Russia in its efforts to safely

dismantle its warheads, and to safely and securely manage the materials from them.

It is important that warhead dismantlement and materials management be conducted successfully both here and abroad. Failure to do the job right in the United States could create risks of accidents, dangers to workers, and harm to the environment and populations. In Russia, all of these risks exist, but there are also risks that the weapons or materials could be diverted and fall into the wrong hands.

Yet, the existing approach by the United States to both U.S. and Russian dismantlement is insufficient. As yet, the Nation has no coordinated, comprehensive policy on this subject and there has been little informed public debate on the establishment of national goals.

The prospects for successfully carrying out dismantlement and materials management activities in the future-and perhaps assisting Russia in similar efforts--an be improved if leadership is provided now at the highest levels of government. Policy guidance will be needed from these levels. To provide such guidance, the Federal Government will frost have to articulate a national policy on dismantlement-a policy that sets the objectives and rationale for permanent stockpile reduction.

In sum, the challenge ahead requires planning and decisions in the near term if it is to be successful in the long term. The process deserves consistent and enduring talent, dedication, and resources, as well as astute management.