

# MILITARY IMPLICATIONS OF START I AND START II

---

TUESDAY, AUGUST 4, 1992

U.S. SENATE,  
COMMITTEE ON ARMED SERVICES,  
*Washington, DC.*

## DISPOSITION OF U.S. AND COMMONWEALTH OF INDEPENDENT STATES (CIS) STRATEGIC NUCLEAR WARHEADS UNDER THE START I TREATY AND THE JUNE 17, 1992 U.S.-RUSSIAN JOINT UNDERSTANDING ON FURTHER REDUCTIONS IN STRATEGIC OFFENSIVE ARMS

The committee met, pursuant to notice, at 2:15 p.m., in room SR-222, Russell Senate Office Building, Senator Sam Nunn (chairman) presiding.

Committee members present: Senators Nunn, Levin, Bingaman, Warner, Wallop, and Mack.

Committee staff members present: Arnold L. Punaro, staff director; Madelyn R. Creedon, counsel; Elizabeth I. Solomon, research assistant; Lucia M. Chavez, research assistant.

Professional staff members present: Robert G. Bell, William E. Hoehn, Jr., and David S. Lyles.

Minority staff members present: Patrick A. Tucker, minority staff director and counsel; George K. Johnson, Jr., Ronald P. Kelly, George W. Lauffer, John E. Mansfield, Ann Elise Sauer, and Gary L. Sojka, professional staff members.

Staff assistants present: Camden Jones Flick, Mary J. Kyle, and Lisa H. Kettlewell.

Committee members' assistants present: Andrew W. Johnson, assistant to Senator Exon; Richard W. Fieldhouse, assistant to Senator Levin; David A. Lewis, assistant to Senator Levin; William J. Lynn, assistant to Senator Kennedy; Edward M. McGaffigan, Jr., assistant to Senator Bingaman; Donald A. Mitchell, assistant to Senator Glenn; Leon S. Fuerth, assistant to Senator Gore; Grayson F. Winterling, assistant to Senator Warner; James M. Bodner, assistant to Senator Cohen; Anthony H. Cordesman, assistant to Senator McCain; Eric H. Thoemmes, assistant to Senator Wallop; Samuel D. Adcock, assistant to Senator Lott; Pam Sellars, assistant to Senator Coats; Ross M. Lindholm, assistant to Senator Mack; Thomas L. Lankford, assistant to Senator Smith.

**OPENING STATEMENT OF SENATOR SAM NUNN, CHAIRMAN**

Chairman NUNN. The committee meets today to continue our hearings on the START I Treaty and the June 17, 1992, U.S./Russian Joint Understanding on further reductions in strategic offensive arms, also known as START II. Our focus this afternoon will be on the disposition of the tens of thousands of U.S. and CIS strategic nuclear warheads that will be withdrawn from deployed inventories as a result of these two treaties.

Under both START I and START II, neither side is required to eliminate a single nuclear warhead. Instead, each side is free to decide which strategic nuclear warheads to disassemble or destroy, which to recycle for use with other strategic nuclear systems, and which to keep in storage.

Last year the prospect of thousands of nuclear weapons suddenly being removed from the missiles, bombers, and ships of the former Soviet Union gave rise in Congress to grave fears that United States and allied nuclear nonproliferation efforts might be seriously undermined. Indeed, this concern was the primary motivation for enactment of the Soviet Nuclear Threat Reduction Act of 1991, known as the Nunn-Lugar program.

To date, the Nunn-Lugar program has been directed principally toward assisting Russia in transporting, safeguarding, storing and eliminating the thousands of tactical nuclear weapons that were rendered excess by the Bush/Gorbachev initiatives of last fall.

The United States has agreed to provide Russia with armored blankets, emergency response equipment, and fissile material containers. Discussions will continue in other areas of possible cooperation, including building new safety and antiterrorism features into Russian rail cars, construction of a storage facility for the fissile materials which Russia will extract from the warheads, and establishment of a sophisticated computer system for the control and accountability of these materials.

As challenging as this Nunn-Lugar undertaking has been so far, it will be equally challenging to try to cope with the large volume of strategic nuclear warheads that are now slated for withdrawal from CIA strategic forces. At our committee's opening hearing on START last Tuesday, Secretary Cheney noted that as a result of these two treaties Russia was going to, quoting from Secretary Cheney, "have a difficult time managing the reduction of all that has been promised to be reduced. There are a huge number of nuclear weapons to be dismantled and it is going to take seven years to get the job done, to get down to those levels."

The Secretary also noted that under the terms of START II the deadline for reaching the final reduction ceilings, including the total elimination of all land-based MIRVs, can be accelerated from 2003 to 2000 if the United States contributes financially to Russia's destruction of these weapons.

Secretary Cheney said we should be prepared to offer a "robust program of assistance" to achieve an acceleration of the deadline, though he could not say exactly how much U.S. assistance might be needed. I look forward to working with the administration as it discusses START II financial aid options with Russia. I am confi-

dent we will be able to tailor future installments of the Nunn-Lugar program to incorporate these funding requirements.

As my colleagues are aware, Nunn-Lugar funding is subject to certain conditions, some of which were specifically intended to ensure that the CIS nuclear weapons that are subject to this program are actually destroyed and not recycled, sold or transferred. For example, before providing assistance under this Act, the President must certify that Russia is committed to foregoing any use of fissionable and other components of destroyed nuclear weapons in new nuclear weapons. He must also certify that Russia is committed to facilitating United States verification of weapons destruction.

The first certification under the Nunn-Lugar program was submitted on April 8, when Deputy Secretary of State Eagleburger, acting on behalf of the President, informed the Congress that "it is our judgment that Russia is committed to facilitating U.S. verification in this area."

Nonetheless, concerns have been raised in some quarters that the verification and control arrangements under the Nunn-Lugar program do not go far enough in protecting against proliferation and should be supplemented with a reciprocal regime under which the United States would grant Russia comparably intrusive inspection rights.

For example, in June the House of Representatives incorporated a provision in its version of the fiscal year 1993 defense authorization bill that would express the sense of the Congress that the President should negotiate a verifiable agreement with the CIS providing for the monitoring and inspection of nuclear weapons dismantlement, the disposal of fissile materials, and a ban on further production of fissile material.

The House provision is not binding. However, a binding provision on this issue was recently adopted by the Senate. In its markup on the resolution of ratification for the START I Treaty, the Senate Foreign Relations Committee approved a condition proposed by Senator Biden which would require the President, as a condition to entering the treaty into force, to agree to seek to negotiate with Russia, quoting from that provision adopted by the committee: "an appropriate arrangement, including the use of reciprocal inspections, data exchanges, and other cooperative measures, to monitor (A) the numbers of nuclear stockpile weapons on the territory of the parties of this Treaty; and (B) the location and inventory of facilities on the territory of the parties to this treaty capable of producing or processing significant quantities of fissile materials."

The Armed Services Committee will need, therefore, to address both of these measures when we return from the August break: the House's warhead control provision in the conference on our bill, as well as the Biden Condition when the START I Treaty comes before the full Senate.

Today's hearing is intended to help inform members on these important issues. We will first hear from a panel of public witnesses with considerable expertise and experience in this area. Dr. Frank von Hippel, Professor of Public and International Affairs at Princeton, has led joint U.S. and Russian discussions on this topic for the

last several years in concert with the Federation of American Scientists (FAS) and the Natural Resources Defense Council (NRDC).

I believe that Jeremy Stone and Tom Cochran of those two groups are here in the audience today and we welcome you. We know you have also been working on this for a long time.

Dr. von Hippel is joined on this panel by Dr. Robert Barker, who has testified before us on many occasions and is making his first appearance before the committee following his tenure as Assistant to the Secretary of Defense for Atomic Energy. Dr. Barker, we are glad to have you back.

We will then hear from a panel of three witnesses representing the administration: Mr. Robert Gallucci, Assistant Secretary of State for Political-Military Affairs; Mr. Richard Claytor, Assistant Secretary of Energy for Defense Programs; and Mr. Douglas Graham, Deputy Assistant Secretary of Defense for Strategic Defense, Space, and Verification Policy.

Mr. Gallucci recently completed service as the senior State Department official working full time on proliferation matters involving the former Soviet Union, and we look forward to hearing his views on this issue from that perspective.

If matters arise during the second panel which require classified answers, I would suggest we reserve those answers until the conclusion of the hearing and then move to the other committee hearing room, SR-232A, which has been secured for a closed hearing. Senator Warner?

Senator WARNER. Thank you, Mr. Chairman. That was a very comprehensive opening statement, and I think very properly sets forth the issues.

I just want to pick up on one or two points after joining you in welcoming the distinguished witnesses that we have before us today.

Let's start off with the point you made, Mr. Chairman, about the proposed Biden condition to the resolution of ratification of START I. Does that not raise some troubling issues? I would hope that you would deal with that today, and specifically, is the condition intended to apply to a START II Treaty pursuant to the June 17 summit agreement? Will such a treaty be achievable if warhead and fissile material controls are required to be included in the agreement? If so, what impact will the condition have on the timely negotiation of such a treaty?

Most important, I think, to a number of us on the committee, is the warhead and fissile material inventory and control regime required by the Biden condition ultimately in the national security interest of the United States?

I look forward with you, Mr. Chairman, to these responses and others. We have had a hearing with the Secretary of Defense and the Chairman, and we also talked about the questions of inoperability of START I and the related Lisbon protocols with the treaty which will be negotiated pursuant to the June 17 agreement.

So these questions, I think, are unique to this framework. On the whole, I wish to congratulate the President, his Secretary of State, and all others who have been involved in bringing forward to the Senate and indeed the whole Nation a framework of treaties which will go a long way to relieve the tensions and misunderstandings

between the former Soviet Union, now the several states, and the United States.

Chairman NUNN. Thank you, Senator Warner. At this time I would like to enter into the record the prepared statements of Senators Dixon and Thurmond.

[The prepared statements follow:]

PREPARED STATEMENT BY SENATOR ALAN J. DIXON

Mr. Chairman, it is a pleasure to have with us today two distinguished panels to discuss the disposition of U.S. and Commonwealth of Independent States nuclear warheads.

I am deeply interested in what these gentlemen have to say about what will happen to the thousands of nuclear warheads which, over the next several years, will be removed from active inventories as a result of the START Treaties. I want to make sure these warheads do not end up in the wrong hands.

I, along with many of my colleagues, am very concerned with the spread of nuclear weapons. Unless some concrete action is taken, I am afraid that with the break-up of the Soviet Union these mass destruction weapons may find their way into other countries, some of whom are not at all fond of United States. I look forward to the comments by our witnesses.

Thank you, Mr. Chairman.

PREPARED STATEMENT BY SENATOR STROM THURMOND

Thank you, Mr. Chairman: Mr. Chairman, I want to join you in welcoming our distinguished panel members. Their combined expertise on nuclear weapons will be helpful to this committee in making recommendations to the full Senate on the ability to verify and the merits of the agreements reached in START I and the Yeltsin-Bush Joint Understanding of June 17, 1992.

As I indicated in the previous hearing on the START I Treaty, I believe that reductions in nuclear weapons are in the Nation's and humanity's best interest. However as we all know, the draw-down of nuclear weapons is only the beginning of the disarmament process. A key question in my mind is what will happen to the thousands of nuclear warheads and their fissionable components.

In that regard, we must ask if it is better to maintain and secure a complete warhead or the plutonium pit. We should also consider how much intrusion we will allow into our nuclear weapons complex. Do we want to give complete access to the PANTEX facility to verify the dismantling of the warhead? In the latter case, I doubt that it is in the Nation's best interest, but I am willing to listen to the experts.

Mr. Chairman, I congratulate you on holding this hearing to look beyond the dismantling of the weapons delivery systems and into the crux of the disarmament process: What happens to the nuclear warhead and its components?

Thank you, Mr. Chairman.

Chairman NUNN. Dr. von Hippel.

STATEMENT OF DR. FRANK VON HIPPEL, PROFESSOR OF PUBLIC AND INTERNATIONAL AFFAIRS, PRINCETON UNIVERSITY, AND CHAIRMAN OF THE RESEARCH ARM OF THE FEDERATION OF AMERICAN SCIENTISTS

Dr. VON HIPPEL. Thank you, Mr. Chairman. I am a physicist as well as professor of public and international affairs at Princeton.

For the past 5 years I have directed a U.S.-Russian joint research project on the verification of nuclear warhead dismantlement under the auspices of the Federation of American Scientists, the FAS. I have submitted to the committee a copy of a report that we wrote a year ago titled "Ending the Production of Fissile Materials for Weapons, Verifying the Dismantlement of Nuclear Warheads: The Technical Basis for Action."

I have also submitted a prepared statement which goes into some detail. I will only outline it in my oral statement.

Chairman NUNN. Your entire statement will be part of the record, without objection.

Dr. VON HIPPEL. Thank you. I have also submitted to the committee a report on a very tricky subject which has drawn a lot of interest, the question of the ultimate disposition of separated plutonium.

Now I will outline what could be done to implement the Biden condition and the proposal in the House defense authorization bill that the President negotiate reciprocal controls on nuclear warheads and materials.

I would just like to interject in response to Senator Warner's concern that the Biden condition could delay the ratification of START II, that the condition only requires the President to seek nuclear warhead and fissile material control agreements.

The problem is that the President has not been seeking such agreements. The Russian government has made clear that it is open to such agreements. If the President was willing to launch negotiations, I think that substantial progress toward a nuclear warhead and fissile material control regime could be achieved before START II came back to the Senate for ratification. And I believe that the supporters of the Biden condition would be satisfied with substantial progress in this area.

Now, why do we need such a regime? In brief, it is to assure the destruction of tens of thousands of CIS warheads and to assure that the recovered fissile materials are disposed of in a safe and irreversible manner. This would minimize the danger that some future regime might break out of the reduction agreements or that warheads or materials might be diverted to Third World countries or terrorist groups.

Part of the proposal would also be to end Russian production of weapons plutonium and to assure that production of highly-enriched uranium for weapons in the CIS is not resumed.

As the Chairman stated, the Nunn-Lugar Act has already taken an important step in this direction in establishing a cooperative relationship under which the U.S. is providing assistance for the disposal of CIS warheads. As the Chairman has also stated, the Nunn-Lugar Act also requires that the President certify that the CIS commits to forego replacement of the destroyed weapons and any reuse in weapons of the fissionable or other components and to facilitate U.S. verification of the weapons destruction.

However, there are limits to how far we can ask Russia to go unilaterally, even in exchange for financial assistance. Recall that the Gorbachev-Yeltsin commitment to destroy approximately 15,000 Russian tactical nuclear weapons was made in response to President Bush's invitation to "go down the road with us" to destroy our entire inventories of ground-launched theater nuclear weapons and a large fraction of our naval tactical weapons.

But the Bush administration apparently has not interpreted "destroy" in the same way that the Russian Government has. The administration wants to keep open the option of building new warheads from the fissile material recovered from our destroyed tacti-

cal warheads, while the Nunn-Lugar Act insists that Russia cannot do the same.

As awareness of this asymmetry spreads, the Yeltsin leadership, which is already being accused of "unilateral disarmament", is likely to get into serious trouble with Russian conservatives.

We do not have any real reason to keep the recycle option open, if the Russians fulfill their reduction commitments. We have agreed to go down to 3,500 strategic warheads, if they do, and General Powell has indicated the U.S. will need no more than 1,600 tactical nuclear warheads. Such reductions could make surplus the fissile material from about 15,000 U.S. warheads, although I am not advocating that we forego the weapons use of all of the recovered material.

Let me conclude briefly by discussing each element of a comprehensive warhead and materials control regime.

#### DECLARATIONS OF WARHEAD AND FISSILE MATERIAL STOCKPILES.

If the administration proposes an exchange of information on warhead and fissile material stockpiles, a positive response was already given on 12 February by Foreign Minister Kozyrev, who proposed such an exchange.

Such declarations could be spot-checked in the same way as declarations of the numbers of reentry vehicles on individual ballistic missiles are to be checked under the START agreement. Exchanges of historical production information, comparison with historical intelligence data, and cooperative "nuclear-archeology" projects could increase our confidence in the declarations.

#### VERIFIED ELIMINATION OF WARHEADS COMMITTED TO BE DESTROYED

Arrangements for verifying warhead destruction would also be straightforward. They should include segregated storage of the warheads committed to be destroyed and segregated storage of the fissile materials recovered from them. We could tag and seal each other's warhead canisters in storage, check the tags and seals when the canisters are delivered to the dismantlement facilities, and then place the recovered fissile materials under IAEA type safeguards.

Now, a brief digression with regard to what to do with the materials. I think there is broad agreement that most highly-enriched uranium could be used to provide fuel for light water reactors. It would be diluted down to enrichments of a few percent, which is unusable for weapons. The dilution should be undertaken as early as possible to relieve concerns that some of the highly-enriched uranium might be diverted.

Plutonium is more problematic. Even if diluted, it could be separated back out from the dilutant quickly by even a subnational group using chemical means. This fuel would therefore have to be subject to very tight safeguards, something that appears to be incompatible with commercial nuclear power.

The cheapest and most secure route for the United States would be to mix the plutonium back into the high-level waste from which it was originally separated, as that waste is glassified. Glassification plants being built at Savannah River and Hanford could each

dispose of at least as much plutonium—about 4 tons a year—as 18 Russian light water reactors.

If this is not workable for Russia for some reason, a modified fuel strategy could be followed that would put plutonium in the fuel of reactors located at only one site in Russia rather than spreading it all over Russia. This could be done by modifying the reactors at that site to use 100-percent mixed plutonium-uranium fuel instead of the one-third limit on reactors designed for low-enriched uranium fuel.

#### A VERIFIED PRODUCTION CUTOFF OF FISSILE MATERIALS FOR WEAPONS

President Bush has made it official that the United States does not intend to resume the production of plutonium or highly-enriched uranium for weapons. President Yeltsin has already offered to turn this into a verified bilateral cutoff.

Some within the Administration object to the acceptance by the United States of the same kind of safeguards that have been accepted by about 50 non-nuclear weapons states under the Nonproliferation Treaty. However, we opened up almost all our civilian nuclear facilities to IAEA inspection in 1980. At this point, we would only have to add to the list the gaseous-diffusion plants.

If we resume production of tritium in a decade or two, it will also be necessary to be able to prove that we are not using the production reactor or accelerator for producing plutonium for weapons. The verification arrangements for this could be quite straightforward.

Overall, if we have IAEA type verification arrangements on U.S. and Soviet civilian nuclear facilities, the cost would be on the order of \$100 million a year, which is a few tenths of a percent of the current U.S. budget for nuclear weapons.

If the United States and Russia were to join the 150 non-nuclear weapons states that have signed the Nonproliferation Treaty in subjecting their civilian fissile materials and production facilities to IAEA safeguards, we would be strengthening the legitimacy of the nonproliferation regime and we would be creating the basis for a universal regime, which it would be difficult for Britain, France, China, Israel, India and Pakistan not to join. The President has already asked Israel to verifiably stop its fissile production.

So, in conclusion, I think we have an opportunity here to lock in the deep cuts that have been negotiated in the CIS nuclear arsenal and to develop the basis for a worldwide cutoff in the production of fissile materials for weapons. We have this opportunity because we have a leadership in Russia which would welcome this kind of development. It is not clear that we will have that leadership indefinitely, and I do not think we should pass this opportunity by.

Thank you.

[The prepared statement of Dr. von Hippel and information referred to follow:]



PREPARED STATEMENT BY FRANK VON HIPPEL, PROFESSOR OF PUBLIC AND INTERNATIONAL AFFAIRS, PRINCETON UNIVERSITY AND CHAIRMAN OF THE RESEARCH ARM OF THE FEDERATION OF AMERICAN SCIENTISTS

CONTROLS ON NUCLEAR-WARHEADS AND MATERIALS

I am a physicist and Professor of Public and International Affairs at Princeton University.

For the past five years, I have directed a U.S.-Russian joint research project on the verification of nuclear-warhead dismantlement under the auspices of the Federation of American Scientists (FAS).\*

A year ago, we summarized the results of this joint research in a report, *Ending the Production of Fissile Materials for Weapons, Verifying the Dismantlement of Nuclear Warheads: The Technical Basis for Action*. This report has been submitted to the Committee along with an article on the same subject by Wolfgang Panofsky and Spurgeon Keeney.<sup>1</sup> A classified report on the same subject was submitted to the Congress by the President."

The Russian participation in our workshops has changed with time. Initially it was a group of Academicians organized by Evgeny Velikhov. After nuclear-warhead arms control became an official goal of the Moscow government, senior members of the Foreign and Nuclear Ministries joined in our workshops.\*\*\* Our most recent workshops, which were held in Bonn and London in June, focused on the problem of disposing of plutonium from dismantled nuclear warheads.\*\*\*\*

**The Biden Condition and House Defense Authorization Language**

This hearing is being held in part because of the Biden Condition, added by the Senate Foreign Relations Committee to its proposed START ratification resolution (copy attached). This condition calls on the President, "in connection

---

\* The Natural Resources Defense Council has also been working on this subject and we have collaborated in organizing joint U.S.-CIS workshops

\*\* *Verification of Nuclear Warhead Dismantlement and Special Nuclear Material Controls* (classified report to Congress with an unclassified summary, July 1991) My understanding is that there are no major technical differences with the FAS report. However, the President's report studiously avoids endorsing controls on nuclear-warheads or materials

\*\*\* It was while he was attending one of these workshops that Victor Mikhailov, then Deputy Minister of Atomic Energy (now Minister), came to Senators Nunn and Lugar last October with a request for \$400 million in U.S. assistance for the construction of a facility to store fissile materials recovered from dismantled CIS warheads

\*\*\*\* These workshops were funded principally by the International Foundation. The Bonn workshop was organized jointly with the Frankfurt Peace Research Institute and the London workshop with the Science Policy Research Unit of Sussex University and the Center for Defense Studies of Kings College, London

with any further agreement reducing strategic offensive arms," to negotiate appropriate arrangements "including the use of reciprocal inspections, data exchanges, and other cooperative measures to: a) monitor the numbers of stockpiled warheads and b) the fissile material inventories of facilities "capable of producing or processing significant quantities of fissile materials."

The House version of the Fiscal Year 1993 Defense Authorization Act contains more detailed language along the same lines (Subtitle D: International Fissile Material and Warhead Control, excerpts attached). This language repeats and amplifies recommendations to the President in the Fiscal Year 1991 Defense Authorization Act (section 3151). Indeed, I believe that the Biden Condition was attached to the ratification resolution in part because the Administration had not responded to Congressional interest in nuclear-warhead and material arms control.

#### Controls on Nuclear-warheads and Materials

This is not a new subject. In 1956, President Eisenhower proposed a verified bilateral cutoff in the production of "fissile materials" (plutonium and highly-enriched uranium [HEU]) for weapons.<sup>2</sup> The Kennedy and Johnson Administrations developed this proposal further<sup>3</sup> and added to it a proposal for the verified dismantlement of large numbers of nuclear warheads and the transfer of the recovered fissile materials to safeguarded non-weapons uses.<sup>4</sup>

The Soviet Union rejected the U.S. proposals because it saw them both as attempts to lock it into quantitative inferiority<sup>5</sup> and excuses for spying. The focus of nuclear-arms control therefore turned to agreements limiting launchers and bombers and other items that could be verified by national technical means.

In the meantime, controls on nuclear materials became the core of the non-proliferation regime. Non-nuclear-weapon states that have signed the Non-proliferation Treaty have accepted IAEA safeguards on their fissile materials and on facilities that process these materials to provide assurance to the international community that they are living up to their commitments. This system of safeguards is now being extended into 14 of the 15 republics of the former Soviet Union; and to Argentina, Brazil, South Africa and (hopefully) North Korea.

As the Biden condition and the House propose, the time is ripe to return to U.S.-Russian nuclear-warhead and fissile-material arms control -- but for a new set of reasons.

Presidents Gorbachev and Yeltsin have committed the C.I.S. and Russia to destroy about 15,000 tactical nuclear warheads<sup>6</sup> and more than two thousand strategic warheads to be withdrawn from Belarus, Kazakhstan and Ukraine.\* Bilateral agreements would make it possible to verify the destruction of these and hopefully additional thousands of warheads and the nonweapons use of the recovered fissile materials.

It is important that these materials be disposed of in a safe and irreversible manner to minimize the danger that some future regime might use them in warheads again or that they might be diverted to Third World countries or terrorist groups

It is also important to assure that Russian production of new weapons plutonium be ended and that production of highly-enriched uranium for weapons not be resumed.

The Biden Condition and House bill propose to achieve these ends by reciprocal and verified agreements.

#### Relationship to the Nunn-Lugar Act

The Nunn-Lugar "Soviet Nuclear Threat Reduction Act of 1991" has already taken an important step in this direction by establishing a cooperative relationship under which the U.S. is providing assistance to assure safe transport and storage of C.I.S. warheads and fissile materials.

Furthermore, the Nunn-Lugar Act requires the President to certify that, in exchange for U.S. assistance, the C.I.S. is

---

\* Following the March holdup of warhead transfers from the Ukraine, Russia has agreed to allow Ukrainian inspectors to track the fissile materials recovered from all warheads removed from Ukraine. Russian officials say that similar arrangements are open to Belarus and Kazakhstan.

"forgoing the replacement of the destroyed weapons...forgoing any use of fissionable and other components of destroyed weapons in new nuclear weapons...[and] facilitating United States verification of [the] weapons destruction."

Russian government officials say that there are no plans to reuse in weapons the fissile materials from the tactical nuclear warheads that Presidents Gorbachev and Yeltsin committed to "eliminate." The Russian Ministry of Atomic Energy is already negotiating with a U.S. company to dilute a significant amount of the HEU to low-enriched levels for sale for power-reactor fuel.<sup>7</sup> It is also negotiating with the U.S. for funding from the Nunn-Lugar \$400 million to help to build a secure storage facility for the remaining HEU and the plutonium.

However, as both the Biden Condition and the House proposals on recognize, there are limits on how far we can ask Russia to go unilaterally -- even in exchange for financial assistance.

In fact, I am concerned that our expectations of unilateralism may make it difficult for Russia to sustain the commitments that it has made. Recall that the Gorbachev/Yeltsin commitment to destroy most Russian tactical nuclear weapons was made in response to President Bush's invitation, in his 27 September 1991 speech:

"to go down the road with us -- to destroy their entire inventory of ground-launched theater nuclear weapons [and] many...tactical nuclear weapons from...ships and attack submarines [and] land-based naval aircraft."

The Nunn-Lugar Act requires Russia to forgo reuse in nuclear weapons of the fissile material recovered from those tactical nuclear weapons. But the Bush Administration apparently is not ready to make the reciprocal commitment.

If the U.S. keeps open the option of recycling fissile material from warheads that we have committed ourselves to destroy while the Nunn-Lugar Act insists that Russia cannot do the same, the Yeltsin Administration is likely to get into serious trouble with Russian conservatives. President Yeltsin is already being accused of agreeing to "unilateral disarmament" because of the "unequal" reductions agreed to in the 17 June 1992 joint understanding on post-START reductions.

Keeping open the U.S. recycle option has also put our negotiators into a difficult position as they try to establish Russian compliance with the Nunn-Lugar requirement, since the Russian government has repeatedly made clear that it wants reciprocity.

In fact, we have no real reason to keep the recycle option open. We have agreed to go down to 3500 strategic warheads if Russia does and General Powell has indicated that, if Russia carries through on its tactical-warhead reduction commitments, the U.S. will need no more than 1600 tactical nuclear warheads. This would correspond to approximately a 70-percent reduction in the U.S. nuclear arsenal relative to 1990 levels. We can therefore afford to commit many thousands of nuclear warheads to destruction including the safeguarded disposal of the recovered fissile materials.

In the remainder of my statement, I would like to briefly explain what would be done under each element of the comprehensive nuclear-warhead and nuclear-materials control regime proposed in the Biden Condition and the House bill.

#### Information on Warhead and Fissile-Material Stockpiles

If the Administration follows through on the Biden Condition and proposes to Russia an exchange of information on warhead and fissile-material stockpiles, the response has already been given. On 12 February, at the plenary meeting of the Conference on Disarmament in Geneva, Russian Foreign Minister Kozyrev proposed that:

"we may consider developing a reciprocal exchange of data between all nuclear powers on the number and types of existing nuclear weapons, the amount of fissionable materials, and on nuclear weapons storage and elimination facilities."

The earlier we exchange such data, the more they will constrain the ability of future governments to conceal warheads or materials.

If such declarations included numbers and types of warheads at different locations, they could be spot checked if desired, just as in the START agreement

which allows spot checks of the numbers of warheads carried by individual ballistic missiles.' There could also be arrangements for challenge inspections, such as are proposed under the Chemical Weapons Ban, to check that warheads are *not* where they are not declared to be.

Total quantities of fissile materials inside the declared warheads could be verified without revealing the quantities in individual warheads by putting weighted samples through a dismantlement facility and assaying the total quantities of recovered fissile materials.

Declared inventories of fissile materials not in warheads or components could be verified by the same assay techniques used by the IAEA.

There would always remain the possibility that some warheads and fissile material had been hidden. However, the declarations would serve to isolate them. Exchange of historical production information, comparison with historical intelligence data and cooperative "nuclear archeology" projects could increase confidence in the declarations.

#### Verified Elimination of Warheads Committed to be Destroyed

Warheads have a finite life. Therefore, in the long term, unless we commit ourselves to go to zero, fissile materials recovered from some dismantled warheads will be recycled into replacement warheads. But, for those warheads that are committed to be "destroyed," destruction would include placing the recovered fissile materials under safeguards.

For Russia, which is reported to have four warhead disassembly/assembly facilities,\*\* the two types of dismantlement activities could be carried out at different locations. In the case of the U.S., which has only one such facility, the

---

\* The declarations could include fabricated warhead components. As in the START verification arrangements, the warheads, components and parts of associated equipment could be covered to protect any sensitive information.

\*\* Near Nizhnyaya Tura and Zlatoust in the Urals, and Penza and Arzamas, south of Nizhni Novgorod (Gorki)

Pantex plant near Amarillo, Texas, the two types of activities could be separated by batch processing.

Possible arrangements for verifying warhead dismantlement are described in both the FAS report and the President's report. In my view, they should include at least segregated storage of the warheads committed to be destroyed and of the fissile materials recovered from them. We could tag and seal each others' warhead canisters in storage, check the tags and seals when the canisters are delivered to the dismantlement facilities, and then have IAEA-type safeguards at the storage facilities for the recovered fissile materials.

It would also be possible to have IAEA-type portal-perimeter controls to assure that the fissile materials recovered from the warheads went only to the safeguarded storage facilities. And the spectrum of the gamma-radiation coming out of the canisters could be measured to check that it matched the declared warhead inside.

**Ultimate Disposition of the Highly-enriched Uranium and Plutonium.<sup>4</sup>** There is already broad agreement on what to do with the highly-enriched uranium (HEU). A relatively small fraction will be kept as highly-enriched uranium to provide fuel for naval-propulsion reactors and a few research reactors. In the U.S., these reactors require only a few tonnes of HEU a year while hundreds of tonnes will be released as a result of the dismantlement of surplus U.S. warheads.

The logical use of the remaining HEU is to provide fuel for light-water power reactors which use fuel enriched to between two and five percent in the isotope uranium-235. For this purpose, the weapons uranium would be diluted with natural or depleted uranium. (Weapons-grade uranium is enriched to over 90 percent U<sup>235</sup>. Natural uranium contains 0.7 percent. Depleted uranium, which is the residue from uranium enrichment, typically contains 0.2-0.3 percent U<sup>235</sup>.) Although it may be necessary to store some of this material temporarily to avoid

---

\* The FAS report contains an example of a gamma-ray spectrum of a Russian warhead, taken by a group organized by the NRDC on the Soviet cruiser "Slava" in the Black Sea off of Yalta on 5 July 1989 [Steve Fetter, Thomas B Cochran, Lee Grodzins, Harvey L Lynch and Martin S. Zucker, "Measurements of Gamma Rays from a Soviet Cruise Missile," *Science* 248, 18 May 1990, pp 828-834]. The leaderships of the two Russian weapons laboratories disagree about whether this spectrum reveals sensitive design information. However, they agree that the same information could be provided in a way which concealed this design information without degrading its value as a fingerprint.

market disruptions, it should be diluted down to non-weapons grade as early as possible. It is not necessary to store low-enriched uranium in a high-security storage facility.

Diluting HEU with natural or depleted uranium "denatures" it for weapons use in a way that is irreversible except with an isotope-separation plant. As the Iraqi program showed, building such a plant is still extremely difficult for even a rich Third-World country.

There is less plutonium in the warheads -- only about 100-140 tonnes versus 500-700 tonnes of HEU in each of the arsenals -- but getting rid of it is more problematic. Plutonium diluted with natural or depleted uranium could quickly be separated back out by even a subnational group using chemical means. Fresh fuel containing plutonium must therefore be subject to almost as tight safeguards as the original plutonium.

Unfortunately, the nuclear ministries of West Europe and Japan, as well as parts of the Russian Ministry of Atomic Energy, are lobbying to use Russian weapons plutonium in "mixed-oxide" (MOX) fuel made up of approximately 4 percent plutonium and 96 percent uranium oxides. The West European and Japanese advocates of MOX fuel see the elimination of Russian weapons plutonium as a new justification for their own commercial programs of plutonium separation and recycle, which are causing great controversy and failing economically at home. Their plan would be to have each large light-water-reactor in Russia fueled with one-third MOX fuel. This would consume weapons plutonium at a rate of about 4 tonnes a year at six sites.<sup>9</sup> At this rate, it would take two decades to process 80 tonnes.

The rate would be much slower, however, if the consumption of civilian plutonium is given priority as planned by the Russian Ministry of Atomic Energy. They have already separated about 50 tonnes of civilian plutonium thus far at the Mayak facility near Chelyabinsk and are continuing to separate it at a rate of about 2.5 tonnes each year. If this plutonium is put in front of the weapons plutonium -- and there are technical arguments for doing so<sup>10</sup> -- consumption of weapon-grade plutonium would be delayed by more than a decade.

There is therefore a strong incentive to find a disposal method that would proceed more expeditiously and would not disperse the plutonium to so many sites.



One idea that would work very well in the U.S. -- where there is, in any case, no serious consideration of using plutonium as fuel -- would be to mix it back into the high-level waste from which it was originally separated as the waste is glassified. To my knowledge, this idea was put forward originally by the Pacific Northwest Laboratory.<sup>11</sup> Billion-dollar glassification plants are being built at the Savannah River and Hanford sites. They will each produce about 400 tonnes of glass a year (assuming an average 50-percent capacity factor). If one percent plutonium were added, each of these plants would dispose of about four tonnes of plutonium a year -- as much as 18 Russian light-water reactors. It is not clear, however, that all Russian weapons plutonium could be absorbed in this way.<sup>12</sup>

Another way to centralize the disposal of plutonium would be to convert a few light-water reactors so that they could use 100-percent MOX fuel. This would make it possible to burn as much Russian weapons plutonium at one site as is currently proposed for six sites. If, the fuel burnup were halved, only three reactors could be used or the throughput at a six-reactor site could be doubled to eight tonnes per year.

In any case, it is important that the U.S. not let itself be stampeded by plutonium-fuel enthusiasts into backing a half-baked and dangerous approach. We should take time to sort out the alternatives -- which will take at least a decade to implement in any case.

In the meantime, we should make sure that there is secure storage for the plutonium.

#### **A Verified Production Cutoff of Fissile Materials for Weapons**

President Bush stated recently that the U.S. does not intend to resume the production of plutonium or highly-enriched uranium (HEU) for weapons. The Department of Energy has been assuming this since at least the beginning of 1990 when it became clear that the U.S. nuclear arsenal was going to be greatly downsized.<sup>13</sup>

If President Bush would like to turn our fissile-material production cutoff into a verified bilateral agreement, the answer has once again already been given.

In his statement of 29 January, President Yeltsin made clear that President Gorbachev's repeatedly offer still stood:

"We confirm the proposal to the U.S. to come to agreement on controlled termination of the production of fissionable materials for weapons."

Some within the Administration have been resisting the verification arrangements for a cutoff.<sup>14</sup> They argue that the new relationship between the U.S. and Russia makes it possible to truncate President Reagan's maxim, "Trust but verify" to simply "Trust." They also complain about the costs of verification. However, their main objection is to the acceptance by the U.S. of the same type of international safeguards that have been accepted by about 50 non-nuclear-weapon states under the Nonproliferation Treaty. This stance undermines the legitimacy of the nonproliferation regime as well as our ability to lock in Russian reductions and reinforce Russia's national safeguards.

In fact, we opened up almost all of our civilian nuclear facilities to IAEA inspection in 1980.<sup>15</sup> At this point, we would only have to add to the list the gaseous-diffusion plants.\* This would be easy now that we are no longer producing highly-enriched uranium for any military purpose including naval-propulsion reactors.<sup>16</sup> It would be easy also to verify nonintrusively that our military plutonium-production reactors and reprocessing plants have been shut down.

If we resume production of tritium in a decade or two, it will also be necessary to be able to prove that we are not using the production reactor or accelerator to produce plutonium for weapons. But that could be done nonintrusively using standard safeguards techniques.<sup>17</sup>

It is true that these verification arrangements would cost money. The IAEA safeguards budget for 1993 is \$62 million -- almost all spent in the nonnuclear-weapon states. It would cost at least as much more to extend the safeguards over the U.S. and Russian civilian nuclear facilities.<sup>18</sup> Presumably the West and Japan will have to foot most of the bill one way or another. However,

---

\* The only sensitive information in these plants relates to the design of the barriers which are hidden inside the piping

the money involved would be only a few tenths of a percent of the current U.S. budget for nuclear weapons.

#### Nonproliferation Benefits

If the U.S. and Russia were to join the 150 nonnuclear-weapon states that have signed the Non-proliferation Treaty in subjecting their civilian fissile materials and production facilities to IAEA safeguards, we would be creating the basis for a universal regime which it would be difficult for Britain, France, China, Israel, India and Pakistan not to join and we would be strengthening the legitimacy of the nonproliferation regime. Many NPT signatories, including Germany and Japan, have always been unhappy about the fact that, although they have committed themselves to remain nonnuclear and accept safeguards, the Soviet Union and U.S. were unwilling even to commit themselves to cut off the growth of their arsenals. India used this as one of its rationales for not joining the Nonproliferation Treaty.<sup>19</sup>

President Bush proposed last year that Israel accept a verified cutoff of its production of fissile material in order to create momentum toward a Middle East nuclear-weapons-free zone. The Israelis with whom I have discussed this proposal have indicated that it would have much more force if it was framed in the context of an effort to achieve a universal production cutoff. I believe that we would also have a better chance in this context to freeze India's and Pakistan's buildups.

#### Conclusion

To conclude, the Biden Condition and the House bill reflect an understanding within the Congress that we should not miss this window of opportunity to lock in the deep cuts in the C.I.S. nuclear arsenal and to develop the basis for a universal set of controls that could be extended to other nuclear-weapon and threshold states. The negotiations should not be difficult, the Russian government has already said "yes." The question is whether we can take "yes" for an answer.

### Notes and References

- 1 Spurgeon Keeny and W K H Panofsky, "Controlling Nuclear Warheads and Materials Steps Toward a Comprehensive Regime" *Arms Control Today* 22 January/February 1992, pp 3-9
  - 2 Letter from President Eisenhower to Soviet Premier Bulganin, 1 March 1956, *Documents on Disarmament, 1943-1959*, pp 593-595
  - 3 The final form of the U.S. fissile-material-production-cutoff proposal was put forward at the beginning of the Nixon Administration by ACDA Deputy Director Fisher to the Eighteen Nation Disarmament Committee, 8 April 1969, *Documents on Disarmament, 1967*, pp 158-164
  - 4 Address by Ambassador Goldberg to the General Assembly [Extract], 23 September 1965, *Documents on Disarmament, 1965*, pp 433-436, Statements by ACDA Director Foster to the First Committee of the General Assembly, 18 October 1965, *ibid.* pp 474-482 and 27 October 1965, *ibid.* pp 505-512 The government also conducted a major exercise to explore the tradeoff between intrusiveness and effectiveness in on-site verification of nuclear-warhead dismantlement [US ACDA, *Demonstrated Destruction of Nuclear Weapons*, Final Report, Volume I, January 1969, partially declassified in 1990]
  - 5 This was, in fact, correct See e.g. Glenn T Seaborg, *Stemming the Tide Arms Control in the Johnson Years* (Lexington, MA Lexington Books, 1987), pp 398-401
  - 6 The commitment, as laid out in President Yeltsin's 29 January 1992 speech includes the following categories of warheads
    - o All nuclear artillery shells, warheads for tactical ballistic missiles and nuclear mines.
    - o One half of the Air Force's tactical nuclear weapons and one half of the nuclear warheads for anti-aircraft missiles, and
    - o One third of the Navy's tactical nuclear weapons
- My estimate that this amounts to about 15,000 warheads is based on Victor Mikhailov's statement at the October 1991 FAS-NRDC-Russian Washington workshop on nuclear-warhead dismantlement that Gorbachev's initiative on tactical nuclear warheads would require the dismantlement of 10-20 thousand tactical warheads and assuming that the range was associated with the uncertainty in the fraction of Air Force and Navy tactical nuclear weapons that would be retired
- 7 Keith Brasher, "U.S.-Russia Uranium Talks Seen," *New York Times*, 23 July 1992, Thomas Lippman and R Jeffrey Smith, "Russian Uranium Proposal Divides U.S. Government," *Washington Post*, 23 July 1992, A-24
  - 8 See also the report, *Disposition of Separated Plutonium*, by Frans Berkhout, Harold Feiveson and Frank von Hippel (Princeton University), Anatoli Diakov (Moscow Institute of Physics and Technology), Helen Hunt (independent consultant), and Marvin Miller (MIT) (Princeton University/Center for Energy and Environmental Studies Report #272, July 1992)
  - 9 Russia currently has eighteen 950-MWe light-water reactors in operation or advanced construction (8 and 10 respectively) at Balakovo (4 and 2), Bashkir (0 and 2), Kalinin (2 and 2), Novovoronezh (1 and 0), Rostov (1 and 2), and Tatar (0 and 2) Assuming a heat-to-electric energy conversion ratio of one third, an average capacity factor of 70 percent and a burnup of 43 GWt-days/tonne, these reactors would require about 300 tonnes of fuel each year
  - 10 Reactor-grade plutonium contains about 10 percent Plutonium-241 while weapon-grade plutonium contains only about 0.2 percent Plutonium-241 decays into americium-241 with a half-life of 14 years  $\text{Am}^{241}$  emits penetrating gamma rays, greatly increasing the occupational radiation dose at MOX fuel-fabrication plants
  - 11 C.H. Bloomster *et al.*, *Options and Regulatory Issues Related to Disposition of Fissile Materials from Arms Reductions* (Richland, WA Pacific Northwest Laboratory Report # PNL-SA-18728, 1990)
  - 12 At two of the three Russian plutonium-production sites, high-level waste (HLW) has been disposed of by deep-well injection The third (near Chelyabinsk) has about as much high-level waste as Savannah River but this waste is apparently being vitrified at twice as high a fission-product concentration so that only about 3,000 tonnes of glass would be made out of the HLW currently in

storage there. At one percent plutonium concentration, this glass would only accommodate 30 tonnes of plutonium. The borosilicate glass used in Western vitrification plants can reportedly apparently accommodate up to 4.5 percent plutonium but Russian experts believe that the Russian phosphate glass can dissolve less than one percent.

13. U.S. Department of Energy, *Nuclear Weapons Complex Reconfiguration Study*, (DoE/DP-0083) January 1991, p. 49.

14. "Soviet Proposals Divide Bush's Aides" by R. Jeffrey Smith, *Washington Post*, 25 October 1992, p. 1.

15. This action was taken in response to the concerns in Germany and Japan that our freedom from IAEA safeguards was giving us a competitive advantage in the area of nuclear technology. In practice, because of its limited safeguards budget, the IAEA has taken up our offer at only a few facilities -- and then only temporarily and for purposes of self-education -- because of its limited safeguards budget.

16. Naval-propulsion reactors require only a few tonnes of HEU per year. The DoE plans to supply this fuel for the indefinite future out of the hundreds of tonnes of HEU that will be released by the dismantlement of surplus nuclear warheads. The high-enrichment stages of the Portsmouth gaseous-diffusion enrichment plant are reportedly already being dismantled.

17. The reactor fuel would be subject to standard safeguards. After radiation measurements verified that the targets in which the tritium is produced contained no fissile material, they could be taken to an unguarded tritium recovery facility.

18. *Costs of a World-wide Safeguards System* (Swedish Government background paper, 15 September 1989).

19. See, for example, the statement of 28 September 1967 by the Indian representative to the Eighteen Nation Disarmament Committee, *Documents on Disarmament, 1967*, pp. 430-440.

---

#### **Biden Condition Added by the Senate Foreign Relations Committee to the Proposed Resolution of Ratification of the START Treaty**

Inasmuch as the prospect of a loss of control of nuclear weapons or fissile material in the former Soviet Union could pose a serious threat to the United States and to international peace and security, in connection with any further agreement reducing strategic offensive arms, the President shall seek an appropriate arrangement, including the use of reciprocal inspections, data exchanges, and other cooperative measures, to monitor --

(A) the numbers of nuclear stockpile weapons on the territory of the parties of this Treaty; and

(B) the location and inventory of facilities on the territory of the parties to this treaty capable of producing or processing significant quantities of fissile materials.

**Excerpts from the Defense Authorization Act for Fiscal Year 1993**  
(as passed by the House)

**Subtitle D: International Fissile Material and Warhead Control**

**Sec. 3141 Findings:....**

(6) Inspection and safeguards procedures for verifying dismantlement of downloaded and retired nuclear warheads and the disposition of removed fissile materials should be examined for inclusion in future arms reduction agreements or verification protocols, for the purpose of making reductions in nuclear arsenals irreversible. Such inspections and safeguards would insure against rapid redeployment of warheads in the empty spaces of downloaded missiles, bar potential reuse of surplus warheads in delivery systems not limited by existing agreements, and reduce inventories of nuclear materials available for potential breakout from the agreement.

**Sec. 3142 Negotiations**

(A) IN GENERAL. -- The Congress urges the President to enter into negotiations with member states of the Commonwealth of Independent States, to complement ongoing and future arms reductions negotiations and agreements with the goal of achieving verifiable agreements in the following areas:

- (1) Dismantlement of nuclear weapons.
- (2) The safeguard[ed] and permanent disposal of nuclear materials.
- (3) An end by the United States and member states of the Commonwealth of Independent States to the production of plutonium and highly enriched uranium for nuclear weapons.
- (4) The extension of negotiations on these issues to all nations capable of producing nuclear weapons materials.

(B) EXCHANGES OF INFORMATION. -- The Congress urges the President, in order to establish a data base on production capabilities of member states of the Commonwealth of Independent States and their stockpiles of fissile materials and nuclear weapons, to seek to achieve agreements with such states to reciprocally release information on --

(1) United States and the member states nuclear weapons stockpiles, including the number of warheads and bombs by type, and schedules for weapons production and dismantlement;

(2) the location, mission, and maximum annual production capacity of United States and member states facilities that are essential to the production of tritium for replenishment of that nation's tritium stockpile;

(3) the inventory of United States and member states facilities dedicated to the production of plutonium and highly enriched uranium for weapons purposes; and

(4) United States and members states stockpiles of plutonium and highly enriched uranium used for nuclear weapons.

(C) TECHNICAL WORKING GROUPS.--The Congress urges the President, in order to facilitate the achievement of agreements referred to in subsection (a), to establish with member states of the Commonwealth of Independent States and with other nations capable of producing nuclear weapons material bilateral or multilateral technical working groups to examine and demonstrate cooperative technical monitoring and inspection arrangements that could be applied to the verification of --

(1) information on mission, location, and maximum annual production capacity of nuclear material production facilities and the size of stockpile of plutonium and highly enriched uranium;

(2) nuclear arms reduction agreements that would include provisions requiring the verifiable dismantlement of nuclear warheads; and

(3) bilateral or multilateral agreements to halt the production of plutonium and highly enriched uranium for nuclear weapons.

# Ending the production of fissile materials for weapons

## Verifying the dismantlement of nuclear warheads

A preliminary report  
of the  
Federation of American Scientists

in collaboration with the  
Committee of Soviet Scientists for Global Security  
and the  
Center for Program Studies of the USSR Academy of Sciences

June 1991

The Federation of American Scientists (FAS), founded 31 October 1945 as the Federation of Atomic Scientists, is the oldest organization in the world devoted to ending the nuclear arms race.

Democratically organized, the FAS is currently composed of 4,000 natural and social scientists and engineers interested in problems of science and security.

The participation of US scientists in this project was done under the auspices of the Federation of American Scientists Fund, the tax-exempt arm of the FAS, as part of the Cooperative Research Project on Arms Reductions. Funding by the Carnegie Corporation of New York, the W. Alton Jones Foundation, and an anonymous philanthropist is gratefully acknowledged.

*\* This report was designed and produced by John Shimwell*



# Contents

Foreword.....	v
Summary .....	1
Introduction .....	7
Verifying a ban on the production of fissile materials for weapons .....	13
Verifying reductions of nuclear-warhead and fissile-material stockpiles.....	27
Disposal of the fissile materials .....	39
Exchanges of information about the sizes of the stockpiles.....	41
First steps .....	43
appendix a	
Classes of data about nuclear weapons and nuclear-weapon materials production that have been declassified by the United States but not the Soviet Union .....	45
appendix b	
Participants in the 29 October–1 November Moscow workshop .....	51
Notes and references .....	53

**Tables and figures**

<b>Table 1</b>	
Deployed US and Soviet strategic warheads.....	8
<b>Table 2</b>	
Deployed US and Soviet tactical nuclear warheads .....	9
<b>Table 3</b>	
Nuclear installations and materials under IAEA safeguards .....	20
<b>Table 4</b>	
Estimated US onsite monitoring and compliance costs over the 13-year verification period of the INF treaty .....	34
<b>Figure 1</b>	
History of the number of operating Soviet and US plutonium-production reactors ..	13
<b>Figure 2</b>	
History of the numbers of warheads deployed by the US and USSR .....	14
<b>Figure 3</b>	
Fissile material flows in civilian and military reactor fuel cycles .....	18
<b>Figure 4</b>	
Interior of the Urenco centrifuge-enrichment facility at Almelo, the Netherlands .....	25
<b>Figure 5</b>	
Safeguards arrangements for a nuclear-warhead dismantlement facility .....	28
<b>Figure 6</b>	
Gamma-ray "fingerprint" of a Soviet cruise-missile warhead .....	31
<b>Figure 7</b>	
Aerial views of Pantex .....	36

# Foreword

Since 1987, the Federation of American Scientists (FAS) and the Committee of Soviet Scientists for Global Security (CSS) have been cooperating on a number of joint research projects on possible technical bases for new arms-control agreements. One of these projects has focused on developing the technical basis for directly verified reductions of nuclear warheads and nuclear-weapon materials.<sup>1</sup>

The Soviet and US governments are now both taking a more serious interest in the possibilities for nuclear-warhead control. The Soviet government made clear in 1989 that it is interested in a bilateral Soviet-US agreement for a verified cutoff of the production of plutonium and highly enriched uranium for weapons. The US has ended its production of such materials in any case, and in 1990 the US Congress mandated an Executive Branch study of the verification arrangements for formal Soviet-US agreements on a production cutoff, the dismantlement of nuclear warheads, and the safeguarded disposal of the recovered fissile materials. (That report was due on 30 April 1991.) The Congress also urged that a joint Soviet-US technical working group be established to study these arrangements.

It would be timely for the US and Soviet governments to take up these issues in connection with the START treaty ratification process as part of a broad discussion of post-START nuclear arms reduction agreements. The START treaty is to eliminate nuclear-weapon delivery systems carrying thousands of warheads but makes no provision for the elimination of those warheads. Additional thousands of tactical nuclear warheads are being withdrawn from central Europe—withdrawals that are expected to be formalized by negotiations over the future of short-range nuclear forces (SNF) in Europe—but, once again, there has been no analysis of the possibility of eliminating these warheads. Uncertainty about the fate of these warheads and the fissile material that they contain may undermine the possibility of future reduction agreements.

In October 1990, the FAS, CSS, and the Center for Program Studies of the Soviet Academy of Sciences held a joint workshop to explore these questions in a preliminary way. (A list of participants is attached as appendix B.) This report of our preliminary findings is being published in

the hope that it will help to lay the basis for a joint government-to-government study and for actual first steps toward warhead arms control.

Because of the tight time schedule for the completion of this report, it has not been possible for the Soviet participants to fully review the final draft. It is possible, therefore, that, while there was agreement by all of the participants on the general thrust of our recommendations, there might still be some disagreement on details.

# Summary

As a result of the INF and START treaties, and forthcoming negotiations on short-range nuclear forces (SNF) in Europe, the Soviet Union and United States are expected to retire or withdraw from Europe about one half of their total nuclear arsenals—on the order of 10,000 nuclear warheads each. However, thus far, no arrangements have been made to ensure that these warheads will not be stored for possible rapid redeployment (in the case of nuclear artillery shells, for example) or be recycled to increase the numbers of warheads available for uncontrolled or difficult-to-verify systems (nondeployed air-launched or sea-launched cruise missiles, for example). There is also always the small but finite possibility that stored intact warheads might become targets for unauthorized use or subject to accidents.

This report therefore outlines the technical basis for a Soviet-US agreement to verifiably eliminate retired warheads.

## **A verified ban on the production of fissile materials for weapons**

The most important part of nuclear-warhead elimination will be to ensure that the fissile materials in the warheads are used or disposed of in such a manner that they cannot be used again to make nuclear weapons. But this would be ineffective if the production of new fissile materials for weapons were unconstrained. We therefore precede our discussion of verified warhead dismantlement with a discussion of the technical basis for the verification of a ban on the production of new fissile material for warheads.

In fact, the US has halted the production of fissile material for weapons, and the Soviet Union is in the process of doing so, although the final stages are currently not scheduled for completion until the year 2000. As both countries expect the numbers of warheads in their nuclear arsenals to decline, they will be able to obtain any material that they need for new warheads more cheaply from warheads being retired. Both the Soviet government and the US Congress have expressed interest in making the production halt formal and verifiable.

A US-Soviet agreement to verifiably halt the production of fissile material for weapons, in combination with the Nonproliferation Treaty,

under which about 140 countries have made internationally verifiable commitments not to produce or divert fissile materials to nuclear weapon production, would lay the foundation for a global production ban in which Britain, France, China, India, Israel, Pakistan, and other threshold nuclear countries could be pressed to join. This would strengthen the basis for still deeper US and Soviet cuts and—after a certain point—parallel cuts in the stockpiles of the other nations.

The verification of a production ban would require International Atomic Energy Agency (IAEA) type safeguards on civilian nuclear facilities and materials. Indeed, this part of the bilateral verification arrangements could be designed so that it could later be merged with the IAEA system of safeguards on the corresponding facilities in non-nuclear weapon states. Safeguards would also be required on the fuel cycles of naval propulsion reactors and reactors producing tritium for nuclear weapons. Negotiating acceptably nonintrusive arrangements to ensure that no significant quantity of enriched uranium could be diverted to weapon production during the process of refueling naval propulsion reactors might be difficult. However, there should be considerable latitude for compromise, as the quantities of uranium-235 flowing annually through the naval fuel cycles are less than 1 percent of the amounts currently in nuclear warheads.

As in the case of the Nonproliferation Treaty, the primary task of detection of any clandestine (undeclared) production facilities would be left to the national intelligence agencies of each country. However, as with the verification arrangements for the proposed ban on chemical-weapon production, onsite inspections at declared facilities could be supplemented by challenge inspections at suspect sites.

#### Verified reductions of the warhead stockpiles

We have considered three alternative approaches to the verified reduction of the US and Soviet nuclear-warhead stockpiles:

- Shifting agreed quantities of fissile materials out of the control of the weapon complexes to safeguarded nonweapon use or disposal. This approach is simple. Its impact would be somewhat unclear because of uncertainties in the amounts of fissile material in the other country's warheads and the fact that not all fissile material in the possession of the nuclear-weapon complexes is actually in warheads. However, both the United States and Soviet Union consider the quantities of fissile materials in particular warhead types to be sensitive design information, and unsafeguarded fissile material not in warheads represents potential warheads. This approach would therefore accomplish most of what would be achieved by the more complex schemes described below.
- The verified dismantlement of agreed numbers and types of warheads and the placement of the recovered fissile material under safe-

guards for nonweapon use or disposal. This approach would involve portal-perimeter controls around facilities to which the Soviet Union and United States would bring the warheads that they had agreed to dismantle. Each country would dismantle its own warheads in privacy in its own facility. The other country would subject this facility to portal-perimeter safeguards in order to assure itself that intact warheads of the agreed types were brought to the dismantlement facility and that all the fissile material that was removed was placed under safeguards.

The principal technical problem in this approach is to devise methods to establish confidence, without revealing sensitive design information, that the warheads delivered to the dismantlement facility are of the agreed types and are intact. One possible approach would involve: i) the placement of the warheads to be dismantled in tagged, sealed containers as early as possible—preferably as they are removed from their deployment sites—and ii) verification that all warheads claimed to be of the same type are identical to within agreed tolerances. The comparison of the warheads could be either through measurements of the penetrating radiation emitted spontaneously by the fissile material in the warheads or through radiographs of the warheads. In the case of the radiographs, the comparisons would be done by a computer to protect design information.

- A combination of both approaches, according to which warheads would be verifiably eliminated and agreed amounts of fissile material that might be more or less than was originally in these warheads would be placed under safeguards. This approach could both provide considerable confidence that warheads were being dismantled and that agreed quantities of fissile material would be removed from potential weapon use.

The cost of the verification arrangements would probably be less than the fuel value of the uranium-235 recovered from the dismantled warheads—about \$6 billion for one half of the US nuclear arsenal.

No new environmental issues would arise, since both the Soviet Union and United States already routinely dismantle obsolete warheads, although in the past they have generally replaced them with "modernized" versions. However, new dismantlement facilities might have to be built so that the verification arrangements would not interfere with unrelated activities at the existing facilities. In the US, such new construction would have to be subject to rigorous and public environmental-impact reviews.

#### Disposal of the fissile materials

Some of the fissile materials placed under safeguards could be kept in secure stockpiles under bilateral safeguards but under the physical control of the owning country if there was concern that the other country might

gain an advantage from possible hidden stockpiles or large residual production capabilities. Surplus highly enriched uranium could be sold to fuel safeguarded nuclear reactors—in most cases after dilution with natural or depleted uranium to the low enrichment used in Soviet and US nuclear power reactors. Plutonium would probably have to be stored under bilateral safeguards because plans for the use or disposal of plutonium being produced in civilian reactors are still not settled in either the Soviet Union or United States.

#### Exchanges of information about the sizes of the stockpiles

Uncertainties in Soviet 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. The Soviet Union and United States are, in any case, both ending their production of fissile material for weapons and entering nuclear arms-reduction agreements that are expected to make about one half of their nuclear warheads superfluous. Formalizing these actions will merely provide reassurance that no significant offsetting new additions to the nuclear arsenals are being made.

However, in order to go beyond the first cuts of 50 percent or so, the Soviet Union and United States will want to have an improved idea of the sizes each other's nuclear stockpiles. We therefore suggest that they seriously consider mutual declarations of the total amounts of fissile material in their nuclear weapons and otherwise available to their nuclear-weapon establishments, exchange production records, and undertake a program of cooperative research ("nuclear archeology") on physical evidence that could be used to confirm and refine these production records.

#### First steps

Some of the measures examined above will probably require considerable negotiation because of concerns about the need to protect sensitive nuclear-weapon and naval-fuel design information. Other measures, such as verified warhead dismantlement, may have to await the design and construction of special facilities. However, certain key measures need not be delayed. These include: the joint Soviet-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. Tagged, sealed warheads that are to be subject to verified dismantlement could be stored at the likely locations of the dismantlement facilities where the integrity of the tags and seals could be periodically checked. The earlier these measures are undertaken, the less the associated verification uncertainties later on and the more the nuclear superpower nuclear arms-reduction agreements will strengthen the legitimacy of the non-



proliferation regime in the crucial period prior to 1995, when the Non-proliferation Treaty must be renewed.

Elimination of unnecessary secrecy relating to past and present nuclear-weapon production activities would also facilitate mutual understanding in establishing verification arrangements. This recommendation is directed especially to the Soviet government, since we have found in carrying out our research that it has been possible to go into considerably further depth with regard to the verification issues relating to US nuclear facilities than those of the Soviet Union. To facilitate the Soviet process of declassification, we include in appendix A a list of the types of information already publicly available about US nuclear-warhead production.

# 1. Introduction

The Soviet Union and the United States currently each have roughly 20,000 nuclear warheads deployed—about half with their strategic forces and half with their general-purpose (“tactical”) forces. If nuclear arms control and unilateral retirements continue as currently planned, these numbers could be reduced by very roughly 50 percent over the next decade.

- The Intermediate-range Nuclear Forces (INF) Treaty has already eliminated deployed and nondeployed US and Soviet missiles capable of carrying about 1,000 and 3,000 warheads respectively.<sup>2</sup>
- The START treaty will cut the number of warheads deployed on US and Soviet strategic ballistic missiles by about 2,800 and 5,000 respectively, to a maximum of 4,900 on each side (see table 1).<sup>3</sup>
- Withdrawals of Soviet forces from Central Europe are eliminating the rationales for most of the approximately 4,000 US and perhaps 7,000 Soviet warheads for artillery, short-range missiles and fighter-bomber aircraft in Europe<sup>4</sup>(see table 2).<sup>4</sup>
- Unilateral reductions are also taking place in the other major category of tactical nuclear weapons—those carried by most US and Soviet combat ships and submarines.<sup>5</sup>

Further rounds of cuts could reduce the numbers of nuclear warheads in Soviet and US stockpiles by another factor of two or more.<sup>6</sup>

What will become of all the retired nuclear warheads? This question was raised repeatedly in the US Senate hearings on the ratification of the INF treaty. That treaty eliminated all Soviet and US land-based missiles with ranges between 500 and 5,000 kilometers and their associated launchers but both parties were allowed to retain the nuclear warheads on these missiles for any use they saw fit, including recycling into warheads for other nuclear-weapon delivery systems. The United States, for example, has reworked the warheads of its Pershing 11 intermediate-range missile into B-61 bombs.<sup>7</sup>

The START treaty, like the INF treaty, is not expected to impose limitations on the use of the warheads of the systems being eliminated and it is the current expectation that the forthcoming Short-range Nuclear

Table 1  
**Deployed US and Soviet  
 strategic warheads  
 (end 1990)**

	Missiles/ bombers	Warheads	Source: Robert S. Norris, Richard W. Fieldhouse, Thomas B. Cochran and William M. Arkin, World Armaments and Disarmament: SIPRI Yearbook 1991, pp. 16, 18. Numbers for bomber loadings from H.A. Feiveson and F.N. von Hippel, International Security 15 (Summer 1990), p. 163.
<b>US</b>			
<b>ICBMs</b>			
Minuteman II	450	450	
Minuteman III	500	1,500	
MX	50	500	
<b>SLBMs</b>			
Poseidon	176	1,760	
Trident I	384	3,072	
Trident II	48	384	
<i>Total ballistic missiles</i>	<i>1,608</i>	<i>7,666</i>	
<b>Bombers</b>			
B-52 G/H (with ALCMs)	154	2,800	
B-1B	90	1,400	
<b>TOTALS</b>	<b>1,852</b>	<b>~ 12,000</b>	
<b>USSR US designations</b>			
<b>ICBMs</b>			
SS-11	310	310 <sup>a</sup>	
SS-13	30	30	
SS-17	50	200	
SS-18	308	3,080	
SS-19	250	1,500	
SS-24	86	860	
SS-25	300	300	
<b>SLBMs</b>			
SS-N-6	176	176 <sup>a</sup>	
SS-N-8	286	286	
SS-N-17	12	12	
SS-N-18	224	1,568	
SS-N-20	120	1,200	
SS-N-23	96	384	
<i>Total ballistic missiles</i>	<i>2,248</i>	<i>9,900</i>	
<b>Bombers</b>			
Bear-H (Tu-142 with ALCMs)	85	500	
Blackjack (Tu-160)	21	250	
<b>TOTALS</b>	<b>2,354</b>	<b>~ 11,000</b>	
Surface-to-air missiles	2,620	3,000	
Antiballistic missiles	100	100	

a. Some have multiple but nonindependently targetable reentry vehicles

Forces (SNF) Treaty limiting Soviet and US tactical nuclear weapons in Europe will follow the same pattern. In the case of nuclear bombs and artillery shells, the SNF agreement could then simply involve the transfer of these warheads out of central Europe to storage sites in the US and Soviet Union from which they could quickly be returned in a crisis.

At the moment, uncertainties about the other country's possible storage or recycle of the warheads from retired nuclear-weapon systems are apparently not causing great anxiety in either the Soviet or US governments. However, as the arsenals of deployed warheads are cut more deeply, the stockpiles of retired warheads will grow rapidly in both absolute and relative terms; these uncertainties may therefore gain political salience and impede progress toward further reductions.

For example, policymakers might become concerned that the other country could be building and stockpiling very large numbers of nuclear-armed long-range cruise missiles that could be rapidly deployed on many types of aircraft and ships in a breakout from treaty limits. (Only deployed cruise missiles will be subject to START limits.) Indeed, such concerns have already been raised by the US House Armed Services Committee about the START treaty.<sup>8</sup>

Table 2  
Deployed US and  
Soviet tactical nuclear  
warheads  
(end 1990)

	US	USSR <i>very rough estimates</i>	<i>Source: SIPRI Yearbook 1991, pp. 17, 20-21. Not included in this table are the warheads on the remaining missiles being eliminated under the INF treaty.</i>
<b>Aircraft</b>			
Land-to-land	1,800	3,100	
Carrier-based	1,350	0	
Anti-ship and submarine	850	1,360	
<i>Total aircraft</i>	<i>4,000</i>	<i>4,500</i>	
Short-range Ballistic Missiles	1,282	3,130	
Surface-to-air Missiles	0	520	
Artillery	1,540	2,000	
<b>Naval Cruise missiles</b>			
Land-attack	325	136	
Anti-ship	0	434	
Anti-submarine missiles	0	420	
Torpedoes	0	520	
<b>TOTAL</b>	<b>~ 7,100</b>	<b>~ 12,000</b>	

Ending the production of fissile materials for weapons

It was therefore timely for the US Congress to address the issue in the Fiscal Year 1991 Defense Authorization Act (section 3151) as follows:

Should the President determine that future international agreements should provide for the dismantlement of nuclear warheads and a ban on the further production of fissile material for weapons, then the Congress urges him to seek to establish with the Soviet Union a joint technical working group to examine and demonstrate cooperative technical monitoring and inspection arrangements that could be applied to the design and verification of [the] dismantlement of nuclear weapons and a ban on further production of fissile materials for weapons.

The Congress mandated that in any case:

The President shall prepare a comprehensive technical report on...the on-site monitoring techniques, inspection arrangements, and national technical means that could be used by the United States to verify the actions of other nations with respect to...a) dismantling of nuclear warheads...b) a mutual United States-Soviet ban, leading to a multilateral, global ban, on the production of additional quantities of plutonium and highly enriched uranium for nuclear weapons [and] c) the end use or ultimate disposal of any plutonium or highly enriched uranium recovered from the dismantlement of nuclear warheads.

The requested report, which is being drafted for the President by the US Department of Energy, was due on 30 April 1991.

The purpose of the present document is to provide an independent report on these same questions based on our own investigations.

#### Fissile material

As is suggested by the congressional request, the primary tool in a comprehensive approach to nuclear-warhead control would be controls on the fissile materials (chain-reacting plutonium and highly enriched uranium)\* that are essential to their manufacture. First-generation nuclear weapons, such as those used on Hiroshima and Nagasaki, would obtain their energy from a fission chain reaction in one or both of these materials. Modern "second generation" weapons, which would derive part of their energy from thermonuclear "fusion" reactions, can only be ignited by a fission explosive.

\* Uranium-235, the rare isotope of uranium (0.7 percent of natural uranium) is the only natural chain-reacting fissionable (i.e. "fissile") material. It is ordinarily assumed that its concentration in uranium must be enriched by isotope-separation techniques to more than 20 percent to be used in a fission explosive. In practice, the highly enriched uranium used in US and Soviet nuclear warheads contains about 90 percent uranium-235. Plutonium is an artificial fissile material that is produced in nuclear reactors as a result of the absorption of neutrons by uranium-238 (the other 99.3 percent of natural uranium). "Weapon grade" plutonium contains more than 93 percent plutonium-239, but lower grades may also be used to make nuclear explosives. Although other artificial fissile isotopes (notably uranium-233) can be produced in reactors, they have apparently not been used on a significant scale in nuclear warheads. However, safeguards on the production complexes can easily be designed to take into account the possibility of their production.

The US nuclear warhead arsenal of about 25,000 nuclear warheads in the early 1980s<sup>9</sup> contained about 100,000 kilograms of plutonium and 500,000 kilograms of highly enriched uranium.<sup>10</sup>

The fact that a nuclear weapon cannot be made without at least a few kilograms of fissile material is the technical basis of the 1970 arrangements for verifying the Nonproliferation Treaty (NPT). (As of the end of 1989, 42 non-nuclear weapon states signatory to the NPT had opened their nuclear facilities to the inspectors and safeguards arrangements of the International Atomic Energy Agency.<sup>11</sup>)

In the following three sections we discuss the basic elements of a set of agreements to limit then verifiably reduce the amounts of fissile material available for nuclear weapons:

- A verified halt in the production of new fissile material for warheads (section 2). Such a halt would not prevent the production of new warheads using fissile material already produced for weapons or recovered from warheads being retired. However, it would provide assurance that future transfers of fissile material out of the Soviet and US warhead-production complexes would not be offset by new production.
- The verified transfer of agreed amounts of fissile material from the nuclear-weapon production complexes to facilities under bilateral or multinational safeguards (section 3). This transfer could involve either direct transfers of fissile materials or the verified dismantlement of warheads. In the latter case, an interim step could involve the placement of warheads to be eliminated in bilaterally safeguarded storage.
- Ultimate safeguarded use or disposal of the transferred fissile materials (section 4).

Some have suggested that it will be necessary to make and verify declarations of the sizes of the US and Soviet stockpiles of fissile material in warheads and available for their manufacture before it will be possible to agree on a production cutoff or reductions. We do not believe this to be the case. Given the end of the Cold War, both the Soviet and US governments have concluded that the sizes of their nuclear stockpiles are excessive, are negotiating deep cuts, and are ending their production of fissile material for warheads in advance of a verifiable agreement to do so. A production-cutoff agreement and negotiated transfers of fissile material out of the arsenals would therefore only make verifiable what appears to be currently planned.\*

---

\* If there is concern that, in the future, some currently unforeseen development might require a new buildup, agreed amounts of the fissile material transferred out of the complexes could be placed in stockpiles under bilateral safeguards but under the physical control of the owning country so that possession could be reestablished if the reduction agreement should break down.

The US nuclear warhead arsenal of about 25,000 nuclear warheads in the early 1980s<sup>9</sup> contained about 100,000 kilograms of plutonium and 500,000 kilograms of highly enriched uranium.<sup>10</sup>

The fact that a nuclear weapon cannot be made without at least a few kilograms of fissile material is the technical basis of the 1970 arrangements for verifying the Nonproliferation Treaty (NPT). (As of the end of 1989, 42 non-nuclear weapon states signatory to the NPT had opened their nuclear facilities to the inspectors and safeguards arrangements of the International Atomic Energy Agency.<sup>11</sup>)

In the following three sections we discuss the basic elements of a set of agreements to limit then verifiably reduce the amounts of fissile material available for nuclear weapons:

- A verified halt in the production of new fissile material for warheads (section 2). Such a halt would not prevent the production of new warheads using fissile material already produced for weapons or recovered from warheads being retired. However, it would provide assurance that future transfers of fissile material out of the Soviet and US warhead-production complexes would not be offset by new production.
- The verified transfer of agreed amounts of fissile material from the nuclear-weapon production complexes to facilities under bilateral or multinational safeguards (section 3). This transfer could involve either direct transfers of fissile materials or the verified dismantlement of warheads. In the latter case, an interim step could involve the placement of warheads to be eliminated in bilaterally safeguarded storage.
- Ultimate safeguarded use or disposal of the transferred fissile materials (section 4).

Some have suggested that it will be necessary to make and verify declarations of the sizes of the US and Soviet stockpiles of fissile material in warheads and available for their manufacture before it will be possible to agree on a production cutoff or reductions. We do not believe this to be the case. Given the end of the Cold War, both the Soviet and US governments have concluded that the sizes of their nuclear stockpiles are excessive, are negotiating deep cuts, and are ending their production of fissile material for warheads in advance of a verifiable agreement to do so. A production-cutoff agreement and negotiated transfers of fissile material out of the arsenals would therefore only make verifiable what appears to be currently planned.\*

---

\* If there is concern that, in the future, some currently unforeseen development might require a new buildup, agreed amounts of the fissile material transferred out of the complexes could be placed in stockpiles under bilateral safeguards but under the physical control of the owning country so that possession could be reestablished if the reduction agreement should break down.

## 2. Verifying a ban on the production of fissile materials for weapons

The United States has terminated and the Soviet Union is terminating production of fissile materials for weapons.

The United States last produced highly enriched uranium and plutonium for weapons in 1964 and 1988 respectively, and the Bush administration has recently dropped its plans to resume production in the future.<sup>13</sup> The Soviet Union announced that production of highly enriched uranium for weapons would end in 1989<sup>14</sup> and has announced the shut-down of seven plutonium-production reactors.<sup>15</sup> Soviet Deputy Foreign Minister Vladimir Petrovsky announced in 1989 that three of the six remaining Soviet plutonium-production reactors would be shut down by 1996 and the remaining three by 2000 (see figure 1).<sup>16</sup> These actions re-

Each kilogram of plutonium or HEU [highly enriched uranium] produced constitutes a future liability to safeguard against escaping into the biosphere or being diverted into unauthorized channels

*Wolfgang K.H. Panofsky*<sup>12</sup>

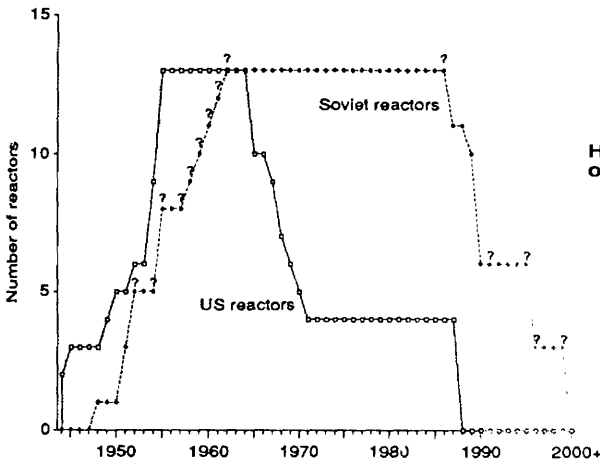


Figure 1  
History of the number of  
operating Soviet and US  
plutonium-production  
reactors<sup>17</sup>

\* One US and at least five of the Soviet plutonium-production reactors have been used to produce steam for electric-power generation as well as plutonium. However, there appears to be no inclination in either country to keep these reactors in operation for electricity production alone.



flect the fact that the sizes of the nuclear arsenals of both nations have peaked and are declining (see figure 2). The fissile material required for any replacement warheads can therefore be obtained from warheads that are being dismantled.

On the diplomatic side, a bilateral production cutoff agreement was a high priority on the US arms-control agenda between 1956 and 1969 but was then dropped as arms-control efforts shifted from warheads to missile-launchers and bombers, whose numbers could be verified using satellites.<sup>19</sup> The Soviet Union, whose stockpile was much smaller than that of the United States during the 1950s and 1960s (see figure 2), rejected the US proposal and only began to express an interest in a production halt beginning in 1982 with a speech at the Second UN Special Session on Disarmament by then Foreign Minister Gromyko.<sup>20</sup> President Gorbachev and Foreign Minister Shevardnadze publicly declared their support for a production cutoff in 1989.<sup>21</sup>

The US response to this Soviet interest has been mixed. There has been considerable interest in Congress, which led to the section in the fiscal-year 1991 Defense Authorization Act quoted above. However, the Bush administration has been reluctant to discuss a fissile-cutoff agreement—at least while it had pending requests for funding to build new production capacity.<sup>22</sup> Now that these requests have been dropped, it may be possible to move forward to a formalized cutoff agreement.

A production cutoff would start with the declaration by both the Soviet Union and United States of the locations of all their facilities capable of enriching significant amounts of uranium, all nuclear reactors (both ci-

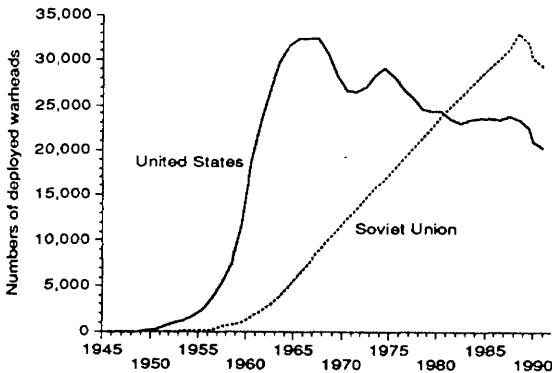


Figure 2  
History of the numbers  
of warheads deployed  
by the US and USSR<sup>18</sup>

vilian and military), and all the associated fuel cycle facilities. Civilian stockpiles of plutonium and enriched uranium would also be declared.

Verification would require reassurance that:

- military production facilities are converted to safeguarded nonweapon 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
- none of the enriched uranium or plutonium in the fuel cycles of civilian nuclear reactors is diverted to weapon production.

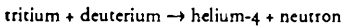
#### Shutdown production facilities

Because operating production reactors generate huge amounts of waste heat,\* their shutdown status can be verified without onsite inspections, using observation satellites equipped with infrared detectors. Onsite visits could in addition verify that key components had been dismantled or, if any reactors were to be kept on standby, could check radiation detectors sealed into the reactor fuel channels for evidence of neutron radiation. (The US demonstrated this technology in the 1960s.<sup>23</sup>)

Most, if not all, of the chemical reprocessing facilities that have been used to recover plutonium from the depleted uranium "targets" used in the production reactors would also be shut down.† Once again, onsite inspections could easily verify that such facilities had been partially or completely dismantled and seals could be applied to key pieces of equipment at any facilities that are kept on standby. Similar arrangements could be worked out for any shutdown uranium enrichment plants.

#### Tritium-production reactors

In modern nuclear warheads, the artificial hydrogen isotope tritium is used in multigram quantities, in combination with the natural hydrogen isotope, deuterium. At the high temperatures present in the middle of a fission explosion, the two isotopes undergo the thermonuclear reaction



The neutrons so produced cause extra fissions and "boost" the yield of the fission explosion.

---

\* Approximately 1 kilogram of uranium-235 must be fissioned to produce 1 kilogram of plutonium. The fission of 1 kilogram of uranium-235 releases about 1 million kilowatt-days or 2,700 kilowatt-years of heat. During the early 1980s each of the three operating US production reactors at the Savannah River site produced the equivalent of about 500 kilograms of plutonium per year and therefore had an average heat output of about 1.5 million kilowatts.

† One Soviet military reprocessing facility has been converted to reprocess spent civilian power reactor fuel to recover plutonium for the Soviet plutonium-breeder reactor demonstration program.

The tritium is produced in reactors through the reaction  
 neutron + lithium-6  $\rightarrow$  helium-4 + tritium.

Tritium has a half-life of 12.3 years, which means that it decays at a rate of 5.5 percent per year.\*

Soviet and US stockpiles of nuclear warheads are expected to decline for some years at a more rapid rate than the tritium that they contain will decay. Therefore, for a number of years, tritium recovered from the warheads being retired can be used to replenish the tritium reservoirs of warheads remaining in the stockpile.<sup>24</sup>

Eventually, however, unless the stockpiles continue to decline to zero, it will be necessary to produce new tritium in production reactors—probably one production reactor operated at a low power in each country.<sup>†</sup> These reactors might be fueled by highly enriched uranium,<sup>‡</sup> and it would be necessary to verify that none of this fuel was diverted to the production of weapons. It would also be necessary to verify that the reactor was not being used to produce plutonium for weapons.

The facility producing the uranium fuel and the fuel itself would be subject to verification. This would include accounting for the uranium from the time it was shipped from a safeguarded enrichment facility until

\* For comparison, plutonium-239 has a half-life of about 24,000 years, and uranium-235, 700 million years. Their longevities as weapon materials are therefore determined by processing losses and not radioactive decay.

† If we assume, for example, that a total inventory of 50 kilograms of tritium would have to be maintained in 10,000 warheads, then it would be necessary to produce about 3 kilograms of tritium per year to offset radioactive decay and other losses. This would require a production reactor to operate at an average heat output of about 600 megawatts—about 20 percent of the peak power output of one of the US production reactors at Savannah River. (Keith Schneider, "Nuclear Complex Becomes a Huge Magnet for Money," *New York Times*, 14 April 1991, p. 1) states that "Energy Department engineers here [the Savannah River site] say that only one of the nuclear reactors operating at such 40 percent of its capacity, is needed to meet all tritium needs." The US nuclear stockpile currently contains about 10,000 nuclear warheads.) The same power output would result in the production of about the same number of atoms of weapon-grade plutonium—about 200 kilograms per year. Since uranium-235 is consumed at a rate of 1.2 grams per thermal megawatt-day (MWT-d) (1.05 by fission and 0.15 by nonfission neutron capture) providing an average of 600 MWT for 365 days per year would consume about 260 kilograms of uranium-235. If the "driver" fuel is replaced when 50 percent of the uranium-235 is consumed, then the annual replacement driver fuel would contain about 500 kilograms of uranium-235—0.1 percent of the current stockpile.

‡ Using highly enriched uranium minimizes the presence of uranium-238 in the reactor. Uranium-238 competes for the capture of neutrons released from the fission of uranium-235, reducing the number of neutrons available to produce tritium. Prior to the shutdown of the US Savannah River production reactors in 1988, they were fueled with highly enriched uranium recovered from the reprocessing of their own fuel, and naval-reactor and research-reactor fuel at the Savannah River site and the Idaho National Engineering Laboratory. Considering the much reduced demand for production-reactor fuel after a plutonium production cutoff and the reduced demand for tritium, because of the reduced size of the US warhead stockpile it might no longer be considered economical to operate these two reprocessing plants. Freshly enriched uranium fuel might be used instead.

the ultimate disposal of the spent fuel. If the fuel were reprocessed to recover the residual highly enriched uranium, the reprocessing plant would also have to be under safeguards as would the recovered uranium and plutonium. Because of the relatively small scale of the tritium production, this verification effort would be small compared to that required to safeguard the corresponding nonmilitary materials and facilities.

The "targets" in which neutrons are absorbed to produce tritium should contain only lithium and no uranium-238 from which plutonium could be produced. Nondestructive examination could be used to detect the presence of uranium-238. Fast neutron irradiation with either a special source or in the production reactor would cause some of the uranium-238 to fission, creating fission products whose characteristic gamma-ray energies could then be identified by gamma-ray spectrometry.

#### Naval-reactor fuel cycle

US naval-propulsion reactors are fueled with uranium enriched to about 97.3 percent in uranium-235 (about 3,000 kilograms and 2,500 kilograms in fiscal years 1991 and 1992 respectively).<sup>25</sup> A Soviet official has stated that Soviet naval-propulsion reactors are fueled with uranium enriched to less than 10 percent—not directly useable in weapons.<sup>26</sup> However, at 10-percent enrichment, about 85 percent of the enrichment work required to produce weapon-grade uranium has been done, making the material attractive as feed to any clandestine enrichment plant. Also, the presence of large quantities of uranium-238 in the fuel will result in the production of significant quantities of plutonium. Therefore, both the Soviet Union and United States would probably want some reassurance that the fissile materials in the other country's naval fuel cycle were not being diverted to weapon use. At the same time, however, concerns about limiting the intrusiveness of inspections might result in the verification procedures not being as rigorous as with the civilian fuel cycle.

The naval reactor fuel cycle would separate from the fully safeguarded civilian fuel cycle at the uranium enrichment plant (see figure 3). Each country would declare the quantities and enrichments of the uranium that it required for the production of naval reactor fuel that year. The other country would check whether the quantity of uranium-235 being declared for naval fuel was plausible based on its understanding of the number, power, and operating patterns of the other's nuclear propulsion reactors, and its inspectors would verify that the amounts being released

---

\* Some interest has been expressed in the possibility of developing a very-high-current proton accelerator as an alternative to a production reactor to produce neutrons for tritium breeding or other purposes. (See for example *Accelerator Production of Tritium: Executive Report* [Brookhaven and Los Alamos National Laboratories, BNL/SFN-88-143, 1989]; Allan Krass, *The Tritium Problem and the Proton Accelerator* [Cambridge, Massachusetts: Union of Concerned Scientists, 1989].) If such accelerators are developed, then it will be necessary to subject their target areas and targets to some type of inspection to verify that they are not being used to produce plutonium or other fissile materials.

into the naval fuel cycle matched the declarations. At the other end of the fuel cycle, if the spent fuel were reprocessed—as has been the practice in the United States—inspectors could check the weights and assays of the recovered uranium and plutonium after they were placed under full safeguards. It would also be possible to check declarations of the amounts of

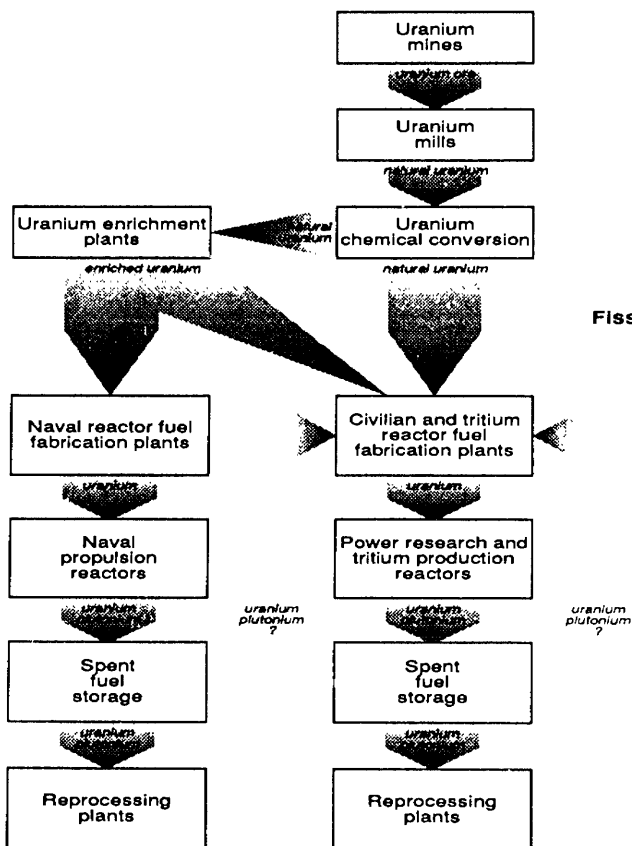


Figure 3  
Fissile material flows in  
civilian and military  
reactor fuel cycles

\* As noted above, US naval reactor fuel has been reprocessed at the Idaho National Engineering Laboratory to recover highly enriched uranium to fuel production reactors.

uranium-235 that had been fissioned by measuring the quantity of uranium-236 in the residual uranium.\*

The release of a batch of enriched uranium to the naval fuel cycle and the return of the resulting uranium and plutonium after it has been used might be many years apart. If we assume that the time will average 15 years in the case of the US, this would mean, at 3,000 kilograms of uranium-235 per year, that about 45,000 kilograms of uranium-235 would be in the naval fuel cycle at any one time—equivalent to about 10 percent of the uranium-235 in US weapons today.<sup>27</sup> Of course, only a fraction of the uranium-235 released to the naval fuel cycle could be diverted to weapon use. Nevertheless, the quantities involved would be large enough so that it could be well worth while to attempt to obtain additional reassurance that significant diversions were not taking place.

It would be possible to develop effective safeguards on the naval-reactor fuel cycles if the Soviet Union and United States were willing to risk exposing some currently classified information about the fuel and reactor designs to each other's inspectors. Depending upon the level of assurance desired, the inspections would be more or less revealing.

Similar considerations would apply to the highly enriched uranium used to fuel military space reactors—although the quantities of uranium-235 involved will be very much smaller than in the naval-reactor fuel cycle for the foreseeable future. Indeed, there have been no reactors operating in space since a Soviet space reactor almost reentered the atmosphere in 1988.<sup>28</sup>

#### Civilian nuclear fuel cycles

Most of the procedures that would be required to verify the nondiversion of fissile materials from Soviet and US civilian nuclear-reactor fuel cycles have already been developed by the International Atomic Energy Agency. The IAEA has the responsibility to verify commitments made by non-nuclear weapon states under the Nonproliferation Treaty not to divert to weapon use fissile materials in their nuclear-reactor fuel cycles. IAEA safeguards cover all significant nuclear facilities and significant quantities of nuclear materials with the exception of uranium mines, the mills where uranium oxide "yellow cake" ( $U_3O_8$ ) is separated from the ore, and conversion facilities where the yellow cake is converted into uranium metal, uranium dioxide ( $UO_2$ ) or uranium hexafluoride ( $UF_6$ ) for fuel fabrica-

---

\* When a uranium-235 atom absorbs a slow neutron in a reactor, the probability of fission resulting is somewhat less than 90 percent. Nonfission absorption results in the formation of the isotope uranium-236, which has a half-life of 24 million years. The percentage of uranium-236 in a sample of enriched uranium therefore reflects the amount of uranium-235 in that sample which has been fissioned. Since some of the uranium-236 will be converted in the reactor by neutron absorption into uranium-237, which decays into neptunium-237, which in turn can absorb another neutron and become neptunium-238, which decays into plutonium-238, more exact estimates of the quantities of uranium-235 fissioned would involve measurements of some of these and other isotopes as well.

tion or enrichment. Safeguards on the materials begin after the uranium recovered from mines and mills is converted to a pure compound suitable for fabrication of natural uranium fuel or for feed to an enrichment plant.

Currently, the IAEA has under safeguards: uranium chemical conversion facilities, gas-centrifuge uranium-enrichment plants, fuel fabrication facilities, nuclear power and research reactors of all major types, fuel re-processing facilities, and fresh and spent fuel in transit and in storage (see table 3).<sup>29</sup>

The IAEA receives reports on the quantities and locations of fissile materials, audits the records maintained at the facilities, and independently verifies that some random fraction of the items or bulk materials are as stated. The agency has developed a variety of techniques to measure the nuclear materials involved and containment/surveillance techniques to "maintain continuity of knowledge" when inspectors are not present.<sup>30</sup>

The principal civilian nuclear facilities for which safeguards arrangements have not yet been worked out are gaseous-diffusion enrichment plants. The United States (and perhaps still the Soviet Union<sup>31</sup>) has enrichment plants based on this technology. However, our review of the

Table 3  
Nuclear installations  
and materials under  
IAEA safeguards  
(end of 1989)

<b>Installations</b>		<i>Source: International Atomic Energy Agency, Annual Report for 1989 (Vienna: IAEA Report # GOV/2440, 1990), p. 115.</i>
Power reactors	183	
Research reactors and critical assemblies	173	
Uranium chemical conversion plants	8	
Fuel-fabrication plants	43	
Enrichment plants (including pilot plants)	7	
Reprocessing plants (including pilot plants)	5	
Separate storage facilities	45	
Other facilities (mostly laboratories)	51	
<b>TOTAL</b>	<b>515</b>	
<b>Materials metric tonnes</b>		
Plutonium in irradiated fuel	284.8	
Separated plutonium	13.6	
Recycled plutonium		
in fuel elements in reactor cores	1.1	
Highly enriched uranium (> 20% U-235)	10.8	
Low-enriched uranium	33,833	
Natural or depleted uranium or thorium	57,134	

\* Under a production ban, consideration might be given to requiring declarations—and perhaps some degree of inspection—of uranium mines and mills.

techniques used by the United States to monitor the flows of uranium through its own gaseous diffusion enrichment plant indicates that it should be relatively straightforward to use the basic safeguards approach of the IAEA to develop quite effective safeguards for such facilities.

The Soviet Union, unlike the United States, has graphite-moderated power reactors that are refueled while operating.<sup>32</sup> Concern has been expressed that such power reactors could be operated as production reactors.<sup>33</sup> The IAEA has, however, developed safeguards for both heavy-water and graphite-moderated reactors that are refueled while operating.<sup>34</sup> This involves installing surveillance instruments to record the fuel elements fed into and removed from a reactor between inspector visits. In at least some respects (smaller fuel assemblies and lower fuel burnup), the Western power reactors that are refueled while on line are more difficult to safeguard than the Soviet reactors.

In designing safeguards, the IAEA uses quantitative goals for the detection of diversions. For smaller facilities, these quantities are 25 kilograms of uranium-235 in uranium enriched to more than 20 percent, 75 kilograms of uranium-235 in low-enriched uranium, and 8 kilograms of plutonium.<sup>35</sup> Twenty five kilograms of uranium-235 in highly enriched uranium or eight kilograms of plutonium are estimated to be comparable to the amounts of such materials that a non-nuclear weapon state might require to make its first nuclear explosive device.

At facilities such as enrichment plants and reprocessing plants with large inventories or throughputs of material, practical limits to the accuracy with which nuclear material can be measured can prevent the achievement of the IAEA's detection goals. In these cases, the IAEA uses "accountancy verification goal" quantities that range from 1 to 3 percent of the material processed and stored in a facility.

Fortunately, however, the nuclear-power reactors that account for almost all the flows of civilian fissile material in the Soviet Union and United States are currently fueled with low-enriched uranium.<sup>†</sup> Therefore, material diverted from the "front end" of power reactor fuel-cycles (i.e.

\* Plutonium production reactors are refueled much more frequently than power reactors to prevent the percentage of plutonium-240 created by neutron absorption in plutonium-239 from building up above the 6-percent level, below which plutonium is considered "weapon grade" level. On-line refueling would make frequent shutdowns unnecessary.

† Some research reactors are fueled by highly enriched uranium but the flows involved were only about 1,000 kilograms per year in the United States in 1982 (J.E. Matos [Argonne National Laboratory], *RETR Program Summary* September 1982). The US Reduced Enrichment for Research and Test Reactors program has demonstrated that most such reactors can be converted to operate on low-enriched fuels, and the majority have been converted. (See for example A. Travelli, "Changing Over to Low-enriched Fuels," *Nuclear Engineering International* 34, 419 [June 1989], pp. 72-74; and Milton M. Hoenig, *Eliminating Bomb-Grade Uranium from Research Reactors* [Washington DC: Nuclear Control Institute, January 1991]).



before the fuel is introduced into the reactors) would not be directly weapon-useable.\*

In the United States, the "back end" of the nuclear-power reactor fuel cycle currently ends with the spent fuel in storage. The spent fuel would have to be safeguarded primarily because of the large amount of plutonium it contains—currently accumulating at a rate of about 20,000 kilograms a year.

The Soviet Union has both a large-scale civilian reprocessing program for recovering plutonium from spent reactor fuel and a plutonium breeder-reactor demonstration project. However, with much reduced expectations for nuclear power growth in the Soviet Union, the momentum of both of these programs is declining.<sup>36</sup> As of 1989, the Soviet stockpile of civilian plutonium (apparently obtained from the fuel of light-water moderated reactors) was reportedly about 20,000 kilograms.<sup>37</sup> Under a production ban, this stockpile and any reactor fuel containing recycled plutonium would have to be placed under tight safeguards. The IAEA has developed safeguards for the facilities (reprocessing plants, plutonium conversion plants and "mixed oxides (uranium and plutonium)" fuel fabrication plants) that would be involved in a plutonium fuel cycle. However, measurement errors might conceal diversions of up to 2 percent of the plutonium. If the entire stockpile of 20,000 kilograms of Soviet plutonium were recycled, up to 400 kilograms of plutonium might, in theory, be diverted. This amount is trivial in comparison with the approximately 100,000 kilograms of military plutonium available to the Soviet Union.<sup>38</sup> Nevertheless, the complications of safeguarding separated plutonium against diversion—by subnational as well as national groups—together with the lack of either economic or environmental justification for spent-fuel reprocessing or plutonium recycle at this time argue strongly for an indefinite halt in such activities in the Soviet Union as well as elsewhere.<sup>39</sup>

---

\* The US enrichment complex, for example, currently produces annually about 2.5 million kilograms of low-enriched fuel (assuming an average enrichment of 3.5 percent), enough to fuel the equivalent of the US nuclear-power capacity (about 100 GWe), or more than enough to fuel twice the nuclear-power capacity of the Soviet Union (based on sales of 10.2 million kilogram-SWUs in fiscal year 1989 [*U.S. Department of Energy Fiscal Year 1992 Congressional Budget Request*, volume 3] and the fact that it takes 4.14 kilogram-SWUs per kilogram to enrich uranium to 3.5 percent for a tails assay of 0.35 percent.) If 2 percent of this low-enriched uranium were somehow diverted without detection (probably a worst-case scenario), it would contain 1,700 kilograms of uranium-235. However, in order to produce weapon-useable fissile material this uranium would have to be further enriched in a clandestine enrichment plant or used to fuel a clandestine plutonium-production reactor.

Of course, it would also be necessary to verify that the enrichment plants were not clandestinely reconfigured or operated so as to produce more than the declared amounts of highly enriched uranium. This would require a considerable degree of access to their interiors. Such access has been negotiated as part of the safeguards arrangements for the West European and Japanese gas-centrifuge enrichment plants. We see no reason for difficulties to arise in negotiating the necessary access at gaseous diffusion plants.

### Safeguards responsibilities and costs

All facilities operated for nonmilitary purposes could, in principle, be safeguarded by the International Atomic Energy Agency. IAEA director Hans Blix has stated that

I am...confident that, given adequate resources, the IAEA would have the ability to verify that no use for weapons purposes is made of any nuclear facility or fissionable material submitted to its safeguards.

*Hans Blix, IAEA director,  
Report to the UN General Assembly, 25 October 1989*

The United States has already opened up its nonmilitary nuclear facilities to IAEA safeguards, and the Soviet Union has similarly opened up many of its nuclear-power and research reactors. The IAEA has not been given the resources to actually implement safeguards arrangements at more than one or two of these facilities in each country, however. Safeguarding US and Soviet nuclear facilities would more than double the IAEA's safeguards task, which was funded at a level of \$52 million in 1989.<sup>40</sup> Even if the IAEA were to be provided the necessary additional financial resources, it would take some years for it to recruit and train the extra technical personnel that it would need. Onsite verification of a Soviet-US agreement to end the production of fissile material for weapons would therefore have to be bilateral, at least initially. If one thinks of the bilateral cutoff as a second step (after the NPT) toward a global cutoff of the production of fissile materials for weapons, however, the safeguards arrangements under the US-Soviet production ban should be compatible with those of the NPT so that the two systems could eventually be merged.<sup>41</sup>

Safeguarding tritium-production reactors and naval propulsion reactor fuel-cycle facilities might be inappropriate for the IAEA, whose statute (Article III.A.5) mandates that it "ensure that special fissionable materials ...under its supervision or control are not used in such a way as to further any military purpose." However, the basic document laying out the IAEA's safeguards in nonweapon states signatory to the NPT<sup>42</sup> contains a section (section 14) permitting certain nuclear materials not subject to restrictions on use by other international agreements to be withdrawn from under safeguards temporarily "for non-proscribed military activity." This provision apparently was put in at the behest of Italy to permit the temporary withdrawal from safeguards of enriched uranium for use in naval-propulsion reactors.<sup>43</sup>

To the extent that facilities are put under bilateral US-Soviet safeguards that would not later be taken over by the IAEA, it would be desirable to design the system to allow for the later inclusion of other nuclear-weapon states.

### Clandestine production facilities

Any complete treatment of the verifiability of a ban on the production of fissile material for weapons must examine the detectability of possible

clandestine production plants. Because the capabilities of technical and human means of intelligence are involved, a full treatment of this subject can only be undertaken by the Soviet and US governments. Nevertheless, given the publicly known capabilities of space surveillance and communications-interception intelligence, we believe that it would be possible to detect with considerable confidence the special combinations of equipment and large numbers of specialized people who would be involved in any secret production of significant quantities of weapon-useable fissile materials. For example, the Reagan administration's fiscal-year 1989 Arms Control Impact Statement on Atomic-Vapor Laser Isotope Separation (AVLIS) suggests the approach that would be taken by national intelligence agencies to the detection of the characteristic indicators of a production facility:

The handling of uranium metal as feed, product and tails may provide both structural indicators and nuclear signatures. An additional detectable electromagnetic signature may be the pulsed operation [of] the laser system at kHz (kilohertz) frequencies. In general, any indication of the association of laser and actinide element R&D would be a reliable indicator of a laser isotope separation program. This includes a staff especially the rapid buildup of a staff with this expertise: physicists and chemists with experience in lasers and optical spectroscopy, electrical engineers experienced in electron optics and pulsed power systems, nuclear chemical engineers, computer specialists, and skilled optical technicians and craftsmen.

There are likely to be no single items so essential and unique to the AVLIS process and simultaneously so easily detectable as to be conclusive indicators of the presence or absence of an AVLIS production facility. However, a number of items can be identified which, observed together, point strongly to the presence of an AVLIS production facility. These include: high average power lasers, large electron beam guns, specialized optics, and the specially fabricated process chambers in which the uranium isotopes are separated and collected.

The unique characteristics of nuclear reactors and reprocessing plants make it completely implausible that a plutonium-production complex of any significant size could be concealed. It is less (although still quite) implausible that a centrifuge uranium plant might be concealed (see figure 4). However, US confidence in its capabilities to detect clandestine uranium-enrichment facilities should have been greatly strengthened by the recent trend toward "glasnost" in the Soviet military-industrial complex. It is essential that this openness continue to develop. Indeed, it might be a useful part of a fissile-production cutoff agreement to exchange data on all facilities at which uranium-enrichment research is taking place—much as it was agreed in 1986 at the Second Review Conference on the Biological Weapons Convention to exchange "data, includ-

---

\* Actinide elements are the heaviest elements in the periodic table, and include the fissionable elements uranium and plutonium.

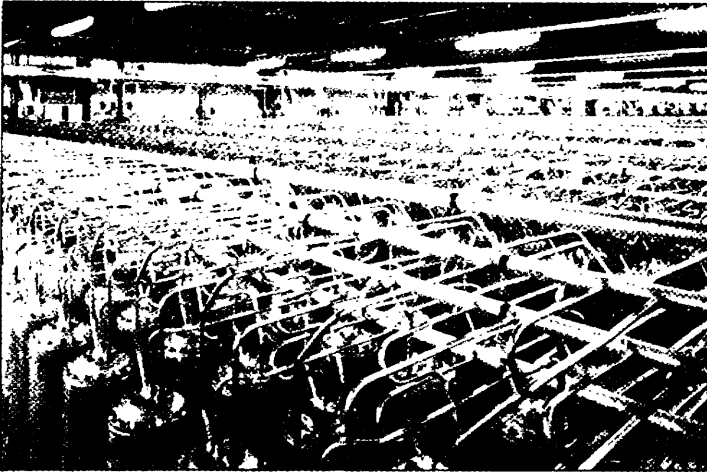
ing name, location, scope and general description of activities" for biological laboratories with special containment facilities for experiments with dangerous microorganisms.<sup>44</sup>

We also assume that some rights for challenge inspections would probably be required in cases where suspicions were aroused. In this connection, we note that there have been extensive discussions and some progress toward agreement on procedures for challenge inspections under the proposed multinational Chemical Weapons Ban which bans the production of specified chemicals at undeclared facilities.<sup>45</sup>

In fact, a clandestine production operation would have to be huge to have any impact on the US-Soviet balance. For example, about 10 million kilograms of natural uranium feed—more than would be required to fuel all Soviet reactors for a year or all US reactors for more than half a year—would be required to produce 50,000 kilograms of highly enriched uranium—about 10 percent of amount that the US has already produced for weapons. A clandestine enrichment operation that could enrich this much material in a year would be comparable to the existing Soviet or US enrichment complexes and could not plausibly be concealed. Enrichment of the same quantity of material over 10 years would require a production complex only one tenth as large but would have to be successfully (and implausibly) concealed for many years, in addition to the several-year pe-

Figure 4  
Interior of the Ureenco  
centrifuge-enrichment  
facility at Almelo, the  
Netherlands<sup>46</sup>

Approximately 10,000 of  
these centrifuges  
operating for a year could  
produce 1,000 kilograms  
of weapon-grade uranium.



riod during which it would be under construction, in order to produce a significant amount of highly enriched uranium.

#### Breakout

As will be discussed below, it is to be hoped that, in the future, most of the fissile material being freed by reductions will be shifted irreversibly out of the control of the national nuclear-weapon complexes. However, agreed quantities—initially perhaps enough to make a few thousand warheads—could be stored under bilateral safeguards but under the physical control of the owning country to be repossessed in case the other country were to break out of the production-cutoff agreement.

### 3. Verifying reductions of nuclear-warhead and fissile-material stockpiles

The verified dismantlement of nuclear warheads and the safeguarded storage or nonweapon use of the highly enriched uranium and plutonium that they contain is a natural complement to the dramatic reductions in deployed nuclear warheads that the United States and USSR are currently planning. Indeed, it would be natural that warheads removed from strategic delivery vehicles as part of the START agreement, or removed from Europe as part of a treaty on short-range nuclear forces in Europe, would be taken directly to jointly safeguarded storage depots prior to their verified dismantlement.

Verified warhead dismantlement would also be a natural follow-on to a verified cutoff in the production of new fissile materials for weapons because the production cutoff would make it impossible to replace fissile material transferred from warheads to safeguarded nonweapon use.\*

Dismantling nuclear warheads removed from nuclear-weapon systems being eliminated or withdrawn by treaty and placing under safeguards the fissile material that they contain would obviate concerns that they might be used to outfit clandestine nuclear delivery vehicles and would strengthen the nonproliferation regime by demonstrating to the rest of the world that the two superpowers were finally reducing, not merely reshaping, their nuclear arsenals.†

We have considered three basic approaches to stockpile reduction:

- ◆ the verified dismantlement of agreed numbers and types of warheads and the placement of the recovered fissile material under safeguards for nonweapon use or disposal

---

\* An obvious follow-on to verified warhead elimination would be direct limits on nuclear-warhead stockpiles. This subject is not treated in this report. A preliminary discussion may be found in *Reversing the Arms Race* (see endnote 1).

† It is possible that one or both countries would wish to use some small fraction of the fissile materials in the warheads being retired to construct permitted new warheads or to make up for recycling process losses. This would reduce somewhat the numbers of warheads proposed for dismantlement.

- transfer of agreed quantities of highly enriched uranium and plutonium out of the control of the weapon complexes to safeguarded facilities for agreed uses or disposal
- a combination of both approaches, in which warheads would be verifiably eliminated and agreed amounts of fissile material that might be more or less than was originally in these warheads would be placed under safeguards.

Each of these approaches has its own strengths and weaknesses.

### Warhead approach

The verified dismantlement of agreed numbers of specific types of warheads and placement of the recovered fissile materials under safeguards could, in principal, be a rather straightforward process (see figure 5). The dismantlement, burning of the chemical high explosives, destruction of the non-nuclear components, and conversion of the fissile material to forms that would not reveal sensitive information would all be done in privacy by the owning country in its own facilities.

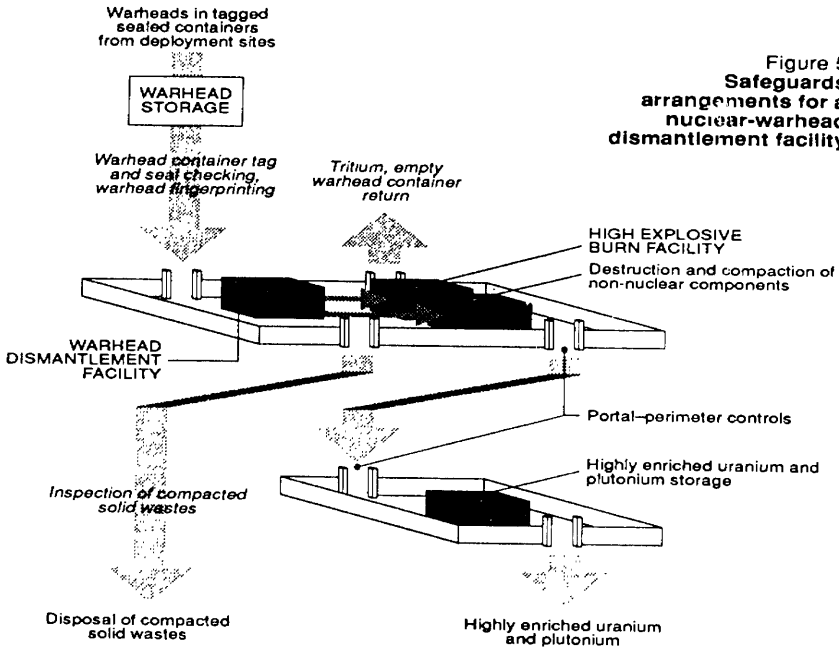


Figure 5  
Safeguards  
arrangements for a  
nuclear-warhead  
dismantlement facility<sup>47</sup>

The inspecting country would establish portal-perimeter controls around these facilities in order to verify that the warheads committed for dismantlement were taken into the facility and the recovered fissile materials were removed only to safeguarded facilities. Information about the quantities of fissile material in individual warheads could be concealed if the fissile materials were taken without weighing to an intermediate separately safeguarded facility in containers too small to contain intact warheads. From this storage facility, shipments of fissile materials could be transferred, after being weighed and assayed isotopically, to safeguarded use as nuclear-reactor fuel or to some other form of ultimate disposal. Periodically, between dismantlement campaigns, the inspecting country would be permitted to check the inside of the dismantlement facility to verify that it contained no undismantled warheads or residual fissile material.<sup>48</sup>

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. The difficulty stems from the trade-off between verification confidence and intrusiveness which might reveal sensitive design information. In 1967, the US Arms Control and Disarmament Agency explored this conflict in a field test of the demonstrated destruction of nuclear warheads. "Inspectors" were given different degrees of access, ranging from external inspection, with and without the use of radiation detectors, to inspection of x-rays of the warheads to see how well they could distinguish between genuine warheads and fakes. Even at the highest level of access, where much sensitive design information was revealed, the ability of the inspectors to make this discrimination was good but not perfect.<sup>49</sup>

In the hopes of reducing the conflict between design secrecy and effective verification, we have examined an alternative approach containing two elements that would increase confidence in warhead authenticity and intactness without necessarily compromising design information:

- 1) Warheads to be dismantled would be placed in containers tagged and sealed by the verifying country—if possible—before their removal from deployment sites.<sup>50</sup> Taking these actions would minimize opportunities to replace warheads with dummies and would also make it implausible that fissile material could have been removed from the warheads.
- 2) Appropriately chosen intrinsic "fingerprints" of warheads declared to be of the same type would be compared to see that they were all indeed identical (to within agreed tolerances). This would force any counterfeiting operation to be applied to all warheads of that type, making its successful concealment implausible.

These two approaches could be strengthened if randomly selected samples of all types of Soviet and US deployed warheads were placed in



tagged and sealed containers early—even including samples of those types not expected to be submitted for elimination in the immediate future. These sample warheads could subsequently be used as standards against which the fingerprints of warheads tagged later could be compared.

#### Fingerprinting warheads

The simplest possible intrinsic fingerprint for a warhead would be the weights and isotopic compositions of the enriched uranium and plutonium that it contains. This choice would be particularly appealing because it would be directly related to one of the principal objectives of the stockpile-reduction agreement: moving fissile material out of weapons and into safeguarded storage. However, this approach is currently blocked by the fact that the quantities of fissile material in any specific type of warhead are currently considered "sensitive" design information by both the US and Soviet nuclear-weapon establishments.

One possible way to deal with this problem would be to measure only the average quantities of fissile material in mixtures of different types of quite disparate warheads (for example, equal numbers of a specific type of CBM warhead and a specific type of nuclear-artillery shell). However, this approach might be too constraining because, given  $n$  fundamentally different warhead types, less than  $n$  independent mixes are possible if the contents of the individual warheads are to be concealed, and  $n$  could be a small number.

A second type of fingerprint could be based on measurements of the gamma and/or neutron radiation outputs of the warhead. These radiation outputs depend in a complex way on the quantities and configurations of the uranium and plutonium in the warhead and on the nature of the surrounding materials. If the measurement arrangements are somewhat constrained geometrically, their results can be quite characteristic while still not providing enough information to reveal design data.

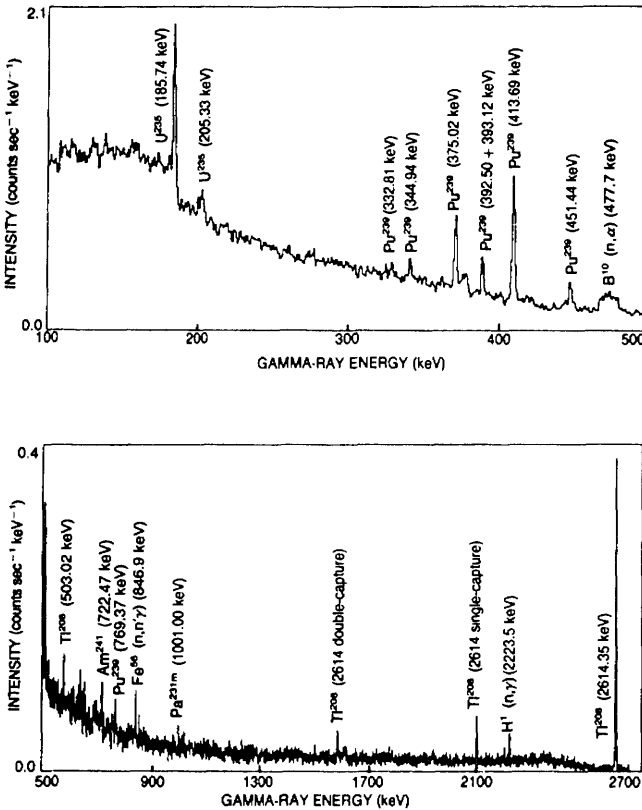
**Gamma-ray fingerprint** In the case of the gamma radiation, a fingerprint would probably be based on measurements using a high-energy-resolution detector (for example a high-purity germanium crystal scintillator). This detector would show a characteristic gamma energy spectrum containing lines associated with radioactive decays of the uranium and plutonium isotopes in the warhead, decays of their radioactive decay products, and captures in the surrounding materials of neutrons spontaneously emitted by the plutonium (see figure 6).

Allowance would have to be made in interpreting these spectra for the fact that the relative intensities of the lines associated with the fissile-isotope decay products would depend upon the age of the fissile material. Also, the intensities of lines associated with minor fissile isotopes could vary depending upon the material's production history. The lines which

would be expected to vary least would be those directly associated with the main fissile isotopes, uranium-235 and plutonium-239.

Analysis of the design information obtainable from measurements taken with an uncollimated germanium detector at a single location near a Soviet warhead for a total time of approximately 20 minutes indicates that sensitive design information was probably not revealed.<sup>53</sup> If necessary, the information revealed could be further limited by: designing the data processor to record data only in agreed energy bands; integrating the data over selected energy bands; or even having the spectrum compared with that of the reference warhead inside a computer without the inspectors having access to the raw data.

Figure 6  
Gamma-ray  
"fingerprint" of a Soviet  
cruise-missile warhead<sup>51</sup>



Ending the production of fissile materials for weapons

**Neutron fingerprint** The intensity of the neutron emissions from a warhead would reflect primarily the amount of the minor isotope, plutonium-240, in the warhead and the neutron-multiplication properties of the geometry of the fissile material.<sup>53</sup> The INF treaty contains arrangements to measure the intensity and angular distribution of the neutrons coming out of Soviet canisters declared to contain single-warhead SS-25 intercontinental ballistic missiles (ICBMs) so as to verify that the canisters do not contain banned three-warhead SS-20 intermediate-range ballistic missiles (IRBMs). However, the neutron intensity from a single warhead would probably not be considered an adequately distinctive fingerprint by itself and, in any case, the intensities from different samples of the same type of warhead might legitimately differ considerably because of variations in the percentage of plutonium-240 in their core plutonium.

**High-energy x ray or neutron radiography** A third possible fingerprint would involve the use of high-energy x-ray or neutron radiography.<sup>54</sup> High-energy x-ray radiography is already used by the US at the Soviet Votkinsk missile-production facility to verify that none of the missile stages being shipped out of the plant in canisters are of the dimensions used in the banned SS-20 intermediate-range missile.

Transmission radiographs would not, however, reveal, for example, whether highly enriched uranium had been replaced with natural uranium. To distinguish fissile from nonfissile material, it would be necessary to detect either the characteristic types of radiation emitted spontaneously by the fissile isotopes or to detect fissions induced by irradiation with neutrons or gamma rays of appropriate energy.<sup>55</sup>

Since detailed radiographs of warheads might reveal sensitive design information, methods would have to be devised to protect such information. One approach, which has already been mentioned above in connection with the gamma-emission fingerprint, would be to compare the radiograph of the warhead being submitted for dismantlement with that of the reference warhead using a computer equipped with security arrangements to prevent access to the data. The computer would check that the image of a warhead to be dismantled was identical, to within agreed tolerances, to that of the reference warhead.\* The performance of the system could be checked by the inspecting party at any time using a variety of known dummy "warheads."

### Fissile material approach

The availability of fissile materials limits the size of a nuclear-warhead stockpile, and fissile materials typically account for about one half of the

---

\* The comparison could be done either directly, using two sets of instruments, or with an image or spectrum encoded in the computer memory.

cost of a warhead. It is often therefore pointed out that the simplest way to decrease the sizes of the nuclear arsenals would be to verifiably transfer out of them agreed quantities of fissile materials. In comparison with verified warhead dismantlement, an agreement to transfer agreed amounts of fissile material out of the nuclear-warhead production complexes would be very simple to verify.

Some would be concerned that this approach might not be eliminating real warheads, as the materials being turned in could be coming from surplus stockpiles of fissile material. Furthermore, the translation of quantities of fissile material into potential warheads would be somewhat uncertain, as the design approaches used by the Soviet Union and United States might differ significantly.

However, if a weapon-production complex *did* possess large stockpiles of surplus unsafeguarded weapon-grade fissile material, new warheads could be manufactured over time to replace those that had been dismantled. And a major reason for the complexity of the warhead dismantlement approach is the insistence of the nuclear-weapon complexes that the quantities of fissile material in individual warheads is sensitive information.

Advocates of the fissile-material approach therefore see it as capturing almost all the real benefits of the warhead approach with much less cost and complexity.

### Combined approach

A third approach to the problem of warhead dismantlement would be to require both that warheads be verifiably destroyed and that agreed amounts of fissile material be placed under safeguards for each warhead dismantled. If the amounts of fissile material in the warheads being dismantled exceeded the agreed amounts to be transferred, the excess could be removed from the dismantlement facility by the owning nation without assay.\* If the amounts of fissile material in the warheads being dismantled were less than the agreed amounts to be transferred, the difference could be made up by supplementary quantities of fissile material brought into the dismantlement facility without assay.

This approach would ease the task of concealing the amounts of fissile material contained in individual types of warheads; it would provide considerable confidence that the agreed warheads were being dismantled; and, to the extent that doubts remained, it would in any case assure that the agreed quantities of fissile material were being removed from potential weapon use.

---

\* To ensure that intact warheads were not being removed, the removals could be made in containers too small to contain a warhead.

### Costs of onsite monitoring and compliance

Verification of the dismantlement of nuclear warheads and/or the transfer of fissile materials from the weapon complexes to safeguarded nonweapon uses would involve extra costs for both the inspecting and inspected countries. These costs would probably be very roughly comparable to those incurred in connection with the Intermediate-range Nuclear Forces (INF) Treaty—about a billion dollars over 13 years (see table 4).

Like the INF treaty, verified warhead dismantlement would require traveling teams of inspectors to visit a considerable number of declared deployment sites in each country. In the case of the INF treaty, the pur-

Table 4  
Estimated US onsite  
monitoring and  
compliance costs over  
the 13-year verification  
period of the INF treaty  
(In millions of 1990  
dollars)

	One-time	Annual
Planning, management and oversight	5- 15	5-15
Research and development	50-100	
376-396 baseline, elimination and closeout inspections at Soviet sites	30- 55	
Hosting Soviet inspectors at 36 baseline and closeout inspections at US sites	10- 55	
Eliminating US missiles and launchers under inspection	55-135	
Establishing portal and perimeter monitoring and operating at a Soviet missile-production facility	45- 50	10-20
Hosting arrangements (mostly security) for permanent Soviet inspectors at a US missile-production facility	105-110	10-20
10-20 annual short-notice inspections at Soviet sites		1- 2
Hosting 10-20 annual Soviet short-notice inspections		1-10
<b>TOTAL</b>	~ 300-500	27-67

Source: Michael O'Hanlon, U.S. Costs of Verification and Compliance Under Pending Arms Treaties (Congressional Budget Office, 1990), pp. 16-19.

pose of the visits to deployment sites was first to verify baseline inventory declarations, then later to verify that all missiles and launchers had been removed. In the case of warhead dismantlement, the inspectors would observe warheads being placed in containers and then seal and tag the containers for transport to central storage.

The INF treaty also involves a team of inspectors establishing continuous portal and perimeter controls at a missile production plant to verify that production of intermediate-range missiles had ceased. In the case of verified warhead dismantlement, similar controls would have to be established at a warhead dismantlement facility in each country.

Additional costs might be required if it were necessary to construct new nuclear-warhead dismantlement facilities because verification arrangements would interfere with other activities not limited by treaty at existing facilities. For example, US nuclear warhead dismantlement is carried out at the Department of Energy's Pantex plant about 20 miles northeast of Amarillo, Texas. However, nuclear-warhead assembly and quality-assurance activities are also carried out at Pantex and the dismantlement of obsolete warheads not covered by a warhead-elimination treaty would also presumably continue there.

A new warhead-dismantlement facility might cost on the order of a billion dollars.<sup>57</sup>

Most of these costs would be avoided if the fissile-material turn-in approach were adopted. However, the fuel value of the highly enriched uranium recovered from warhead dismantlement would probably exceed the costs of the warhead dismantlement and verification costs. (Even at current depressed uranium prices, the fuel value of one half of the uranium-235 in US weapon uranium is about \$6 billion.<sup>58</sup>)

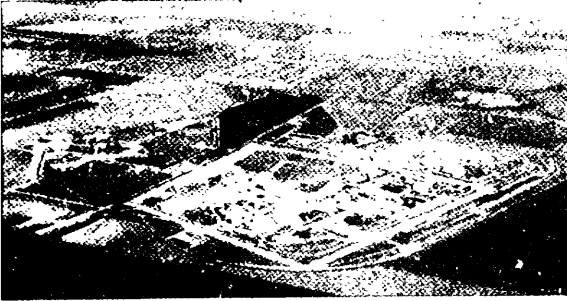
### Environmental issues

The demilitarization of large numbers of nuclear weapons (tens of thousands of tactical and strategic devices) will require careful attention to environmental compatibility and public perceptions of the risks associated with the transportation, storage, dismantlement, and disposal of nuclear radioactive materials.

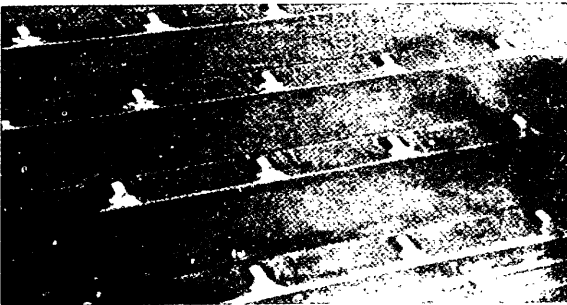
The transport, storage, dismantlement, and disposal of both high-level and low-level nuclear waste from military and civilian programs has encountered serious opposition worldwide. Opposition is also being manifested to the transportation, storage, and incineration of chemical munitions at all eight proposed US destruction sites, at the Soviet site, and at Johnson Island in the Pacific.

Nuclear weapons are currently stored at overseas bases, on ships, in missile silos, and in domestic storage depots. They would have to be transported to temporary domestic storage in the proximity of a dismantlement facility pending their demilitarization. Because existing or new

Figure 7  
Aerial views of Pantex<sup>56</sup>



Entire site



Warhead storage "igloos"



Warhead assembly and  
dismantlement "bays"

dismantlement facilities are not likely to be able to promptly handle the throughput of thousands of weapons, weapons might be kept in storage for years.

The operations and products of dismantlement are safely conducted only under special environmental safeguards because they involve radioactive materials, potential nuclear criticality conditions, high explosives, beryllium, and other hazardous materials. Not only the dismantlement but also the disposal of the associated hazardous wastes will require careful environmental consideration.

There are special concerns over the continued availability of facilities that are qualified to carry out the several stages of dismantlement. For example, the Rocky Flats plant, which processes the plutonium in the fission triggers of US nuclear warheads, might not be available in the future to assist in this important phase of dismantlement, and it takes many years to qualify other sites.

Despite these concerns, we believe that the activities associated with nuclear warhead dismantlement will not encounter the same public resistance as radioactive-waste or chemical-weapon disposal. The opposition to radioactive-waste disposal stems in large part from opposition to nuclear power more generally, while in contrast, public opinion is quite supportive of reductions in the nuclear arsenals. Also, unlike chemical-weapon disposal, nuclear-warhead dismantlement has been conducted routinely for many years and has had an environmental impact that has been relatively minor in comparison with the impacts of nuclear-weapon production.

The activities of greatest environmental sensitivity are likely to be associated with the transformation of the plutonium in warhead cores into nonweapon-related forms suitable for weighing and isotopic assay and later the ultimate disposal of the plutonium. In the United States, the processing of plutonium recovered from dismantled cores and the fabrication of new plutonium cores have been traditionally carried out at the Rocky Flats plant outside Denver, Colorado. This facility is now shut down because of occupational health and environmental concerns, and it is not clear whether it will be restarted. A facility such as the New Special (Plutonium Scrap) Recovery Facility at the Savannah River plant in Georgia would probably be adequate to convert plutonium cores into standard forms for weighing and assay. It would be best to establish a single plutonium facility at the dismantlement site, however, since otherwise portal-perimeter controls would be required at two sites.

The ultimate disposal of the recovered plutonium is discussed in section 4.



### **Interim storage of warheads to be dismantled**

Negotiating arrangements for verified warhead dismantlement and building any new facilities required might take several years—perhaps even a decade. In the meantime, as strategic warheads are removed from missiles and bombers and tactical warheads are withdrawn from Europe, it will be necessary to store them securely.

In the United States, the total number of strategic and tactical warheads that are expected to be retired will exceed existing storage capacity at Pantex, and new storage capacity will have to be built or military storage sites will have to be used. It would obviously be desirable to locate any new storage capacity where the verified warhead dismantlement is to take place and design it to facilitate joint Soviet-US safeguards. The warheads would be stored in sealed, tagged containers in a manner so that the tags and seals could be periodically inspected by joint teams of inspectors. As noted above, confidence that authentic warheads were indeed in the containers would be maximized if the warheads were put into the containers at the deployment sites with inspectors of the other side watching and then applying tags and seals.

## 4. Disposal of the fissile materials

What would be done with the fissile material recovered from dismantled warheads? Above, we have suggested that some might be kept in stockpiles under bilateral safeguards but under the physical control of the owning country in order to assure that neither country would be caught at a disadvantage should the other break out of the reduction agreement.

### Highly enriched uranium

After any such stockpile requirements had been met, there would not be any significant problem about the safeguarded disposal of highly enriched uranium (HEU). Enriched uranium is the basic fuel of nuclear reactors today.

Some weapon-grade uranium could be to fuel reactors requiring highly enriched uranium—naval reactors and some research reactors in the case of the United States.\* Given the anticipated cuts in the stockpiles, however, hundreds of metric tonnes of HEU will become available—much greater than the few tonnes per year required to fuel these reactors. The Soviet Union and United States would therefore have to agree on how much of the excess HEU could be kept in long-term stockpiles with the rest being diluted with natural uranium (0.711 percent uranium-235) or depleted uranium (0.2–0.35 percent uranium-235, in the case of the US) down to the low-enriched grades (3–4 percent uranium-235) used by power reactors. In the US, power reactors currently consume each year fuel containing approximately 100 tonnes of uranium-235 in low-enriched uranium.† Since low-enriched uranium will not sustain a fast

\* As noted above, the enrichment of the uranium used in US naval reactors is 97.3 percent. This is even higher than the 93.5 percent enrichment of US "weapon grade" uranium. A small amount of additional enrichment work might therefore be required to bring the enrichment of uranium recovered from US warheads up to Naval grade.

† About 800 kilograms of uranium-235 in low-enriched (3–4 percent uranium-235) uranium will fuel a standard large (1,000 megawatt electric (MWe) or 3,000 megawatt thermal) power reactor for about a year at 65-percent average capacity factor. If this low-enriched uranium were produced by diluting weapon-grade (94 percent uranium-235) with natural uranium (0.7 percent uranium-235) uranium, about 80 percent of the uranium-235 would come from the weapon-grade uranium. The US nuclear generating capacity in 1990 was about 100,000 MWe. In 1989, the USSR had 36,636 MWe of nuclear-generating capacity in operation and 23,960 MWe under construction (*Nuclear Engineering International* 34, [June 1989], pp. 72–74.)

chain reaction, diluting highly enriched uranium down to low-enrichment levels effectively "denatures" it for weapon use.

#### Plutonium

Because of poor economics and security concerns, neither the United States or the Soviet Union uses plutonium on a large scale as a reactor fuel today. Nor has either country yet worked out a long-term radioactive waste disposal policy. Plutonium is currently accumulating in spent US nuclear power-reactor fuel at a rate of about 20,000 kilograms a year—enough in five years to equal the entire US past production of plutonium for weapons. Worldwide, plutonium is and being separated out from spent power-reactor fuel is accumulating at a rate that is more than three times the US rate. Strategies for the disposal of surplus plutonium recovered from dismantled nuclear warheads and plutonium in spent fuel should therefore be developed as coordinated parts of a larger international plutonium and radioactive waste disposal strategy.

In the meantime, it would probably be simplest to agree to interim secure storage of surplus plutonium under bilateral or IAEA safeguards.<sup>59</sup>

## 5. Exchanges of information about the sizes of the stockpiles

In connection with the verification arrangements for an agreement to halt the production of fissile material for weapons, the Soviet Union and United States will have to declare the locations and give descriptions of their military production and civilian nuclear facilities and their civilian stockpiles of fissile materials.

Because both the Soviet Union and United States appear convinced that the sizes of their nuclear stockpiles are excessive, it should be possible to agree on a production ban and a first round of stockpile reductions without declaring the sizes of the stockpiles. However, in order to go beyond the first 50-percent cuts, both countries will probably want to have an improved idea of each other's stockpiles. We therefore suggest that the Soviet and US governments seriously consider mutual declarations of the sizes of the stockpiles of fissile material available to their weapon complexes and an exchange of production records and cooperative research ("nuclear archeology") on the physical evidence that could be used to check and refine these production records.<sup>61</sup>

Other reasons to move forward promptly with such exchanges of documentation and cooperative evaluations of physical data are the facts that the records are getting old and the dismantlement of old production facilities may soon begin. Our basic premise is that the more one knows about the history of the production and disposition of the weapon stockpile of the other party, the greater the confidence one will have in verifying a given stockpile level. Intelligence agencies will almost inevitably deal with uncertainties by including in their estimates "conservative" upper limits on the other side's stockpiles, which will tend to increase the reluctance of the political leaderships to reduce.<sup>62</sup> The longer the delay, the more concerns will develop that records or physical evidence may have been altered. Failure to take some very simple steps now could therefore limit future verification capabilities and perhaps ultimately the level of achievable reductions.

---

\* The dismantlement of old production reactors has begun in both the Soviet Union and United States, but the defueled graphite-moderated core structures are still intact.

Even given a cooperative program of nuclear archeology, however, we expect that uncertainties on the order of 10 percent will remain in estimates of existing stockpiles based on the physical evidence of past production.<sup>60</sup>

---

42 Verifying the dismantlement of nuclear warheads

## 6. First steps

Some of the measures examined above will probably require considerable negotiation, because of concerns about the need to protect sensitive nuclear-weapon and naval-fuel design information. Other measures, such as verified warhead dismantlement, may have to await the design and construction of special facilities. However, certain measures need not be delayed and there would be considerable advantage if they were not. These include: the joint Soviet-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 such as uranium enrichment plants, civilian reprocessing plants, and civilian plutonium stores. Also, if possible, the warheads that are to be subject 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.

The earlier these measures are undertaken, the less the associated verification uncertainties later and the more the Soviet-US nuclear arms-reduction agreements will strengthen the legitimacy of the nonproliferation regime in the crucial period prior to 1995, when Nonproliferation Treaty must be renewed.

Elimination of unnecessary secrecy relating to past and present nuclear-weapon production activities would also facilitate mutual understanding in establishing verification arrangements. This recommendation is directed especially to the Soviet government, since we have found, in carrying out our research, that it has been possible to go into considerably further depth with regard to the verification issues relating to US nuclear facilities than those of the Soviet Union.

To facilitate the Soviet process of declassification, we include in appendix A a list of the types of information already publicly available about US nuclear-warhead production.

## appendix a

### Classes of data about nuclear weapons and nuclear-weapon materials production that have been declassified by the United States but not the Soviet Union<sup>64</sup>

*by Thomas Cochran and Christopher Paine*

The types of information listed below, related to US nuclear warheads and their production, have been released by the US government. However, most of the corresponding information concerning Soviet warheads and their production is still treated as secret in the Soviet Union and is therefore unavailable to independent researchers concerned about public policies relating to arms control and disarmament, environmental contamination, and public health problems resulting from nuclear weapon production.

#### **The nuclear-warhead stockpile and its history**

The identification of each type of warhead in the active stockpile and the associated delivery system or systems (e.g. the comparable US list would include: W87 - MX; W88 - Trident II, etc.). The total list would give the total number of different types of nuclear warhead in the active stockpile.

The history of the stockpile, including the identification of warhead types that have been retired from the stockpile, or cancelled, and their respective delivery systems. Dates when design work began and was completed, when engineering development began, when construction began and was completed, when the warheads were in the active stockpile, and when the retirement process began and was completed—or, for warheads whose development was cancelled prior to deployment, the stage and date at which the decision took place.

The approximate size (i.e. to two significant figures) of the stockpile at some point in its recent history and a graph showing the relative size of the stockpile from 1949–1990.

#### **Design and production of nuclear weapons and test devices**

With respect to facilities involved in the present or past in the design, development, construction, or testing of nuclear weapons, or their major components, the following information:

- The name of the facility
- Its mission
- Its operating dates

- Its area and location
- A map identifying its principal buildings and/or production areas and their major functions
- A list of the major research facilities at the site
- Whether it currently handles, or has handled in the past, significant quantities of plutonium, highly enriched uranium, natural or depleted uranium, other special nuclear materials, tritium, natural or enriched lithium, deuterium, lithium deuteride, or high-explosive materials
- Whether it has facilities designed to assemble nuclear weapons or test devices, or store the same.

With respect to functions, the name and location of each facility where the following functions are performed or warhead components are manufactured:

*Research, development and testing*

- Nuclear-warhead or nuclear-explosive design
- Nuclear-warhead system integration (for example, the work performed at the Sandia laboratories in the United States)
- Hydrodynamic testing of the fission-trigger designs.
- Nuclear explosive testing
- Research and test facilities for inertial confinement fusion

*Warhead component manufacture and assembly*

- Fissile cores
- High-explosive materials
- High-explosive components
- Detonators
- Firing circuits
- Fuzes, arming and safing, permissive action links, altimeters, and other electrical circuits
- Neutron-generator fission initiators
- Plutonium components
- Highly enriched, natural, and depleted uranium components
- Beryllium components
- Deuterium-containing components
- Components containing enriched lithium and lithium deuteride
- Components containing tritium
- Assembly of thermonuclear secondaries



- Final warhead (and bomb) assembly
- Warhead dismantlement
- Design, assembly and testing of aerodynamic cases (for example, bomb cases and ballistic-missile reentry vehicles).

### **Nuclear materials production**

With respect to each present and past facility involved in the production of nuclear-weapon materials, the following information:

#### *Uranium mining*

- Mine locations
- Annual production from all mines (metric tons of ore/year)
- Average annual ore concentration (percentage of uranium in the ore by year)

#### *Uranium mills*

- Name and location of each facility
- Operating dates
- Annual output (tonnes of  $U_3O_8$  by year)

#### *Uranium fuel conversion and fabrication facilities*

- Name and location of each facility
- Operating dates
- Products (types and quantities annually)

#### *Uranium enrichment plants*

- Name and location of each facility
- Type (gaseous diffusion, gas centrifuge, laser, etc.)
- Mission (research and development, pilot plant, production plant)
- Production history (annual values of: kilogram-separative work unit [swu] capacity, kilogram-swu output, kilowatt-hours input; uranium feed, product and tails assay)
- Size of workforce (employment by year)
- Dates for beginning construction; end of construction; beginning of operation, periods of extended shutdown, restart, and permanent shutdown

#### *Plutonium and tritium production reactors*

- Name and location of facility
- Type (i.e. graphite- or heavy-water-moderated reactor)
- Mission (research and development, test or production reactor)

- ◆ Products (weapon-grade plutonium, tritium, plutonium-238, by-product steam for electricity production, etc.)
- Capacity, measured in megawatts (thermal) given on an annual basis or at the time of each upgrade
- Production history (monthly values of output measured in thermal megawatt days)
- Workforce (employment by year)
- Dates for beginning construction; end of construction; beginning of operation; periods of extended shutdown, restart, and permanent shutdown
- Detailed description of the reactor including the number of channels, control and safety rods, physical dimensions of the vessel, moderator, coolant channels, fuel and target channels, etc.
- Physical description of each type of fuel and target element utilized (i.e. enrichment and dimensions) and its date of introduction

*Chemical separation facilities for plutonium production and nuclear fuel recycling*

- Name and location of facility
- Type (for US facilities it would be PUREX, REDOX, etc.)
- Mission (research and development, pilot or production plant) and source and type of feed (i.e. which reactors and, if appropriate, whether the feed is driver or target elements)
- Capacity measured in metric tonnes of uranium per year at the time of each upgrade
- Workforce (employment by year)
- Dates for beginning construction; end of construction; beginning of operation, periods of extended shutdown, restart, and permanent shutdown
- Detailed description of the chemical process with flow charts

*Naval fuel fabrication and assembly facilities*

- Name and location of facility
- Purpose or mission
- Operating dates
- Fuel enrichment (percent uranium-235)
- Annual enrichment requirements (kilogram-SWUS/year).
- Fuel flow charts showing how each of the facilities identified above are tied together, giving the chemical form and enrichments of materials flowing between respective facilities.

*Waste-management activities*

- ◆ Method of classifying waste (i.e. high level, low level, transuranic, etc.) with precise definitions of each
- ◆ Locations of all nuclear waste storage and disposal sites
- ◆ Quantities (volume and curie amounts) of each class of waste stored or buried at each site
- ◆ The curie amounts of cesium-137, strontium-90, and plutonium-239 at each site.

## appendix b

### Participants in the 29 October–1 November Moscow workshop

#### Soviet Union

*Academician Spartak Belyaev*

Deputy Director for Physics, Kurchatov Institute of Atomic Energy;  
Moscow

*General Vladimir Belous (retired)*

Committee of Soviet Scientists for Global Security

*Dr. Victor Kravetz*

Center for Program Studies, USSR Academy of Sciences

*Dr. Valentin Lebedev*

Physics Division, Kurchatov Institute

*Dr. Alexei Mitrophanov*

Physics Division, Kurchatov Institute

*Academician Karl K. Rebane*

Institute of Physics of the Estonian Academy of Sciences, member of the  
Soviet Congress of Deputies

*Dr. Stanislav Rodionov*

Soviet Space Research Institute

*Dr. Alexander Sanin*

Center for Program Studies, USSR Academy of Sciences

#### United States

*Dr. Thomas B. Cochran*

US Natural Resources Defense Council

*Dr. Alex De Volpi*

Argonne National Laboratory (observer)

*Professor Steve Fetter*

School of Public Affairs, University of Maryland, College Park

*Dr. William Higinbotham*

Safeguards Group, Brookhaven National Laboratory (retired)

*Christopher Paine*

Arms-control adviser to Senator Edward Kennedy  
(now at the Natural Resources Defense Council)

*Dr. Theodore Taylor*

Consultant

*Professor Frank von Hippel*

Princeton University, chairman of the research arm of the Federation of  
American Scientists

*Dr. David Wright*

Federation of American Scientists

# Notes and references

1. The most comprehensive summary of this work is presented in Frank von Hippel and Roald Sagdeev, eds., *Reversing the Arms Race: How to Achieve and Verify Deep Reductions in the Nuclear Arsenal* (New York: Gordon and Breach Science Publishers, 1990). Earlier versions of some of the chapters of that book were published in *Science & Global Security*.
2. *Treaty between the U.S. and USSR on the Elimination of their Intermediate-range and Shorter-range Missiles, Memorandum of Understanding*, December 1987.
3. As of the end of 1990, the Soviet Union had an estimated 9,906 warheads on deployed intercontinental and submarine-launched ballistic missiles and the United States had an estimated 7,666 (see table 1). The START treaty will require that these totals be reduced to less than 4,900 each. As of the end of 1990, the Soviet Union had an estimated 762 and the United States 4,284 warheads deployed on bombers. The effects of START on these bomber-carried warheads is uncertain because the START counting rules will count US [Soviet] bombers equipped with nuclear-armed long-range air-launched cruise missiles (ALCMs) as carrying 10 [8] warheads each and non-ALCM bombers as carrying only one warhead each—although the estimated warheads loadings of US [Soviet] ALCM and non-ALCM nuclear bombers are about 20 [6] and 20 [12] respectively (see table 1).
4. NATO had an estimated 3,989 warheads deployed in Western Europe in the fall of 1990. Of these warheads, 1,450 were nuclear artillery shells, 1,400 were bombs, 680 were for the short-range Lance missile, and 160 were depth bombs. The remaining 299 were warheads for ground-launched cruise, Pershing 1A and Pershing 11 missiles whose elimination is to be completed by 1 June 1991 (Robert S. Norris and William M. Arkin, *Bulletin of the Atomic Scientists*, October 1990, p. 48). (See also table 2.)
5. The US Navy, for example, has recently retired without replacement its nuclear-armed ship-launched ASROC and its submarine-launched SUBROC anti-submarine weapons, and its nuclear-armed ship-launched anti-aircraft Terrier missiles for an estimated total of 1,100 warheads. The Soviet Navy has been dramatically reducing the number of its combat ships (*World Armaments and Disarmament*, 1990, pp. 12, 33–35).
6. See for example Michael M. May, George F. Bing, and John D. Steinbruner, "Strategic Arsenals After START," *International Security* 13, Summer 1988, pp. 90–133; Harold A. Feiveson and Frank von Hippel, "Beyond START: How to Make Much Deeper Cuts," *International Security* 15, Summer 1990, pp. 154–180; Richard C. Davis and Jon Wolfsthal, *Potential START II Outcomes and Their Implications: Report of a Workshop* (McLean, Virginia: Science Applications Inc., 1990); and Roger D. Speed, *Strategic Forces: Future Requirements and Options* (Lawrence Livermore National Laboratory report L-1050, 1990).
7. Robert S. Norris and William M. Arkin, "Beating Swords into Swords," *Bulletin of the Atomic Scientists*, November 1990, pp. 14–16.

8. *Breakout, Verification and Force Structure: Dealing with the Full Implications of START* (Washington DC: US Government Printing Office, House Committee on Armed Services Print # 21, 24 May 1988).
9. Thomas B. Cochran, William M. Arkin and Milton M. Hoenig, *Nuclear Weapons Databook Volume 1: U.S. Nuclear Forces and Capabilities* (New York: Ballinger, 1984), p. 14.
10. Frank von Hippel, David Albright, and Barbara Levi, *Quantities of Fissile Materials in U.S. and Soviet Nuclear Weapons* (Princeton, New Jersey: Princeton University, Center for Energy and Environmental Studies, PU/CBES report #168, 1986); Thomas B. Cochran, William M. Arkin, Robert S. Norris, and Milton M. Hoenig, *Nuclear Weapons Databook Volume 2: U.S. Nuclear Warhead Production* (New York: Ballinger, 1987). Perhaps 10–20 percent of these materials were in the production pipeline and in process waste awaiting recovery. In modern warheads, much of the weapon-grade uranium is probably in the secondary "thermonuclear" stages.
11. IAEA, *Annual Report for 1989* (Vienna: IAEA report GOV/2440, 1990), p. 103. An additional 40 NPT-signatory nonweapon states had signed safeguards agreements with the IAEA but did not yet have significant nuclear activities to be safeguarded. Yet another group of 10 states were not signatories to the NPT but had accepted IAEA safeguards on specific nuclear facilities as part of agreements with the countries that had supplied those facilities.
12. Letter to Representatives Fascell, Tauke, and Wyden, 16 May 1989, reprinted in *International Plutonium Control Act—H.R. 2403*, p. 191.
13. US Department of Energy, *Nuclear Weapons Complex Reconfiguration Study*, DOE/DP-0083, January 1991, p. 49.
14. Speech by President Gorbachev in London on 7 April 1989.
15. Thomas B. Cochran and Robert S. Norris, *Soviet Nuclear Warhead Production* (Washington DC: Natural Resources Defense Council working paper, NWD 90-3, 3rd revision, February 1991).
16. V.F. Petrovsky, statement to the UN General Assembly, 25 October 1989.
17. *U.S. Nuclear Warhead Production*, p. 61. *Soviet Nuclear Warhead Production*.
18. Robert S. Norris and William Arkin, *Bulletin of the Atomic Scientists*, November 1989, p. 53, updated by Norris, private communication, 4 April 1991. These curves include estimated spares and so are somewhat higher than the totals for deployed warheads shown in tables 1 and 2.
19. See US Arms Control and Disarmament Agency, *Documents on Disarmament* (Washington DC: U.S. Government Printing Office, annual).
20. Speech to the Second UN Special Session on Disarmament by Soviet Foreign Minister Gromyko, 15 June 1982.
21. An 11 May 1989 report from Tass stated that, in a meeting between President Gorbachev and US Secretary of State Baker, "Gorbachev suggested [that] Baker starting drafting work on a bilateral agreement on the controlled cessation of the production of all weapon-grade fissile materials." (*News and Views from the USSR* [Washington DC: Soviet Embassy, Information Department, 12 May 1989]). On 26 September 1989, in a speech to the UN General Assembly, Soviet Foreign Minister Shevardnadze stated that "there is an urgent need for verifiable cessation of the production of fissionable material for weapons purposes." (*New York Times*, 27 September 1989, p. A-12.) (Both of these references are from Warren Donnelly's review, *Proposals for Ending US and Soviet Production of Fissile Materials for Nuclear Weapons* [Washington DC: Library of Congress, Congressional Research Service, Issue Brief 1889141, 9 November 1989]).

22. Thus the Arms Control and Disarmament Agency commented, in an answer submitted to a question for the record of the hearing on the *International Plutonium Control Act* (p. 140) that

It is uncertain whether the Congress would provide funds to rebuild the U.S. production facilities when there would be a law against operating them in a plutonium production mode once they were constructed.

23. "Statement by United States Expert [Jensen] to the Delegates to the Eighteen Nation Disarmament Conference: Description of a Monitoring System for Shutdown Nuclear Reactors, August 10, 1966," in *Documents on Disarmament, 1966* (Washington DC: US Government Printing Office, 1967), pp. 538-546.

24. See for example US General Accounting Office, *Decreasing Tritium Requirements and Their Effect on DoE [Department of Energy] Programs* (Washington DC: General Accounting Office report # GAO/RCED-91-100, February 1991).

25. In its fiscal year (FY) 1991 budget proposal, the US Navy "and other government customers" requested (and subsequently received) funding to purchase 600,000 kilogram-SWU of separative work to produce fuel for reactors. The request for FY 1992 was for 500,000 kilogram-SWU. (*U.S. Department of Energy Fiscal Year 1991 Congressional Budget Request*, [Washington DC: Office of Financial Management and Controller, February 1991], volume 3, p. 129. We assume that only a small part of this demand was for research reactors. The US enrichment plants are currently operating at a depleted uranium "tails" assay of 0.35-percent uranium-235 (David Thomas, manager of gaseous diffusion operations, US Department of Energy, private communication, 2 April 1991). At this assay, 197 kilogram-SWU would be required to produce 1 kilogram of 97.3 percent enriched uranium.

26. Statement by Evgeny I. Mikerin, head, Main Department of Manufacturing and Technology, USSR State Committee for the Utilization of Atomic Energy, 7 July 1989, reported in *Science & Global Security* 1 (1989), p. 174. French officials have also stated that the fuel used in their naval propulsion reactors is enriched to less than 10 percent. [Marvin Miller, "Nuclear-powered Attack Submarines and the Proliferation of Nuclear Weapons," in *Averting a Latin American Nuclear Arms Race: New Prospects and Challenges*, proceedings of the Conference on Latin American Nuclear Cooperation: New Prospects and Challenges, Montevideo, Uruguay, 11-13 October 1989 (London: Macmillan, in press).]

27. Von Hippel, Albright, and Levi, *Quantities of Fissile Materials in U.S. and Soviet Nuclear Weapons*. Cochran, Arkin, Norris, and Hoenig, *Nuclear Weapons Databook Volume 2: U.S. Nuclear Warhead Production*.

28. Steven Afergood, "Background on Space Nuclear Power," *Science & Global Security* 1 (1989), pp. 93-107. See also J.R. Primack, N.E. Abrams, S. Afergood, D.W. Hafemeister, D.O. Hirsch, R. Mozley, O.F. Prilutsky, S.N. Rodionov, and R.Z. Sagdeev, "Space Reactor Arms Control: Overview," *Science & Global Security* 1 (1989), pp. 59-82. There are more than 30 spent reactors stored in orbits of between 700 and 1,500 kilometers above the earth.

29. IAEA, *Annual Report for 1989*, p. 115.

30. See for example *Guidelines for States' System for Control of and Accounting for Nuclear Materials* (Vienna: IAEA report # IAEA/SG/INF/2); *An Introduction to IAEA Safeguards* (report # IAEA/SG/INF/3); *IAEA Safeguards: Aims, Limitations, and Achievements* (report # IAEA/SG/INF/4); *IAEA Safeguards: Implementation at Nuclear Fuel Cycle Facilities* (report # IAEA/SG/INF/6, 1985); *IAEA Safeguards Techniques and Equipments* (report # IAEA/SG/INF/5, 1984); *IAEA Safeguards Glossary* (report # SG/INF/1, rev. 1, 1987).

31. The first enrichment plants built in the Soviet Union, as in the US, were apparently gaseous diffusion plants. However, the Soviet Union has since shifted over entirely or almost entirely to gas centrifuge enrichment. (Interview with Evgeny I. Mikerin, *Science & Global Security* 1 (1989), p. 174.)
32. As of 1 January 1989, the Soviet Union had 27 operational light-water cooled, graphite-moderated power reactors with a total generating capacity of 16.8 Gwe, four under construction, and two shut down (H.F.R. Masters, "World Survey: Widespread Stagnation" in *Nuclear Power International*, June 1989, pp. 20-30).
33. See for example Kathleen C. Bailey, deputy assistant director, US Arms Control and Disarmament Agency in *International Plutonium Control Act*, pp. 11-12.
34. *IAEA Safeguards: Implementation at Nuclear Fuel Cycle Facilities*, pp. 35-41.
35. *IAEA Safeguards Glossary*, rev. 1 (1987), p. 24.
36. Cochran and Norris, *Soviet Nuclear Warhead Production*, p. 16.
37. Interview with Evgeny I. Mikerin, *Science & Global Security* 1 (1989), p. 172.
38. *Ibid*, p. 174.
39. See for example D. Albright and H.A. Feiveson, "Plutonium Recycling and the Problem of Nuclear Proliferation," *Annual Reviews of Energy* 13 (1988), pp. 239-265.
40. *Costs of a World-wide Safeguards System* (Swedish Government background paper, 15 September 1989).
41. For a more extensive discussion of the IAEA's potential role in safeguarding Soviet and US nuclear facilities and fissile materials recovered from dismantled nuclear materials as part of the verification arrangements see Lawrence Scheinman and I.G. Gverdzteli, "Verifying a Production Cutoff for Nuclear Explosive Material: IAEA Safeguards Against Diversion and Proliferation," in J. Holdren, M. Goldberg, and S. Kapitza, eds., *Verification: American, Soviet and European Perspectives on Monitoring Arms Control Agreements* (Boulder, Colorado: Westview Press, 1990); and Warren H. Donnelly and Lawrence Scheinman, *New Concepts in Nuclear Arms Control: Verified Cutoff and Verified Disposal* (Centre for International Policy Studies, University of Southampton, Southampton, England: Program for Promoting Nuclear Non-Proliferation, occasional paper # 5, 1990).
42. *The Structure and Contents of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons* (Vienna: IAEA, INF/CIRC/153, 20 April 1971).
43. David Fischer and Paul Szasz, *Safeguarding the Atom: A Critical Appraisal* (London and Philadelphia: Taylor and Francis, 1985), p. 81.
44. "Final Declaration of the Second Review Conference of the Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction," (BWC/CONF.11/13, 30 September 1986), article v, reprinted in Erhard Geissler, ed., *Strengthening of the Biological Weapons Convention by Confidence-Building Measures*, (New York: Oxford University Press, 1990), annex 2.
45. See for example Thomas Bernauer, *The Projected Chemical Weapons Convention: A Guide to the Negotiations in the Conference on Disarmament* (New York: United Nations, 1990), chapter 10.
46. Source: Urenco, the Netherlands.
47. Based on Theodore B. Taylor, "Verified Elimination of Nuclear Warheads," *Science & Global Security* 1 (1989), pp. 1-26, figure 2.



48. See for example Theodore B. Taylor, "Verified Elimination of Nuclear Warheads."

49. US Arms Control and Disarmament Agency, *Demonstrated Destruction of Nuclear Weapons*, final report, volume 1, January 1969 (declassified 16 July 1990). A summary of this report may be found in *Science & Global Security* 2 (1990), pp. 103-108.

50. A wide variety of tags and seals that are very difficult to defeat are available. (See for example Richard L. Garwin, "Tags and Seals for Verification," *Bulletin of the Council for Arms Control* 40, October 1988, pp. 3-4; A. De Volpi, "Tags and Seals for Arms Control Verification," in *Proceedings of the Second Workshop on Verification of Arms Reductions, Vienna, Austria, 3-5 September 1990* [to be published].)

51. See Steve Fetter, Thomas B. Cochran, Lee Grodzins, Harvey L. Lynch, and Martin S. Zucker, "Measurements of Gamma Rays from a Soviet Cruise Missile," *Science* 248, 18 May 1990, pp. 828-834. Figure © 1989 the American Association for the Advancement of Science.

52. *Ibid.*

53. Steve Fetter, Valery A. Frolov, Marvin Miller, Robert Mozley, Oleg F. Prilutsky, Stanislav N. Rodionov, and Roald Z. Sagdeev, "Detecting Nuclear Warheads," *Science & Global Security* 1 (1990), pp. 225-285.

54. See for example A. De Volpi, "Application of Cineradiography to Nuclear-reactor Safety Studies," *Reviews of Scientific Instruments* 55, 8 (1984), p. 1197; and Robert Mozley, "Particle Sources and Radiography" in *Reversing the Arms Race*, pp. 353-368.

55. Such techniques are discussed in some detail in S. Fetter, V.A. Frolov, M. Miller, R. Mozley, O.F. Prilutsky, S.N. Rodionov, and R.Z. Sagdeev, "Detecting Nuclear Warheads," *Reversing the Arms Race*, pp. 237-353.

56. Thomas B. Cochran, William M. Arkin, Robert S. Norris, and Milton M. Hoenig, *Nuclear Weapons Databook Volume 3: U.S. Nuclear Warhead Facility Profiles* (New York: Ballinger, 1987), pp. 76, 79. Photos b) and c) were taken by Robert del Tredici.

57. Theodore B. Taylor, "Verified Elimination of Nuclear Warheads."

58. The United States has approximately 500,000 kilograms of uranium-235 in highly enriched uranium in its nuclear stockpile. At current US enrichment plant tail assays of 0.0035 percent, approximately 256 kilograms of natural uranium must be mined and 118 kilogram-SWU of separative work are used to yield 1 kilogram of uranium-235 in 3.5-percent enriched uranium for power-reactor fuel. Assuming current (depressed) costs of about \$30 per kilogram of uranium and \$120 per kilogram-SWU, 1 kilogram of uranium-235 in highly enriched uranium, after being diluted with natural uranium to an enrichment of 3.5 percent, would have a value of about \$25,000. Two hundred fifty tonnes of uranium-235 in HEU (about one half of that in all US weapon uranium) would have a value of about \$6 billion.

59. The basic statute of the IAEA (article XX.A.5) instructs it "to require deposit with the Agency of any excess of any special fissionable materials [plutonium or uranium enriched to more than 20 percent in uranium-235] recovered or produced as a by-product over what is needed for the above-stated uses in order to prevent stockpiling of these materials, provided that thereafter at the request of the member or members concerned special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use under the same provisions...." There were extensive discussions by an international working group under the auspices of the IAEA during the 1980s about the activation of this provision but these discussions failed to reach agree-

ment—especially on rigor of the conditions under which plutonium would be released from the store. (International Plutonium Store, papers available from the IAEA. See also the discussion in Fischer and Szasz, *Safeguarding the Atom: A Critical Appraisal*, pp. 115–116.)

60. *Hearing on the International Plutonium Control Act—H.R. 2403*, 20 June 1989, p. 142.

61. See for example the discussion of a methodology for estimating the quantity of plutonium that has been produced in a production reactor based on measurements of the fractions of various isotopes in the permanent structural components of the core that have been made radioactive by neutron capture (Steve Fetter, "Estimating Plutonium Production from Long-lived Radionuclides in Permanent Structural Components of Production Reactor Cores," in *Reversing the Arms Race*, pp. 83–90)

62. For example, in a question for the record of the hearing on a proposed International Plutonium Control Act, the US Arms Control and Disarmament Agency was asked "Why do you continue to assert that such a cutoff [of fissile material for nuclear weapons] is not verifiable?" The answer included two scenarios of which the first is relevant here:

"Scenario 1: The Soviets possess a large stockpile of reactor-grade plutonium as part of its civil nuclear program.... Undeclared amounts of this stockpile could be upgraded clandestinely by laser isotope separation, in relatively small facilities, to weapons-grade material."

63. For example, the US Department of Energy estimates that about 1.8 tonnes of plutonium—about 2 percent of historical US production of weapon-grade plutonium—are in transuranic waste retrievably stored in its facilities (principally the Savannah River Site [34 percent], the Hanford Reservation [27 percent], the Los Alamos National Laboratory [23 percent] and the Idaho National Engineering Laboratory [15 percent] as of the end of 1986.) (Total curies given in Shirla G. Betram-Howery et al., *Preliminary Comparison with 40 CFR Part 191, Subpart B for the Waste Isolation Pilot Plant, December 1990* [Albuquerque, New Mexico: Sandia National Laboratory report # SAND90-2347 UC-721, 1990], table 1-3). This inventory is shown to be dominated by "contact handled" waste. The isotopic composition of the waste plutonium in grams is shown as 91 percent plutonium-239, 6 percent plutonium-240 and 3 percent plutonium-238. Representative breakdowns of two types of contact waste are provided in table 1-5, where it is shown that plutonium-239 is assumed to account for 4 percent of the curie inventory of waste drums and 6.4 percent of the curie inventory of standard waste boxes. It is assumed that the average drum contains 15 grams of plutonium and that the average standard waste box contains 85 grams. An overall average value of 4.6 percent is given in Bob P. Rechar, Harold Iuzzolino, and Jim S. Sandha, *Data Used in Preliminary Performance Assessment of the Waste Isolation Plant (1990)* [Albuquerque, New Mexico: Sandia National Laboratory report # SAND89-2408 UC-721, 1990], table 111-6.) Similar quantities of plutonium could be expected to have been lost in high-level waste.

64. A good sense of the information publicly available in the United States about the US and Soviet nuclear-weapon production complexes may be obtained from the first three volumes (US) and fourth volume (Soviet) of the *Nuclear Weapons Databook* series (New York: Ballinger) and from Cochran and Norris, *Soviet Nuclear Warhead Production*.

Chairman NUNN. Thank you, Dr. von Hippel. Dr. Barker?

**STATEMENT OF DR. ROBERT B. BARKER, FORMER ASSISTANT TO  
THE SECRETARY OF DEFENSE FOR ATOMIC ENERGY**

Dr. BARKER. Thank you, Mr. Chairman.

I want to thank you for the opportunity to appear before you today, as you said, for the first time representing myself after appearing before you gentlemen many times representing the administration.

It turns out yesterday morning I resumed employment at Lawrence Livermore Laboratory, a place where I had 20 years of prior experience, but only had an opportunity to spend 4 hours there before coming back for this particular hearing. The invitation in fact caught me halfway in-between the two jobs.

Chairman NUNN. We appreciate you coming here today.

Dr. BARKER. Thank you.

Senator Nunn, you have read into the record the text of the Biden condition, and I will not repeat it here. That is indeed the focus of my comments this morning.

The objectives of the condition are indeed worthy. I do not think anyone could object to the objective of trying to make sure that fissile material from nuclear weapons are not lost and put into the hands of potential proliferators.

Somehow, when I look at this condition, I come to the conclusion that those who have advocated it have failed to appreciate the major elements of it are already well on the way to being implemented, without the benefit of laborious negotiations requiring reciprocal implementation.

Other elements, I believe, are so difficult to achieve as to call into question the utility of potentially delaying other significant reductions in the strategic arms domain while waiting for the conclusion of an agreement in this area.

I believe there is a sound basis for believing that these more difficult elements are also unnecessary to the achievement of the condition's objective. In what follows I would hope to make clear the basis for my views.

As you have already said, Senator Nunn, the actions of the U.S. Government, with the significant help of the Nunn-Lugar Act, have resulted in tremendous progress in the very areas which this condition appears to address. As a result of the exchange of unilateral commitments regarding tactical nuclear weapons, the conclusion of a START Treaty, and the further reductions agreed to in the recent Joint Understanding, the nuclear stockpiles of both the United States and Russia are scheduled to be reduced to a small fraction of their current levels.

In the United States and in Russia, nuclear weapons are being stored, awaiting destruction. The U.S. schedule is viewed as solid, but depends upon continued funding and the ability to continuously operate the single facility capable of nuclear warhead dismantlement.

The Russian schedule really counts on U.S. financial assistance to construct containers and facilities for the storage of the fissile materials derived from dismantled weapons. They tell us that defi-

iciencies in these areas limits their ability to dismantle weapons. Under the provisions of the Nunn-Lugar Act, the United States is preparing to provide assistance in these areas.

The reality is that Russia today is also seeking our help in the establishment of a nuclear material accountability system for all fissile material in excess of its nuclear weapons requirements. That is fissile material generated as part of their civil reactor program as well as fissile material declared in excess of the weapons program, material that once upon a time might have been in Russian nuclear weapons.

A representative of the Russian general staff, during discussions of potential assistance, surprised me when he freely agreed, without any discussion whatsoever, that should the United States fund any facility in which fissile material would be stored the United States would, of course, have free access to that facility to determine that the facility was used in the manner in which the funding was intended.

Now the details of U.S. assistance are still being worked out, but the significance is inescapable. With this kind of access to facilities and information, we will have a sound basis for any judgments about the potential for the loss of Russian nuclear material into the hands of potential proliferators. Given the same degree of cooperation, if we have any misgivings about Russian nuclear material security, we will have the option of assisting the Russians to do an even better job. The Nunn-Lugar Act has played a major role in these accomplishments.

This is the current reality. For nuclear material in excess of Russian nuclear weapon requirements, we, the United States, already have been offered the opportunity to help design a secure storage and accounting system for Russia. If we accept and follow through, we should have confidence that the risk of loss has been minimized.

For Russian nuclear weapons and fissile material for nuclear weapon modernization, we have been consistently told that all is well as far as the security of related facilities is concerned and that no U.S. help is wanted or needed.

In my own limited personal experience of a visit to an abandoned Soviet nuclear weapons storage site in what was once East Germany, I came away very impressed with the Soviet commitment to nuclear weapons security, but I also believe we have never had any reason to believe that the former Soviet Union in the past or Russia today has been or is cavalier about the security of nuclear weapons.

I believe it will continue to be legitimate to presume that Russia will have no interest in losing a nuclear weapon or the fissile material it is counting on for future nuclear requirements. Further, we should not forget that they will always have the option of adapting the technology we will share with them for storage and accountability of non-weapons material. They can apply the same techniques themselves to nuclear weapons storage if they see a need for it.

As I said in the beginning, the objective of the Biden condition is unobjectionable. The loss of a nuclear weapon or fissile material

which could be used in a nuclear weapon would be a threat to international security.

As this committee is very well aware, this country has spent significant monies to ensure the security of United States nuclear weapons and United States nuclear weapon materials. I see no need to spend even more taxpayer dollars to implement Russian inspections of U.S. nuclear weapons storage sites or U.S. nuclear material production, processing, or storage facilities.

A concern about Russian nuclear weapons security should not result in a mandate for Russian inspection of U.S. facilities. An automatic requirement for reciprocity is, frankly, old-think. The problem identified in the condition is attributed to the former Soviet Union; a solution, therefore, need be found only in the former Soviet Union, or at least in that part of the former Soviet Union where the problem is found to be real.

But, as I have previously described, Russia has already welcomed U.S. assistance in the secure storage and accountability of fissile materials in excess of weapons requirements. For this case, the objective of the condition is well on the way to being met; the condition is not needed.

So far as monitoring Russian weapons and their fissile material reserve is concerned, the condition requires a significant change in well-established Russian opposition, and I believe there is not even a sound basis for concern in this area since I believe that the Russians have taken the security of nuclear weapons quite seriously.

The negotiation of the monitoring of Russian nuclear weapons storage sites is almost guaranteed to significantly complicate and delay the conclusion of an agreement codifying the provisions of the Joint Understanding.

Mr. Chairman, in conclusion I would like to say I believe the condition is not necessary. Where the threat of fissile material loss in the former Soviet Union is greatest, the objective is already being met; where the concern is least justified, there are major difficulties with verifiability and negotiability.

One should not forget that in response to the National Defense Authorization Act for fiscal year 1991 the administration did present a report to Congress last October. In his cover letter, the President says: "As the Advisory Committee reports, the United States could not effectively verify the number of existing weapons or the amount of special nuclear material currently on hand." He means in the former Soviet Union. "We likewise could not have high confidence in discovering clandestine warheads or special nuclear material stockpiles. In addition," the President goes on, "the report notes the extreme difficulty in monitoring the many potential paths which nuclear warheads or special nuclear materials could be produced."

Let me make one last comment that occurred to me as I was listening to Professor von Hippel's remarks. From time to time I got confused about who it is that we cannot trust. Professor von Hippel noted that the President of the United States has declared that we are not producing fissile material for nuclear weapons purposes. This Committee has oversight over this entire area, has access to all the information. I presume this Committee does not believe the President has lied in making that statement, and this Committee is

fully capable of continuing to monitor U.S. compliance with the President's commitment.

I fail to see why we need Russian inspectors or multinational inspectors on U.S. territory at sensitive U.S. facilities monitoring this kind of commitment where there is already extensive oversight in this body, if you choose not to believe the word of the President.

There is that same element of distrust of the executive and, it seems to me, distrust of the oversight of the legislative branch of this government in several of the proposals articulated by Professor von Hippel. And maybe in his subsequent remarks he will have an opportunity to expand on that.

I believe that our system of government has sufficient checks and balances that the world should be convinced we are meeting our open commitments. I think one of our objectives should be to see to it that the government of Russia, of the republics of the former Soviet Union have exactly the same kind of system where one can have an executive and legislative joint oversight over these areas and not be dependent upon the trappings of the Cold War, the trappings of incredibly long, involved negotiations of bilateral agreements requiring reciprocal processes every step of the way.

I went on slightly longer than I intended, Senator Nunn. I will conclude with that point. Thank you very much.

[The prepared statement of Dr. Barker follows:]

PREPARED STATEMENT BY DR. ROBERT B. BARKER, FORMER ASSISTANT TO THE  
SECRETARY OF DEFENSE FOR ATOMIC ENERGY

Mr. Chairman, I am pleased to appear today before the Senate Committee on Armed Services to testify on the disposition of United States and Commonwealth of Independent States (CIS) strategic nuclear warheads under the START I Treaty and the June 17, 1992 U.S./Russian Joint Understanding on further reductions in strategic offensive arms. I will devote my remarks to my views on the practicality, verifiability, negotiability, and even the necessity of a binding condition to the START I resolution of ratification, adopted by the Senate Foreign Relations Committee, which would require the President to seek, in conjunction with any further reduction in strategic arms, to negotiate an international monitoring and verification regime for U.S. and CIS nuclear weapons and fissile material production and reprocessing facilities.

Mr. Chairman, as you know, 2 months ago I left the position of Assistant to the Secretary of Defense for Atomic Energy, a position I held for more than 5½ years. During the 3 years prior to my joining the Department of Defense I was Deputy Assistant Director for Verification and Intelligence at the U.S. Arms Control and Disarmament Agency. Yesterday, I rejoined the Lawrence Livermore National Laboratory, where I served for 20 years before joining the government. From November 1991 until June 1, 1992 I was the senior Defense Department official involved in discussions with the Russians on how to implement the provisions of the Nunn-Lugar Act which authorized the expenditure of Department of Defense funds to assist in the destruction of Russian weapons of mass destruction. From June 1986 to January 1988 I led the U.S. delegation in efforts to negotiate effective verification provisions for the Threshold Test Ban Treaty. I have been honored in the past to testify before this and other committees of the Congress as a representative of the administration. Today, I speak only for myself.

It is difficult not to begin any discussion of the subject before us today without observing how much the world has changed. It has been difficult for the national security community to reformulate its thinking to reflect the new world. It seems to me that it has been even more difficult for the so-called arms control community to come to grips with the changes associated with the new reality. Despite the major successes in negotiated agreements, in the exchanges of unilateral commitments, and in Russian acceptance of U.S. assistance in some of their most sensitive national security areas, we continue to see advocacy for arms control schemes whose time is past—schemes born during the height of the Cold War.

The objectives of the condition which is being addressed today are worthy. Somehow, those who have advocated it have failed to appreciate that major elements of it are already well on the way to being implemented—without the benefit of laborious negotiations requiring reciprocal implementation. Other elements are so difficult as to raise questions as to whether they could ever be truly achieved. I believe there is a sound basis for believing that these more difficult elements are also unnecessary to the achievement of the condition's objective. In what follows I hope to make clear the reasons for my views.

As a result of the exchange of unilateral commitments regarding tactical nuclear weapons, the conclusion of a START Treaty, and further reductions agreed to in the recent Joint Understanding, the nuclear stockpiles of both the United States and Russia are scheduled to be reduced to a small fraction of their current levels. In the United States and in Russia nuclear weapons are being stored awaiting destruction. The U.S. schedule is viewed as solid but depends upon continued funding and the ability to continuously operate the single facility capable of nuclear warhead dismantlement. The Russian schedule counts on U.S. financial assistance to construct containers and facilities for the storage of the fissile material derived from dismantled weapons. They tell us that deficiencies in these areas limits their ability to dismantle weapons. Under the provisions of the Nunn-Lugar Act the United States is preparing to provide assistance in these areas.

The reality is that Russia today is also seeking our help in the establishment of a nuclear material accountability system for all fissile material in excess of its nuclear weapons requirements. A representative of the Russian General Staff, during discussions of potential assistance, has freely granted that the United States should have access to any facility in Russia funded by the United States for the storage of fissile material from retired Russian nuclear weapons. The details of U.S. assistance are still being worked out but the significance is inescapable. With this kind of access to facilities and information, we will have a sound basis for any judgments about the potential for the loss of Russian nuclear material into the hands of potential proliferators. Given the same degree of cooperation, if we have any misgivings about Russian nuclear material security we will have the option of assisting the Russians to do any even better job. The Nunn-Lugar Act has played a major role in these accomplishments.

This is the current reality. For nuclear material in excess of Russian nuclear weapon requirements we, the United States, already have been offered the opportunity to help design a secure storage and accounting system for Russia. If we accept and follow through we should have confidence that the risk of loss has been minimized.

For Russian nuclear weapons and fissile material for nuclear weapon modernization, we have been consistently told that all is well as far as the security of related facilities is concerned and that no U.S. help is wanted or needed. In my own limited personal experience of a visit to an abandoned Soviet nuclear weapon storage site in what was once East Germany, I came away very impressed with Soviet commitment to nuclear weapon security. But, also I believe we have never had any reason to believe that the former Soviet Union in the past or Russia today has been or is cavalier about the security of nuclear weapons. I believe it will continue to be legitimate to presume that Russia will have no interest in losing a nuclear weapon or the fissile material it is counting on for future nuclear requirements. Further, we should not forget that they will always have the option of adapting the technology we will share with them for the storage and accountability of non-weapons fissile material to nuclear weapon storage purposes if there are any benefits for doing so.

I now return to the binding condition as I understand it was incorporated into the Senate Foreign Relations resolution of ratification for START:

Inasmuch as the prospect of a loss of control of nuclear weapons or fissile material in the former Soviet Union could pose a serious threat to the United States and to international peace and security, in connection with any further agreement reducing strategic offensive arms, the President shall seek an appropriate arrangement, including the use of reciprocal inspections, data exchanges, and other cooperative measures, to monitor—

(A) the numbers of nuclear stockpile weapons on the territory of the parties to this treaty; and

(B) the location and inventory of facilities on the territory of the parties to this treaty capable of producing or processing significant quantities of fissile materials.

As I have said before, the objective of this condition is unobjectionable. The loss of a nuclear weapon or fissile material which could be used in a nuclear weapon would

be a threat to international security. As this committee is very well aware, this country has spent significant moneys to ensure the security of its nuclear weapons and its nuclear weapon materials. I see no need to spend even more taxpayer dollars to implement Russian inspections of U.S. nuclear weapon storage sites or U.S. nuclear material production, processing, or storage facilities. A concern about Russian nuclear weapon security should not result in a mandate for Russian inspection of U.S. facilities.

An automatic requirement for reciprocity is "old think." The problem identified in the condition is attributed to the former Soviet Union. A solution therefore need be found only in the former Soviet Union, or at least that part of the former Soviet Union where the problem is found to be real.

But, as I have previously described, Russia has already welcomed U.S. assistance in the secure storage and accountability of fissile materials in excess of weapons requirements. For this case the objective of the condition are well on the way to being met. The condition is not needed.

As far as monitoring Russian weapons and their fissile materials reserved for weapon use, the condition requires a significant change in well established Russian opposition. There is not even a sound basis for concern, as far as I know, about the security of the relevant Russian weapon facilities. The negotiation of the monitoring of Russian nuclear weapon storage sites is almost guaranteed to significantly complicate and delay the conclusion of an agreement codifying the provisions of the Joint Understanding.

In fact, if the job of negotiating an agreement which would require the declaration of all nuclear weapon storage and allow reciprocal access to all storage facilities were to be taken seriously, I would wonder whether a truly verifiable agreement could ever be consummated. When one considers that some nuclear weapons are about the same size as a common fire extinguisher, it quickly becomes obvious that one could never have confidence that all nuclear stocks had been declared or that one would have even the slightest chance of finding an undeclared weapon if the Russians were to pay the slightest attention to keeping it hidden. In fact, I believe the job is so difficult, that, were it not for the sponsorship of the condition, I might have suspected the condition to have the purpose of blocking all further agreements reducing strategic offensive arms. Certainly those who believed that the additional reductions contemplated by the Joint Understanding were coming too fast on the heels of START ought to welcome the condition with open arms.

Mr. Chairman, the condition is not necessary: where the threat of fissile material loss in the former Soviet Union is greatest the objective is already being met; where the concern is least justified there are major difficulties with verifiability and negotiability. This concludes my remarks.

Chairman NUNN. Thank you, Dr. Barker. Again, we appreciate you being here and regret you were not able to fully escape Washington for a few days at least before you were called back.

Dr. von Hippel, in your statement you basically say that we have to have reciprocity with the Russians on the whole question of the Biden amendment and verification and so forth. Do you base that on conversations with Russian officials? Do you base it on reading what they have said? Do you base it on past experience? Or do you base it on some special insight or just your intuitive feeling?

Dr. VON HIPPEL. Well, in the last year the FAS and NRDC had joint workshops with high-level Russian officials on this subject in October in Washington, in December in Moscow and Kiev, and in February in Washington again.

In each case, there was a statement that they could not really go beyond a certain point without reciprocity.

Senator WARNER. Without what?

Dr. VON HIPPEL. They could not go beyond a certain point in really opening up their warhead complex to our verification of what they were doing without reciprocity.

Chairman NUNN. Since that time we have moved well down the road in implementing Nunn-Lugar, and they have indeed opened up their process and there has been almost complete cooperation,



and there has been no reciprocity. Have you reexamined that viewpoint since all of this has happened?

Dr. VON HIPPEL. I have been impressed by how far they have been willing to go. But I still do not think it is a stable situation for the longer term. They are being criticized by their conservatives. And I just do not see why we should not accept reciprocity. It is not because I do not trust this committee to oversee the executive branch; I just do not see why we cannot continue as we have in the past in agreements with the Russians to accept a reciprocal relationship.

Chairman NUNN. Do you believe that this condition, the Biden condition, is verifiable?

Dr. VON HIPPEL. Verification is never perfect, and I do agree with Dr. Barker that we could not physically prove that there are no warheads hidden someplace. All we could do is isolate those warheads and have a baseline and a lot of information from which we could then work to increase our confidence that, in fact, the declarations were true.

But we could never prove that in the way you can prove things in physics. The measurement uncertainties are too great.

Chairman NUNN. Dr. Barker, your feeling that we should not have this condition, even though the purpose of it you agree with, how much of that is based on you feeling that this is not verifiable? Is that a big factor or small factor?

Dr. BARKER. It is half the story, Senator Nunn. I believe that we ought to take credit for the significant accomplishments that have been made with the assistance of the Nunn-Lugar Act, and I find, because of my personal involvement in the early stages of implementing that process, I find it objectionable that there would be language in legislation which would almost ignore the significant accomplishments that you spoke of a moment ago.

The other half of the equation indeed is that I think despite significant energy and significant time, I do not believe that we could negotiate a verification regime that would result in a level of confidence that would justify the effort expended.

I think our ongoing relationships with the Russians will give us a much better feel for their ability to control their material than any negotiating process.

Chairman NUNN. If we had tried to negotiate what has already occurred under Nunn-Lugar, we would probably have taken a couple years, would we not? I guess both of you would agree with that. I do not know whether we would have ever been able to negotiate it, based on what I know about what has actually occurred.

They had a recent hearing in the Foreign Relations Committee with General Burns testifying. I cannot conceive of them ever agreeing to what has already taken place, can you?

Dr. VON HIPPEL. Well, I think we do have a new situation. It is a post-Cold War situation. It is basically that we have had a remarkable leadership in the international security area in Moscow since Gorbachev. There has been a continuity of this kind of "new thinking" in the group around Yeltsin. This is a very unusual phenomenon, I think.

And I do attribute a lot of what has been accomplished to that. And I think that the positive reaction that they have had to Nunn-

Lugar partly reflects this new thinking. I think that, if we want to negotiate something, we can negotiate it very quickly with this group of people.

Chairman NUNN. Dr. Barker, let me come at you from another angle on this one. You are concerned about verification. You were in the Defense Department last May, were you not, May of 1991?

Dr. BARKER. Yes, I was.

Chairman NUNN. At that time, President Bush called on the nations of the Middle East to, quoting his words, "implement a verifiable ban on the production and acquisition of weapons-usable nuclear material and place all nuclear facilities under International Atomic Energy Commission, IAEA, safeguards."

And you were in the Department of Defense at that time. Did the Defense Department take exception to that proposal?

Dr. BARKER. I should have warned Mr. Graham, but I would prefer to defer the answer to that to him in the next panel, Senator Nunn.

Chairman NUNN. Now that you are able to give your personal views, do you think that President Bush was just whistling in the dark when he called for that verifiable ban, because the question arises if we expect them to do it in the Middle East, why can't we do it?

Dr. BARKER. I think there is a significant difference, to pick up a little bit on what Professor von Hippel said a moment ago. In the Middle East we are dealing with an arena in which there are historic distrusters. I find it very hard to believe that there is a basis for any expectation that those nations would accept the validity of unilateral declarations between each other.

As I said a moment ago, I think with the new relationship with the former Soviet Union I believe there is a very good basis for believing that unilateral declarations will meet the objective, and I think it is important to give that mechanism a chance in some areas, not all.

I think it is important that START be ratified and implemented and that the verification provisions there be given a chance. But I look at the tremendous success we have had as a result of the President's initiative of last year, with the assistance of the Nunn-Lugar Act, how far we have gone in the exchange of unilateral declarations and the arena of transparency.

I think we deserve to give that mechanism more of a chance, and I think this is an ideal arena in which to do it.

Chairman NUNN. I guess my question is, I understand your context of differing parties and historical distrust and so forth, but aside from that do you believe that this kind of condition is verifiable anyway?

Dr. BARKER. I believe there will be huge uncertainties associated with any verification mechanism that tries to count warheads or count fissile material. The physical objects that one is trying to control are very small. Remember that a 5-inch artillery shell is about the same size as a large fire extinguisher. The idea of being able to count and control those objects down to a count of one is, well, preposterous is probably the first word that comes to my mind.

And where small numbers missing make a difference, in an area like the Middle East, there is probably reason for concern. But the discussion process, I think, in the Middle East would be a healthy beginning. I have my doubts about whether one could ultimately end up with a watertight verification regime.

Chairman NUNN. Senator Warner.

Senator WARNER. Thank you, Mr. Chairman.

Gentlemen, this has been an excellent presentation by both of you so far, and I think it will be very helpful to the Committee in the course of its deliberations.

But I want to go back again to this Biden amendment. Dr. Barker, as a participant in the SSD discussions with Russia, do you believe that the Biden condition on warhead and fissile material control could have a negative effect on the ongoing progress of the negotiations?

Dr. BARKER. I think it could, Senator Warner. I would like to return to the NRDC-FAS meetings with the Russians and something that took place in the Ukraine the latter part of last year. Indeed, as Professor von Hippel said, it is my understanding—I was not there, so I am reporting what others have told me—the issues of accountability, tagging, and intrusive inspections came up during those discussions.

When the U.S. Government first had a chance to sit down and have serious discussions with the Russians I found them actually uninterested in these topics. They said, "We do not want your help. We are not going to sell our sovereignty for \$400 million." We had to sit down with them and ask what they were talking about. They said, "Well, when we met with these people from the NRDC and the FAS, they told us that if we were going to accept this money, we were going to have invoke all of these different kinds of provisions which are not acceptable to us."

We made it clear to them that the U.S. Government was not the FAS or the NRDC. Let's start from ground zero. Let's talk about what we can do and what we cannot do.

I would be concerned that this condition might actually set the clock back to that era. And my reports of those meetings indicated that it was the U.S. side—the FAS and NRDC—that brought up demands of reciprocity as much as, if not more often, than their Russian counterparts.

So I am puzzled about the origin of this demand for reciprocity, whether it is the advocates of the scheme in the U.S. or whether any of it comes from the Russian side. And, as I said in the beginning, my personal experience was that those discussions actually were a detriment to the initial government-to-government discussions when they took place in January.

Senator WARNER. Dr. von Hippel, would you care to give your own version?

Dr. VON HIPPEL. Yes, thank you. What the Russians were reacting to was the Nunn-Lugar requirements for verification, which are unilateral, and it was nothing that we laid on them. It was what the Congress laid on them, and they have accepted it to some degree. I am quite impressed how far they have come along that road.

Now, just to make clear how much further we could go down the road if we had reciprocity, I would like to ask a few rhetorical questions. Wouldn't we like to know how many warheads there are in the Russian/CIS stockpile? Wouldn't we like to be able to look at their production records? Wouldn't we like to be able to go into their uranium enrichment plants and see that they are not producing highly-enriched uranium any more?

Wouldn't we like to assure ourselves that the plutonium that they are continuing to produce is not going to warheads? I am impressed by how far we have been able to go unilaterally, but I think that it is 10 percent of how far we could go on a reciprocal basis.

Dr. BARKER. Senator Warner, could I make an interjection here? Senator WARNER. Sure.

Dr. BARKER. There is no doubt that I, and, I am sure, many in this country would love to know how many Russian nuclear weapons there are. My difficulty has been that I am not sure we can believe any scheme that we can negotiate would give us the right answer.

With respect to fissile material, however, the situation is very, very different. I said before that the Russians are welcoming from us assistance in the establishment of an accountability and control system for fissile material in excess of their nuclear weapons requirements. Therefore, we have had access. We will have access to fissile material production facilities, storage facilities. We will know how much material is coming out of the weapons complex into this storage, the so-called civilian storage.

So the things that are being implemented as part of Nunn-Lugar today are permitting us to help the Russians and, at the same time, ourselves achieve confidence that their accounting and control system is as good as our own. I do not think additional measures are needed to achieve the kind of confidence we want as far as non-weapons fissile material is concerned, and that includes material coming out of weapons.

Senator WARNER. Let me do just a quick follow-up, and then my time is expired.

Dr. von Hippel, in your statement, you said there will always remain the possibility that some warheads and fissile material had been hidden. Do you have in mind—and perhaps you, too, Dr. Barker—what amount could be secreted before it begins to really undermine the basic goals of the treaty itself?

Dr. VON HIPPEL. Let me just say I believe at the moment we are dealing with people we can trust.

Senator WARNER. Let's say, who are desiring to act in good faith.

Dr. VON HIPPEL. Well, they are in charge of their government, and I think at this point we really are in a cooperative mode with the Russians. So I think we could get a declaration from them which would probably be correct.

The question is, could we check it on the basis of physical evidence, and the answer is that there will always be an uncertainty. We have looked at this. I think that you could shrink the uncertainty if you get production records and can develop increased confidence.

If you just based it on the physical evidence, however, you could probably hide 1,000 warheads someplace in the uncertainty. But if we had access to the production records and were able to check that against our historical evidence and question people and go into things, I think we could shrink those uncertainties down.

Senator MACK. Could you say that last part again? You could do what?

Dr. VON HIPPEL. You could shrink the uncertainties.

Senator MACK. To what level?

Dr. VON HIPPEL. There will always be an uncertainty.

Senator MACK. 500?

Dr. VON HIPPEL. Our confidence in the declarations will be increased, but we will never be able to physically prove that material that was lost—

Senator MACK. Give me a range, though, if you could, of what we might expect if it was 1,000 before. Would it be 250, 500, 10?

Dr. VON HIPPEL. It would never be as low as 10. I think what I am saying is the physical uncertainties would probably always be in the range of 1,000, but I think the confidence that we have, the different checks we could subject the declaration to, would increase our confidence that we had actually gotten a good faith declaration. But we would never be able to, with measurement, close in on those last 1,000 warheads.

Dr. BARKER. Senator Mack, if I might add, I am not sure where Professor von Hippel gets his 1,000 from. It is partly wishful thinking, I think, because, as I say, the physical dimensions of the kind of warheads we are talking about are not large.

The opportunities for hiding them are incredible. It depends very much, highly depends on the will of the agent to hide them as to how many he would choose to hide. In fact, I am sure he could hide more than he could ever conceivably deliver.

So we started out this discussion with START. We are talking about this ability to deliver strategic nuclear weapons, where we are talking about things that are relatively verifiable in terms of aircraft and missiles and submarines. And somehow this issue of warhead counting has been interjected, which is a totally different kettle of fish, something in which the physical dimensions are incredibly different, the opportunities for hiding them are very different.

Maybe the Professor's estimate of 1,000 is right, but it is certainly not based on any geometrical analysis of the opportunities for hiding those weapons.

Dr. VON HIPPEL. Of course you could hide these small objects, millions of them if you wanted. But the point is that in order to make nuclear warheads in the first place you need highly-enriched uranium and plutonium. And that has been done in a centralized way. We do have some knowledge about what was going on, where it was going on. We could get more information on historical production activities and put limits on the total amount of material that could be missing. That is really what I am talking about. There are many layers of the verification program which reinforce each other.

So just talking about how small a warhead is is neglecting all the other layers.

Senator WALLOP. I am delighted by this hearing, as somebody who has been one of arms control's principal skeptics all my life. It seems to me that the only thing verified out of all this is the position I have held all these years, that when you really need arms control it does not measure up to the job because you cannot trust, cannot verify, cannot find out all you need—witness the extraordinary things that we have found out about what did not take place under the agreement we had with the INF Treaty.

When international tensions between parties relax to the point that you can have some confidence in it, you no longer need it, as we do not need an arms control arrangement with France or with Canada or with any of our other allies. I must confess, Dr. Barker, that I much admire and much agree with what you have said, but your call for us to ratify a START agreement with more than 1,000 pages in it because it gives us confidence, and yet trust is the basis for all the progress outside it, and further negotiations merely confound that.

I agree that further negotiations would merely confound it, but I am not certain what relevance START possesses in the era in which we now find ourselves, and particularly I am not certain what relevance START possesses in terms of the follow-on understandings between the President and Mr. Yeltsin.

So why is START of any consequence now?—

Dr. BARKER. Is that question addressed to me, Senator Wallop?

Senator WALLOP. Yes.

Dr. BARKER. I think it is useful to codify the significant effort that has been expended in reaching the point where we are today. There are certain inspection opportunities that have been negotiated with agonizing effort associated with that Treaty.

I think my response more simply would be: why not? Why not take advantage of what has been negotiated over many years as part of an interacting set of arrangements with the former Soviet Union? But I do not look upon such negotiated agreements as the model for the future. I would rather look to the exchange of unilateral commitments and transparency as the model for the future rather than these extended negotiating processes as a model for the future.

Senator WALLOP. As you both have pointed out, there has been an extraordinary amount of progress that has gone well beyond where START started and stopped, and those were not negotiated. As a matter of fact, progress in Europe that has taken place in the last few years far exceeded anything that took place in 20 years of negotiations.

My guess is that there is a political statement that is attached to such things as START agreements, mostly because people such as yourself have worked on them for such a long time. But the problem then becomes that the political statement sort of exceeds the competency of the agreement. I am not suggesting that the agreement is not competent but that events have gone beyond it to such an extent that any complications that might arise—and there are real complications that might arise—if you view the treaty in terms of a treaty arranged between contesting powers.

And if we are not contesting powers, we do not need the treaty. My biggest problem with the follow-on arrangements are that we

make the assumption or tell the Soviets—you have even suggested, Dr. von Hippel, that reciprocity is a requirement—so we say, now, just for the purposes of this negotiation be our enemy again; we cannot trust each other.

I do not really see where that does anything except verify Dr. Barker's suggestion that that probably is an impediment to progress rather than a greasing of a wheel. Could you comment on that?

Dr. VON HIPPEL. I guess my answer is that we are going from a primary focus on U.S.-Soviet arms control to a focus on nonproliferation, and many of these arrangements we are talking about have their analogs in the area of nonproliferation.

For example, we ask Germany and Japan to open themselves to IAEA safeguards. Now, the question is, why do we? We trust them. They are democracies. And, at this point, they are certainly much more stable and trustworthy than Russia.

The reason we asked them—and have convinced them—to subject themselves to IAEA safeguards is because we wanted to be able to go to a country like North Korea and say, "Look, everybody is doing it. The Germans and Japanese are doing it. You do it to." We want to make sure whatever their nuclear facilities are—

Senator WALLOP. Do you honestly believe they would?

Dr. VON HIPPEL. Pardon?

Senator WALLOP. Do you honestly believe that that would create such a sense of guilt in Korea or Israel or Argentina or Pakistan or India or any other place that they would automatically do that? I do not believe that.

Dr. VON HIPPEL. Well, we create a basis, a legitimacy for the rest of the world community to demand it of them. And there is extraordinary pressure now on North Korea, as you know, to comply with this.

Senator WALLOP. Does not Soviet behavior or Russian behavior and U.S. behavior create that same legitimacy without the agreement? I mean, we are already well beyond the point where—I suggest we are well beyond the point where you and NRDC and a whole lot of others ever thought we would get a couple or 3 years ago.

It just seems to me—and my time is up and I will stop with this, but it seems to me that engaging in a whole series of most complex negotiations about dots and commas and words and definitions and other kinds of things is in fact, as Dr. Barker says, a real impediment to progress because it creates tensions in the very parties that are now trying to get along.

The Russians do that I have talked to have one principal thing that they really do not like, and that is that they are being talked down to. At the risk of being recorded in the press as a bigot, one of them told me, you are treating us like Jamaicans. Basically they want to be treated kind of the way Dr. Barker has said, that because of Nunn-Lugar we have been approaching them.

My guess is that, if I was going to choose sides, I like the side that says the progress we are doing is a whole lot faster than the negotiations that we are not.

Chairman NUNN. Thank you, Senator Wallop. Senator Levin.

Senator LEVIN. Thank you.

On that point, first, Dr. von Hippel, I happen to agree with Senator Wallop that we want to deal with the Russians in the appropriate fashion. We do not want to talk down to them and deal with them as though they were a second-rate state.

Have you felt any of that would be present if we offered to negotiate a dismantlement agreement with the Russians, that they would take that as though we were treating them as though they were anything other than a first-line, first-class nation?

Dr. VON HIPPEL. Well, I think that would be treating them on the basis of equality. At the moment we are not. They have proposed to us an exchange of information and then verification on the warhead and fissile material stockpiles, which is the content of the Biden condition.

Senator LEVIN. Both on dismantlement of the warheads and on disposal of fissile material, both?

Dr. VON HIPPEL. Well, to be specific, Foreign Minister Kozyrev, on the 12th of February, proposed—let me just read the language: “We may consider developing a reciprocal exchange of data between all nuclear powers on the number and types of existing nuclear weapons, the amount of fissionable materials, and on nuclear weapons storage and elimination facilities.”

Senator LEVIN. So that would seem to include both on the question of dismantlement and on the question of disposal of the fissile material after dismantlement.

Dr. VON HIPPEL. There has been an additional proposal most recently renewed by President Yeltsin on January 29, when he stated on fissile material cutoff that “we confirm the proposal to the United States to come to agreement on controlled termination of the production of fissionable materials for weapons.”

Now, there is no corresponding statement at such an official level on warhead dismantlement and disposition of the fissile materials, but it has certainly been made repeatedly in an informal way by Russian officials.

Senator LEVIN. So rather than taking that proposal and then entering into those discussions, we have basically ignored it. Is that what has happened?

Dr. VON HIPPEL. That is right. We have not responded.

Senator LEVIN. Just have not responded.

Dr. VON HIPPEL. No.

Senator LEVIN. Well, if anything is demeaning, it would seem to me to be not responding to a serious proposal even from an ally—in fact, maybe even more so than from an ally it is demeaning. I mean, we negotiate agreements with allies all the time, as you have just said. It is very common. We are trying to negotiate an agreement with Mexico. We recently negotiated an agreement with Canada.

We negotiate agreements with allies all the time. And even if we view Russia as an ally now or a friend—and I hope we do—surely if they have made a proposal relative to the dismantlement of nuclear weapons and the disposal of fissile material, we should treat that seriously and with appropriate seriousness. We have not done it.

Now, Dr. Barker, you have a different view on that point, I gather.



Dr. BARKER. Well, I think I am going to have to defer to the subsequent panel, Senator Levin, about the degree to which the Russian Government has made a formal proposal to the United States with respect to an agreement to declare stockpile numbers. I have no personal knowledge of that kind of interaction.

I would point out that the offer of President Yeltsin that was just cited by Professor von Hippel is another one of these strange circumstances where the United States had already announced its cessation of production of fissile material for weapons purposes. As I said before you came in the room, this committee has full oversight of U.S. compliance with that declaration, and it is somewhat strange to have President Yeltsin propose that we should somehow or other have to sign an agreement in order to get the Soviets to make the same kind of commitment.

There is a case where certainly an exchange of unilateral declarations is a much more appropriate direction to go in view of the current reality.

Senator LEVIN. But that gets into some sort of diplomatic niceties. The bottom line, though, is if he has proposed that we enter into that kind of an agreement, surely discussions about entering into that agreement cannot be demeaning to Russia. If he has made a proposal to enter into discussions about an agreement, it cannot be demeaning to enter into those discussions.

Would you not agree with that?

Dr. BARKER. I did not say it would be demeaning.

Senator LEVIN. No, I did not say that you said it. I am saying surely it would not be demeaning to enter into the discussions which have been proposed by Russia. It may or may not be wise, but it surely is not demeaning.

Dr. BARKER. Is it not demeaning to engage in any reasonable negotiation.

Senator LEVIN. And the only problem that you have with it is that we ought to be each doing that unilaterally without entering into an agreement, but we ought to be doing it?

Dr. BARKER. I think we have entered into a new world, Senator Levin, one in which an exchange of unilateral commitments is a more appropriate method to approach problems. I believe we should try that approach to the maximum extent possible and ought not to think in terms of automatic reciprocal negotiated agreements as a way to achieve progress in the whole arena of arms reduction.

Senator LEVIN. Are we willing to open up our own facilities to the same kind of inspection which we would like them to unilaterally offer us in their facilities?

Dr. BARKER. In which area, Senator?

Senator LEVIN. In the dismantlement area and in the disposal of the enriched uranium?

Dr. BARKER. They have already made clear that they have no desire whatsoever for us to access their dismantlement facilities. They have rejected any assistance from us in the actual dismantlement process itself because they do not want us accessing their dismantlement facilities.

On the other hand, they have sought our help in the area of storage and accountability, and they are granting us access in that

entire area. So we have a sound basis for understanding the quantities of fissile material in excess of their defined nuclear weapons requirements, and we have a sound basis for understanding whether material is going into that system from retired weapons.

So they have made a clear distinction in their discussions with us.

Senator LEVIN. My time is up, but Dr. von Hippel do you have any comment on that? Do you agree with that last comment?

Dr. VON HIPPEL. Well, apparently they have other storage facilities, and how they define what they require—

Senator LEVIN. In terms of accessibility to dismantlement, do you agree with that characterization?

Dr. VON HIPPEL. Well, if you ask whether we are reciprocating, of course we are not. We are not giving the Russians access to the Pantex storage igloos where we store our plutonium, and I do not think we have any intention of doing so.

Senator LEVIN. But are we willing to give them the same access to our facilities that we would like at their dismantling facilities?

Dr. VON HIPPEL. Well, I agree with Dr. Barker that I do not think it is necessary for us to go inside the dismantlement facilities. I would like to be able to have us visit their warhead storage facilities and be able to see the warheads delivered to the dismantlement facilities, and maybe, between campaigns, look inside to see that they have taken apart all the ones that are committed to destruction.

Senator LEVIN. Just on that point, and then I am going to end, have they offered to do that or refused to do that?

Dr. VON HIPPEL. Well, we have discussed it in these unofficial, non-governmental workshops, and I think we do have a common understanding of how one could verify these arrangements if one wanted to.

Senator LEVIN. Thank you. My time is up.

Chairman NUNN. Thank you, Senator Levin. Senator Mack?

Senator MACK. Thank you, Mr. Chairman.

I want to go back to the verification thing again. If you would, Dr. von Hippel, try again to explain to me why we should verify the elimination or destruction of warheads and material when we could not verify in specific enough numbers to make us feel comfortable.

Dr. VON HIPPEL. Well, it is a question of uncertainties. At the moment, I do not think we know how big the Russian stockpile is to 10,000 warheads. I do not think we know how much fissile material they produced for weapons within a couple of hundred tons at least.

We could reduce those uncertainties by mutual disclosures—by exchanging information about production history and by declarations. We had this experience with the chemical weapons where we were estimating a huge Russian stockpile. They finally declared how much they had. It was still huge, but it was, I think, about a quarter as much as we had estimated.

Our intelligence people very quickly accepted that declaration as being legitimate, and we felt better knowing where it was, how much they had, and what the breakdown was. It was confidence-building.

The question is what is the matter with that. Is this not in our interest? I think the Russians know much more—

Senator MACK. I do not think I disagree with the concept of verification. It is just if you cannot verify to a point, I mean, I do not know how the average person in this country would react to saying that we have gone through a tremendous verification process but we are still not quite sure whether we have got that last 500 warheads or last 1,000 warheads.

Most people think that just a few of them are dangerous enough.

Dr. VON HIPPEL. That is right. I think already in the 1950s President Eisenhower said that we had gone beyond the point where we could confidently verify going back to zero nuclear weapons. We are condemned to an uncertainty.

Senator MACK. Is that something you believe, by the way?

Dr. VON HIPPEL. I think that we will never know for sure. Even if we decided to go to zero nuclear weapons, we would never know for sure we had gotten there, yes.

Senator MACK. Dr. Barker, did you want to comment on the question I posed about verification?

Dr. BARKER. Just one note of caution with respect to Professor von Hippel's citation of the former Soviet chemical weapons stockpile and the need to continue to differentiate between intelligence estimates and reality and between claims and reality.

I think, to rephrase what Professor von Hippel said, we had an estimate. The Russians came in and said they had so much. The intelligence estimate was changed. We still do not really know how much they have. We have not been there to count it, and we are never going to be every place in the Soviet Union where chemical weapons can be to know how accurate that declared stockpile was.

In the case of chemical warfare, you may have tons of agent outside of what is declared that has a limited military utility. If you are talking about the same volume of nuclear weaponry, there may be a significant military utility associated with it.

Senator MACK. One of the comments that Dr. von Hippel made earlier basically indicated that we really ought to act now since we have a leadership that we believe in in the sense of where they are going and what they are trying to accomplish, and we ought to act now so that we do not look back some time in the future and say we missed a golden opportunity.

What is your reaction to that, Dr. Barker?

Dr. BARKER. My reaction, Senator Mack, is that if there is a significant reversal in the attitudes of a Russian government to the point where something similar to a Cold War revived, we clearly are not going to be able to trust what they do across the board. I do not understand how an agreement made now is somehow going to tie the hands of people whose behavior we expect to be totally reprehensible in the future.

If you believe those bad guys are going to live up to the agreements they have already negotiated, I guess that you are free to do that, but I always have difficulty with the logic itself.

Senator MACK. Dr. von Hippel, I think you wanted to react.

Dr. VON HIPPEL. I think this is an extraordinary leadership in the sense that they do not have the reactions that we are used to

from virtually all past Russian leaderships. What we would accomplish is that we would lock their successors into the declarations.

First of all, I think it is much more difficult to break a treaty than to break a unilateral commitment. But even if they broke a treaty, this leadership would have provided us information that would give us a better understanding of what they have produced in the past and what they have now than we could get in any other way.

Senator MACK. And how would we go about verifying that information?

Dr. VON HIPPEL. Well, what I was saying was that, first of all, I think we have a basis for having, as you said, some confidence in what they say. But then, by exchanging production records—which might not be possible in the future after production records are destroyed and physical evidence is destroyed—we would be able to find out whether we were confident in that information or not.

Dr. BARKER. I would only point out we are getting beyond the Biden condition, because I think what we are confusing is a scheme that Professor von Hippel has devoted a decade of his life to with the exact language of the Biden condition.

I cannot read Biden to require that we have to exchange production records for the last 40 years between the two sides. There is a cadre of people who I am sure are eager and ready to sit down and negotiate excruciatingly detailed verification measures to implement the scheme that Professor von Hippel has discussed, and another group of people who are eager to spend hours and years negotiating the agreement.

If this country decides to spend its money that way or to spend hours that way, so be it. My point is that part of it is unnecessary and part of it I think is doomed to failure before it starts, and why one would want to hang this as a condition on advise and consent to START is beyond me.

As someone who is no longer in government, I can say that.

Chairman NUNN. Okay. We thank both of you for being here.

Our next panel I have already introduced: Mr. Robert Gallucci, Assistant Secretary of State for Political-Military Affairs; Mr. Richard Claytor, Assistant Secretary of Energy for Defense Programs; Mr. Douglas Graham, Deputy Assistant Secretary of Defense for Strategic Defense, Space, and Verification Policy.

If Mr. Gallucci can be allowed to sit down, we will start with you. I would urge you, if you could, to summarize your statements, it would be very helpful. Because of a longstanding commitment, I must leave at 4:00. We will not have to conclude then, but I would like to hear as much as I can before I depart.

**STATEMENT OF HON. ROBERT L. GALLUCCI, ASSISTANT  
SECRETARY OF STATE FOR POLITICO-MILITARY AFFAIRS**

Mr. GALLUCCI. Mr. Chairman, thank you. It is a pleasure to appear before this committee today to address the issue of the disposition of nuclear weapons in the former Soviet Union.

Indeed, Mr. Chairman, with your permission I will submit my full statement for the record and simply highlight key points in the administration's approach to the issue.

That approach began with President Bush's September 27 nuclear initiative.

Chairman NUNN. Would you pull that mike up as close as you can, Mr. Gallucci?

Mr. GALLUCCI. I certainly will.

That initiative began with President Bush's September 27 nuclear initiative in which he proposed discussions on the safety and security of nuclear weapons as well as their storage, transportation, and destruction.

The President's September initiative was followed by the establishment of an experts group that first met in Washington last November. That same month, the Congress passed and the President signed the Nunn-Lugar legislation, which gives the President the discretionary authority to transfer up to \$400 million in Department of Defense funds to transport, store, and destroy nuclear, chemical and other weapons, and to establish verifiable safeguards against their proliferation.

Our efforts began to pay off at the June summit, when four agreements related to the safe, secure dismantlement of nuclear weapons were signed by Russia and the United States. These included an umbrella agreement providing an international legal framework for the transfer of Nunn-Lugar funds, and three other agreements under which the United States will provide armored blankets for the safe, secure transport and storage of nuclear weapons, nuclear weapon accident response equipment and clothing and training in its use, and transportation and storage containers for fissile material from dismantled warheads.

More work remains to be done. We are moving closer to an agreement so we can help modify Russian rail cars used in the transport of nuclear weapons to enhance their safety and security. We are also working with the Russians to identify requirements for a facility for the storage of fissile material removed from nuclear weapons.

The latter effort, however, is related to conclusions yet to be drawn on the ultimate disposition of highly-enriched uranium and plutonium removed from dismantled weapons. We and the Russians agree that the best use for the highly-enriched uranium would be to dilute it to lower its enrichment level and sell it as nuclear power reactor fuel.

This could earn hard currency for Russia and eliminate the military potential for this material. The U.S. Government has not yet completed its review of the various possible arrangements for the U.S. participation in the conversion of Russian uranium, but both we and the Russian government agree that, whatever arrangements are finally made, we need to decide upon standards and criteria for physical protection of the material and nonproliferation measures.

The disposition of plutonium presents a more difficult challenge because there is no ready market for it as a power reactor fuel or for other peaceful uses. For this reason, plutonium will likely require secure, long-term storage.

Finally, we are continuing our discussions with the Russians on establishing an effective nuclear material control and accounting system and a system for the physical protection of nuclear materi-

al. This is important because the former Soviet Union lacked a modern control and accounting system for bulk nuclear material.

I want to also note the one area in which I have been particularly deeply involved, namely the science centers in Russia and the Ukraine. Just as important as the potential loss of control over warheads or fissile material is the potential proliferation of expertise in their production.

To reduce this so-called brain drain threat, the International Science and Technology Center in Moscow and the Science and Technology Center in Kiev are being established to provide professionally-rewarding, non-weapons-related projects on which the ex-Soviet weapons scientists and engineers can collaborate with scientists and engineers in the West.

Let me now turn specifically to strategic weapons. Our involvement in the disposition of nuclear weapons in the former Soviet Union will also follow from the START Treaty and the Joint Understanding on Further Reductions in Strategic Offensive Arms reached at the June summit.

These agreements will result in large numbers of strategic warheads entering the same storage and dismantlement stream as the tactical nuclear warheads removed from service under the earlier Bush, Gorbachev and Yeltsin nuclear initiatives. As the Committee is well aware, neither START nor the June 17 Joint Understanding require the elimination of strategic nuclear warheads. Others on this panel will be prepared to address the rationale for this.

I would simply make the point that our involvement with strategic systems and their warheads in the former Soviet Union will probably go well beyond the strict provisions of those two agreements, further increasing their transparency.

Let me address briefly one condition included in the resolution of ratification reported out by the Senate Foreign Relations Committee. This condition would require, in connection with any further agreement reducing strategic offensive arms, that the administration seek an arrangement to monitor (1) the numbers of nuclear stockpile weapons on territories of the parties of the treaty, and (2) the location and inventory of facilities on the territory of the parties to the treaty capable of producing or processing significant quantities of fissile materials.

The administration completely agrees with the premise of the SFRC condition—that is, that “the prospect of a loss of control of nuclear weapons or fissile material in the former Soviet Union could pose a serious threat to the United States and to international peace and security.”

As I have just indicated, however, the administration is pursuing a number of measures that should help to reduce the risk of such loss of control. Our analysis of the SFRC condition is not yet complete. However, based on our preliminary review, the administration is concerned with the implications of this condition for several reasons.

First, we do not want to delay agreement on the codification, ratification and implementation of the Joint Understanding agreed to at the June Washington summit. Any interpretation of the Foreign Relations Committee condition that links Treaty implementation to an agreement on the monitoring of fissile material produc-

tion or weapons stockpiles risks at least a delay and possibly the unraveling of the Understanding. It would be opposed by the administration.

Second, the administration is concerned that the Senate Foreign Relations Committee condition would require the U.S. to propose reciprocal inspections. While we are still studying the implications of this language for our statutory obligation to protect nuclear weapons design information, we obviously would not want to propose a monitoring scheme that we ourselves could not accept.

Alternatively, we would not want to propose verification measures that met U.S. or Russian requirements for protection of nuclear weapons design information but which did not ensure that all weapons or production facilities were declared.

In short, the condition concerns the administration because it might require us and the Russians to take steps that appear at this point to be at least very difficult, probably unnecessary, and potentially damaging to the rapid implementation of one of the most important arms control agreements in history.

Mr. Chairman, members of the committee, let me conclude by stating that the administration's efforts to address the safe, secure transport, storage, and dismantlement of nuclear weapons in the former Soviet Union and prevent their proliferation have been both far-reaching and intensive. Our discussions with Russia and the other newly-independent Republics and their actions to date have demonstrated that they fully share our concerns and goals in these regards.

Our task, as we see it, has been to give them the tools, where necessary, to help ensure their control over nuclear weapons and fissile material. While more remains to be done, I believe the administration's efforts are addressing the basic concern reflected in the Foreign Relations Committee condition.

That concludes my statement. I would be happy to address any questions members of the committee might have.

[The prepared statement of Mr. Gallucci follows:]

PREPARED STATEMENT BY ROBERT L. GALLUCCI ASSISTANT SECRETARY OF STATE FOR  
POLITICO-MILITARY AFFAIRS

Mr. Chairman, it is a pleasure to appear before this committee today to address the issue of the disposition of nuclear weapons in the former Soviet Union. I know this committee, as part of its consideration of the START Treaty, is specifically interested in those weapons that are being removed from strategic systems in accordance with that agreement. We have a panel of witnesses who are prepared to address a number of different aspects of this issue. I would like to use my time to give you an overview of the administration's efforts to ensure the responsible control and disposition of nuclear weapons belonging to the former Soviet Union and to establish safeguards against their proliferation.

As you are well aware, the attempted coup of last August, and the ultimate breakup of the Soviet Union, posed new challenges and opportunities in the area of national security. President Bush responded to these challenges and opportunities beginning with his September 27, 1991 nuclear initiative. As part of that initiative, the President proposed discussions to explore cooperation on the safety and security of nuclear weapons and on their safe and environmentally responsible storage, transportation and destruction.

Our objective has been to enhance the security of nuclear weapons in the former Soviet Union, especially those nuclear weapons slated for elimination under unilateral commitments made by Presidents Gorbachev and Yeltsin. Tactical nuclear weapons, in particular, because of their small size and transportability, pose the greatest risk of loss of control or seizure by third parties. We wanted to take steps

to ensure these weapons were quickly disabled and consolidated at sites where they could be securely controlled. In addition, we wanted to put into motion a process for quickly dismantling these weapons.

#### SSD DIALOGUE

President Bush's September initiative was followed by the establishment of an experts group to discuss the safety, security and dismantlement (SSD) of nuclear weapons. This group first met in Washington last November. That same month, the Congress passed, and the President signed, the Dire Emergency Supplemental Appropriations Act—the Nunn-Lugar legislation—which gives the President the discretionary authority to transfer up to \$400 million in Department of Defense funds to destroy nuclear, chemical and other weapons; transport, store and safeguard these weapons in connection with their destruction; and establish verifiable safeguards against their proliferation.

After some initial fits and starts caused by the breakup of the Soviet Union and the growing pains of Russia and the other newly independent republics as they attempted to put their own governmental structures into place, our SSD efforts began to pay off at the June summit when four agreements related to the safe, secure dismantlement of nuclear weapons were signed by Russia and the United States.

The first, an umbrella agreement, provides an international legal framework for the transfer of the \$400 million as authorized by the Nunn-Lugar legislation. Under three other agreements, the United States will, over the course of the next several years, provide Russia with approximately 500 armored blankets for the safe, secure transport and storage of nuclear weapons and fissile material; over 1,000 pieces of nuclear weapon accident response equipment and clothing, and training in its use; and 10,000 transportation and storage containers for fissile material from dismantled warheads. Initial deliveries of armored blankets have already taken place in Moscow.

More work remains to be done. We are moving closer to an agreement on a program of assistance to modify Russian railcars used in the transport of nuclear weapons to enhance their thermal insulation as well as their fire and intruder detection features. We are also working with the Russians to identify requirements for a facility for the storage of fissile material removed from nuclear weapons. Any U.S. assistance in the construction of such a facility will require Russian agreement to a high degree of transparency in its operation. The administration is currently considering a range of measures in this regard.

An agreement with the Russians on the design and construction of a storage facility will also depend, in part, on the conclusions reached in our continuing discussions on the ultimate disposition of highly enriched uranium and plutonium removed from dismantled weapons. We and the Russians agree that the most desirable use for the highly enriched uranium would be to dilute it to lower its enrichment level, and sell it as nuclear power reactor fuel. This could earn hard currency for Russia and eliminate the military potential of this material. The U.S. Government has not yet completed its review of the various possible arrangements for U.S. participation in the conversion of Russian uranium, but both we and the Russian government agree that, whatever arrangements are finally decided upon, we need to decide upon standards and criteria for physical protection of the material and non-proliferation measures.

Plutonium presents a more difficult challenge than uranium because there is no ready market for it as a power reactor fuel or for other peaceful purposes. For this reason, plutonium will likely require secure, long-term storage.

Finally, as part of our SSD dialogue, we are continuing our discussions with the Russians on establishing an effective nuclear material control and accounting system (MC&A) and a system for the physical protection of nuclear material. The former Soviet Union lacked a modern MC&A system for bulk nuclear material. On the other hand, their controls on manufactured items, for example reactor fuel assemblies, appears adequate and, by all accounts, they have an effective system for controlling nuclear weapon inventories.

We have also established a dialogue with Ukraine, Belarus, and, most recently, Kazakhstan aimed at providing Nunn-Lugar assistance. All tactical nuclear weapons have been removed from these republics and, ultimately, all strategic weapons will be removed as well. However, where appropriate, we have discussed the provision of possible accident response equipment and assistance in the monitoring of the withdrawal of nuclear weapons from these republics. It is likely that we will also be providing assistance to one or more of these republics in the dismantling of strategic weapon systems currently located on their territory. Where appropriate, for example Ukraine, we are also discussing MC&A systems for controlling nuclear materials



associated with civilian power programs. We have also addressed export controls with these and other republics, as well as Russia, and are considering additional assistance in this area under Nunn-Lugar.

#### "BRAIN DRAIN"

Finally, I want to note the one area in which I have been deeply involved—namely, the Science Centers in Russia and the Ukraine. Equal in our mind to the potential loss of control over warheads or fissile material is the potential proliferation of knowledge in their use. The administration considered it important to address the non-proliferation threat represented by the possible emigration of unemployed or under-employed weapon scientists to countries that seek an indigenous capability for delivering weapons of mass destruction.

To reduce this so-called "brain drain" threat, the International Science and Technology Center in Moscow and the Science and Technology Center in Kiev are being established to provide professionally-rewarding non-weapons related projects on which the ex-Soviet weapons scientists and engineers can collaborate with scientists and engineers in the West. In Russia, we expect the majority of the projects will employ weapons designers and engineers from their nuclear laboratories. In Ukraine, we expect that most projects will employ the ballistic missile scientists and engineers at their missile production facilities.

#### START AND THE JOINT UNDERSTANDING

Our involvement in the disposition of nuclear weapons in the former Soviet Union will also follow from the START Treaty and the Joint Understanding on further reductions in strategic offensive arms reached at the June Summit. These agreements will result in large numbers of strategic warheads entering the same storage and dismantlement stream as the tactical nuclear warheads removed from service under the earlier Bush, Gorbachev and Yeltsin nuclear initiatives.

As the committee is aware, neither START nor the June 17 Joint Understanding require the elimination of strategic nuclear warheads. However, our involvement with strategic systems and their warheads in the former Soviet Union will probably go well beyond the strict provisions of those two agreements, further increasing their transparency. For example:

— We expect to have a significant role in the ultimate disposition of strategic systems and warheads in the former Soviet Union as a result of the resolution of destruction obligations between Russia, Ukraine, Belarus and Kazakhstan necessary to implement START.

— We will also be pursuing the early deactivation and disarming of those systems the sides have agreed to eliminate under START and the Joint Understanding.

— Finally, we will be involved in providing assistance to help ease the financial and technical burden of storage and dismantlement. Of particular note, the Summit Joint Understanding states that reductions will be carried out by the year 2000 (vice 2003) if the United States can contribute to the financing of the destruction or elimination of strategic offensive arms in Russia. We intend to begin these discussions in the near future.

Much of our assistance program under the Nunn-Lugar legislation will also be directly relevant to the process of eliminating strategic arms.

#### THE SFRC CONDITIONS ON START RATIFICATION

Let me address briefly one condition included in the resolution of ratification reported out by the Senate Foreign Relations Committee. This condition would require, in connection with any further agreement reducing strategic offensive arms, that the administration seek an arrangement to monitor:

— the numbers of nuclear stockpile weapons on the territories of the parties to the treaty; and

— the location and inventory of facilities on the territory of the parties to the treaty capable of producing or processing significant quantities of fissile materials.

The administration completely agrees with the premise of the SFRC condition, i.e., that "the prospect of a loss of control of nuclear weapons or fissile material in the former Soviet Union could pose a serious threat to the United States and to international peace and security." As I have just detailed, the administration is pursuing a number of measures in the SSD context that should help to reduce the risk of such a loss of control.

Our analysis of the SFRC condition is not yet complete. However, based on our preliminary review, the administration is concerned with the implications of this condition for several reasons. First, the administration is concerned that we not

delay agreement on the codification, ratification and implementation of the Joint Understanding on further reductions in strategic offensive arms, including the elimination of MIRVed ICBMs, agreed to at the June Washington Summit.

This Understanding represents an extremely important achievement of immense benefit to the United States. All substantive areas associated with the Joint Understanding have been resolved; the only remaining task is to turn the agreement between President Bush and President Yeltsin into appropriate treaty language.

Any interpretation of the Foreign Relations Committee condition that would require adding new provisions not agreed to at the Summit that would require reopening the scope of the treaty, or that links its implementation to an agreement on the monitoring of fissile material production or weapons stockpiles risks at least a delay and, possibly, the unraveling of this accomplishment and would be opposed by the administration.

Second, the administration is concerned that the Senate Foreign Relations Committee condition would require the United States to propose "reciprocal inspections . . . to monitor the number of nuclear stockpile weapons and the location and inventory of facilities . . . capable of producing or processing significant quantities of fissile materials." We are still evaluating whether or not such monitoring can be implemented in a manner consistent with U.S. security interests and our statutory requirements under the Atomic Energy Act of 1954 for the protection of nuclear weapons design information. Naturally, the administration would be unwilling to propose a monitoring scheme that we were unprepared to accept because it would be inimical to U.S. security interests. Our review of this aspect of the Senate Foreign Relations Committee condition is continuing.

Finally, we are concerned that any verification measures that would be consistent with U.S.—or Russian—requirements for protection of nuclear weapons design information would be woefully inadequate to ensure that all weapons or facilities were declared. Acceptable verification measures probably could be devised to allow us to monitor *declared* weapons and facilities. However, additional measures would be needed for verification of *undeclared* weapons and facilities. Such measures would be exceedingly intrusive, expensive, and complex. Based on the level of intrusiveness alone, such measures would most likely be unacceptable to both the United States and Russia. Moreover, they would not be sufficient to ensure that all nuclear weapons, fissile material and nuclear facilities located on the territory of the Russian federation were declared and accounted for.

I would add two additional political points. First, I would be loathe to see any attempt to negotiate a verification or monitoring regime slow the pace of weapons dismantlement in Russia. I believe this would be the outcome of such a process. Second, it should be borne in mind that there is already a degree of self-policing that is taking place within the Commonwealth of Independent States (CIS). In last December's Minsk Agreement, Ukraine, Belarus and Russia agree that the process of destruction of nuclear weapons located on the territory of Ukraine and Belarus would take place with the participation of those states. This was followed by a more detailed agreement between Russian and Ukraine. These agreements, by all accounts, appear to now be working smoothly. The perceived benefits of any U.S. intervention into this intra-CIS process would have to be carefully weighed against our larger foreign policy objectives and our relations with these states.

Mr. Chairman, let me conclude by stating that the administration's efforts to address the safe, secure transport, storage and dismantlement of nuclear weapons in the former Soviet Union and to prevent their proliferation have been both far-reaching and intensive. Our discussions with Russia and the other newly independent Republics, and their actions to date, have demonstrated that they fully share our concerns and goals in these regards. Our task, as we see it, has been to give them the tools, where necessary, to help ensure their control over nuclear weapons and fissile material. While more remains to be done, I believe the administration's efforts are effectively addressing the basic concern reflected in the Foreign Relations Committee condition.

Mr. Chairman, that concludes my statement. I would be happy to address any questions members of the committee might have.

Senator WALLOP [presiding]. Thank you, Mr. Gallucci. Mr. Claytor.

**STATEMENT OF HON. RICHARD CLAYTOR, ASSISTANT  
SECRETARY OF ENERGY FOR DEFENSE PROGRAMS**

Mr. CLAYTOR. Mr. Chairman and members of the committee, I am pleased to appear before you today to respond to your request for the Department of Energy's plans for the nuclear weapons being withdrawn from the stockpile and for associated nuclear materials.

I respectfully request my written statement, previously submitted to the Committee, be included in the record.

Senator WALLOP. It will, and we appreciate your summary.

Mr. CLAYTOR. I will respond to each of the issues in your letter of invitation.

First, plans for warheads withdrawn from operational inventories. The Department of Energy will dismantle all retired weapons turned over to it by the Department of Defense. This will consist of disassembling each weapon, removing and storing the uranium and plutonium portions of the weapon, and disposing of the remaining portions of the weapon in accordance with State and Federal regulations.

The weapons retired by DOD are shipped to DOE's Pantex plant near Amarillo, Texas, where they are dismantled. These shipments will be metered by DOD so as to allow DOE to dismantle weapons at a maximum rate of approximately 2,000 per year. This rate was selected to provide assurance that we can carry out this dismantlement in an orderly, safe, and environmentally-sound manner.

This rate will also allow us to complete the dismantlement of anticipated planned retirements by the end of this decade. We are currently approaching this rate and expect to dismantle approximately 1,800 weapons in fiscal year 1992, and reach the 2,000 rate in fiscal year 1993.

Second, categorization of strategic warheads. Your invitation letter requested I give the Committee some indication of which current U.S. strategic nuclear warheads will be retained in storage, which will be modified or remanufactured for redeployment, and which will be disassembled.

Although it is clear the nuclear weapons stockpile will continue to be reduced significantly over the next several years, the precise number of each type of weapon being retained and being scheduled for dismantlement is reflected in the Nuclear Weapons Stockpile Plan (NWSP) approved by the President. The development of this plan is the responsibility of the Joint DOE/DOD Nuclear Weapons Council, of which I am a member. The President has directed that the plan be modified to reflect the June 17 U.S.-Russian Joint Understanding. That process is now under way.

Several additional points can be added in response to your request. There are no current plans to build any new weapons or remanufacture existing weapons. A certain limited number of modifications have been previously scheduled for weapons being retained in the stockpile. Beyond this, we are actively exploring modifications to enhance safety of weapons being retained in the stockpile.

It should be noted that most of the weapons in the planned smaller stockpile do not have all of the desired safety features. In the future, we may also need to make modifications to correct con-

ditions which could develop as the stockpile ages or which might be identified from our ongoing stockpile evaluation program.

Such potential modifications emphasize the vital importance of continuing a limited nuclear testing program set forth in the administration's recently issued testing policy to assure such modifications enable weapons affected to meet their performance specifications.

Third, disposition of fissile materials.

Senator WALLOP. Mr. Claytor, before you leave that, you have a paragraph which you did not include, and I just want to have a quick clarification. That is with respect to weapons safety enhancement. "Studies are under way by both DOD and DOE examining the desirability of making such enhancements. It should be noted that most of the weapons in the planned smaller stockpile do not have all the desired safety features."

Would you comment on how many tests are needed to assure us of that? Safety, it would seem to me, would be paramount to most Americans.

Mr. CLAYTOR. Safety certainly is paramount, Senator Wallop. Precisely how many is not—I cannot be too precise on that, but there will be as many as approximately five systems left in the stockpile, the smallest stockpile we envision, which do not have all of those modern safety features of Fire-Resistant Pits (FRPs), Insensitive High Explosives (IHEs), and Enhanced Nuclear Detonation Safety (ENDS).

And it typically will take as many as five tests per system. It could be more than that, depending on the outcome of tests. Therefore, if you say five systems and five tests per system, it could be as many as 25 tests. The constraints that are being suggested in the Hatfield amendment really puts, I think, the addition of safety features to these weapons in a box, in that I think 15 tests are allowed in a relatively short period of time.

Senator WALLOP. It would put some safety modernizations beyond reach, would it not?

Mr. CLAYTOR. Yes, sir, I think so. Beyond that, there are other safety problems which could arise in the stockpile which are not simply adding these new safety features. We have indeed found problems in the past. Big surprises have occurred, and we have had to modify weapons and test them for safety reasons.

We had one weapon about 4 or 5 years ago in which that occurred. So it is not simply adding these modern safety features that is important. It is important that we have the ability to test because of some unpredictable requirement that could affect safety.

I would like to add one other point. There are significant long term safety improvements under development. Under this arrangement closing out testing in 1996, we could not effect the very significant safety improvements that could make these weapons have the kind of enhanced safety I think we would all like to see.

So it is a very serious problem.

Senator WALLOP. Thank you. Forgive the interruption, but I have got to tell you I believe that most Americans would opt for safety in the remaining nuclear stockpile if they knew that that was their choice. I appreciate it.

Mr. CLAYTOR. Yes, sir.

Third, with the disposition of fissile materials, as I indicated earlier, the plutonium and highly enriched uranium (HEU) portions of the dismantled weapons are being stored. The plutonium portion or pit is being placed in specially designed steel shipping containers and stored safely and securely in earth-covered bunkers at our Pantex plant.

This is considered to be an interim arrangement until we have completed the Programmatic Environmental Impact Statement (PEIS) for the nuclear weapons complex reconfiguration and the Secretary of Energy makes a subsequent Record of Decision, now scheduled for late 1993. A limited number of the plutonium pits have potential application in a pit-reuse concept and potential safety enhancements to weapons being planned for retention in the stockpile. This is being considered in the safety enhancement studies previously mentioned.

Pit reuse will, of course, require nuclear testing. Studies are also being initiated both within and outside DOE to examine the options for the long-term disposition of plutonium removed from U.S. weapons.

The highly enriched uranium or HEU portion of the weapon is being returned to DOE's Y-12 plant in Oak Ridge, Tennessee, where traditionally this product has been assembled, disassembled, and stored in a safe, secure manner. In addition, naval nuclear reactors continue to use HEU and the quantity available from weapon returns is sufficient to service the Navy for many years, thus enabling DOE to suspend operations of the Portsmouth highly enriched uranium production plant.

Although no specific plans have been made for other use of this material, it is known that it can be blended with natural uranium to produce a valuable commercial fuel for nuclear power plants. This is being studied by DOE. In its report on the National Defense Authorization Act of fiscal year 1993, the House Armed Services Committee has requested that DOE perform a cost-benefit analysis of such blending and submit a report to the Defense committees by December 15, 1992.

Fourth, monitoring and verification regime of U.S. weapons and fissile materials. As the President has recently announced, we will no longer produce highly enriched uranium or plutonium for weapons purposes. No enriched uranium has been produced for weapons purposes since 1964, and no virgin plutonium has been produced since 1988. Thus, there is no fissile material production going on in the United States.

With respect to reprocessing facilities, the Secretary of Energy announced earlier this year that DOE's reprocessing facilities at the Idaho National Engineering Laboratory and the Savannah River site will be phased out. These facilities are no longer needed to extract enriched uranium from spent reactor fuel.

The Idaho facility will be shut down within the next year, while the Savannah River facility plans to reprocess spent reactor fuel for the next 4 to 5 years, but this is for purposes of waste management of the spent reactor cores.

With respect to on-site inspections of U.S. nuclear production facilities, we are still evaluating whether or not such monitoring can be implemented in a fashion consistent with U.S. security interests

and our statutory requirements under the Atomic Energy Act for the protection of nuclear weapons design information.

In response to section 3151 of the National Defense Authorization Act of 1991, the Department of Energy provided to the Congress in July 1991 a classified report entitled "Verification of Nuclear Warheads Dismantlement and Special Nuclear Material Controls." This report describes some of the complexities and difficulties of monitoring and verification regimes and the difficulties in protecting nuclear weapons design information.

Mr. Chairman, that concludes my statement and I would be pleased to answer any questions you or other Members may have. [The prepared statement of Mr. Claytor follows:]

PREPARED STATEMENT BY RICHARD CLAYTOR, ASSISTANT SECRETARY OF ENERGY FOR DEFENSE PROGRAMS, U.S. DEPARTMENT OF ENERGY

Mr. Chairman, members of the committee, I am Richard Claytor, the Assistant Secretary of Energy for Defense Programs, and the responsible official to the Secretary of Energy for the United States Nuclear Weapons Program, including the dismantlement of nuclear weapons retired by the Department of Defense. I am also responsible for the safe and secure storage of nuclear materials removed from these weapons. I am pleased to appear before this committee to respond to your request for the Department of Energy's (DOE's) plans for the nuclear weapons being withdrawn from the stockpile and for associated nuclear materials.

COMMITTEE REQUEST

Your letter of invitation specifically requested:

1. DOE's plans and requirements for the thousands of U.S. nuclear warheads which will, over the next several years, be withdrawn from operationally deployed inventories pursuant to the START I Treaty and the June 17, 1992 U.S./Russian joint understanding on further reductions in strategic offensive arms.
2. Which current U.S. strategic warheads will be retained in storage, which will be modified or remanufactured for redeployment, and which will be disassembled.
3. With respect to those weapons which will be disassembled, a description of DOE plans with regard to the ultimate disposition of the fissile material.
4. DOE's views as to the verifiability of an international monitoring and verification regime for U.S. and CIS nuclear weapons fissile material production and re-processing facilities, and our views as to the degree of intrusiveness that would be entailed if on-site inspections of U.S. nuclear production facilities were required.

I will respond to each of these to the extent that DOE's responsibilities are involved.

PLANS FOR WARHEADS WITHDRAWN FROM OPERATIONAL INVENTORIES

The Department of Energy will dismantle all retired weapons turned over to it by the Department of Defense (DOD). This will consist of disassembling each weapon, removing and storing the uranium and plutonium portions of the weapon, and disposing of the remaining portions of the weapon in accordance with State and Federal regulations. The weapons retired by DOD are shipped to DOE's Pantex plant near Amarillo, Texas, where they are dismantled. These shipments will be metered by DOD so as to allow DOE to dismantle weapons at a maximum rate of approximately 2000 per year. This rate was selected to provide assurance that we can carry out this dismantlement in an orderly, safe and environmentally sound manner. This rate will also allow us to complete the dismantlement of anticipated planned retirements by the end of this decade. We are currently approaching this rate and expect to dismantle approximately 1800 weapons in fiscal year 1992 and reach the 2000 rate in fiscal year 1993.

CATEGORIZATION OF STRATEGIC WARHEADS

Your invitation letter requested that I give the committee some indication of which current U.S. strategic nuclear warheads will be retained in storage, which will be modified or remanufactured for redeployment, and which will be disassembled. Although it is clear that the nuclear weapons stockpile will continue to be reduced significantly over the next several years, the precise number of each type of

weapon being retained and being scheduled for dismantlement is reflected in the Nuclear Weapons Stockpile Plan approved by the President. The development of this plan is the responsibility of the joint DOD/DOE Nuclear Weapons Council, of which I am a member. The President has directed that the plan be modified to reflect the June 17, 1992 U.S./Russian joint understanding; that process is now underway. Several additional points can be added in response to your request:

- There are no current plans to build any new weapons or remanufacture existing weapons.

- A certain limited number of modifications has been previously scheduled for weapons being retained in the stockpile. Beyond this, I must add that we are actively exploring modifications to enhance safety of weapons being retained in the stockpile. In the future, we may need to make modification or to correct conditions which could develop as the stockpile ages or which might be identified from our ongoing stockpile evaluation program. Such potential modifications emphasize the vital importance of continuing the limited nuclear testing program set forth in the administration's recently issued testing policy, to assure such modifications enable weapons affected to meet their performance specifications.

- With respect to weapon safety enhancements, studies are underway by both DOD and DOE examining the desirability of making such enhancements. It should be noted that most of the weapons in the planned smaller stockpile do not have all of the desired safety features.

- Dismantlement will proceed, as I have indicated, at a rate of about 2000 per year. DOD will temporarily store weapons planned for dismantlement to accommodate this dismantlement rate.

#### DISPOSITION OF FISSILE MATERIALS

As I indicated earlier, the plutonium and highly enriched uranium (HEU) portions of the dismantled weapons are being stored.

The plutonium portion, or pit, is being placed in specially designed steel shipping containers and stored safely and securely in earth-covered bunkers at our Pantex plant. This is considered to be an interim arrangement until we have completed the Programmatic Environmental Impact Statement for the nuclear weapons complex reconfiguration and the Secretary of Energy makes a subsequent Record of Decision, now scheduled for late 1993. A limited number of the plutonium pits have potential application in a pit reuse concept in potential safety enhancements to weapons being planned for retention in the stockpile; this is being considered in the safety enhancement studies previously mentioned. Studies are also being initiated both within and outside DOE to examine the options for the long-term disposition of plutonium removed from U.S. weapons.

The HEU portion of the weapon is being returned to DOE's Y-12 plant in Oak Ridge, Tennessee, where traditionally this product has been assembled, disassembled and stored in a safe, secure manner. Although no specific plans have been made for other use of this material, it is known that it can be blended with natural uranium to produce a valuable commercial fuel for nuclear power plants. This is being studied by DOE. In its report on the National Defense Authorization Act of Fiscal Year 1993, the House Armed Services Committee has requested that DOE perform a cost/benefit analysis of such blending and submit a report to the defense committees by December 15, 1992.

#### MONITORING AND VERIFICATION REGIME OF U.S. WEAPONS AND FISSILE MATERIALS

I will address this subject with respect to U.S. nuclear weapons and fissile materials.

I will first speak to fissile material production and reprocessing facilities which the committee's request asked that we address.

As the President has recently announced, we will no longer produce highly enriched uranium or plutonium for weapons purposes. No enriched uranium has been produced for weapons purposes since 1964 and no virgin plutonium has been produced since 1988. Thus there is no fissile material production going on in the United States.

With respect to reprocessing facilities, the Secretary of Energy announced earlier this year that DOE's reprocessing facilities at the Idaho National Engineering Laboratory and the Savannah River site will be phased out. These facilities are no longer needed to extract enriched uranium from spent reactor fuel. The Idaho facility will be shutdown within the next year while the Savannah River facility plans to reprocess spent reactor fuel for the next 4 to 5 years for waste management reasons.

With respect to on-site inspections of U.S. nuclear production facilities, we are still evaluating whether or not such monitoring can be implemented in a fashion consistent with U.S. security interests and our statutory requirements under the Atomic Energy Act of 1954 for the protection of nuclear weapons design information. In response to section 3151 of the National Defense Authorization Act of 1991, the Department of Energy provided to the Congress in July 1991 a classified report entitled "Verification of Nuclear Warheads Dismantlement and Special Nuclear Material Controls." This report describes some of the complexities and difficulties of monitoring and verification regimes and the difficulties in protecting nuclear weapons design information.

Mr. Chairman, that concludes my statement. I would be pleased to address any questions members of the committee might have.

Chairman NUNN [presiding]. Thank you, Mr. Claytor.

If Mr. Graham would let me ask one question—because I may have to leave before you get through testifying; I hope I do not, but I have to leave at 4:00. Mr. Gallucci, I noted in my opening statement that the June 17 summit agreement provides for an acceleration of the START II deadlines from 2003 to 2000, if the United States "can contribute to the financing of the destruction or elimination of strategic offensive arms in Russia."

Secretary Cheney testified before our committee last week and said he believed it was very much in our interest to try to achieve this earlier date and to give some assistance in that respect. He did not mention amounts or how and so forth. Mr. Gallucci, do you agree with Secretary Cheney that it is in our interest to try to achieve this earlier date for START implementation—2003 to 2000?

Mr. GALLUCCI. Mr. Chairman, yes, I do, and it is my understanding that we plan on beginning discussions aimed at that objective just as soon as we can.

Chairman NUNN. Discussions with the Russians?

Mr. GALLUCCI. Yes, indeed.

Chairman NUNN. I was going to ask you the time table and the procedure for deciding the level of U.S. assistance that will be required. Is that what will come out of these discussions?

Mr. GALLUCCI. Senator, I do not know the answer to that. Maybe someone else at this table does.

Mr. GRAHAM. Mr. Chairman, I confess I am not exactly certain on the timing of that. I know that the issue is currently being addressed within the administration, and it is our hope to have some specific proposals in that regard in the relatively near future.

Chairman NUNN. Is Russia asking us to help them destroy only those systems whose elimination is required by START, such as silos and mobile ICBM missiles, or do they want help also in eliminating nuclear warheads? Does anyone know?

Mr. GRAHAM. Again, I think, sir, that one of the issues we need to do is engage with them in discussions about how we might assist them. We are doing our own homework at this point to put some specific proposals together, but we need to hear from them specifically what they have in mind in terms of ways that we might assist them in accelerating that dismantlement.

Chairman NUNN. Do any of you want to comment on the best procedure to use? Do we want to expand the Nunn-Lugar legislation, or do you want to create something new? What is the disposition, or have you gotten that far yet?

Mr. GRAHAM. Again, I think we are aware of the fact that the Congress is adding additional funding for the purposes of carrying



out the Nunn-Lugar assistance, and I do not think we have yet decided what mechanism yet to utilize for the purpose of that assistance, sir.

Chairman NUNN. Okay. Thank you for the interruption, Mr. Graham. You may proceed. Thank you, Senator Wallop.

**STATEMENT OF HON. DOUGLAS R. GRAHAM, DEPUTY ASSISTANT SECRETARY OF DEFENSE FOR STRATEGIC DEFENSE, SPACE, AND VERIFICATION POLICY; ACCOMPANIED BY JOHN BIRELY, ACTING ASSISTANT TO THE SECRETARY OF DEFENSE FOR ATOMIC ENERGY**

Mr. GRAHAM. Thank you, Mr. Chairman. I am pleased to be here today before the Senate Armed Services Committee to testify on the START Treaty and on nuclear weapons dismantlement. It is a particular pleasure for me to be back before this committee. I think this is the first time I have had an opportunity to formally testify in front of the committee.

Chairman NUNN. We are glad to have you back, Doug.

Mr. GRAHAM. Thank you. I trust the fact that it took 6 years was not a reflection on the work I did while I was here. [Laughter.]

It is good to be back. I have spent so much time in this room that it does feel a bit like coming home, and it is nice to be here.

In the interest of time, I will substantially shorten my statement and ask that the full text be included in the record.

Chairman NUNN. Without objection, it will be.

Mr. GRAHAM. The committee has asked that we address the question of why the U.S. has not, either in the START Treaty or the Joint Understanding, required the dismantlement of nuclear warheads. There are a number of reasons why the administration chose not to pursue this course of action.

First, from the Department's perspective, we frankly needed to reuse some of these warheads ourselves. For example, some warheads from Trident I missiles on Poseidon submarines will be redeployed on Trident II missiles aboard Trident submarines. A requirement to destroy existing warheads on systems retired under START would force us to produce new warheads, and, while the production of new warheads is permitted under START, it would not be a cost-effective approach.

Further, as the committee well knows, we currently have no operational capability to produce new warheads, given the current status of our production complex.

Second, elimination of the means to deliver warheads was and is, in our view, the most meaningful and verifiable way of reducing strategic nuclear forces. Once launchers are eliminated, missiles and their warheads no longer pose the same imminent threat to U.S. security that they do today. For this reason, we chose, in drafting START, to require the elimination of the means to deliver warheads, such as ICBM and SLBM launchers and heavy bombers. Reduction in the number of deployed warheads were achieved by removing missiles from their silos—with specific warhead numbers attributed to each missile type.

Rebuilding the delivery systems would be extremely expensive, would take a long time, and, particularly in comparison with war-

heads, it would be relatively easy for us to monitor those sorts of developments.

Finally, we question the utility of requiring warhead elimination absent numerical limits or constraints on the production of new warheads. We found that we could not effectively verify compliance with inventory limits or production constraints on warheads, even with levels of intrusiveness that would pose serious and unacceptable risks of disclosure of sensitive U.S. technology.

As you know, we are unsure how many warheads the former Soviet Union has produced, and we are not completely sure of the numbers of production or storage facilities in the former Soviet Union. I believe members got into some of these issues in front of the Senate Select Committee on Intelligence last week.

Since the collapse of the Soviet Union, we have moved away from our adversarial relationship with Russia. Today we find ourselves in an environment characterized by an increasing degree of cooperation on mutual security concerns and, in particular, as we have talked about at some length today, that is reflected in the Nunn-Lugar assistance package on which we have been working very diligently with the Russians. It is also reflected in some of the discussions we have ongoing about the disposition of nuclear materials.

In our view, these measures, which have been described by the other witnesses, will help to ensure that the warheads and the fissile material are firmly under Russian control and secure from terrorists or other unauthorized parties. They will also contribute to achieving our goal of increasing transparency of the nuclear weapons and fissile material stockpile in Russia.

In conclusion, the administration is concerned about the safety, security, and dismantlement of nuclear weapons in the former Soviet Union. We are pursuing a number of measures that should help to reduce the risk of loss of control of nuclear weapons and fissile material, while at the same time increasing the transparency of the Russian inventory of such weapons and material.

Russia and the United States are partners in this endeavor and share the same goals. As my colleagues have commented, that makes it a significantly different situation than the types of arms control verification tasks we have confronted in the past.

Since times have changed, and in the area of nuclear weapons this is particularly the case, we believe that the efforts that we are pursuing in the context of the safe, secure dismantlement of nuclear weapons of the former Soviet Union are sufficient to accomplish the basic goals that were expressed in the Senate Foreign Relations Committee condition to the resolution on START ratification.

It enables us to pursue that goal in a way that does not delay or threaten the movement towards elimination of all MIRVed ICBMs. We would urge members of this Committee and the full Senate to adopt a more flexible approach to this problem that enables us to address it in the most effective manner, and in our view that involves continuation of the work that we have ongoing in the area of SSD.

Mr. Chairman, thank you, and I look forward to answering any questions you may have.

[The prepared statement of Mr. Graham follows:]

PREPARED STATEMENT BY DOUGLAS R. GRAHAM, DEPUTY ASSISTANT SECRETARY OF  
DEFENSE FOR STRATEGIC DEFENSE, SPACE, AND VERIFICATION POLICY

Mr. Chairman, I am pleased to appear today before the Senate Armed Services Committee to testify on the Strategic Arms Reduction Treaty and nuclear weapons dismantlement. The mere fact that we are discussing today the question of an American approach to facilitate the safe, secure, dismantlement of the nuclear weapons of the former Soviet Union attests to the dramatic transformation of our security environment. The START Treaty that the committee is considering represents the first step in the strategic arms reduction process, and supplies the framework essential to the implementation of the treaty codifying the Washington Summit Joint Statement. The Joint Understanding represents an agreement of historic proportions that builds on the foundation established by START. And, the dramatic developments spawned by the President's nuclear initiatives, our dialogue with Russia on pursuing a Global Protection System, and the Nunn-Lugar funding authority have provided for cooperation in other critical endeavors that will reduce the risk of war.

The committee has asked that we address the question of why the United States has not, either in the START Treaty or the Joint Understanding, required the dismantlement of nuclear warheads. There are a number of reasons why we chose not to pursue this course of action. First, we need to reuse some of the warheads. For example, some warheads from Trident I missiles aboard Poseidon submarines will be redeployed on Trident II missiles aboard Trident submarines. A requirement to destroy existing warheads on systems retired under START would force us to produce new warheads. While production of new warheads is permitted under START, it would not be cost effective. Further, we currently have no operational capability to produce such new warheads, given the status of our production complex.

Second, elimination of the means to deliver warheads is the most meaningful and verifiable way of reducing strategic nuclear forces. The cost of nuclear weapons is relatively modest in relationship to the cost of delivery vehicles. Even dismantled nuclear weapons could be reassembled at relatively modest cost. We could not then, nor now, identify a practical way to effectively verify actual warhead elimination even with an unacceptable degree of intrusiveness. Hence, dismantling warheads appeared to have few benefits. On the other hand, once launchers are eliminated, missiles and their warheads no longer pose the same imminent threat to U.S. security that they do today. For this reason, we chose, in drafting START, to require the elimination of the means to deliver warheads, such as ICBM and SLBM launchers and heavy bombers. Rebuilding such systems would be extremely expensive, would take a long time, and, in comparison with warheads would be relatively easy to monitor.

Finally, we questioned the utility of requiring warhead elimination absent numerical limits or constraints on the production of new warheads. However, we found that we could not effectively verify compliance with inventory limits or production constraints, even with levels of intrusiveness that would pose serious and unacceptable risks of disclosure of sensitive U.S. technologies. As you know, we are unsure how many warheads the former Soviet Union has produced. Further, we are not completely sure of the numbers of production or storage facilities in the former Soviet Union. Given that nuclear weapons are nearly two orders of magnitude smaller than ICBMs, which are themselves difficult enough to monitor, we concluded that it would have been impossible to verify compliance with a warhead limitation regime. Therefore, we opted not to pursue a treaty requirement for warhead elimination in START and in the Joint Understanding.

Since the collapse of the Soviet Union, we have moved away from our adversarial relationship with Russia. Today we find ourselves in an environment characterized by an increasing degree of cooperation on mutual security concerns. Both of our countries share the common goal of ensuring the safe, secure storage and dismantlement of nuclear weapons in the former Soviet Union. The types of arrangements that are needed when you and a partner are working toward the same goal are quite different than those that are needed when there is an adversarial relationship and considerable suspicion. The best example of this new relationship between Russia and the United States is the ongoing efforts to assist the new states of the former Soviet Union with the safe, secure dismantlement of nuclear weapons using a portion of the \$400 million provided for that purpose under the Nunn-Lugar Act.

During the course of our discussions with Russian officials on the safe, secure dismantlement of nuclear weapons, the Russians have stated that they neither require nor desire U.S. help in the actual dismantlement of their nuclear weapons. Rather,

they have asked for our help with safe and secure transportation and storage of both the weapons and the fissile material from dismantled weapons.

While the progress has not always been as rapid as we would all like, we have been moving ahead in these areas. During the June Summit, we signed an umbrella agreement on assistance and three implementing agreements with Russia on providing: protective armor blankets; nuclear accident response equipment and training; and transportation and storage containers for fissile materials. Delivery of 250 Army nylon blankets was completed on July 14 to provide ballistic and fragmentation protection during weapons transport. An additional 250 soft armor blankets will be delivered to Russia by June 1993. We will be providing Russia by June 1993 with over 1,000 items of accident response equipment and clothing to improve their ability to respond in the event of an accident involving a nuclear weapon. Delivery of this equipment will begin in February 1993. Our assistance in this area will include training for Russian personnel and maintenance support. Further, we will produce 10,000 fissile material containers and deliver them to Russia over the next 3 years.

While discussions continue about modifying Russian railcars to provide safe secure transport of warheads to storage and elimination facilities, we have reached an understanding in principle on the functional requirements for a set of equipment that would be added to 100 Russian railcars to enhance their thermal insulation, fire detection, and intruder detection features as well as improvements to 15 associated guard cars. The Russians must provide additional technical information to allow our experts to complete the design of the system. Once the design is complete, the two sides will modify a small number of cars to complete systems integration and joint testing. Production of modification kits and their delivery to Russia would follow.

With regard to the question of inventory control of the fissile material from dismantled weapons, the administration will work to ensure effective material control and accounting procedures are in place. We will also ensure appropriate transparency measures will meet the provisions of the Nunn-Lugar legislation that requires U.S. oversight.

Another area of concern for us is the final disposition of the fissile material after the weapons have been dismantled. Dismantlement of nuclear weapons in the former Soviet Union will result in stockpiles of excess plutonium and highly enriched uranium. The United States and Russia have agreed on the need to protect the fissile material so as to prevent its diversion to another party, and are discussing the ultimate disposition of this material. Unlike plutonium, highly enriched uranium can be blended down through isotopic dilution with natural or depleted uranium to low enriched uranium containing approximately 3 percent U-235. This material is not directly usable in nuclear weapons and is the principal material used in fuel for nuclear power plants around the world. As such, the Russian highly enriched uranium represents a potentially large source of hard currency for Russia. The sale and use of low enriched uranium will be subject to existing non-proliferation controls and safeguards measures.

Plutonium, on the other hand, will remain a far more serious proliferation threat. However, research is currently being conducted on the feasibility to mix plutonium with natural uranium to produce power reactor fuel. For this reason, plutonium will need to be securely stored for many years until an acceptable means for its destruction or disposal are developed. As Secretary Claytor indicated in his testimony, we have not yet resolved the issue of disposing of our own excess plutonium.

The administration is also continuing to review possible arrangements for U.S. participation in the conversion of uranium. The U.S. and Russia agree that whatever arrangements are finally decided upon, we need to reach agreement on standards and criteria for physical protection of the material and on non-proliferation measures. We understand that the Russians have also discussed commercial agreements with foreign firms as well; we do not know the status of those discussions, but Russia has repeatedly reassured us of its commitment to non-proliferation.

We are continuing to review the Russian request for U.S. assistance in constructing a new facility for long-term storage of fissile material, both highly enriched uranium and plutonium, from dismantled nuclear weapons. We have identified four approaches to meeting their needs: modification of existing Russian storage facilities for nuclear weapons to accommodate the fissile material; use of existing deep underground facilities in Russia; use of a U.S. design for a storage facility that would meet their needs; and the Russians' proposal to build new underground storage facilities using their designs. We have not yet decided which of these four approaches to implement, however, in order to be ready to move quickly, we are presently en-

gaged in discussions with the Russian Federation on its design effort for a new storage facility.

The measures that I have described will help ensure that the warheads and the fissile material are firmly under Russian control and secure from terrorists or other unauthorized parties. They will also contribute to achieving our goal of increased transparency of the nuclear weapons and fissile material stockpile in Russia.

The administration is concerned about the condition sponsored by Senator Biden and approved by the Senate Foreign Relations Committee in its proposed resolution of ratification of the START Treaty. Nevertheless, the administration agrees with the premise that "the prospect of loss of control of nuclear weapons in the former Soviet Union could pose a serious threat to the United States and to international peace and security." As I have described, the United States is currently pursuing a number of measures that should help to reduce the risk of such a loss of control as part of our on-going discussions on safety, security, and dismantlement of nuclear weapons. While we—and, importantly, Russian officials—agree on the statement of the problem, we do not believe the Senate Foreign Relations Committee condition is the right solution. We have a number of specific concerns in this regard.

First, we do not want to delay codification, ratification, or implementation of the agreement on additional reductions in strategic offensive arms and the elimination of all MIRVed ICBMs recorded in the June 17 Washington Summit Joint Understanding. This understanding represents a significant accomplishment of great benefit to the United States. We believe that all substantive areas associated with the Joint Understanding have been resolved; the remaining task now is to turn the Joint Understanding into agreed treaty language.

Any interpretation of the Senate Foreign Relations Committee condition that would require adding new provisions to the de-MIRVing agreement, thus reopening its scope, or that links implementation of the new treaty to an agreement on fissile material production or warhead stockpiles risks at least a delay and possibly the unraveling of the important accomplishments of the Joint Understanding. Such an outcome would be particularly unfortunate since the agreement advances our non-proliferation objectives in important ways. Thus, we oppose any interpretation of this condition that would require the administration to seek agreement within the new treaty or that linked ratification or implementation of the new treaty to an additional agreement yet to be negotiated. We should not delay entry into force of an agreement that requires elimination of all MIRVed ICBMs by the year 2003, or possibly even by the year 2000.

Second, we are concerned that the Senate Foreign Relations Committee condition would require the United States to propose "reciprocal inspections . . . to monitor the number of nuclear stockpile weapons and the location and inventory of facilities . . . capable of producing or processing significant quantities of fissile materials." We are still reviewing whether such monitoring can be implemented in a fashion consistent with U.S. security interests and our statutory requirements under the 1954 Atomic Energy Act. However, there is no danger of diversion of nuclear materials in the United States, so there is no need for such reciprocity. I would like to stress again that there is no concern about the safety and protection of fissile material in the United States. Our experience in the SSD area suggests that the Russians would also be concerned about such intrusive inspections. This could therefore retard, rather than advance, our efforts to ensure effective controls over their materials.

Third, as I stated earlier, we need to take account of the new era in U.S.-Russian relations. In the area of safe, secure dismantlement of nuclear weapons, we have common objectives. We do not need to enter into protracted negotiations to seek highly intrusive and expensive verification regimes designed to deter and detect cheating, especially when such regimes are not likely to be effective. What we need—and what this administration is currently discussing with the Russian Government—are measures designed to increase transparency of the inventory of fissile material in the former Soviet Union and to ensure that all nuclear weapons and fissile material in Russia can be stored safely and securely.

In conclusion, this administration is deeply concerned about the safety, security, and dismantlement of nuclear weapons in the former Soviet Union. We are pursuing a number of measures that should help to reduce the risk of loss of control of nuclear weapons and fissile material, while at the same time increasing the transparency of the Russian inventory of such weapons and material. Russia and the United States are partners in this endeavor and share the same goals. Times have changed and in the area of nuclear weapons, we believe that the efforts that we are pursuing in the context of safe, secure, dismantlement of nuclear weapons in the former Soviet Union are sufficient to accomplish the goals that were expressed in

the Senate Foreign Relations Committee condition to the resolution on START ratification, without delaying or threatening the movement toward the elimination of all MIRVed ICBMs. We urge members of this committee and the full Senate to adopt an approach to this problem that enables us to address it in a reasonable and effective manner. Thank you.

Chairman NUNN. Thank you, Mr. Graham. I appreciate it very much.

Let me ask one question in departing; have you all decided whether you are for or against the Biden amendment? Maybe I missed that in your testimony. Did you say clearly, Mr. Claytor, which way you all are coming down—the administration?

Mr. CLAYTOR. Well, from a Department of Energy standpoint, the Biden amendment poses a real problem to us in reciprocal verification and the protection of our facilities. It makes it very costly, very complex, and, in my view, that would be a real difficulty from our standpoint.

Chairman NUNN. Mr. Gallucci?

Mr. GALLUCCI. Senator, I think in sum our judgment at this point, based substantially on advice we get on the difficulty of verification or implementation of the language, is that it would be extremely difficult to put in place what would be necessary to have in place to verify the requirements in the condition.

It is not at all clear to us that it is necessary, in light of the progress we have made with the Russians, the character of that progress, and, to the extent it would hold up, stall, or in any way jeopardize the understanding, the June Understanding, we think it would be extremely harmful to what is really the most extraordinary, or at least one of the most extraordinary arms control agreements in history.

Senator WARNER. Bottom line, you are not in favor of it?

Mr. GALLUCCI. I think that is a fair summary, Senator.

Chairman NUNN. Okay. Senator Warner, unfortunately I have to depart for a meeting that I cannot avoid. We have had good testimony, and the witnesses all have their total statements in the record; they did a good job of summarizing.

Mr. Graham learned over a period of time here that summaries are very valuable commodities, and he did a good job, and all the others did, too.

I am going to have to leave you all here. Senator Levin is supposed to return, but until then go ahead and ask your questions.

Senator WARNER [presiding]. I will ask questions, but Senator Wallop has been here the longest, so I will be glad to follow you.

Senator WALLOP. Thank you, Mr. Chairman.

Mr. Graham, you are a victim of the Stockholm Syndrome. You have now been captured by the arms controllers. [Laughter.]

Senator WARNER. He was trained well here.

Senator WALLOP. There was a time when he had a more historical view of arms control than is contained in this statement.

Senator WARNER. That is correct. [Laughter.]

Senator WALLOP. I am assuming that it was drafted for you by OMB or something. [Laughter.]

It just contains absolutely zero memory of history. Your statement here: "Second, the elimination of the means to deliver war-

heads is the most meaningful and verifiable way of reducing strategic nuclear forces." Gerard Smith wrote that for you.

Don't you recall around here, when we were questioning these things, the photograph of a Minuteman being fired from the back of a jeep on a little concrete pad?

Mr. GRAHAM. From the back of a jeep? I confess, Senator Wallop, I do not recall that photo.

Senator WALLOP. A jeep parked right beside a little concrete pad, poured just long enough to get hard, a jeep there, and there is a picture of a Minuteman already off the pad, launched.

So my complaint about this is that you have made that sort of puffery statement about arms control, and it is the political value of START and not its strategic value of which you speak.

The fact is that counting holes in the ground provides nothing in the way of security. I am quite willing to accept previous testimony that we have had earlier of the changed relationship. In fact, that sort of verifies my whole view of arms control in the first place, that when nations can trust each other about it they already do not need it. And I believe Dr. von Hippel's statement that if you changed regimes over there, you went back to a more hostile regime—I do not know why he insists on using the word "conservative" when it would be a purer form of communist—but basically he said that you could not count on either the agreements or the treaty in terms of verifiability.

So what this statement of yours says is undone by the later statements with which I agree. "The types of arrangements which are needed when you and a partner are working toward the same goal are quite different than those that are needed when there is an adversarial relationship and considerable suspicion."

But it is not a true statement historically or accurately in any way to say that the elimination of the means to deliver warheads is the most meaningful and verifiable way of reducing strategic nuclear forces.

Mr. GRAHAM. Senator Wallop, the notion that the most effective way to control strategic arms was by eliminating both launchers and missiles is the basis of the START agreement. Reductions in warheads result from the elimination of missiles.

Senator WALLOP. But it does not eliminate missiles—no requirement that they either stop being built or no requirement in fact that they be destroyed.

Mr. GRAHAM. To finish my thought, what we are talking about here is that the elimination of warheads per se is not the way to proceed. In our view, the best way of addressing the threat was to get at the missiles and the launchers themselves, things that are verifiable and through them to warhead reductions. For the latter, we have continuing rules and on-site inspections.

Senator WALLOP. I do not quarrel with that statement, but I quarrel with the thesis that it is the most effective means of reducing strategic nuclear forces. It is in fact not. I mean, this is the game of arms control, in fact, and that is to claim for it achievements that it cannot possibly fulfill.

The most honest thing you can say about the START agreement was that it was begun in an era when those kinds of negotiations had real significance, and concluded in an era when events have

already passed it by. My problem with all of this is that ultimately these agreements, should we go back to an era of greater confrontation, will be binding upon us in ways in which they will not be binding upon them.

It has been the history of arms control. We were bound and you cite in your testimony SALT I. You may recall, in your days back here, and I think Senator Warner will recall, that everybody, including Democrats, said that it was fatally flawed, and yet I think the Senator from Virginia would agree with me it was so fatally flawed that its ghost bound every decision we made, even under Ronald Reagan, who considered arms control and, in particular, ran a campaign——

Senator WARNER. That was when Mr. Graham was here.

Senator WALLOP. I know. So I guess all I am saying is that I really object to the characterization which is basically designed to make arms control sound effective, that this is the most effective means and verifiable way of reducing strategic forces, and once launchers are eliminated missiles and their warheads no longer pose the same threat.

They do. Counting holes in the ground is only one measure of confidence, and not a very good one at that. And the thing that gives the world a little confidence and America a little confidence is, frankly, the fact that the relationship between our two countries has changed.

I go back and say that I hope that we do not, through a Biden understanding or other kind of thing, put ourselves in the position where you place the Soviets on the other side and say for today you are our enemy, and all the progress that has been made with Nunn-Lugar and all the kinds of things that are going in the right direction are put on hold while we try to figure out a way to resolve problems between us that only exist because we have told them to sit on the other side of the table.

When the problems exist come back to exist, God forbid, that confronted us before, none of these things will be of a whole lot of help except that we will have developed relationships and understanding about what they possess that we did not have before.

But when powers feel it is in their best interest to confront other powers, the arrangements that are made between them are not really very valuable in terms of safety and security. So I do not mean to make your first return back here such a welcome event, but this, you will understand from memory, is not a new position for me with regard to arms control.

I am finished. I already asked Mr. Claytor when you were gone, John, about the statement in his paper on nuclear testing, because his paper says: "With respect to weapons safety enhancement, studies are under way by both DOD and DOE examining the desirability of making such enhancements. It should be noted that most of the weapons in the planned smaller stockpile do not have all the desired safety features."

I asked him, just in the name of safety, how many tests would be needed, and I will let him answer again, but he said typically five per system and five systems would probably be remaining. And you cannot predict that each of those tests will provide information that does not require some subsequent arrangement.



So what we have done by stopping at 15 is simply put on hold a lot of planned new safety, and in a sense make it beyond our reach. As much as Americans may not like nuclear testing, I am certain that they would like to have those nuclear systems that remain as safe as they possibly can be.

Senator WARNER. Then that will be our job when our bill goes to the floor.

Senator WALLOP. Well, I think Mr. Claytor gave us some very valuable testimony to be quoted when we get to that point.

Mr. GRAHAM. Mr. Chairman, might I have just one brief moment?

Senator WARNER. You take the time you need, Mr. Graham.

Mr. GRAHAM. I hope I am not digging my hole any deeper. The reference in my testimony was a historical reference to the fact that during the deliberations on START the administration decided that you could not try and reduce the unverifiable, which was warheads. What you ended up focusing on in START was missiles and launchers, and through them limit warheads. That is what we did in START.

Senator WALLOP. I understand that, and if you read Gerard Smith's book, he says what we did was tailor the agreement to national technical means of verification. And that is exactly what your statement says too. That is the easiest thing to verify, is the number of holes in the ground. But it does not, and it did not, provide what your second paragraph says is the means of, once launchers are eliminated, missiles and their warheads no longer pose the same threat.

That is simply not true. That is what Gerard Smith told us, and that is what the administration set out to do in this negotiation. But it is not an historically acceptable statement that you are relieved of peril once you stop counting holes in the ground.

Mr. GRAHAM. Those holes and missiles and their associated warheads. As to the point that in this new environment one is able to take a very different approach to those things, I would certainly agree with that, and this Administration has. We have been talking about the withdrawal from service and elimination of tactical nuclear systems.

Senator WALLOP. I understand that, which is why I quoted that. I mean, that is a far better path and a far more certain statement of where we might go to enhance our safety than literally—I mean, I believe, and I think you once believed, that SALT I did very little about even limiting the growth of, let alone the number of missiles because it counted holes in the ground.

Mr. GRAHAM. It also did not count warheads, which we did in START. But I take your point. I still feel that way about SALT I.

Senator WALLOP. Good. Thank you, Mr. Chairman.

Senator WARNER. Thank you, Mr. Wallop.

I want to return, Mr. Gallucci and Mr. Graham, to the Biden condition. This is where I personally have the greatest problems right now. Dr. Gallucci, I welcome you. This is our first opportunity to have you before us, is it not?

Mr. GALLUCCI. It is indeed, Senator.

Senator WARNER. Both you and your wife make a great contribution to national security and we are fortunate to have you in public service.

Mr. GALLUCCI. Thank you.

Senator WARNER. So I address this question to these two gentlemen. Is it the view of the administration that the Biden condition to START I would apply to the treaty to be negotiated pursuant to the June 17 Joint Understanding on further strategic arms reductions?

Mr. GALLUCCI. Senator, I am not a lawyer. Looking at the language, it would seem to me that it would. Indeed, it is the implications for that that most concern us.

Senator WARNER. Mr. Graham?

Mr. GRAHAM. I would agree with that.

Senator WARNER. If it were determined that the condition would apply to the next treaty, what is your view of the possible impact of the Biden condition on ultimately achieving such a treaty agreement which would incorporate not only the significant strategic arms reductions but also the warhead and fissile material controls required under the Biden condition?

Mr. GALLUCCI. Senator, the implications, I think, would depend precisely on what would be required in order to verify the requirements set down in the condition, and I need to defer to my colleagues as to what precisely would be required and whether you could balance off on the one hand the desire to protect weapons design information, which we are statutorily obligated to do, and on the other hand the desire to be intrusive enough in order to verify.

Looking at the preliminary analysis of that, it looks like that would be hard to do, and our concern is one would not want to err in either way, either by compromising restricted data about nuclear weapons or to agree to an arrangement that we really could not verify.

That leads us in the Department of State, when looking at that preliminary analysis, to think that if you try to negotiate an arrangement like that it would be difficult and it would get in the way of the one thing we have on our side, which is speed and movement down the road to getting the Joint Understanding turned into a treaty.

So at this point we are quite concerned.

Senator WARNER. Is the Secretary going to make any formal pronouncements on this issue?

Mr. GALLUCCI. Senator, I do not know the answer to that. Maybe someone else here does.

Senator WARNER. Your testimony is very helpful and that of others, but it seems to me at some point he should address it. Does anyone have that answer in the room?

Mr. GALLUCCI. Senator, I will certainly report that.

Senator WARNER. Would you? Thank you.

Mr. GRAHAM. Mr. Chairman, I think, as you recall from last week, Secretary Cheney told the Committee his views about that.

Senator WARNER. Oh, yes, no question about it. But I do believe that the Secretary of State should have the opportunity. I would

suggest that you may convey to him my sentiments on it—that I think it is important that he do so.

Mr. GRAHAM, did you have anything to add to that answer?

Mr. GRAHAM. I think it is our view that, with the sort of intrusive verification provisions that would be required if you were to create this requirement, it would significantly complicate finalizing the de-MIRVing agreement.

Senator WARNER. Would the Biden agreement have an impact on the timing of reaching that agreement?

Mr. GRAHAM. Certainly. It would be very complex to do so, no question about it. In our view, you could not effectively verify it, even with verification provisions that were so intrusive that it raises further security concerns.

Senator WARNER. Could I ask Dr. Birely to just take the end seat here at the table, please? I would like to direct a question to you.

Dr. Birely, in the context of assistance to the former Soviet Union under the Nunn-Lugar provisions, discussions are ongoing concerning the requirement for safety and security of stored Russian fissile material and nuclear warheads.

I have a concern that a significant amount of U.S. dollars may be used to build a new storage facility in Russia when current facilities are available, such as the deep underground shelters, which could be modified to serve as long-term storage facilities. In addition, modifying existing facilities would likewise be cheaper and could be achieved much quicker.

Give us a little situation report on the negotiations in this area of storage facilities. Where are we today?

Dr. BIRELY. Thank you, Senator Warner. For those who do not know me, I am Acting Assistant to the Secretary of Defense for Atomic Energy.

We have had continuing discussions with the Russians about both interim and long-term storage facilities, and let me start with the view of the intelligence community. In their judgment, there is adequate space in existing Russian military facilities to store all of the warheads that will be returned under existing reduction and arms control agreements.

We have been discussing the storage space issue as a linkage to the question of ultimate disposition—in other words, what is it that you want to store and how long; how do you do materials control and accountability. In other words, how does one give transparency to the storage problem. Then finally, what storage facilities, if any, are needed in the interim or long term.

Senator WARNER. Anyone else wish to comment on this? It is a subject of considerable interest here. [No response.]

Let me pose the following question, then. Director Gates, CIA, testified last month before the Senate Foreign Relations Committee concerning START, and he said: "If, for whatever reason, CIS arrangements for the control of strategic forces and cooperation among the states relative to START dissolve, the prospects for implementation as well as our ability to monitor detailed Treaty provisions would probably decline."

In light of this statement, it seems to me that a full understanding of the arrangements among the four republics for implementation of the treaty and control of strategic nuclear forces is neces-

sary before, underline "before," this committee can make an informed assessment of the military significance of the treaty.

Dr. Gallucci, would you like to comment on that, and any views that you might have, Mr. Graham?

Mr. GALLUCCI. Senator, I apologize. I think I might have missed the—

Senator WARNER. Well, I gave the quote, and the question is, it seems to me that a full understanding of the arrangements among the four republics for implementation of the treaty and control of strategic nuclear forces is necessary before this committee or the Senate can make an informed assessment of the military significance of the treaty.

Mr. GALLUCCI. Senator, I am going to begin an answer to that and then I am going to seek help.

My understanding is that there is an arrangement or an agreement among the four with respect to the disposition of the nuclear weapons on the territories of the four, and that it relates to the dismantlement of the nuclear weapons. Our understanding is that there have been no problems and that the monitoring of that agreement has been proceeding to the satisfaction of those involved.

Beyond that, I am not sure I have much to add.

Senator WARNER. Well, I guess it is just a question of the what-if. What if there is a dissolution of the CIS arrangement? In other words, if that was dissolved, where would we be?

Mr. GALLUCCI. Senator, let me try on this one, too, and then if others wish to correct or add, please do.

My understanding is one of the major advantages of the START Treaty and one of the reasons we are concerned that it be ratified is that we want to institutionalize the arrangements that we have in the protocol that would have Ukraine, Belarus and Kazakhstan adhere to the NPT. It would also, the treaty that is, institutionalize in structure the arrangements among the four, which might otherwise become, let us say, competitive in ways that the treaty would exclude, at least with respect to the disposition of the nuclear weapons on their territories.

So I see the treaty as important to stabilizing the relationships among particularly the states still having nuclear weapons, independent of the future of the CIS. But again if others would like to add to that.

Senator WARNER. Mr. Graham, do you have any views on that?

Mr. GRAHAM. Just a couple comments, Mr. Chairman. First of all, I think the committee is aware that there are ongoing discussions amongst the four states of the former Soviet Union on this subject. I am not familiar with the information that the committee has on it, but there is a fair amount of information the administration has that I am sure, if we have not, we would be happy to make available to you.

It is also important to note in that regard that the way we have proceeded with the START agreement, it is with each of the individual states. It is not with the CIS. So in our view the obligations of the treaty would remain legally binding on each of those parties, even if the CIS itself were somehow to dissolve.

We would be happy, if it would be useful to the Committee, to provide an update on our understanding of those discussions.

Senator WARNER. Let me shift to one more point and then we will conclude the hearing.

Yesterday the Senate adopted a provision which places strict unilateral limitations on U.S. nuclear testing, including a ban on testing after fiscal year 1996. Do any of you believe that these unilateral limitations, if enacted, would have any significant impact on the resumption of testing by Russia, France, or on the cessation of testing by China and the United Kingdom?

Mr. GALLUCCI. Senator, again I will start on this. I cannot say what the impact of that language in that legislation would have on the testing programs of any of the states that you mentioned. I am afraid I was anticipating your mentioning other states, since usually the rationale for such testing limitations is in terms of the proliferation of nuclear weapons. As you began your question I was forming my answer; unfortunately, I did not get the right question.

But with the answer all formed, Senator, I really do not believe that it would have much of an impact on the proliferation of nuclear weapons. But with respect to the states you mentioned I really cannot guess what the impact would be there.

Senator WARNER. Mr. Claytor?

Mr. CLAYTOR. Senator, it is very clear the United Kingdom is of course affected because their only means of testing is at our test site in Nevada. We have a bilateral arrangement with the United Kingdom and in our conversations with them I know that they feel this is a severe impact. Of course, they have not declared any moratorium at all.

With respect to the French, I know in their technical community there is strong support from a safety/reliability standpoint that this is very important, that any nation that has nuclear weapons feels the necessity to test to assure the safety and reliability of the stockpile.

Sometimes the political considerations have overridden that, but I believe that those nations with whom we deal would want to resume testing. My colleagues may want to comment on Russia.

Senator WARNER. Could you comment on China?

Mr. CLAYTOR. I do not think it would make any difference if we have a moratorium. I am sure the Chinese would not be affected one way or the other. That is my view.

Mr. GRAHAM. Mr. Chairman, I guess I would agree with Assistant Secretary Claytor. In our view, the reasons we test have nothing to do with the fact that the Russians are testing or the French are testing, and in our view the Russians and the French have very compelling reasons to be doing testing of their own. As long as they rely on nuclear weapons, it seems to me that we have an interest in those things being as safe and secure as possible.

Testing, we know, is critical to ensuring such safety. The nuclear weapons testing experts in both countries know that. So I do not know what sort of impact the passage of a moratorium on U.S. testing would have on their programs, but as long as those two countries rely on nuclear weapons it seems to us that the United States has an interest in their having as safe and secure a stockpile as possible.

Senator WARNER. Gentlemen, thank you very much. We appreciate your participation. It has been a very helpful contribution.

You have the floor. Dare I leave, or do I need to protect the other side of this?

Senator LEVIN [presiding]. You can safely leave, because all I am going to do is ask them about safety and reliability.

Senator WARNER. Those subjects which are of modest interest.

Senator LEVIN. Right.

On that subject, since you have gotten into the safety subject, has Russia proposed now that we resume testing, that both countries resume testing? You said that any nuclear weapons state feels that it should test. I am just wondering; does Russia now propose to resume testing?

Mr. CLAYTOR. Well, I can answer only this. I am aware that Russia has, that Mr. Yeltsin, has directed they prepare to resume testing. I know they are doing that.

Senator LEVIN. That is in the event we start, is it not?

Mr. CLAYTOR. No. I do not know that that is the case, sir.

Senator LEVIN. So they have said in any event, whether we stop or not, they are going to now restart testing. Is that what Russia has really said?

Mr. CLAYTOR. All I know is that they are prepared to restart.

Mr. GALLUCCI. Senator, if I might, my appreciation for this is that the Russians are in fact in a moratorium, and I believe their declaratory position is that the extent of their moratorium is related to what we do.

Senator LEVIN. I am curious to know about Mr. Claytor's statement that every nuclear weapons state wants to test their nuclear weapons, if in fact Russia has declared a moratorium and has said that they will not resume unless we do.

Mr. CLAYTOR. Let me respond to that. Our laboratory directors from our weapons laboratories have been in touch with their counterparts and have actually visited the former Soviet Union. I am suggesting to you, sir, that the technical community in Russia, from the information fed to me, feel it is very important to continue testing for safety and reliability of their stockpile.

That is the only view I have.

Senator LEVIN. You said Russia. Every state with nuclear weapons, I thought you said, wants to test. It is not every state; it is just the technicians in those states.

Mr. CLAYTOR. I am not privy to the position of the top leadership, but I am privy to the position of the scientists and engineers who are responsible for these weapons. And I know their views, sir.

Dr. BIRELY. Senator Levin, if I could, I am John Birely, Acting Assistant to the Secretary of Defense for Atomic Energy.

In a recent discussion that Mr. Graham and I had with a top-level official of the Russian defense establishment, we asked him, in conjunction with the Russian notification according to the Threshold Test Ban Treaty, of their further testing plans—and they have notified us of their intent to resume testing under that treaty—why the Russians were going to resume testing.

And he said, well, just read your own President's policy. So the top level policymakers in Russia, in addition to the technical

people, are also actively debating the resumption of testing, for the exact technical reasons that we have incorporated in our policy.

Senator LEVIN. Well, wait a minute. It may be that it is our policy to test that causes them to test, rather the reasons behind our policy to test.

Dr. BIRELY. In my view, that is not necessarily a bad thing.

Senator LEVIN. I am not saying it is a bad thing or good thing. I am just simply saying that it is not necessarily our reasoning which they support at the top level; it is the fact that we continue to test that has caused them now to say if you are going to continue to test, so are we.

Dr. BIRELY. We did not have that discussion. But an alternative point of view might be the same one that we have, namely for the foreseeable future, although we will have far fewer weapons systems and far fewer weapons, both sides will have a substantial stockpile. As long as we have that stockpile, improving and assuring its safety and reliability is the responsibility of both sides, and one could make an argument based on those concerns that it would be to our advantage to have them testing.

Senator LEVIN. Well, one can make the argument, and it was made presumably before we agreed to a Nonproliferation Treaty which committed us to a comprehensive test ban before the conference renewing that Treaty in 1990, when we made a commitment to a comprehensive test ban, before the Threshold Test Ban Treaty, which renewed a commitment to a comprehensive test ban. I presume all those arguments were made.

We still signed treaties committing ourselves to a comprehensive test ban. Now, what you are saying is, well, we suddenly decided—and, by the way, President Reagan renewed that commitment to negotiate a test ban to this Committee in exchange for our getting a certain concession from the House of Representatives at conference. And now you are saying that well, it is this Administration's position that it is in everybody's interest to have nuclear explosions.

That is what you are saying. It is in everybody's interest to do it. We are going to do it because we are a nuclear weapons state. And if other countries want to do it, fine. I say there is a tremendous price that we pay in terms of proliferation.

But that debate has been going on for a decade. That debate was resolved when we put our name on a treaty which committed us to negotiate a comprehensive test ban. That debate was resolved when we joined the statement in 1990 at the renewal conference of that Nonproliferation Treaty agreeing that we will seek to negotiate a comprehensive test ban because there is a relationship between our insisting on testing and the proliferation of nuclear weapons.

It was explicit in an agreement that we signed. So yes, sure, there is a reasonable argument that can be made that you want to test, and there is, I think, a more compelling argument that you want to end it because of the relationship to proliferation.

But my point here is that has been resolved. We made a commitment. You folks who want to test for safety reasons, thereby risking that every other country is going to test too, thereby risking

more proliferation, you have made that argument. Folks, you lost it. You have lost that argument. We signed a treaty.

Now the question is, are our treaty commitments worth something. That is the question. I know the scientific community in every country wants to continue to test; their jobs are at stake. I understand that. But, you know, when we sign our names to a treaty, it has got to be worth something. When we signed our name in 1990 to this renewal conference, it has got to be worth something.

So substantively I disagree with you, but that is not really the point. The point here is that we made a commitment. We made a commitment and you folks want to back away from that commitment to negotiate a comprehensive test ban. I will argue with you on the merits in terms of whether or not the improvements for safety, those marginal improvements, are outweighed by the proliferation which it is going to engender. I will be happy to debate those issues on the merits, and yes, there are some advantages in terms of the marginal improvement on safety and there are disadvantages on proliferation.

But again, we crossed that when we signed a treaty. The Senate ratified that treaty. We ratified another treaty committing ourselves. So when you say as long as we have nuclear weapons we should test, that flies right in the face of treaties which said we are going to negotiate a comprehensive test ban, even though we continue to have nuclear weapons.

You are trying to get a word in edgewise there.

Mr. GRAHAM. Senator Levin, if I could respond to that for a moment, I think we can disagree about whether or not U.S. testing has anything to do with driving the proliferation problem worldwide. In our view, it does not.

Senator LEVIN. But we signed a statement in 1990 saying it did.

Mr. GRAHAM. We signed a statement in 1990 in the context of the TTBT and other things committing ourselves to a CTB as a long-term goal.

Senator LEVIN. Excuse me. No, no. We signed a statement in 1990 at that 5-year conference which explicitly said there is a connection between proliferation and testing.

Mr. GRAHAM. As a matter of U.S. policy, and I do not have that statement you are referring to in front of me, we have always been clear, at least as long as I have been involved in this business, that we are committed to a CTB as a long-term objective and that it was in the context of a time when we were no longer relying on nuclear weapons for deterrence.

Those conditions have not yet been realized and, hence, in our view it is not appropriate to move towards a CTB.

Senator LEVIN. Well, we are trying to get the statement that we signed. I quoted it on the floor of the Senate the other day, and it was a statement that we participated in in the 5-year review conference.

So I do not have it handy here because I did not know this subject was coming up this afternoon until Senator Warner raised it. Mr. Clayton.

Mr. CLAYTOR. Senator, I would like to take exception to your statement that this is a jobs issue for our people.



Senator LEVIN. Well, it is partly a jobs issue.

Mr. CLAYTOR. It is true that it is hard to keep top-notch scientists and engineers in our laboratories if we cannot test the products that they design. That is a fact. That is not the driver.

There is serious concern that we have a very small stockpile that we are headed toward today. Safety problems do arise, and I am not talking simply about making these changes of the insensitive high explosive and fire-resistant pits and so on. I am not talking only about that.

Things occur in the stockpile, and they have. As a matter of fact, in 1988, we discovered a weapon which we thought in every respect from our calculations and other non-nuclear tests would work fine, and it was similar to a previous test. We tested the weapon. We expected a yield of some 100 pounds. It was a yield of ten tons, 200 times that. We had to fix the weapon. We had to change it out and we had to conduct a series of tests.

It is important, as long as we have the deterrent, to have this capability to make sure it is safe and it is reliable. I think that is the driving force, not jobs. I would like to leave that, sir, on the record.

Senator LEVIN. Well, I think that that is true. I think our present inventory is safe. We have been assured over and over and over again that it is safe. And now, all of a sudden, when we come down to—

Mr. CLAYTOR. Senator. may I respond to that?

Senator LEVIN. Let me just finish that thought. All of a sudden now, when we are approaching the possibility of reducing the threat of proliferation through a comprehensive test ban, now all of the possibilities of disaster are placed in front of our face.

We never heard that until now, never. We never saw all these graphs, these graphic pictures of what might happen.

Mr. CLAYTOR. I realize, Senator, it has been dramatized, but these plans to upgrade the safety of the stockpile have been going on for some time. And by the end of this century, even without tests for this particular feature, all the weapons will have Enhanced Nuclear Detonation Safety (ENDS) because we are retiring those weapons that do not.

So we have had a program for many, many years and planned tests to do that. The major areas that we have—we have five systems in the stockpile that we will have by the end of the century that will not have all of these features.

Senator LEVIN. Which features?

Mr. CLAYTOR. The features of insensitive high explosives and fire-resistant pits.

Senator LEVIN. How many tests will it take?

Mr. CLAYTOR. I was asked that by Senator Wallop, and I gave the following answer. There are five systems. In our judgment, on the average, when we make a correction to the system such as this, maybe about five tests. So there would be roughly 25.

Now, when you run these tests surprises do occur. This is still a very inexact science. And you may end up with more tests. To try to constrain in 3½ years, from July 1, 1993, to September 30, 1996, 15 tests to do the safety features we are talking about is really insufficient if we are going to make those changes.

Senator LEVIN. Just so long as we have your testimony clearly. What you are saying is that to complete the safety testing on those two features, the explosives and the pits, that it is going to take 25 more tests.

Mr. CLAYTOR. Well, it could take that many, yes, sir. It might take more than that.

Senator LEVIN. But your best estimate is 25 tests.

Mr. CLAYTOR. I do not want to be too precise.

Senator LEVIN. Because others have estimated three to five tests for each of those, about 6 to 10 tests to complete the safety testing just on the pits and on the explosives. You are saying they are wrong. That is what it comes down to.

Mr. CLAYTOR. From my information—and I am not a technical expert, but I deal with our laboratories—three to five tests has been estimated. I think five is a better number from experience. And if we have five systems, then that is the way you get 25 tests.

Senator LEVIN. All right.

Mr. CLAYTOR. So I think that is a more precise and accurate number. You could not get them all done, typically. I would add one other thing. After a weapon is deployed, a modified weapon is deployed, we typically about a year later, after it has been in service, test it to verify that everything is working all right.

So there are a number of years involved if we are to make these safety corrections well beyond September 30, 1996.

Senator LEVIN. Has it been decided to add all these safety features to all five systems?

Mr. CLAYTOR. No, sir, it has not been decided.

Senator LEVIN. When will that decision be made?

Mr. CLAYTOR. Well, it will be made over the course of the next many months, probably over a year. We have studies under way—and you recall the Drell panel that recommended that we examine these weapons for this purpose, and we are doing that.

But, Senator, let me repeat one thing I said, that there are, aside from these features I just mentioned, there is the possibility of an unpredictable problem, both a reliability problem and a safety problem. And indeed they have occurred.

We believe the weapons are safe, but we do discover from our technology development things happen that we did not understand. We have had a reliability problem on a weapon that occurred about three years ago that we did not expect.

Senator LEVIN. I have seen that whole litany of all the problems that we now have or we are now afraid of. All I can tell you is it is a new list that we are getting here publicly, and I think the effort is to justify something which previously has not been urged, that somehow or other our inventory is not safe. I think that that is not true; our inventory is safe.

Mr. CLAYTOR. I respectfully disagree with you, sir.

Senator LEVIN. You think it is unsafe?

Mr. CLAYTOR. No, no. I respectfully disagree that we have just now come forth with this information. Ever since I have been in this job for the last two years, this has been a major issue and a major problem that we have addressed before the Congress.

We believe that the stockpile we have is safe, but as we learn more, the enhancement of that safety we owe to this country and to the American people, and we are looking very seriously at that.

Senator LEVIN. Do we owe nonproliferation to the American people?

Mr. CLAYTOR. Absolutely, Senator.

Senator LEVIN. I will read you what we agreed to about the connection because you asked me before about the connection. Let me give it to you.

This is what the final document of the last review conference said in 1990: "The conference noted that no multilateral negotiations had taken place between 1985 and 1990 toward the achievement of an agreement banning all testing explosions of nuclear weapons for all time." By the way, that is the commitment that we made in the Nonproliferation Treaty, that we would seek to achieve the discontinuance of all test explosions of nuclear weapons for all time, and continue negotiations to this end.

That is the treaty, a sacred document, some people think. In any event, sacred or otherwise, it is something we agreed to. And here is what we agreed to in 1990. "Mindful that the extension of the treaty will be considered in five years, the conference expressed its belief that a comprehensive test ban treaty would significantly enhance the universality and durability of the Nonproliferation Treaty beyond 1995. The conference reaffirmed"—that is us; we are a conferee—"The conference reaffirmed that a comprehensive test ban treaty adhered to by all states would make the single most important contribution toward strengthening and extending international barriers against the proliferation of nuclear weapons."

The United States agreed to that. You apparently do not agree with it.

Mr. GRAHAM. I think part of the answer to that, Senator, is that we have some experience in the past five years in the case of Iraq where they did not test a nuclear weapon and yet they were very close to having a nuclear weapons capability.

Senator LEVIN. So we no longer subscribe to that statement?

Mr. GRAHAM. I am not suggesting that that is the case.

Senator LEVIN. Well, do we subscribe to it?

Mr. GRAHAM. U.S. policy, as I said, over the ten years that I have been involved in it, has been quite clear about our commitment to a CTB. We are committed to a CTB. It is a long-term objective and there are a number of conditions that have to be satisfied.

Senator LEVIN. Let me ask the direct question. Do we subscribe to this statement that a comprehensive test ban treaty adhered to by all states would make the single most important contribution toward strengthening and extending international barriers against the proliferation of nuclear weapons? Do we still subscribe to that?

Mr. GRAHAM. I cannot answer that question out of context.

Senator LEVIN. Okay. And then the last statement that we agreed to in 1990 was that "the conference once again emphasizes the critical importance of a comprehensive nuclear test ban and calls for early action toward that objective." You are saying it is a long-range objective. Two years ago, we said, the United States said, under this President, that we emphasize—we were a confer-

ee—the critical importance of a comprehensive nuclear test ban and call for early action toward that objective.

Now, let me tell you, if we have changed our policy in the last two years, I think the world ought to know it, France ought to know it, because they are going to start testing again if we do. If we continue our testing, France says they are going to continue. Russia says they are going to start doing it. And that means, hey, Katie, bar the door because a whole lot of other countries are going to test as well.

And we are not in a very good position to maintain the nonproliferation argument that the administration says it is interested in but acts otherwise.

Let me get to the subject of today's meeting very briefly and then we will let you folks go. Has the administration responded to the Russian Foreign Minister's proposal of February 12, 1992, for an exchange of data between nuclear weapons powers on inventories of nuclear weapons and fissile materials and on nuclear weapons production, storage and elimination facilities?

I think this goes to Mr. Gallucci.

Mr. GALLUCCI. Senator, I heard that question when it was asked earlier, and I still do not know of that offer, and I will have to take that and take it for the record, unless someone here knows that answer.

Mr. GRAHAM. I saw the excerpt in Professor von Hippel's testimony. I do not know in Secretary Baker's discussions with Foreign Minister Kozyrev that that proposal has been made to us officially. But we will have to check on that.

Senator LEVIN. It was an official statement of the Russian Foreign Minister on behalf of President Yeltsin at the plenary meeting of the Conference on Disarmament. This was an official statement that he was reading on behalf of the President. It is amazing to me that nobody here can tell me what our response has been. This was February 12.

Mr. GRAHAM. I do not know if he has even raised it with us in our bilateral meetings.

Senator LEVIN. We were at this meeting.

Mr. GRAHAM. Correct.

Senator LEVIN. You say you are not sure if he has raised it.

Mr. GRAHAM. In our meetings that we have had together with him, I do not know that he has said that this was a serious issue from their perspective and they were interested in pursuing it.

Senator LEVIN. Well, it is a serious issue. A Foreign Minister is reading a President's statement. I think we ought to take it seriously. There was something said earlier here today about treating the Russian government with appropriate attitude, and clearly if this was made at a plenary session we should not be acting as though it was not made.

But maybe we have, so you are going to get us that answer. In other words, you are saying maybe we have responded, so I do not want to assume we have not, even though I am surprised that none of you know whether we have. Just let us know for the record. I guess that is all we can do.

Mr. GALLUCCI. Senator, I am sorry to amaze you with ignorance, but I do not know of that statement and, as I said, we will respond for the record.

[The information follows:]

In his February 12, 1992 speech to the Conference on Disarmament, Russian Foreign Minister Kozyrev stated "... we may consider developing a reciprocal exchange of data between all nuclear powers on the number and types of existing nuclear weapons, the amount of fissionable materials and on nuclear weapons production, storage and elimination facilities. Agreement to this effect could be reached at the Conference on Disarmament, where all the nuclear powers are represented, as it has experience in dealing with similar issues in the context of CW negotiations." Foreign Minister Kozyrev did not raise this proposal during his February 16-18 discussions with Secretary Baker in Moscow. Nor have Russian officials raised the issue with us since that time, or formally tabled this proposal in the Conference on Disarmament. Consequently, the administration has not provided a response to Kozyrev's proposal.

Senator LEVIN. I think, Mr. Graham, this is your question. Would we be better off knowing the total inventory of the Independent States' nuclear warheads? Is that to our advantage, to know what is in their inventory precisely?

Mr. GRAHAM. It would certainly be useful information to know what was in their inventory.

Senator LEVIN. Would it be worth it to gain this knowledge, even if it meant giving them the same data on a reciprocal basis?

Mr. GRAHAM. I guess the underlying question is, it seems to me, what confidence would we have in the information that was provided to us. Could you verify that that number was accurate? Our experience in that case, as has been discussed on both panels today, is that unilateral declarations about numbers of weapons are something that provide a useful data point, but it is very difficult, and in this case impossible, to verify the information.

So it could serve as a useful confidence-building measure. We just should not overstate the utility of it.

Senator LEVIN. Has that data been provided to us?

Mr. GRAHAM. To us?

Senator LEVIN. Yes.

Mr. GRAHAM. I do not believe so.

Senator LEVIN. Are we willing to provide that data to them on a reciprocal basis since it would engender confidence?

Mr. GRAHAM. One of the questions we would have to address is whether or not you are getting into revealing classified information by providing the sort of specifics that you might be talking about. Let me answer that question for the record, if I could, Senator.

Senator LEVIN. As to whether we would be willing to do that?

Mr. GRAHAM. Right, whether it would involve revealing classified information.

Senator LEVIN. No, no. Whether we would be willing to swap that information.

Mr. GRAHAM. Okay. And our judgment on that would depend in part on whether it involved revealing classified information.

Senator LEVIN. But you do not know what the position is or whether—you do not know what the position is, or we have not decided that? How would you describe the status of that resolution? We have not resolved that issue?

Mr. GRAHAM. I do not know that we have taken a position on the subject.

Senator LEVIN. Okay.

Do we think we know accurately the inventory of CIS highly-enriched uranium and plutonium that is available for nuclear weapons? I think, Mr. Claytor, that may be yours, but anybody can answer.

Mr. CLAYTOR. I do not track that.

Mr. GRAHAM. I think members of the committee, a number of members were involved in the combined hearing with the Senate Select Committee on Intelligence in which intelligence community witnesses addressed some of those issues.

I understand that they have promised to get more detailed information back to the committee and, frankly, I would just as soon defer to them, if that is okay.

Senator LEVIN. Thank you very much. We will stand adjourned. We appreciate your being here today.

We do not quite stand adjourned yet. You are all excused, but we have some technical committee matters.

The record will be held open for members to submit questions for the record to the executive branch witnesses.

And then, without objection, I would ask that several reports and policy statements related to these topics at hand today be printed in the record of the hearing, including a Policy Brief by the Natural Resources Defense Council; on the Biden condition on START Ratification; an article by Spurgeon Keeney and Wolfgang Panofsky on the control of nuclear warheads and materials that was published in "Arms Control Today"; and the unclassified cover letter from President Bush and unclassified executive summary from the July 1991 report on verification of nuclear warhead dismantlement by the Federal Advisory Committee headed by Ambassador Paul Robinson.

[The information follows:]

# NRDC NUCLEAR POLICY BRIEF

## The "Biden Condition" on START Ratification: Monitoring of Nuclear Warheads and Fissile Materials

(July 16, 1992)

For more information, contact:  
Christopher Paine - (202) 624-9350;  
Thomas Cochran - 624-9329

On July 2 1992, the Senate Committee on Foreign Relations adopted a condition, proposed by Senator Biden, to the resolution of ratification for START. It directs the President to seek an appropriate arrangement, "in connection with any further agreement reducing strategic arms," that would permit monitoring of nuclear stockpile weapons and fissile material production facilities, through the use of reciprocal inspections, data exchanges, and other cooperative measures (text of Biden condition is attached at the end of this brief). The committee apparently does not intend that such arrangements must be incorporated in the expected deMIRVing treaty codifying the results of the June 1992 Bush-Yeltsin summit. However, in connection with the submission of such a treaty to the Senate, the committee apparently expects the President to be in a position to certify that such a verification arrangement, however accomplished, will be in place at the time the new treaty enters into force.

A number of important considerations led the committee to take this step. While the former Soviet Union announced in 1989 that it had ceased production of highly-enriched uranium for weapons, the Russian Ministry of Atomic Energy has continued to produce plutonium for both military and civil purposes. The United States, on the other hand, has not produced highly-enriched uranium for weapons since 1964, or plutonium for weapons since 1988, and has announced that it will not produce either material for weapons purposes for the foreseeable future.

The United States does not use separated plutonium as a fuel in its civil nuclear power program, and maintains a policy of discouraging other nations from doing so in the interest of limiting the spread of nuclear weapons production capability.

Beginning in 1989, the USSR and then Russia sought negotiations with the United States to ban the production of fissile material for weapons. These overtures have been rebuffed or ignored by the Executive Branch. However, in testimony before the Committee on June 23, 1992, Secretary of State Baker noted that "we haven't produced any [fissile material] for a long time" and that "right now, we have all we need." Despite the vast surpluses of weapons-usable material generated by deep reductions in nuclear stockpiles, Secretary Baker also testified, "if we are going to maintain a nuclear deterrent, and have to have some fissile material, then we would have to have the right to produce it." This position is without merit. Given that the radioactive "half-life" of the existing U.S. fissile material inventory is measured in tens of thousands of years, Secretary Baker's statement implies that the Executive Branch is seeking to reserve "the right" to revert to a potential nuclear force even larger than average U.S. stockpile of 20,000 - 30,000 weapons maintained throughout most of the Cold War. The implication is technically unjustified, and politically unsustainable in light of the overriding U.S. objectives of ensuring stable long-term deep reductions in nuclear arsenals and a halt to the proliferation of fissile material production capabilities.

While supporting prompt conclusion of a deMIRVING treaty, the committee majority was less than sympathetic to the Administration's argument that the desired verification arrangements would unduly burden the next round of negotiations. Through numerous resolutions, amendments, and reporting requirements, the Executive Branch has long been apprised of congressional views favoring inclusion of controls on nuclear weapon disposition and fissile material production facilities in agreements beyond START. The government of the former Soviet Union under President Gorbachev likewise suggested the inclusion of such controls in INF and START, but was encouraged to drop the issue by the Reagan-Bush administrations.

Today, the case for such controls is even more compelling. They would reduce significantly the uncertainties which now surround the disposition of nuclear weapons material in



the new nations formed from the former Soviet Union, and they would provide a firm political basis for reaching agreement on strengthened proliferation controls at the 1995 conference to extend the Nuclear Nonproliferation Treaty (NPT). Over the last decade, the Congress has appropriated hundreds of millions of dollars for the development of improved verification techniques, precisely so that the Executive Branch would be prepared to implement enhanced verification arrangements whenever such controls were judged to be both technically essential and politically feasible. That time has arrived, and many in Congress expect the Executive to swiftly demonstrate to the American people that they have received full value for their large investment in improved verification techniques.

Russian officials estimate that as much as 60 metric tons of plutonium and 300-500 tons of highly-enriched uranium will be released from weapons before the year 2000. As Ambassador Robert Gallucci, the State Department's Senior Coordinator for nuclear nonproliferation assistance to the CIS, recently observed, "If this situation doesn't get fixed, in the long term it will be an area in which we will have real worries about materials disappearing."<sup>1</sup> We differ with Ambassador Gallucci in only one respect -- there is every reason to be concerned about the short-term problem of nuclear material diversion as well. The Executive Branch should therefore place a high priority on the prompt achievement of the monitoring objectives set forth in the Committee's resolution.

A global ban on the production and acquisition of nuclear weapons material, if verified and enforced by an international sanctions regime, would effectively bar further proliferation of nuclear weapons, and would provide the basis for a strengthened international inspection system assuring permanent deep reductions in nuclear weapons stockpiles. The Committee notes that on May 29, 1991, the President called on the nations of the Middle East to "implement a verifiable ban on the production and acquisition of weapons-usable nuclear material" and "place all nuclear facilities in the region under International Atomic Energy Agency safeguards."<sup>2</sup>

---

<sup>1</sup> Quoted in William Broad, "Nuclear Accords Bring New Fears on Arms Disposal," *New York Times*, July 6, 1992, p. A1.

<sup>2</sup> *White House Fact Sheet on the Middle East Arms Control Initiative*, May 29, 1991.

Agreement between the United States and the appropriate states of the CIS on the desired verification arrangements would lend momentum and credibility to the President's important -- but neglected -- initiative. The extensive on-site inspection measures needed to verify a production ban would guard against a recurrence anywhere in the Middle East of secret programs to produce weapons usable nuclear materials like that mounted -- with foreign assistance -- by Iraqi dictator Saddam Hussein.

On February 12, 1992, Russian Foreign Minister Russia Andrei Kozyrev formally proposed a reciprocal exchange of data between all nuclear weapon powers on inventories of nuclear weapons and fissile materials, and on nuclear weapons production, storage, and elimination facilities. The Executive Branch failed to respond positively to this Russian initiative at the time, and to our knowledge, has still not responded in a positive manner to this constructive proposal.

In light of the above considerations, the Senate Foreign Relations Committee condition requiring nuclear warhead and fissile material monitoring is reasonable, desirable, and achievable. The Executive Branch should seriously examine the following measures for inclusion in supplemental monitoring arrangements that meet the verification objectives of the Committee's resolution:

- a data exchange, including the total number of warheads of each type, and the total masses of plutonium and highly-enriched uranium metal within and outside of nuclear weapons;
- an exchange of serial numbers and storage locations of warheads and bombs, which could be updated at six- or twelve-month intervals;
- application by the owning party of tamper-resistant, laser-readable bar-codes and/or "intrinsic fingerprint" tags on all nuclear weapons (or on their containers sealed with tamper-indicating locks), accompanied by immediate provision of these data to the verifying party at the inspection site;

- random on-site inspection of weapon storage sites to verify the disposition of warheads as set forth in the periodic exchanges of data; identification of all nuclear weapons or sealed weapon canisters entering a dismantlement facility or leaving a production facility by matching the serial number to a unique barcode and/or "fingerprint" tag;
  
- international safeguards over fissile material permanently removed from weapons use, civil stocks, and plants capable of producing such material.

We further recommend that the following, or similar types of data be considered for annual or semiannual exchanges between the Parties to any further agreement reducing strategic arms:

(1) the numbers of CIS/Russian and U.S. nuclear stockpile weapons added, retired, dismantled, and remaining in service (if any) in each of the following categories:

- (i) total stockpiles;
- (ii) strategic ballistic missile warheads;
- (iii) strategic bomber weapons;
- (iv) nonstrategic ground-to-ground weapons;
- (v) nonstrategic land-based air-delivered weapons;
- (vi) surface-to-air weapons;
- (vii) nonstrategic naval weapons.

(2) the current status, fissile material inventories, and output of all known CIS/Russian and U.S. facilities with the capacity for producing or processing significant quantities of fissile materials.

(3) the total masses of all CIS/Russian and U.S. plutonium and highly-enriched uranium contained:

- (i) in nuclear weapons;
- (ii) in other inventories not covered by an internationally verified commitment to peaceful use.

- (4) the total masses of CIS/Russian and U.S. plutonium and highly-enriched uranium:
- (i) in weapons on strategic nuclear delivery vehicles;
  - (ii) in all other nuclear stockpile weapons;
  - (iv) in stored weapons committed for dismantlement;
  - (v) in stored components of previously dismantled weapons;
  - (vi) removed from dismantled weapons and irrevocably committed to non-weapons use;
  - (vii) in naval fuel cycles;
  - (viii) in civil program stocks.

In developing the verification arrangements required by the Biden condition, we recommend that the Executive Branch seek to engage nuclear weapon experts of the former Soviet Union in the joint development and implementation of:

- (1) reliable techniques and arrangements for verifying a global ban on the production of fissile materials for weapons purposes;
- (2) reliable techniques and procedures for permanently transferring agreed quantities of fissile materials out of the nuclear weapons production cycle, and for safeguarding the secure storage of these materials pending future nonweapon uses or permanent disposal;
- (3) techniques to permanently dispose of nuclear weapons components and materials in a verifiable and safe manner so as to prevent recovery for use in weapons;
- (4) increased technical assistance to the IAEA to aid in the accomplishment of its global safeguards and inspection responsibilities.

To assure that there will be no undue delays in the ratification of further arms reduction agreements, the Executive Branch should engage cooperatively with the Senate in a process of advance consultation, as negotiations proceed on warhead and fissile material monitoring arrangements.

**BIDEN CONDITION TO THE RESOLUTION OF RATIFICATION  
FOR START ADOPTED BY THE SENATE COMMITTEE ON  
FOREIGN RELATIONS -- JULY 2, 1992.**

"(8) Inasmuch as the prospect of a loss of control of nuclear weapons or fissile material in the former Soviet Union could pose a serious threat to the United States and to international peace and security, in connection with<sup>1</sup> any further agreement reducing strategic offensive arms<sup>2</sup>, the President shall seek an appropriate arrangement, including the use of reciprocal inspections, data exchanges, and other cooperative measures, to monitor --

(A) the numbers of nuclear stockpile weapons on the territory of the parties to this Treaty; and

(B) the location and inventory<sup>3</sup> of facilities on the territory of the parties to this treaty capable of producing or processing significant quantities of fissile materials."

---

<sup>1</sup> According to Committee staff, this phrase means that the supplemental monitoring measures need not be part of the text of a deMiring (START II) agreement; the additional verification arrangements could be included in a separate protocol or executive agreement that would enter into force in conjunction with a deMiring treaty.

<sup>2</sup> i.e. any agreement beyond START I.

<sup>3</sup> i.e. the fissile material inventory.

# Arms Control Today

January/February 1992

\$5.00

## Nuclear Weapons In the Former Soviet Union

Warhead Control Regimes

Spurgeon M. Keeny, Jr.  
Wolfgang K.H. Pamofsky

Steps to Reduce the Dangers

Ashton B. Carter

Verifying Dismantlement

Christopher Paine  
Thomas B. Cochran

Post-Soviet Nuclear Control

Richard L. Garwin

The Nuclear Archipelago

Robert S. Norris

Proliferation Risks

William C. Potter

————— *Special Feature: Map of Soviet Nuclear Sites* —————

**ACA**

A Publication of the Arms Control Association

## Controlling Nuclear Warheads and Materials: Steps Toward a Comprehensive Regime

*Spurgeon M. Keeny, Jr. and Wolfgang K.H. Panofsky*

**T**he abrupt collapse of the Soviet Union has focused world attention on the future status of some 25,000 to 30,000 Soviet nuclear warheads. The possibility that command and control might be lost over even a portion of this immense nuclear arsenal has raised the specter not only of thousands of nuclear warheads proliferating to unstable new states, but also of "loose nukes" falling into the hands of irresponsible groups or even becoming items of clandestine commerce with nuclear aspirants in the developing world. This new situation has dramatically underscored the importance of actually destroying the vast excess of nuclear warheads as part of the arms control process.

Until the Soviet Union went into free fall after the defeat of the August coup, most arms control thinking had focused on limiting and destroying the launchers or delivery vehicles for nuclear warheads. Without their associated delivery systems, nuclear warheads were not seen to pose as immediate a military threat, and they were viewed as being much more difficult to monitor than their associated delivery vehicles. The Intermediate-range Nuclear Forces (INF) Treaty, which required the destruction of the entire class of U.S. and Soviet intermediate-range missiles, did not require the destruction of any of the associated nuclear warheads. Even the Strategic Arms Reduction Treaty (START), which is formulated in terms of limits on warheads, places no obligation on the parties to destroy warheads made excess by the elimination of their associated delivery

---

*"The control and elimination of nuclear warheads has emerged not only as a critical barrier to nuclear proliferation, but also as a necessary component of efforts toward deep worldwide nuclear reductions."*

---

vehicles or launchers. Although these warheads could be used either to arm other delivery systems or to serve as a convenient "mine" of fissionable material for new warheads, these additional warheads and materials were not considered to have great military significance, given the superabundance of nuclear warheads in the arsenals of the two superpowers. Now, with the withering away of the Soviet threat and the potential loss of central control over the vast Soviet stockpile of nuclear warheads, the future of those warheads has become a central security issue. **The control and elimination of these warheads has emerged not only as a critical barrier to nuclear proliferation, but also as a necessary component of efforts toward deep worldwide nuclear reductions—an objective which suddenly appears within reach.**

### The Need for Control

The new situation, combined with the long-standing need to limit and reduce

nuclear arsenals, has created three quite distinct nuclear control issues. First, there is the time-urgent problem of preventing any part of the enormous nuclear arsenal of the former Soviet Union from adding a new dimension to the threat of nuclear proliferation. Second, there is the unique opportunity to ensure the destruction of thousands of warheads that might otherwise be the source of future proliferation, or provide a basis for "breakout" from agreements on deep reductions in strategic and tactical nuclear arsenals. Third, there is the possibility of verifiably reducing, to as low a level and as irreversibly as possible, the total number of nuclear warheads in the arsenals of each of the nuclear weapon states.

The United States and both the fading Soviet Union and the new Russian state properly focused their attention on the immediate problem of ensuring the security of nuclear weapons during the difficult transition to the still vaguely defined post-Soviet world. A solution to this problem will not require any formal international agreement, since it is dependent on unilateral actions by Russia and understandings between it and the other former republics in the new Commonwealth of Independent States. Although a satisfactory long-term resolution cannot yet be guaranteed, at this writing Russia and the Commonwealth, with active prodding from the United States, appear to be moving expeditiously toward a satisfactory solution of the first problem.

Accomplishing the second objective, verifiably destroying warheads, will take considerably more time, and will require bilateral agreements to establish procedures to corfirm that designated warheads have in fact been destroyed. This process would ensure that the warheads could not proliferate if control is lost in the future, and would prevent redeployment of the designated warheads by a possible successor regime. Successful implementation of such

---

*Spurgeon M. Keeny, Jr., former deputy director of the U.S. Arms Control and Disarmament Agency, is president and executive director of the Arms Control Association. Wolfgang K.H. Panofsky is director emeritus of the Stanford Linear Accelerator Center and chairman of the National Academy of Sciences' Committee for International Security and Arms Control.*

a regime would not, however, constrain Russia from making new weapons from existing or newly produced stocks of fissionable material.

The third, much more ambitious objective would establish a comprehensive regime to control the total stockpiles of nuclear warheads, initially of the United States and Russia and then of each nuclear-weapon state. This would permit radical reductions in the nuclear arsenals of all nuclear-weapon states, with confidence that another state would not be able to retain or secretly produce militarily significant numbers of illegal warheads. Verifiable constraints would have to be placed on the manufacture of new warheads from existing stocks, or from newly produced fissionable material. Such a regime is technically possible, since all nuclear warheads require highly enriched uranium or plutonium, both of which can only be produced in highly specialized plants whose operation and product flow can be monitored. The problem is complicated, however, by the fact that once produced, the two fissionable materials for all practical purposes last forever, and considerable uncertainty exists as to how much of each was produced in the former Soviet Union's highly secret program over the past 45 years. Despite this fundamental difficulty, this regime can be safely ap-

proached incrementally, contributing to U.S. security at each step while presenting little danger. Successful implementation of such a regime would have far-reaching significance for world security, long after the current crisis over the security of the Soviet nuclear stockpile has become only an alarming footnote to a turbulent chapter in history.

#### Control in the Post-Soviet World

A brief review of the response to the current nuclear control crisis in the post-Soviet Commonwealth underscores the difference between this immediate problem and the larger problem of developing a regime to control nuclear warheads. When it became apparent after the failed August coup that the Soviet Union's ability to control its huge and widely dispersed nuclear arsenal could no longer be taken for granted, President Bush took the imaginative and courageous initiative of announcing on September 27 that the United States would unilaterally destroy all land-based tactical nuclear warheads, after withdrawing those currently deployed overseas; he also announced that all sea-based tactical warheads would be returned to the United States, where some would be destroyed. This action provided then-Soviet President

Mikhail Gorbachev with the needed rationale to announce a week later that the Soviet Union would also unilaterally destroy all land-based tactical nuclear warheads. Gorbachev also proposed to destroy sea-based tactical nuclear warheads and to move air-delivered tactical warheads to central storage. President Bush's initiative, which dramatically broke with past U.S. insistence on effective verification of all nuclear arms reductions, received almost unanimous approval here and abroad.

With the creation of the Commonwealth, US policy has focused on establishing the legal framework for the succession of nuclear responsibility. The United States has emphasized that the nuclear warheads of the former Soviet Union must remain under the strict control of a single authority, with no proliferation of independent command or control. To this end, US representatives have made it clear that the United States expects the newly independent non-Russian states to join the Nonproliferation Treaty (NPT) as non-nuclear-weapon states, and to support the obligations of START and the Conventional Armed Forces in Europe (CFE) Treaty. Under the NPT, Russia would be considered the sole successor nuclear-weapon state to the Soviet Union. So far, all former republics appear to have agreed to this approach, although final details have yet to be worked out, particularly in the case of Kazakhstan.

According to US officials, the process of moving tactical nuclear warheads to Russia is going forward rapidly. Senior Russian officials have stated that, as of the end of January this year, all tactical nuclear warheads have been removed to Russia from all republics except Ukraine and Belarus, from which all remaining tactical warheads will be removed by July. Strategic warheads will also be removed to Russia in accordance with schedules still under discussion.

As the situation in the Soviet Union deteriorated after the failed coup, interest grew in the possibility of not only moving warheads to secure storage, but also promptly disabling warheads that might be at risk, and establishing procedures to ensure that weapons slated for destruction were actually destroyed. Congress demonstrated its concern about the problem by appropriating \$400 million of Defense Department funds to assist the Soviet destruction program.

The US debate on how to proceed in this effort has been confused by the notion that US scientists will somehow have to teach Russian scientists how to disable or



Missile reentry vehicles crushed under the terms of the Intermediate-range Nuclear Forces Treaty. Similarly, under a verified warhead dismantlement regime, inspectors could check that critical warhead components had been destroyed, and fissionable materials from warheads placed under safeguards, without revealing secret weapon design information.



disassemble nuclear warheads. Such procedures, which are highly dependent on specific weapon designs, are relatively straightforward, and can best be carried out by the technicians who originally assembled and maintained the weapons. For example, nuclear warheads, many of which may already be protected by effective "permissive action links" (PALs), can easily be physically disabled by the removal of such critical components as the tritium reservoirs, special batteries, electronic firing units, or arming sensors. The warheads will remain unusable indefinitely unless the possessor has access to "spare parts" or the capability to manufacture them—not a simple process, particularly in the case of tritium. Full disassembly is more time consuming, and involves reversing the initial warhead assembly process. Nevertheless, this is a relatively straightforward exercise for technicians familiar with the weapon, in an appropriately equipped facility.

A proper role for U.S. scientists in this situation is to help educate Russian and Commonwealth political officials as to the importance of the problem, and to present possible options, so that they will not be entirely dependent in their decision-making on their own scientists or military advisers, who may have vested interests in how to proceed. As a consequence of the extremely compartmentalized nature of the former Soviet military-industrial-scientific complex, few, if any, of the new political leaders within the Commonwealth, or even their scientific and military advisers, necessarily have any independent knowledge of the highly secret Soviet nuclear weapon program.

Undersecretary of State Reginald Bartholomew met separately in mid-January with Russian, Ukrainian, Belarusian, and Kazakh officials in the latest of a series of meetings on these issues. The U.S. delegation included U.S. nuclear weapon experts who continued previous technical discussions on the transportation, storage, disabling, and disassembly of nuclear weapons. In addition, for several years various U.S. nongovernmental organizations, in particular the Natural Resources Defense Council (NRDC), the Federation of American Scientists (FAS), and the National Academy of Sciences (NAS), have sponsored groups that discussed these and closely related problems in meetings with Soviet scientific and policy groups. Most recently, last December, the NRDC and FAS held meetings in Moscow and Kiev in which the U.S. delegation was joined by past and present scientists from the U.S. nuclear weapon program (see p. 15).

#### Dismantlement Step By Step

So far in these meetings, first Soviet and then Russian officials have taken the position that the problem is under control, technical assistance is not needed, and verification of warhead destruction can only be considered on a reciprocal basis. While the United States has encouraged Russia to disable and then destroy the declared tactical nuclear warheads, the

When transferred to a central storage site, the warhead would be received by a joint team, which would check the tags to authenticate the weapon. To confirm that the warhead was not a dummy, substituted for a real nuclear warhead, the joint team could inspect it externally with both passive and active sensors, which can at close range confirm the presence of plutonium and highly enriched uranium. Techniques for accomplishing this were developed

---

*"Successful implementation of such a warhead control regime would have far-reaching significance for world security, long after the current crisis over the security of the Soviet nuclear stockpile has become only an alarming footnote to a turbulent chapter in history."*

---

United States has avoided any suggestion that it would be prepared to accept reciprocal verification to ensure that the designated Russian warheads had actually been destroyed.

Despite the reluctance of the United States and at least some Russian officials to agree to the reciprocally monitored destruction of warheads, this could be accomplished relatively easily without revealing sensitive warhead design data.

At the outset, the number and types of warheads to be destroyed would be declared, in order to avoid subsequent charges of bad faith. "Tagging" of all warheads to be destroyed would be very desirable, but not absolutely mandatory, in order to facilitate management of the entire inventory of declared weapons through the destruction process, which would take several years to complete. Since all tactical warheads will have been removed from the field to storage sites within Russia before an agreed verification plan could be put into effect, tagging of weapons by joint teams would not be a difficult operation. Prior to tagging, the weapons could be disabled by host-country technicians, if this had not already been done. Many inexpensive tagging schemes which uniquely "fingerprint" items have been developed, such as special paint with suspended glitter particles or recording of minute surface irregularities. Tamper-proof seals, such as bundles of optical fibers which, when illuminated, provide unique signatures, are also available to insure the integrity of containers for warheads or materials.

some 40 years ago, in connection with concern over the possibility that nuclear weapons might be smuggled into the United States, more recently, they have been studied in great detail by government and nongovernment scientists. If further evidence were desired to confirm that a nuclear weapon had in fact been turned in, a low-resolution X-ray could externally confirm a weapon configuration without revealing detailed weapon design information. The United States is already using special X-ray machines under the INF Treaty to determine the general nature of the contents of containers leaving the Votkinsk final assembly plant for ballistic missiles. At the completion of this examination, the warhead could be placed in a secure container with appropriate tamper-proof seals to ensure against subsequent exchange of containers or warheads. The containers would then either be sent directly to a destruction facility or put in secure storage under joint surveillance, with physical security provided by the host country pending the availability of space at a destruction facility.

The actual "destruction" of the warheads would take place at a limited number of special facilities, which would probably be the same facilities that previously assembled the warheads (one in the United States at the Pantex plant in Texas and two or more in Russia). While the dismantlement of the weapons would be carried out by host-country personnel, observers would receive and check the tags on all warheads received from storage and would

check all recovered materials leaving the facility. The facility itself would be subject to perimeter monitoring by sensors and observers, to ensure that the weapons or the fissionable materials recovered from the weapons were not being clandestinely withdrawn. The fact that the destruction process would probably take place at facilities that currently assemble warheads might initially present a complication, however, when warhead assembly was also brought under control (as described below) this collocation could prove advantageous, leaving fewer facilities to inspect.

The "destruction" of a warhead would actually consist of its disassembly into its component parts. The fissionable materials and any other valuable retrievable materials, such as tritium (if it had not already been removed), natural uranium metal, or beryllium would be separated from the high explosives and other components unique to the weapon, such as firing circuits, batteries, sensors, casing, or reentry vehicle. Then, in a restricted area, host personnel would burn the high explosives and destroy the other non-nuclear, weapon-related components by agreed techniques to prevent the residual materials from revealing sensitive design information. The host could convert the recovered fissionable material into ingots by crushing or melting to protect sensitive design information. The fissionable materials and any other valuable materials recovered in the destruction process would then be passed on to a joint team, where observers would check that the types and amounts of materials corresponded to the number of weapons dismantled.

Although conceptually straightforward, the process outlined here is demanding—both in time and equipment—as a result of the large numbers of warheads involved and the dangerous and sensitive nature of the operation. Soviet officials have indicated that their existing facilities could handle 1,500-4,000 warheads per year, depending on how many shifts of workers were employed and the availability of special equipment.

#### A Problem of Fissionable Material

Once the fissionable material has been removed from a dismantled weapon, it could be placed in long-term secure storage or preferably further processed so that it could not be directly refabricated for weapons use, but could still be used in the host country's peaceful nuclear program.

Highly enriched uranium can be dealt with in a straightforward manner that meets these requirements, plutonium presents a much more difficult problem, but one that has acceptable, if not ideal, solutions.

Weapon-grade uranium (enriched to more than 90 percent U-235) could be blended with natural uranium (containing only 0.7 percent U-235) to produce uranium enriched to about 3 percent U-235, which is of no value in warheads but is optimized for use as reactor fuel. To be reused in weapons, the material would have to be highly enriched again in an isotope separation facility, an expensive and monitorable step. While storage as 3 percent enriched material should continue to be secure and accountable, once the uranium was in this form there would be little incentive to reintroduce it back into the weapons program. The material could be held in storage until needed as fuel for peaceful power reactors or sold abroad for hard currency.

The isotope of plutonium used in weapons (Pu-239) presents a much more difficult problem, since there are no abundant plutonium isotopes with which it can be diluted to make it unsuited for weapons use. As a partial solution, the plutonium metal could be converted to the oxide form and mixed with low-enriched uranium oxide to provide an alternative "mixed oxide" fuel for nuclear reactors. In this form, plutonium would not be immediately available for use in weapons. However, the plutonium could be reconverted to a form usable in weapons by chemical processing, a much easier barrier to overcome than re-enriching low-enriched uranium.

Alternatively, the recovered plutonium could simply be greatly diluted in combination with other reactor wastes for irremovable deep underground burial. The economics of using plutonium in the fuel cycle and of breeder reactors may well be sufficiently unfavorable for the foreseeable future that the costs of converting the plutonium to safer products and storing it securely for an indefinite period cannot be justified, making disposal the more attractive option. However, given the natural predilection to retain materials with perceived future value, and the universal sorry state of nuclear waste disposal, there would undoubtedly be resistance to this solution.

The nominal economic value of the fissionable material recoverable from warheads is many billions of dollars. Yet, economic motives to convert that material into commercial nuclear fuel are weak for a number of reasons. With the stagnant status of the nuclear power industry, there

is no shortage of fuel, and the uranium mining and uranium enrichment industries are underutilized. In addition, only a few percent of the cost of electricity from nuclear power plants derives from the cost of fissionable material; the bulk of the costs come from the very high capital costs and the time necessary to bring a plant on line. Thus, the primary motive for conversion of weapon-grade fissionable material to commercial fuel is arms control, not economics. Nevertheless, the destruction process would provide Russia with large stocks of low-enriched uranium, which could eventually be utilized to generate electric power or could be sold abroad for hard currency. To encourage warhead destruction, and avoid charges of "dumping" in an already depressed market, the United States and other Western European countries might buy the material for strategic energy reserves at fixed prices.

#### Controlling Nuclear Stockpiles

The procedures discussed thus far would guarantee that a substantial number of designated warheads had actually been destroyed, and the associated fissionable materials either permanently removed from the stockpile or segregated from it for as long as it was monitored. To go further, and create a regime to control the total arsenal of nuclear weapons and the stockpile of fissionable materials potentially available for weapons, would require measures to ensure that these materials could not be obtained from existing military or civilian stockpiles or by the production of new fissionable materials. Implementing such a regime would require a major effort. However, with the change in the East-West relationship and the verification precedents established by the START, CFE and INF treaties, it now appears within reach, if the political will exists in the United States, Russia, and eventually in other nuclear weapon states as well.

A verifiable regime to control the total nuclear warhead stockpile would require the following measures, in addition to the verified destruction of declared warheads discussed above:

- 1) Declarations of all nuclear weapons and stockpiles of fissionable material.
- 2) A cutoff in production of weapon-grade material.
- 3) Safeguarded operation of the commercial nuclear power industry; and
- 4) Prohibition or monitored operation of all facilities to fabricate and assemble nuclear weapons.

In establishing such a comprehensive regime, the United States and Russia should initially exchange declarations of the number of warheads in their arsenals by type, taking into account any that were in the process of being destroyed. Declaration of the amounts of fissionable materials in each warhead type would be very helpful, but not absolutely necessary. The sides would also exchange declarations on the total amounts of plutonium and enriched uranium (by levels of enrichment) that had been produced from the beginning of their programs, as well as the amounts of these materials currently in their military and civilian inventories, taking into account amounts expended in tests, operation of reactors, exports, and so on. In the case of Russia, these estimates would have to take into account materials now located elsewhere in the Commonwealth.

In the past, both the United States and the Soviet Union considered such declarations much too sensitive to discuss. Today, however, such declarations would not be out of line with the detailed declarations made in connection with the INF, START, and CFE treaties. Along with these declarations, all existing nuclear warheads should be tagged in a joint operation. Such tagging would provide a built-in mechanism for validating and tracking any warhead subsequently designated for destruction. The

process of applying the tags would also partially validate the declarations themselves. Once tagging was completed, any untagged warhead that was observed in any inspection process, for this or any other agreement, would automatically constitute a violation.

A cutoff of production of weapon-grade uranium and plutonium would prevent the introduction of new fissionable materials to replace those removed from the military weapons programs as warheads are destroyed. Such a cutoff could be verified relatively easily, and would not impose any burden on either the United States or Russia.

Indeed, The United States discontinued the production of highly enriched uranium for weapons in 1964, closed down the last plutonium production reactor in 1968, and has no plans to produce either material in the future. The Soviet Union announced that it had stopped the production of highly enriched uranium in 1989 and would close its last plutonium production reactor by the end of the century. The delay in the shutdown of the final Soviet plutonium production reactors may be explained by the fact that some of these reactors are dual purpose, also supplying substantial amounts of electric power. However, in the present situation, Russia has no conceivable requirement for any ad-

ditional plutonium production, given the large number of nuclear warheads it is already committed to eliminate from its arsenal in the near future.

#### A Cutoff in Materials Production

A cutoff of fissionable materials for weapons is not a new idea. Originally part of the 1946 Baruch Plan, the cutoff was reintroduced by the United States in the mid-1950s, and was a central element in U.S. arms control proposals during the 1960s. While the Soviet Union originally opposed the concept, in the 1980s the Soviet Union supported the cutoff and the United States opposed it. The verification of such an agreement has been studied in the United States since World War II, and has in recent years been revisited by government and nongovernment scientists. Moreover, the International Atomic Energy Agency (IAEA) has accumulated a great deal of practical experience in related verification practices, in the process of monitoring the nuclear facilities of all non-nuclear-weapon states party to the NPT. On the basis of this extended experience, there should be no problem in promptly establishing an adequately verified cutoff of production of fissionable material.

In the case of uranium enrichment, national technical means of verification can determine whether a known plant is in operation, and this can easily be positively confirmed by on-site inspection. Under a cutoff, some enrichment plants would continue to produce low-enriched material for power plants. This would require on-site personnel to confirm the level of enrichment of the plants' output. Since some isotope separation techniques (such as centrifuge separation) permit the level of enrichment to be increased fairly rapidly by changes in piping and valving, intrusive on-site inspections of such plants would have to be quite frequent if not continuous.

A potential complication results from the fact that current U.S. nuclear-powered submarine reactors require uranium enriched to weapon grade. However, highly enriched uranium for submarine purposes could be provided by utilizing material recaptured from dismantled weapons. If additional highly enriched uranium for these nonwarhead purposes were needed, a specified amount could be produced in a designated facility and fabricated into fuel elements under on-site inspection. The burn-up of the material could be monitored by changes recording the energy production in the submarine reactor. Nuclear sub-



*Under a fissionable material control regime, highly enriched uranium from dismantled weapons could be mixed with natural uranium to make low-enriched reactor fuel. That material could not be used in weapons unless it was "re-enriched" in a large and observable facility such as the URENCO gas centrifuge plant in the Netherlands, shown above. These plants would be under international safeguards.*



*Inside the Atomic Reactor at Chelabinsk, the first Soviet plutonium production reactor. This reactor, like a number of other plutonium production reactors in the former Soviet Union, has been shut down and Russian President Boris Yeltsin has called for a cessation of further production of plutonium and its use in nuclear weapons.*

namics of the former Soviet Union reportedly do not require uranium enrichment to weapon grade levels.

A cutoff of plutonium production presents a somewhat intractable technical problem, since plutonium is produced as a by-product in peacetime civilian power reactors. In the United States, plutonium is not separated from irradiated fuel from civilian reactors, since today the bulk cost of the chemical separator process makes its use economically uncompetitive with low enriched uranium. Technically, the plutonium chemical process separates a portion of fuel products and produces a stream of plutonium. The process is so effective that these plutonium products could be used as a nuclear weapon.

In the Soviet Union, plutonium is separated from spent nuclear fuel in a peacetime production reactor at Chelabinsk, and the fuel is used in nuclear power plants. Because of the role of plutonium production in the Soviet nuclear program, the reactor is located in the weapon priority zone. In 1992, Yeltsin signed a law to shut down the potential Chelabinsk program, and the Soviet Union has been developing plutonium reactors in the United States. In fact, since 1975, the plutonium program has been shut down for the direct program. The program is now only for research and development.

percent of the quantity that will become available from the 10,000 to 20,000 tactical nuclear warheads that Russia has declared to be dismantled.

#### Safeguarding Peacetime Programs

For the cutoff to be effective, the entire peacetime nuclear program must be isolated from the nuclear weapon program, so that parts of the peacetime nuclear program are not used for weapons. This is a critical issue, since plutonium has probably been produced as a by-product of a peacetime program in at least 100 countries. In the United States, the separation process for the fuel from the Chelabinsk reactor for the peacetime nuclear program is not used for weapons.

It is not a simple problem. It has been pointed out that the separation of the fuel from the Chelabinsk reactor has been a part of a worldwide cooperation to control and prevent nuclear weapons. For the United States, the separation of worldwide cooperation is all about a small reactor, but it is the only one of its kind in the world. The separation of the fuel from the Chelabinsk reactor is a critical issue.

The separation of the fuel from the Chelabinsk reactor is a critical issue. The separation of the fuel from the Chelabinsk reactor is a critical issue.

agency's record has been remarkably good. Some criticism has surfaced as a consequence of the clandestine Iraqi weapon program. However, it must be remembered that in the past, the IAEA was limited to inspection of declared facilities. Steps are now underway to extend its mandate to inspect "suspect" facilities as well. Since US intelligence was aware of the existence of most of the Iraqi facilities, if not the specifics of all of their activities, IAEA inspection of these sites would have revealed the extent and nature of those activities, or if denied, would have created a much earlier international recognition that a substantial illegal program was probably underway.

In the case of the US and Commonwealth programs inspections could be conducted either bilaterally or through the IAEA. If the IAEA were utilized for routine inspections, the inspection procedures could be supplemented by a separate bilateral agreement between the United States and each of the independent Commonwealth states calling for mandatory bilateral inspection of "suspect" sites.

IAEA inspection procedures were designed to give a simple warning of possible violations, not to be more than a first step in a program and first to prevent subversion. Consequently, it would be highly desirable to design peacetime programs that do not involve large quantities of weapons grade fissile materials. In this context, given its present dire economic straits, Russia would be well advised to start on the economic plutonium program for better use of its resources and more than a broader program will see economic stabilization at best far in the future. As part of the new market economy, the states of the new Commonwealth should take a critical look at the trade economics of recycling plutonium from power programs and of other programs. The critical problem of plutonium production for power programs will be greatly mitigated by a US economic assistance program on the development of processing of plutonium. This program is a cost of acceptable temporary measure, since it may already be underway or preparing its broader program.

The US is a peacetime nuclear commitment. It is a commitment to the United States and the Commonwealth. The US is a peacetime nuclear commitment. It is a commitment to the United States and the Commonwealth.

major expansion of the program, or a separate U.S.-Commonwealth verification program, would be a very small item in the present security budget.

### Warhead Production

A final barrier to the use of fissionable materials either from clandestine stocks or from the peaceful program could be provided by monitored control of warhead production facilities. Ideally, there would be a complete ban on the production of new warheads; however, both sides may perceive a need for some standby production capability to permit refabrication in the event of unanticipated reliability or safety problems with existing weapons.

This capability could be permitted at a single declared facility for the fabrication of fissile components (not a trivial operation for sophisticated weapons), and a single, final warhead assembly facility. These two facilities would be closely monitored, along the same lines as weapon disassembly plants, with all materials entering and leaving the plant subject to detailed external inspection with sensors and X-rays. For every new warhead produced, a declared warhead not already scheduled for destruction would have to be destroyed, and an agreed equivalent amount of fissionable material from any permitted reserve assigned to the weapon production program.

While this approach would have to allow a certain infrastructure of supplies of weapon components to continue, these could also be subject to periodic inspection to ensure that the scale of the operation was consistent with this radically reduced level of production. Since a significant clandestine warhead production line would be extremely difficult to keep secret under a regime of mandatory inspections of suspect sites, this provision would substantially reduce the potential danger posed by uncertainties in the reserves of fissionable materials. However, one could not rely on it alone if the other elements of the regime were unconstrained and unverified.

### Reducing the Uncertainties

A fundamental problem with such a comprehensive approach to the reduction of total warhead inventories to agreed levels is the uncertainty as to the existing Soviet stockpile of highly enriched uranium and plutonium. Despite extensive information on the Soviet fissionable

material production complex, present estimates involve substantial uncertainties. These uncertainties are in part due to the extreme secrecy which has surrounded the Soviet nuclear program from its beginning and which, despite recent relaxation, still exists, and in part are inherent in the production processes themselves. Although these uncertainties can be narrowed with access to facilities through on-site IAEA-type inspections, they will still remain significant, due to the complex operating history of the plants, some of which have been substantially modified, closed down, or even torn down over the past 45 years. With our current knowledge of the Soviet program, this uncertainty is equivalent to thousands of nuclear warheads. With purely technical assessments, based on conventional on-site inspection, it would probably still remain in the range of a few thousand.

However, while purely technical verification measures cannot be expected to reduce uncertainties to very small numbers, a combination of technical assessments with auditing procedures applied to production records, reactor operation logs, records of consumption of materials in weapons tests, and power production should prove very powerful. The veracity of such records can be checked by comparing their consistency with the physical conditions of the production facilities and other historical data. How far such auditing procedures can be pushed remains to be seen, and depends on the degree of cooperation and openness between the two sides. At some point, the inspectors may decide on the basis of consistency and validation that certain production records are accurate. This conclusion could drastically reduce the range of uncertainty. A bank auditor, after all, does not actually count all the money or personally examine every asset held by an institution.

In any event, at present stockpile levels these uncertainties are not a major matter of concern, since there are no operating forces to deliver any excess warheads that might exist. Consequently, excess material, if it exists, would not affect the military balance. However, as the amount of fissionable material in permitted levels of warheads approached the levels of uncertainty, that uncertainty would take on greater significance.

The successful implementation of such a regime, with the amount of cooperation and intrusive access involved, would substantially reduce concern about the actual existence of hidden reserves and would leave each side far more secure in its assess-

ment of the other's stockpile. Nevertheless, at some point the theoretical uncertainty would place a floor on the regime's effectiveness. This may indicate the level to which nuclear stockpiles can be reduced, or suggest that a fissionable material reserve of that magnitude should be held in monitored storage if nuclear warhead inventories are eventually reduced to very low levels.

### A Major Opportunity

Russia and the Commonwealth of Independent States have reacted promptly and sensibly to the critical problem of achieving effective control over the arsenal of nuclear warheads belonging to the former Soviet Union. Despite the major uncertainties in the political situation, the immediate control problems will probably have been at least temporarily addressed in the near future. A major opportunity exists to augment these unilateral actions with agreed measures for the verified destruction of the substantial number of warheads that the two sides have declared will be eliminated from their nuclear stockpiles. However, realization of this important objective will require U.S. acceptance of reciprocal verification procedures, since Russian leaders will probably find it politically impossible to accept unilateral U.S. inspection. (See p. 15.)

The collapse of the Soviet Union has drawn attention to the broader problem of bringing the entire U.S. and Russian stockpiles of nuclear warheads under verified control. Such a regime, which now seems technically and politically feasible, would have to include declarations on total stockpiles of warheads and fissionable materials, a cutoff in fissionable material production for weapons, full-scope safeguards on all peaceful programs, and monitoring of any permitted continued nuclear warhead production.

The implementation of the full control regime will take some time, and will in due course have to encompass the programs of all of the nuclear weapon states. However, even its initiation by the United States and Russia would be a major contribution to reducing the threat of nuclear proliferation, helping to ensure the unlimited extension of the Nonproliferation Treaty in 1995.

Finally, and most important, the organization and implementation of such an international regime is an indispensable component of any program to reduce nuclear warheads and nuclear weapon delivery systems to very low levels. ■

THE WHITE HOUSE  
WASHINGTON

October 7, 1991

Dear Mr. President:

I am transmitting with this letter a report to the Congress: Verification of Nuclear Warhead Dismantlement and Special Nuclear Material Controls, as required by section 3151 of the National Defense Authorization Act for Fiscal Year 1991. The report reflects the views of a Technical Advisory Committee on the subject defined by Congress: on-site monitoring techniques, inspection arrangements, and national technical means that may be useful to verify the dismantlement of nuclear warheads, and on the production of plutonium and highly enriched uranium for nuclear weapons, and the disposition of these materials recovered from dismantled nuclear warheads.

A distinguished panel of Government and nongovernment technical experts was assembled, according to Federal Advisory Committee Act guidelines, to serve as the Technical Advisory Committee under the requirements of the Act. They have summarized their findings in the unclassified Executive Summary, and approved the material presented in the classified full report, initially prepared by the Department of Energy. The Technical Advisory Committee had full independence in expressing their expert opinions on these matters. The Committee was chaired by Ambassador C. Paul Robinson who served as the U.S. Ambassador to the Nuclear Testing Talks.

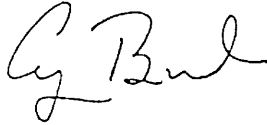
The mandate to the Committee in the legislation was challenging. It is difficult and potentially misleading to evaluate verification issues in isolation from the details of a potential agreement. Since there are no such agreements drafted, the adequacy of the verification measures could only be discussed in broad and general terms. That said, the report makes clear the difficulties and risks involved. ~~As the Advisory Committee reports, the United States could not effectively verify the number of existing warheads or the amount of special nuclear material currently on hand. We likewise could not have high confidence in discovering clandestine warhead or special nuclear material stockpiles. In addition, the report notes the extreme difficulty of monitoring the many potential paths in which nuclear warheads or special nuclear material could be produced.~~

UNCLASSIFIED WITH  
SECRET ATTACHMENT

- Secret Attachment Deleted

The Committee charter was limited to the assessment of technical verification arrangements and techniques, and therefore their report does not address the broader national security implications of the possible outcomes defined in the legislation. The Committee was in unanimous agreement, however, that for any controls regarding warhead demilitarization or special nuclear material production, maintenance of an effective and modern nuclear deterrent must not be compromised.

Sincerely,



The Honorable Dan Quayle  
 President of the Senate  
 Washington, D.C. 20510

OFFICIAL COMMUNICATION  
 RECEIVED IN THE OFFICE OF  
 THE PRESIDENT OF THE SENATE

DATE RECEIVED RECEIVED OCT 07 1991

TIME RECEIVED \_\_\_\_\_

DATE DELIVERED \_\_\_\_\_

UNCLASSIFIED WITH  
SECRET ATTACHMENT

- Secret Attachment Deleted



REPORT TO CONGRESS

VERIFICATION OF NUCLEAR WARHEAD DISMANTLEMEN

AND

SPECIAL NUCLEAR MATERIAL CONTROLS (U)

JULY 1991



## REPORT TO CONGRESS

VERIFICATION OF NUCLEAR WARHEAD DISMANTLEMENT  
AND SPECIAL NUCLEAR MATERIAL CONTROLS (U)

JULY 1991

## EXECUTIVE SUMMARY (U)

## A. INTRODUCTION (U)

This report has been 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 onsite monitoring techniques, inspection arrangements, and national technical means of verification (NTM) 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 United States and the Soviet Union should provide for such dismantlement to be carried out in a mutually verifiable manner
- A mutual United States-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 plutonium and highly enriched uranium recovered from the dismantlement of nuclear warheads. (U)

## B. CONTEXT (U)

This report addresses onsite monitoring techniques, inspection arrangements, and national technical means 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. The

short-hand term *SNM* (special nuclear material) is generally used throughout the report to designate fissile material, such as Pu or HEU, which can be used to build nuclear weapons. (U)

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 highly-enriched uranium that could be used to build additional nuclear weapons. That issue can only be decided on the basis of strategic, military, and political judgements, including a net assessment of the objectives and capabilities of other nations relative to US security, which lie beyond the scope of this report. (U)

The effectiveness of the verification methods, which would be used to verify compliance with potential agreements in warhead dismantlement or material production controls, are but one factor in that assessment. The overarching question is whether such agreements would support US national security interests, even if all parties were in full compliance with such agreements. In addition, all potential routes to produce nuclear materials and assemble them into nuclear weapons would need to be addressed, as well as the effectiveness of our ability to verify such activities. (U)

Assessing the adequacy of potential verification measures is extremely difficult. Standards for verification would depend not only upon the objectives and the details of specific agreements, but also upon their geopolitical context. The relationship with the Soviet Union; the degree of openness of Soviet society; and the two sides' nuclear force postures, including number and type of weapons and delivery vehicles, total amount of SNM, and size of research, development, and testing programs, and production and material processing complexes would be among the factors that influence verification standards. Therefore, the adequacy of verification measures can be discussed here only in very broad and general terms. (U)

Verification for compliance purposes goes beyond onsite monitoring techniques, inspection arrangements, and NTM, necessarily including information from all intelligence sources, and the political judgments that are made on the basis of this information. 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. (U)

If a proposed agreement provides for dismantlement of specified numbers of weapons or for specified reductions of 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

- Prohibited existing facilities are shut down
- Allowed production and processing facilities are not used to produce prohibited materials or warheads
- Clandestine/prohibited production and processing facilities do not exist. (U)

While agreements on warhead dismantlement or on limits on production of SNM for weapons might be viewed as arms control measures in their own right, it would be better to view them as supplements to support arms control measures that would control the numbers of warheads and/or delivery vehicles. The reason is that it would be difficult to significantly reduce the uncertainty in knowledge of total Soviet SNM and warhead inventories with present or foreseeable verification techniques and arrangements. (U)

If one would seek to impose limits on total numbers of warheads, and total weapon SNM stockpiles, then knowledge of the total SNM that could possibly be used for weapons would be essential. SNM of, or near, weapons-quality is also used for other purposes, including breeder reactors, research reactors, and submarine power plants. The importance of the uncertainty in our knowledge of the total SNM stockpile inventory would increase as the size of the weapons stockpiles were decreased. (U)

There are significant asymmetries between the US and Soviet nuclear warhead material production and processing infrastructures. In general the Soviet infrastructure is considerably larger and has more redundancy. This asymmetry would place a much greater burden on US verification of Soviet nuclear activities than vice versa. The negotiation of treaties including measures for warhead destruction and SNM controls could (and, from a US perspective, should seek to) redress these asymmetries. An incentive for the Soviets to close such facilities is the fact that many of these facilities are old and environmentally hazardous. (U)

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. (U)

### C. NTM, ONSITE MONITORING TECHNIQUES, AND INSPECTION ARRANGEMENTS (U)

The utility and effectiveness of inspection arrangements, onsite monitoring techniques, and NTM would be highly dependent on the objectives and specifics of a negotiated agreement and the degree of detail of the corresponding verification protocols. The key observations from this portion of the report are listed on the next page. (U)

- For some of the verification tasks associated with warhead dismantlement and SNM control (for example, monitoring declared stocks, warhead dismantlement, facility shutdown, and activities at permitted facilities) onsite inspection would play a dominant role, with NTM playing a lesser role. ~~However, even the full suite of NTM inspection arrangements and onsite monitoring techniques probably could not provide verification of total SNM quantities or the absence of clandestine production facilities without a significant margin of error.~~ (U)
- While simple techniques (such as visual monitoring or chain-of-custody) can suffice for some verification tasks, more complex monitoring techniques (such as active interrogation of treaty-limited items [TLIs]), some of which have yet to be developed, would be required for other tasks. (U)
- Warhead dismantlement and material production have some unique, externally observable signatures useful in other monitoring efforts. However, these signatures have limited value in monitoring by national technical means. NTM could aid in monitoring some changes in the status of declared facilities, particularly those declared to be inactive. However, the detection and identification of undeclared SNM and weapon-associated sites through NTM could not be relied upon at present and the prospects for developing such detection and identification capabilities in the future are low. (U)
- It is important that specific treaty provisions should be negotiated with adequate knowledge of the limitations of the inspection and monitoring techniques that would be employed. (U)

#### D. VERIFICATION OF NUCLEAR WARHEAD DISMANTLEMENT (U)

The warhead dismantlement process can be represented as three separate processes from a verification point-of-view. (U)

1. 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. (U)

2. 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. (U)
3. Dismantlement - disassembly of the warhead-containing system to the degree required. (U)

The key observations concerning verification of warhead dismantlement are as follows. (U)

- From a narrow technical perspective, verification of the dismantlement of nuclear warheads could be accomplished with high confidence; however, there are costs and risks involved in the process of verifying dismantlement, particularly the risks of disclosing sensitive information. Such disclosures could reveal potential vulnerabilities of our nuclear forces or reveal design information that could be used by others to develop or improve their own nuclear weapons. (U)
- 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. This would apply to both warheads of a particular type and to total stockpiles. Uncertainties in initial inventories could become more important as the size of the warhead stockpiles decrease. (U)
- SNM and nuclear weapons emit characteristic radiation which could be used as the basis for detecting the presence of these materials and their quantities under onsite inspection arrangements. It might be possible to develop techniques that offer improvements in warhead identification with reduced risks of disclosing sensitive information. (U)
- Chain-of-custody arrangements offer the possibility of verifying dismantlement with a lower risk of divulging sensitive information. Portal/perimeter monitoring techniques might be applied to warhead dismantlement facilities in order to avoid the intrusiveness of direct monitoring of the dismantlement process. Inspection arrangements that use a combination of tagging and random selection of warheads for further monitoring might reduce monitoring costs and also limit intrusiveness. For these

possibilities, evasion scenarios must be carefully and thoroughly evaluated. (U)

- 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 onsite inspection regimes, might have to be provided. (U)
- 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. (U)

#### E. VERIFICATION OF SNM PRODUCTION CONTROLS/CUTOFF (U)

Special nuclear materials are produced to serve both military and civilian needs. It is assumed that any agreement to control or ban the production of SNM for use in nuclear weapons would be designed in such a way as to permit other uses. The key observations from this section of the report are listed below. (U)

- ~~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.~~ The resulting uncertainty would likely become more important as the total SNM stockpile decreases. Furthermore, monitoring techniques would be unable to effectively reduce this uncertainty due to the ease of concealment, the lack of external observables, and the difficulty of determining the performance of past operations. (U)
- 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. (U)
- In any agreement to limit production of SNM, verification would require monitoring of appropriate elements of the civilian fuel cycle. (U)
- Tritium production reactors would also need to be monitored to foreclose the possibility of prohibited Pu production. Similarly, all other production and use of SNM (e.g., naval

fuel, research reactors, breeders, and as tritium reactor fuel) would need to be monitored. (U)

- It would be very difficult to detect and identify production from undeclared enrichment plants. Although detection of undeclared reactors would be somewhat less difficult, it would not be assured. (U)
- The potential of new technology, such as laser isotope separation of uranium and Pu, or modern centrifuge enrichment, would open up significant new opportunities for SNM production with minimal observables. (U)
- Possible benefits that would arise from the monitoring of SNM and related facilities include opportunities for onsite presence at the correspondingly larger number of Soviet facilities as well as a strengthening of commitments to the Non-Proliferation Treaty (NPT). (U)

#### F. VERIFICATION OF SNM DISPOSITION (U)

The disposition options for SNM recovered from warhead dismantlement include its reuse in weapons programs; use for naval or space reactors; use in commercial reactors; monitored storage; and irretrievable disposal. The SNM returned from dismantled weapons has substantial value that would represent major cost savings if these materials could be used in permitted programs, such as to fuel commercial power reactors. The key observations from this section are provided below. (U)

- Most disposition options would be reversible at some cost. (U)
- Blending highly-enriched uranium with appropriate amounts of depleted uranium would significantly reduce the weapon utility of such material, such that it would require re-enrichment along with those attendant costs. However, additional enriched uranium would then have to be produced in order to provide material for permitted uses, such as naval reactors. (U)
- The weapon utility of Pu can be significantly reduced by adding highly radioactive material (*denaturing*) which would require subsequent reprocessing in shielded facilities to remove the added material in order to reuse it in weapons. Although this denatured plutonium would be difficult to handle, it could be purified for reuse in existing reprocessing plants, at a lower cost than for producing new plutonium.

Other less reversible processes for preventing plutonium reuse might be developed, such as incorporation in a glass matrix, that would increase the costs for recovery and reuse. (U)

- ~~Material disposition options that would return SNM to non-weapons programs (commercial and defense), would transfer the need to monitor the material to those other programs, which would enlarge the monitoring tasks and introduce concerns regarding protection of sensitive information. (U)~~
- Long-term storage of material would likely be possible to monitor using standard safeguards technologies. However, the form and location of the material would be a critical parameter since some forms (full-up weapons systems or intact components, for example) would easily be returned to their military function with minimal cost and time penalties, to facilitate a breakout. (U)

#### G. MULTILATERAL CONSIDERATIONS (U)

The potential for multilateral involvement in warhead and material control regimes includes some additional considerations. These are summarized below. (U)

- The allowed margin of error in determining the size and disposition of weapons or SNM stockpiles would depend on the specific parties involved and the degree of maturity of their nuclear weapons programs, and of course whether these parties even had such programs. (U)
- US obligations under the Non-Proliferation Treaty would need to be considered if inspectors from proliferant or non-nuclear weapon states would be involved in the inspection of US nuclear weapon facilities. The level of intrusiveness of verification arrangements would become more important if it compromised design information or other weapon technologies. (U)
- Potential positive impacts would include a reinforcement of international perception of the intent of the treaty parties to abide by Article VI of the Non-Proliferation Treaty. (U)



**Senator LEVIN.** Now we will stand adjourned and thank you all.  
[Questions for the record with answers supplied follow.]

QUESTIONS SUBMITTED BY SENATOR SAM NUNN

**Senator NUNN.** Does the State Department believe that the arrangements for verification that are currently in place under Nunn-Lugar program are adequate in promoting our non-proliferation interests or would it favor putting CIS nuclear dismantlement activities under some form of reciprocal or international control?

**Mr. GALLUCCI.** We believe that our current efforts are adequate in promoting our non-proliferation interests. International control over nuclear dismantlement activities is unnecessary, would prove difficult to arrange since they may require detailed negotiations, and could slow the process of dismantlement. Reciprocal measures are unnecessary, since the problem is safeguarding fissile material in the former Soviet Union, and ensuring that it is not diverted to other countries. The United States already has adequate safeguards in place for its own fissile material.

**Senator NUNN.** One outstanding Nunn-Lugar issue is whether the United States should assist Russia financially in the construction of a storage facility for fissile material extracted from CIS nuclear warheads until decisions are made on the ultimate disposition of these materials. Do you think such a linkage should be made, and if so, what is the timetable and procedure for reaching an understanding with Russia on the ultimate disposition of the fissile material?

**Mr. GALLUCCI.** The administration sees a direct linkage between the size of a storage facility for fissile material and the resolution of the ultimate disposition issue. Because there is currently little prospect for a cost-effective civilian use of plutonium in the near term, a storage facility will be needed at a minimum to store 50 tons of plutonium declared by Russia to be in excess of its defense needs. In addition, even if we can reach agreement with the Russians to sell their excess highly enriched uranium (HEU) for conversion to low enriched uranium (LEU) for civilian nuclear power plants, some fraction of the HEU will need to be stored temporarily, pending conversion to LEU. Because of these considerations, a sizable storage facility will be needed even if the ultimate disposition discussions result in HEU being converted and sold into the civilian market.

The United States is still evaluating possible assistance to Russia in the construction of such a facility. Without prejudice to a decision on U.S. assistance for construction, we are seeking an agreement on a joint U.S.-Russian design effort for the proposed facility.

It is our intention to press forward on discussions on ultimate disposition in the next few months to reach agreement. Such an agreement will permit the United States to make a better decision as to the extent of assistance that might be provided in construction of the proposed fissile material storage facility.

**Senator NUNN.** During our first panel, Dr. von Hippel maintained that "there are limits on how far we can ask Russia to go unilaterally—even in exchange for financial assistance." Do you anticipate that if the United States offers a level of financial assistance sufficient for Russia to agree to move the START II deadline up to the year 2000 Russia will also insist on reciprocal verification rights vis-a-vis U.S. nuclear weapons dismantlement activities?

**Mr. GALLUCCI.** No. Both Russia and the United States recognize a common interest in moving the completion of the reductions mandated by the June 17 Joint Understanding from the year 2003 to the year 2000. In the discussions leading to the Joint Understanding the *only* condition for such acceleration was U.S. assistance. There was no discussion by either party of warhead dismantlement or of inspection rights with respect to such dismantlement. We would resist any attempt to combine the subject of warhead dismantlement with the treaty codifying the June 17 Joint Understanding.

**Senator NUNN.** Do you agree with Dr. von Hippel's assertion that START II could be blocked by "Russian conservatives" if the United States keeps open the option of recycling fissile material from our warheads while insisting pursuant to the Nunn-Lugar program that Russia not recycle theirs?

**Mr. GALLUCCI.** Neither Russia nor the United States has linked fissile material controls to the implementation of the June 17 Joint Understanding. We intend to move rapidly to codify the Joint Understanding in a treaty. While, for various reasons, some Russian conservatives have reservations about the June 17 Joint Understanding, we anticipate that both the United States and Russia will ultimately find the future treaty in their interest and will act to bring it into force.

**Senator NUNN.** How concerned do you believe Russia is about its nuclear weapons ending up in some Third World country?

Mr. GALLUCCI. The Russian Government and the military establishment of the Commonwealth of Independent States have stated that they are very interested in preventing the transfer of any nuclear weapons to third states, and that they have taken all possible measures to prevent such transfers. Such transfers would be of great concern, both to Russia and to the United States. We further believe that the danger of proliferation of former Soviet nuclear weapons or components is a serious concern in Russia and is a significant factor in the cooperative Russian approach we have experienced on these matters.

Senator NUNN. Secretary Gallucci, what safeguards has Russia put in place to guard against such proliferation?

Mr. GALLUCCI. [Deleted.]

Senator NUNN. Do you believe that the United States can confidently certify pursuant to the Nunn-Lugar legislation that the nuclear warheads we are assisting Russia to destroy are actually being destroyed and not recycled or transferred to other countries?

Mr. GALLUCCI. Our judgment is that Russia is committed to foregoing any use in new nuclear weapons, and preventing the transfer to other countries, of fissile material and other components of dismantled nuclear weapons. On April 8, 1992, Acting Secretary Eagleburger provided the appropriate certification pursuant to the Nunn-Lugar legislation. The administration stands by this certification.

Senator NUNN. Mr. Claytor, in your statement you say: "with respect to onsite inspections of U.S. nuclear production facilities, we are still evaluating whether or not such monitoring can be implemented in a fashion consistent with U.S. security interests and our statutory requirements under the Atomic Energy Act of 1954 for the protection of nuclear weapons." When will the Department complete this evaluation.

Mr. CLAYTOR. Although at the present time there are no ratified nuclear arms reduction agreements which would require onsite inspections of U.S. nuclear weapons production facilities, the Department, in order to prepare for such inspections under future treaties (e.g., the CWC) has been studying this issue. We have completed an initial review which has shown, primarily, how much more work we have to do to address the issue. As noted, we must look at the question in the context of the legal requirements under the Atomic Energy Act to protect secret restricted data (SRD) and SRD is involved in all aspects of the Department's nuclear weapons program. In addition, at some DOE facilities, monitoring raises safety issues which must be carefully reviewed. We do not believe that it is Congress' intent to have monitoring result in a significant slow down of the dismantlement program or substantially increase its costs. The review is more of a continuum than a set point in which we must look at each type of operation, identify serious problems, explore the feasibility of overcoming those problems and assess the cost in time and money of the potential solution. As a consequence of these complexities, we cannot provide a specific end date.

Senator NUNN. In your February 25 appearance before this committee, you testified as follows: "The accelerated rate of weapon retirements resulting from changes in Department of Defense requirements has produced a formidable challenge to the DOE transportation fleet and to the disassembly and disposal operations conducted at the Pantex plant." Since that testimony, the United States and Russia have agreed to a much more far-reaching nuclear arms reduction drawdown.

What additional workload, storage requirements, and funding, will be necessitated as a result of the summit agreement?

Without getting into a classified area, can you give us a rough idea of what percentage of the strategic nuclear warheads we will be withdrawing from deployed inventories as a result of START I and START II will be destroyed, what percentage will be recycled into other nuclear weapons, and what percentage will be maintained intact?

Mr. CLAYTOR. The impact of the summit agreement is that the dismantlement workload will continue at the planned level for a longer period of time. This is consistent with the currently planned resource requirements.

As I indicated in my prepared statement, the precise number of each type of weapon being retained and being scheduled for dismantlement is reflected in the Nuclear Weapons Stockpile Plan approved by the President. The President has directed that the plan be modified to reflect the June 17, 1992, U.S./Russian Joint Understanding, and the Nuclear Weapons Council is working on the revision. Until we have completed that effort, and the President approves it, it would be premature to comment on the disposition of the warheads affected by the Joint Understanding.

Senator NUNN. A July 23 article in the Washington Post reported that the administration was deeply divided over the proposal by Russia to sell Russian weapons-

grade uranium to us for use as fuel in civilian nuclear reactors. According to the article, the Departments of Energy and Defense oppose the proposal out of concern that accepting it could create pressure for us to agree to dispose of our fissile material, rather than retain it for recycling into other nuclear devices.

a. Is this article accurate?

Mr. CLAYTOR. The article was inaccurate. The Department of Energy does not oppose the proposal to seek an agreement with Russia concerning the disposition of highly enriched uranium from dismantlement of nuclear weapons in Russia. Under such an agreement, uranium from weapons in Russia could be sold to the United States for use as fuel in civilian nuclear reactors. Also, it is our understanding that the Department of Defense shares this view.

Senator NUNN. For many years the Department of Energy has taken back and reprocessed spent research reactor fuel from foreign research reactors. The Department of Energy did this when it had provided the new fuel for these foreign research reactors. This was done to reduce the proliferation potential of the fuel provided. Proliferation was a particular concern in the Department of Energy program to take back natural uranium reactor fuel used in CANDU reactors (when reprocessed this fuel yields plutonium). Will this program stop? What is the proliferation potential of such a decision?

Mr. CLAYTOR. The Department has accepted spent research reactor fuel of U.S.-origin for reprocessing since 1968. No such fuels have been accepted since 1988. We have also accepted natural uranium spent fuel from the Taiwan Research Reactor. No natural uranium spent fuel from CANDU power reactors has been accepted by the Department.

The vast majority of U.S.-origin spent research reactor fuels are located in countries with which we have no proliferation concern. While some U.S.-origin highly enriched uranium, which has been irradiated, is located in countries of proliferation concern, the quantities themselves are not of major significance. The Department is presently reviewing its policy for acceptance of U.S.-origin spent research reactor fuels in light of the changing situations involving reconfiguration of Departmental facilities as a result of the end of the Cold War.

Senator NUNN. Mr. Claytor, when was the last time a test was conducted primarily for stockpile evaluation and not in response to a specific pre-identified problem?

Mr. CLAYTOR. [Deleted.]

Senator NUNN. In your statement you indicate that the stockpile memo in response to the June 17, 1992, understanding is still being prepared, and thus, you do not respond to the question asking what weapons will be in the stockpile. However, you state "it should be noted that most of the weapons in the planned smaller stockpile do not have all of the desired safety features. What are the weapons in the planned stockpile?"

Mr. CLAYTOR. Regardless of the actual stockpile composition, the statement that "... most of the weapons . . . do not have all of the desired safety features" is accurate. Until we determine the stockpile composition and warhead disposition following the June 17, 1992, Joint Understanding, the DOE and the DOD are studying the desirability of making safety enhancements to the warheads which might remain in the stockpile.

Senator NUNN. In your statement you say that "there are no current plans to build any new weapons or remanufacture existing weapons."

How does this statement fit with the Department of Energy's efforts possibly to reuse pits from retired weapons in the weapons safety modification program?

How does this statement fit with the amended budget request?

Mr. CLAYTOR. In my prepared statement, I said "A limited number of the plutonium pits have potential application in a pit reuse concept in potential safety enhancements to weapons being planned for retention in the stockpile; this is being considered in the safety enhancement studies previously mentioned." These studies have not progressed to the point of identifying specific design modifications.

The amendment to the fiscal year 1993 budget request reflects the reduced workload which resulted from cancellation of the W88 and other warhead production programs.

Senator NUNN. In 1989, the Director of the IAEA proposed that the former Soviet Union store the fissile materials extracted from its surplus nuclear warheads with the Agency. Did the Department of Energy support this proposal or have any position on it?

Mr. CLAYTOR. We are not aware of such a proposal in 1989 by the Director of the IAEA. In 1989, Soviet Foreign Minister Shevardnadze gave a speech at the 44th U.N. General Assembly, in which he called upon all nuclear states to commence preparation for conclusion of an agreement to stop and ban the production of fis-

sionable material for military purposes and in which he suggested that IAEA safeguards could be used in verifying such an agreement. The Director of the IAEA noted that a reduction in the production of such material for weapons purposes would be very broadly welcomed and that, given adequate resources, the IAEA would have the ability to verify that no use for weapons purposes is made of any nuclear facility or fissionable material submitted to its safeguards. However, no proposal was made by the Director of the IAEA for the Agency to store fissile materials extracted from former Soviet Union surplus nuclear warheads.

In any case, as a result of the dramatic changes that have occurred in the former Soviet Union, we are now addressing the issues associated with fissile materials recovered from former Soviet Union in our ongoing discussions with Russia. These discussions include use of Nunn-Lugar Act funds to assist the Russians in building a safe and secure storage facility for recovered highly enriched uranium (HEU) and plutonium and establishing an effective material control and accounting and physical protection system for such a facility. In addition, on August 28, 1992, the United States and the Russian Federation initialed an agreement to ensure that HEU from dismantled nuclear weapons in Russia will be used only for peaceful purposes. The agreement provides for the conversion of this material into civilian reactor fuel and establishes measures to ensure that the nonproliferation, physical security, material accounting and control, and environmental requirements covering this material are met. Specifically, the agreement states that the HEU and the low enriched uranium (LEU) acquired by the United States under the agreement will be subject to safeguards in accordance with the agreement between the United States of America and the International Atomic Energy Agency (IAEA) for the Application of Safeguards in Connection with the Treaty for the Non-Proliferation of Nuclear Weapons. In addition, the agreement states that the United States and the Russian Federation maintain physical protection of the HEU and LEU acquired by the United States. At a minimum, this protection should be comparable to the recommendation set forth in IAEA document INFCIRC/225/REV.2 concerning the physical protection of nuclear material. In addition, we are assessing a full range of policy options for the disposition and management of the excess weapons plutonium (Pu).

#### REGARDING DISPOSITION OF EXCESS U.S. FISSILE MATERIAL

Senator NUNN. In your statement, you say: "Studies are also being initiated both within and outside DOE to examine the options for the long-term disposition of plutonium removed from U.S. weapons." At U.S. insistence, Article XII.A.5 of the IAEA statute requires that any fissile material extracted from excess nuclear warheads that is surplus to the civilian nuclear reactor fuel requirements of its member nations be deposited with the IAEA for safekeeping.

a. Is the United States considering turning over to the IAEA any excess U.S. fissile material that will be freed up as a result of the START I and II Treaties?

b. Does the Department of Energy still think it important that other nations do so?

Mr. CLAYTOR. a. The United States has made no decisions at this time on what materials will be made excess from its weapons stockpile. Similarly no decisions have been made concerning the long-term disposition of any nuclear materials declared to be excess. Pursuant to Article XII of the IAEA Statute, the United States has no agreement with the IAEA under which it could deposit with the IAEA U.S. fissile material resulting from START I and II.

b. Although the IAEA statute provides for the storage of excess plutonium under IAEA auspices, such an international plutonium storage system has yet to be established. We would be prepared to work with other member states of the IAEA to define such a system.

Senator NUNN. In your statement you state that the Department of Energy will phase out all fuel reprocessing at Savannah River except for reprocessing spent reactor fuel for waste management purposes. I was under the impression that reprocessing generates substantial additional waste, including high level waste. Why is the Department of Energy reprocessing for waste management purposes?

Mr. CLAYTOR. The portion of my statement which you reference was meant to convey our intent to conduct stabilization and spent fuel management activities. My statement was not meant to imply a change in mission for the reprocessing plants. The decision to phase out reprocessing and bring the plants to a stable, shut down condition is clear, the details and specific schedules for achieving the phase out are in the process of being finalized. Activity at the Savannah River Site's H-Canyon will continue over the 5- to 6-year time period required to process plutonium-238 in support of a scheduled National Aeronautics and Space Administration mission and stabilize, by conversion to oxides, solutions currently being stored at the reprocess-

ing facility. Whether or not spent fuels will continue to be reprocessed in the facilities during the phaseout is under the early stages of consideration. Any decision will be made consistent with the NEPA process.

Senator NUNN. a. In your statement, you say: "We are unsure how many warheads the former Soviet Union has produced." Can you give us a range of uncertainty here; in other words, how many warheads do we think they still have, plus or minus what?

b. As I noted in my opening statement, as part of the Nunn-Lugar program, the United States has offered to assist Russia by giving them a sophisticated computer system that can be used to establish an accounting and inventory control system for their nuclear stockpile. Does this mean the U.S. questions whether Russia knows how many nuclear warheads the former Soviet Union has produced and how many are still retained?

c. In February, Russia proposed a data exchange among the nuclear powers with regard to their respective nuclear weapons inventories. With what degree of confidence would we view such data declaration by Russia, compared, say, to the Soviet Union's data declarations under the START, INF, and CFE treaties?

Mr. GRAHAM. [Deleted.]

The United States has no reason to doubt that Russia knows how many nuclear warheads were produced by the former Soviet Union, and how many are still retained. During the Safety, Security, and Dismantlement discussions, the Russians informed us that Russia had an effective accounting and control system for nuclear weapons in place, and that no U.S. assistance was required in this area. However, they did indicate that U.S. assistance would be welcome in the area of accounting for nuclear materials. Therefore, the United States offered to help Russia to establish an accounting system for nuclear material. We offered not only to share our experience but also to provide the necessary computers, software, measurement devices, and training at U.S. cost.

Only data that the United States itself measures or obtains directly using its own resources can be used reliably in making compliance judgments. Any unverifiable exchange can serve only as a confidence building measure. Declared data would have to be treated as unverified information. However, some data, like numbers of silo launchers, could be confirmed by national technical means and used with confidence. Any verification measures that would be consistent with U.S.—or Russian—requirements for protection of nuclear weapons design information would be woefully inadequate to ensure that all weapons or facilities were declared. Acceptable verification measures probably could be devised to allow us to monitor declared weapons and facilities. However, additional measures would be needed for verification of undeclared weapons and facilities. Such measures would be exceedingly intrusive, expensive, and complex. Based on the level of intrusiveness alone, such measures would most likely be unacceptable to both the United States and Russia. Moreover, they would not be sufficient to ensure that all nuclear weapons, fissile material, and nuclear facilities located on the territory of the Russian Federation were declared and accounted for.

Senator NUNN. Some of the proposals discussed today involve placing all facilities in Russia and the United States capable of producing significant quantities of fissile material under a joint or international verification and control regime. The July 1991 report of a Federal Advisory Committee on warhead dismantlement includes the following conclusion:

"There are significant asymmetries between the U.S. and Soviet nuclear warhead production and processing infrastructures. In general, the Soviet infrastructure is considerably larger and has more redundancy. This asymmetry would place a much greater burden on U.S. verification of Soviet nuclear activities than vice versa." Can you elaborate?

Mr. GRAHAM. The Russian nuclear weapons production complex is more redundant than ours and portions of all production capabilities remain functional. Russia has announced plans to phase out production of weapons-grade plutonium but has indicated that this may not be accomplished until the year 2000, whereas U.S. capabilities in this area has been shut down since 1988. Furthermore, unlike the United States, which has laws prohibiting the use of civilian reactors for producing materials for weapons, Russia could use its civilian nuclear program to augment military production. Normal and proper operation of some of Russia's power reactors, for instance, produce weapons-grade plutonium. Clandestine production would be very difficult to detect; weapons-grade uranium could be produced in relatively small facilities using advanced technologies. Finally, the Russians have acknowledged that they have more than one facility for weapons assembly/disassembly, whereas the United States has only one. The United States would have to monitor all of Russia's weap-

ons production complexes and a significant portion of its civilian nuclear industry under a comprehensive regime.

Senator NUNN. What can you tell us about the kinds of verification arrangements Russia has agreed to establish with Ukraine in response to Ukrainian demands that it know what was happening to nuclear warheads currently on its soil that are being shipped to Russia for elimination?

Mr. GRAHAM. A copy of the agreement, its protocol, and the annex to the protocol is attached for your information.

DEPARTMENT OF STATE  
OFFICE OF LANGUAGE SERVICES

(Translation)

LS No. 138094  
PH/AO  
Russian

A G R E E M E N T

between Ukraine and the Russian Federation concerning  
the Procedure for Movement of Nuclear Munitions from  
the Territory of Ukraine to Central Pre-Factory Bases  
of the Russian Federation for the Purpose of  
Dismantling and Destroying Them

Ukraine and the Russian Federation, hereafter referred to as  
the Parties,

Taking into account the Agreement on Joint Measures with  
respect to Nuclear Weapons of December 21, 1991, the Agreement  
between the Member States of the Commonwealth of Independent  
States on Strategic Forces of December 30, 1991, and also the  
Agreement between the Member States of the Commonwealth of  
Independent States on the Status of Strategic Forces of February  
14, 1992,

Reaffirming their adherence to the Treaty on the  
Non-Proliferation of Nuclear Weapons of March 1, 1968,  
Guided by the objective of eliminating nuclear weapons,  
Considering the consequences of possible accidents with  
nuclear weapons during their movement,  
Have agreed as follows:

Article 1

For the purposes of this Agreement, the terms cited below  
have the following meanings:

"Nuclear munitions": standard nuclear munitions for tactical  
and strategic nuclear weapons; ? sets of spare parts,  
instruments, and accessories [Russian acronym: "ZIP"]; and  
accompanying documentation for these munitions.

"Special equipment": training and practice nuclear weapons,  
their simulators and ? loading mockups, operational and  
technological equipment, operational documentation, special  
transport and hoisting equipment intended for transporting  
nuclear munitions, [for] working with them in field conditions,  
and also for use in eliminating accidents.

## Article 2

Ukraine will exercise the rights and fulfill the obligations arising from this Agreement with reference to her territory and taking into account her interests connected with implementing the Agreement on Joint Measures with respect to Nuclear Weapons of December 21, 1991. She will carry out monitoring of the movement of nuclear munitions located on her territory, and jointly with the Russian Federation will ensure their removal to central pre-factory bases located on the territory of the Russian Federation, for dismantling and destruction.

The Parties will carry out monitoring of the elimination of nuclear munitions according to a procedure defined by the Protocol to this Agreement.

## Article 3

Any movement of nuclear munitions on the territory of Ukraine and removal thereof to the territory of the Russian Federation will be carried out according to plans agreed upon with the agencies authorized by the Parties' governments.

Monitoring of movement of nuclear munitions on the territory of the Parties will be carried out by their authorized agencies. They will monitor the actual quantity and designation of the nuclear munitions being removed in transport vehicles, and will maintain a documentary accounting of the nuclear munitions turned over for subsequent dismantling and destruction.



## Article 4

Each Party will ensure secure and unimpeded movement of transports with nuclear munitions on its territory. In the planning and organization of transports of nuclear munitions, the provisions of the relevant regulatory documents for these munitions are in effect. The Parties will ensure the unimpeded crossing of their borders by transports with nuclear munitions without the conducting of a Customs inspection.

For the transport of nuclear munitions, special vehicles are used, the escort and guarding of which will be carried out only by the personnel of nuclear ? technical forces and units.

## Article 5

In case of an accident on the territory of Ukraine, the consequences of such an accident will be eliminated by the Parties.

Issues connected with liability for compensation of damages caused by an accident, including compensation of damages to natural and juridical persons of third states, will be reviewed by a special commission of the Parties, created on a basis of parity.

If an accident occurs with nuclear munitions, the Party on whose territory the accident took place will immediately notify the governments of the Commonwealth of Independent States and the International Atomic Energy Agency.

## Article 6

During the entire period in which nuclear munitions are located and [or] moved ? on their territory, the Parties will employ the appropriate regulatory documents for activities of troops (of naval forces) and of special units in connection with possible accidents with nuclear weapons.

The designation of the special equipment located in nuclear technical forces and units deployed on the territory of Ukraine, and subject to removal, and the procedure for its removal, will be defined in a separate Agreement.

## Article 7

The Parties will hold consultations by mutual arrangement to review issues connected with implementing the provisions of this Agreement, and also the possible introduction of amendments to it.

## Article 8

The provisions of this Agreement are without prejudice to the sovereign rights of the Parties, including those deriving from their current laws and international agreements.

## Article 9

The Agreement becomes effective on the date of its signing, and remains effective until the measures for which it provides have been carried out.

Done at..... on....., 1992,  
in two originals, each in Ukrainian and Russian, both texts being  
equally authoritative. :

For Ukraine:  
[--]

For the Russian Federation:  
[--]

## P R O T O C O L

to the Agreement between Ukraine and the Russian Federation  
"Concerning the Procedure for Movement of Nuclear Munitions  
from the Territory of Ukraine to Central Pre-Factory Bases of  
the Russian Federation for the Purpose of  
Dismantling and Destroying Them"  
Concerning the Procedure for Monitoring the Destruction of  
Nuclear Munitions, Removed from the Territory of Ukraine,  
at Industrial Enterprises of the Russian Federation

Ukraine and the Russian Federation, hereafter referred to as  
the Parties,

In accordance with the provisions, and in implementation of,  
the Agreement concerning the Procedure for Movement of Nuclear  
Munitions from the Territory of Ukraine to Central Pre-Factory  
Bases of the Russian Federation for the Purpose of Dismantling  
and Destroying Them," hereafter referred to as the Agreement,  
Have agreed as follows:

## Article 1

For the purposes of this Agreement, the terms cited below  
have the following meanings:

"Observer": a person appointed by a Party to carry out the  
activity of observation and monitoring of the dismantling and  
destruction of nuclear munitions at industrial enterprises;

"Dismantling": the process of disassembling nuclear  
munitions into their component parts with extraction of the  
warhead;

"Industrial enterprise": an enterprise of the Russian  
Federation that manufactures nuclear munitions, at which the  
dismantling and destruction of nuclear munitions are carried out;

"Destruction": the process of physical demolition or  
irreversible deformation of the casing and component parts and  
the extraction from the warhead of the fissionable materials in  
order to rule out the possibility of reuse in nuclear munitions.

## Article 2

Ukraine will carry out monitoring of the dismantling and  
destruction of nuclear munitions, removed from her territory, at  
industrial enterprises of the Russian Federation with the  
participation of the Republic of Byelarus and the Republic of  
Kazakhstan, with the consent of the latter.

## Article 3

The Russian Federation will give Ukraine the necessary data on the scope of monitoring. The Procedure for monitoring the dismantling and destruction of nuclear munitions is defined by the Annex to this Protocol on Procedures for Observation and the Activity of Monitoring the Destruction of Nuclear Munitions at Industrial Enterprises of the Russian Federation.

## Article 4

Ukraine will create her agency for monitoring the dismantling and destruction of nuclear munitions. Direct observation and monitoring of the dismantling and destruction of nuclear munitions at industrial enterprises will be carried out by observers. The observers will carry out their activity in the interests of the Party that appoints them, and are accountable to its monitoring agency.

## Article 5

The Russian Federation, to enable the observers to carry out their functions effectively during the entire period of their stay at the industrial enterprises, will create suitable conditions for them for the purpose of assisting their activity. In this connection, the observers, without prejudice to their activity, are obligated to respect the current laws of the Russian Federation and not to interfere in the technological processes of the dismantling and destruction of nuclear munitions which are carried out in accordance with the requirements of the regulatory and technical documentation.

[no signatures]

## Article 6

The Russian Federation shall provide the observers with appropriate material-technical, lodging and medical support during the entire period of their presence at the industrial enterprises.

The expenses for the maintenance and support for the activities of the observers at the industrial enterprises of the Russian Federation shall be dealt with in accordance with the Annex to this Protocol.

## Article 7

The Sides shall conduct consultations by mutual agreement for considering questions connected with the implementation of this Protocol and possible amendments to it.

## Article 8

The provisions of this Protocol shall not affect the sovereign rights of the Sides including the valid legislation and international obligations resulting from them.

## Article 9

This Protocol shall be an integral part of the Agreement. It shall enter into force simultaneously with the entry into force of the Agreement.

Done at \_\_\_\_\_ on \_\_\_\_\_ 1992 in two originals each in the Ukrainian and Russian languages, both text being equally authoritative.

For Ukraine

For the Russian Federation

## ANNEX TO THE PROTOCOL

between Ukraine and the Russian Federation "on the Monitoring Procedures for the Destruction of Nuclear Munitions Removed from the Territory of Ukraine to Industrial Plants of the Russian Federation" on the procedures and activities concerning the monitoring of the destruction of nuclear munitions at industrial plants of the Russian Federation

In accordance with the provisions and in implementation of the Agreement on the Procedures of the Transfer of Nuclear Munitions from the Territory of Ukraine to the Central Pre-Factory Bases in the Russian Federation for the Purpose of Dismantling and Destroying them, and of the Protocol on the Monitoring Procedures in the Destruction of Nuclear Munitions, removed from the territory of Ukraine to industrial plants of the Russian Federation, hereinafter referred to respectively as the Agreement and the Protocol, the Sides herewith agree on the procedures regulating the implementation of the monitoring of the destruction of nuclear munitions at industrial plants of the Russian Federation.

## I. GENERAL PROVISIONS

The elimination of nuclear munitions removed from the territory of Ukraine shall be carried out in industrial plants of the Russian Federation.

For the purposes of ensuring monitoring of compliance with the provisions of the Agreement and the Protocol, the Russian Federation shall cooperate in carrying out monitoring activities of the destruction of nuclear munitions removed from the territory of Ukraine.

## II. OBSERVERS' LEGAL STATUS

The monitoring is carried out by observers from the two Sides who conduct the observation.

The observers may be Ukrainian citizens carrying out the monitoring functions, or citizens of the Russian Federation hired on contract. The observers are designated from among the

officer corps having practical work experience with nuclear munitions.

Ukraine shall have the right to designate no more than three observers at every industrial plant. It shall provide a list of its observers to the Russian Federation for approval. This list shall contain the first and last name, patronymic, day, month, year, and place of birth, as well as the number of the candidate's identity papers.

A person included in the list of observers may be removed from it by the Russian Federation only if criminal proceedings have been instituted against him/her on the territory of the Russian Federation, or if he/she has been convicted by the courts of the Russian Federation.

The observers carry out their functions in accordance with this Annex.

The observers shall not disclose information received in the course of their activity as observers. They shall continue to be bound by this obligation even after the end of their activities as observers.

While carrying out their functions, the observers shall deal with the personnel of the industrial plant only through the administration and the competent personnel of the military representation.

Except as provided in this Annex, the observers shall not interfere in the activity carried out at the place of observation and the observed work. They shall not cause hindrances or delays in the work of the plant and shall not undertake any actions affecting their safe functioning.

In carrying out their activities, the observers comply with the safety rules established at the place of observance, including the rules for personal and equipment safety.

If the observers in carrying out their functions violate the rules and procedures which govern their observation activities, the administration of the industrial plant may

inform the leader of the group of observers of this in order that he may take appropriate measures. If absolutely necessary, the administration of the industrial plant may include a description of such activities in the observation report, and the leader of the group of observers may include an answer to that description.

The Russian Federation shall ensure that the observers are able to maintain contact with the authorized bodies of the Sides during the entire course of their presence at the industrial plants, and it also shall provide transport in order to resolve official questions.

### III. PROCEDURES FOR THE DISMANTLING AND DESTRUCTION OF NUCLEAR MUNITIONS

The initial data on the extent of the monitoring of the dismantling and destruction of nuclear munitions removed from the territory of Ukraine shall consist of designation, type, and number of the munitions as well as the manufacturer's serial number, according to the delivery papers presented to the control organ.

The dismantling plan for nuclear munitions shall be submitted by the industrial plant to the chief of the group of observers in good time, but no later than 30 days before its implementation.

The representatives of the military receiving unit at the industrial plant shall furnish the observers with records of the nuclear munitions to be dismantled and destroyed.

The dismantling of the nuclear munitions into their component parts, and their destruction shall be carried out in strict adherence to the requirements of the appropriate manufacturing documents. The observers shall control step by step the dismantling of nuclear munitions into their component



parts and their destruction, the extraction and dismantling of the charge.

IV. EXPENSES OF THE ACTIVITIES  
OF THE OBSERVERS AT THE  
INDUSTRIAL PLANTS

For the entire duration of the observers' presence at the industrial plants, the Russian Federation shall provide the observers with food, quarters, and work space, and where necessary, official vehicles, and medical and other services at conditions and prices which may not be less advantageous than those applied to citizens of the Russian Federation.

The expenses of these services shall be distributed as follows:

United States Department of State



a) expenses for official vehicles and <sup>Washington, D.C. 20520</sup> emergency medical services shall be borne by the Russian Federation;

b) expenses for food and use of living space as well as for temporary and permanent work space, including common services and operating expenses for these places shall be borne by Ukraine;

c) expenses for transporting the observers, their personal effects and equipment shall be borne by Ukraine

This Annex shall be an integral part of the Agreement. It shall enter into force simultaneously with the entry into force of the Agreement.

Done at \_\_\_\_\_ on \_\_\_\_\_ 1992  
in two originals, each in the Ukrainian and Russian language,  
both texts being equally authoritative.

For Ukraine

For the Russian Federation

Senator NUNN. Some experts have recommended that the United States and Russia disable all warheads now that are on systems scheduled for dismantlement under START I and START II. What is the Defense Department's assessment of the merits and risks of such an approach.

Mr. GRAHAM. During the discussions at the time of the Washington Summit agreement between the United States and Russia, which was signed on June 17, 1992, the United States raised the concept of early deactivation of land-based MIRVed missiles and other systems that would be reduced under START and the new agreement, to include the removal of their warheads. We are very interested in the concept of early deactivation, particularly for land-based MIRVed missiles, as a means of removing the systems' immediate potential for accidental, unauthorized, or deliberate use. We intend to pursue further discussions with the Russians on this topic. The United States has already taken off alert its Minuteman II missiles. We will eliminate these systems under the START Treaty, and are now in the process of removing their warheads to safe and secure central storage areas. To date, the topic has not been discussed with the other three former Soviet republics with nuclear weapons on their territories.

---

#### QUESTIONS SUBMITTED BY SENATOR JOHN W. WARNER

Senator WARNER. Dr. Gallucci, do you believe it is dangerous to the United States if the Russians were to retain the pits from dismantled weapons. Is it possible they would rebuild their strategic forces?

Mr. GALLUCCI. Russian retention of the pits from dismantled weapons would not pose an unacceptable danger to the United States. Rebuilding Russian strategic forces requires far more than reassembling warheads; our primary tool for reducing those forces is START and the new treaty implementing the June 17 Joint Understanding, which will reduce the number of launchers, and thus the number of deployed missiles and deployed warheads, in the former Soviet Union. Since we are not depending on warhead dismantlement to reap the security benefits of reducing the former Soviet arsenal, the risk of warhead reassembly does not unduly threaten our security.

At the same time, Russian officials have informed us that they do not plan to recycle for military uses plutonium and highly enriched uranium resulting from nuclear weapons destroyed during the dismantlement process. Hence, the two sides have begun discussions on a possible U.S.-Russian design effort for a long-term storage facility for fissile materials from dismantled weapons, and on the ultimate disposition of those materials. Our program of assistance, which will include a thorough material control and accounting system and associated transparency measures, should provide added assurance that the fissile materials from Russian nuclear weapons are not being recycled.

Senator WARNER. Dr. Gallucci, as you know the resolution of START, which was approved by the Senate Foreign Relations Committee on July 1, contains a condition that subsequent strategic arms reduction treaties provide for an inventory and verification of both warheads and fissionable material.

Dr. Gallucci, as someone who has first hand experience as an on-site inspector, what is your professional judgment of the verifiability of an agreement which requires an inventory and monitoring of stockpiled fissionable material and warheads?

In general, Dr. Gallucci, what would be the most important inspection requirements and activities to be able to verify a baseline inventory of fissile material and warheads, if such an arrangement were to be reached?

Mr. GALLUCCI. The verifiability of such an agreement concerns me. While acceptable verification measures could probably be devised to monitor declared weapons and facilities, the additional inspection measures needed to detect undeclared weapons and facilities would be exceedingly intrusive, complex, and expensive. Even with intrusive verification provisions for undeclared facilities they may still not be sufficient to ensure that all nuclear weapons, fissile material, and nuclear facilities in Russia were declared and accounted for.

For these reasons, the administration has not determined baseline inspection requirements for such an agreement.

Senator WARNER. Have the Russians shown any indication that they will need to retain the pits from dismantled weapons for the purpose of maintaining their stockpile?

Mr. GALLUCCI. According to Russian officials, they have historically not needed long-term storage facilities for weapons grade materials, because the fissionable ma-

material from dismantled warheads was recycled into new warheads. Recent statements indicate that Russia now plans to store rather than recycle plutonium and highly enriched uranium resulting from nuclear weapons destroyed during the dismantlement process—hence the requirement to build long-term storage facilities. Russian willingness to allow U.S. participation in the construction and joint Russian-U.S. operation and control of this storage facility (even to the extent of a dual-key access system) demonstrates their intent not to reuse this fissionable material in weapons.

Senator WARNER. Mr. Claytor, the Senate yesterday adopted a limitation on nuclear testing which requires the submission to Congress of an extensive report relating to the U.S. nuclear weapons stockpile. What is the current status of the ongoing stockpile plan update as a result of the June 17 summit agreements on strategic arms reduction? When can we reasonably expect to receive that report? And, to the extent that you are familiar with the report required in the provision adopted yesterday in the Senate, will the stockpile update include all the requested information?

Mr. CLAYTOR. The President requested that the fiscal years 1993-1998 Nuclear Weapons Stockpile Memorandum (NWSM) be submitted to update the existing stockpile plan in response to the June 17, 1992, summit. The Joint Chiefs of Staff have been updating the nuclear weapons requirements with the Commanders in Chief in the field, and the results have been put into a draft NWSM. The NWSM is projected to be ready for the signatures of the Secretary of Defense and the Secretary of Energy by the end of September 1992.

If required, the "extensive report" relating to the U.S. nuclear weapons stockpile will be submitted by March 1, 1993.

The fiscal years 1993-1998 NWSM will contain the following information, which supports the proposed "extensive report" specified on pages S11195-S11196 of the August 3, 1992, Congressional Record—Senate, concerning discussions of the Senate Appropriations bill:

1. The number and type of nuclear warheads that will remain in the United States stockpile of active nuclear weapons on September 30, 1996.

2. The number and type of nuclear warheads that will remain in the U.S. stockpile of nuclear weapons and that—

- (i) will not be in the U.S. stockpile of active nuclear weapons;
- (ii) will remain under the control of the Department of Defense (DOD); and
- (iii) will not be transferred to the Department of Energy (DOE) for dismantlement.

Information provided by 1 and 2 above would enable us to know which warheads to provide safety-feature descriptions. Other information for the extensive report will have to be collected from within DOE and DOD in order to complete a final report to Congress.

#### CORRECTION OF TESTIMONY

Senator WARNER. Mr. Claytor, in your prepared statement you indicate uncertainty about the ultimate disposition of highly enriched uranium not needed for weapons. It was my understanding that a decision had been announced to use this HEU to produce naval nuclear reactor fuel.

Has there been a change in that decision, or is your testimony not correct?

Mr. CLAYTOR. The Department did announce last year that highly enriched uranium (HEU) returned from weapons would be used to meet the needs of the Naval Nuclear Propulsion Program.

In my prepared statement I was referring to the fact that no plans have been made for use of this material for commercial fuel for nuclear power plants.

Senator WARNER. Mr. Claytor, the July 1991 report to Congress contains the following statement, in the midst of a number of serious cautions concerning the verifiability of a fissile material control regime:

"The importance of the uncertainty in our knowledge of the total SNM (special nuclear material) stockpile inventory would increase as the size of the weapons stockpiles were decreased."

What was the projected size of the U.S. stockpile and the Russian stockpile when this report was prepared?

Mr. CLAYTOR. During the preparation of this report, a stockpile level of approximately 20,000 weapons was assumed for the United States and the U.S.S.R. each.

Senator WARNER. Please elaborate on this statement, in light of the significant anticipated reductions in both stockpiles.

Mr. CLAYTOR. The uncertainty in our knowledge of the stockpiles of the former Soviet Union (FSU) in units of metric tonnes would amount to material available for a very large number of nuclear weapons. As the declared number of deployed and stockpiled warheads decreases, the equivalent warhead uncertainty becomes a larger fraction of the declared number and therefore assumes a greater significance in the verification regime.

Senator WARNER. Mr. Claytor, the July 1991 report to Congress on the verifiability issues associated with warhead dismantlement and fissile material inventory and controls contains a number of serious cautions concerning the verifiability of warhead controls and dismantlement. What were the assumptions about the availability of on-site inspection of warhead and fissile material production and dismantlement facilities which were used in making the assessments included in the report? If on-site inspections are factored out of the monitoring regime, would the conclusions of the report change significantly?

Mr. CLAYTOR. The assessments in the report were offered in the context that on-site monitoring techniques, inspection arrangements, and national technical means could somehow be applied in synergism or independently to attempt verification, since this was the actual topic of the report.

The conclusions of the report would not change significantly if on-site inspections are factored out of the monitoring regime, because it was concluded that monitoring with high confidence would be very difficult at best, and accurate SNM and warhead stockpile initializations would be practically impossible. If anything, because the capability of NTM to accomplish the task was questioned, monitoring without on-site inspections would make matters somewhat worse.

Senator WARNER. Mr. Claytor, the July 1991 report also states that, "In any agreement to limit production of SNM, verification would require monitoring of appropriate elements of the civilian fuel cycle." This sounds like a monumental task, both from our perspective and that of Russia. Could you comment on this observation please.

Mr. CLAYTOR. Very large quantities of fissile material, relative to that required to manufacture a nuclear weapon, are available from normal nuclear electrical and thermal power production in the United States, FSU, and throughout the world. To ignore this fact and only monitor declared shutdown weapons, material production facilities would significantly decrease a country's confidence that another is not stockpiling weapons or weapons material clandestinely.

Senator WARNER. Mr. Claytor, if the U.S. decides to store the complete pits at PANTEX, as has been suggested, do you envision any problem in having international inspectors monitor the deposit and withdrawal of pits from the storage facility? Would that be in our interest?

Mr. CLAYTOR. Although there would certainly be security and operational problems resulting from international inspections at a facility such as PANTEX, accommodation can be made if such inspections were included in the agreement.

First, it must be recognized that we are legally bound under the Atomic Energy Act (AEA) to protect sensitive nuclear weapons design information (restricted data). Presently there is no demonstrated and accepted way to certify that an object is a pit without revealing restricted data, and knowledgeable observers could readily gain useful nuclear weapons design information from viewing pits. This would not be permitted under current prohibitions of the AEA and would conflict with U.S. responsibilities under the Nonproliferation Treaty.

There would also be significant operational impacts that would affect schedules and costs. Under present circumstances and procedures, and without providing new or renovated facilities, the United States would have to disrupt on-going work to provide for the international inspectors and the dismantlement rate we are currently able to achieve for U.S. nuclear warheads may be negatively affected. Thus, we do not think the presence of international inspectors at our storage facilities would be in our interest.

Senator WARNER. Mr. Graham, assume for a moment that the Biden Condition is adopted by the Senate as a condition for ratification of START I.

- What is the current status of our ability to verify the accuracy of initial data provided by Russia on their existing stockpile of nuclear warheads and fissile material, as well as their current production capacity?

- Assuming this data can be proven accurate, what is required in terms of on-site inspection and other measures to ensure against covert or clandestine production of such material, as well as disarmament of nuclear warheads and accounting for fissile material?

- What are the practical problems and potential security risks of on-site monitoring of warhead dismantlement?

Mr. GRAHAM. [Deleted.] The former Soviets have announced that they have shut down most of the plutonium production reactors and plan to shut down the rest by the year 2000. [Deleted.]

A verification regime that would require measures for detection of undeclared weapons and facilities would be exceedingly intrusive, expensive, and complex. [Deleted.] However, the benefits of any such regime would only be marginal, as any inspections for undeclared weapons and facilities could only improve our chances, but could never guarantee, that all nuclear weapons, fissile material and nuclear facilities located on the territory of the Russian Federation were declared and accounted for. Further, highly intrusive inspections of U.S. facilities would raise security concerns about revealing national security information or nuclear weapons design information protected under the 1954 Atomic Energy Act.

Moreover, experience suggests that the Russians would likely be unwilling to accept such highly intrusive inspections. Russia would likely require reciprocity in any inspection regime negotiated in a START or new agreement context. Given this possibility, the administration would be unwilling to propose a monitoring scheme that we were unprepared to accept ourselves because it was inimical to U.S. security interests.

Senator WARNER. Mr. Graham, if the United States were required to dismantle nuclear warheads and destroy the fissile material from those warheads, do you believe that the United States ought to reassess the recently announced Presidential policy on nonproliferation, which bans the production of plutonium and highly enriched uranium?

Mr. GRAHAM. The U.S. requires an assured availability of fissile material to maintain a modernized nuclear stockpile in a safe, reliable state. The Presidential policy clearly assumed the ability to use the fissile material from dismantled warheads to maintain the U.S. nuclear stockpile.

Senator WARNER. Mr. Graham, why does the June 17 Joint Statement on START completely relax the difficult-to-negotiate warhead "downloading" constraints of START, specifically, the important requirement that modernized missiles which have been "downloaded" have a new "front section"?

Is the June 17 Joint Statement on START actually a step backward in the long U.S. effort to constrain the number of warheads that former Soviet missiles can potentially carry? Is it inconsistent or unrealistic for the full Senate to adopt the Biden Condition in the Senate Foreign Relations Committee's START resolution of ratification encouraging the negotiation in the June 17 Summit Joint Statement of a requirement for the destruction of nuclear warheads on both sides?

Mr. GRAHAM. Under START, the Soviets sought significantly more downloading than the United States wanted to permit. Our concern was not simply the extent of Soviet breakout capability, but also that significant downloading would have allowed the Soviets to field a much larger force structure than would otherwise have been possible. The disintegration of the Soviet Union, the move to democratic rule in Russia and the other republics, and the severe economic problems in the former Soviet Union have diminished, to a certain extent, these earlier U.S. concerns.

The United States sought relief under the new agreement from START downloading constraints in order to meet the limits on SLBM RVs. We wanted to be able to download more than 500 RVs from U.S. SLBMs—all that START would allow—and more than a total of 1250 RVs, given that downloading of 500 Minuteman IIIs to a single-RV configuration would account for 1000 warheads under the START downloading limit. Finally we did not want to have to destroy the RV platforms on Trident missiles, and deploy new ones—which START would require if a missile were downloaded by more than two RVs. The START provision requiring reentry vehicle platforms to be destroyed when ICBMs or SLBMs are downloaded by more than two reentry vehicles was included at Soviet insistence to conform with claimed Soviet practices. The United States did not seek the provision and has based no verification or breakout decisions upon it. We regard this requirement, which has no verification provisions associated with it, as, at best, a confidence building measure. Thus, we do not consider Russian acceptance of our proposal that platform destruction not be required under the Joint Understanding increases the risk of breakout. The new agreement when codified would afford us relief in each of these areas, while not modifying the downloading provisions in the START Treaty itself, as these provisions apply under START.

The June 17 Summit Statement is not a step backward on downloading—it provides substantial flexibility for the United States and still results in the elimination of all Russian MIRVed ICBMs. Under the new agreement when codified, the Russians will not be able to download their SS-18s. While they could potentially download their SS-19s and SS-24s by up to 4 RVs, these systems would still have more

than one warhead—and would therefore have to be eliminated by the end of the second phase of the new agreement, i.e., by the year 2003 (or by the year 2000, if the United States can assist Russia in the elimination of its strategic offensive arms). With regard to SLBMs, we doubt that Russia will conduct any downloading beyond that allowed by START. Given their probable force structure, there would appear to be little reason for them to do so.

With regard to the Biden Condition, the administration is concerned that we not delay codification, ratification, or implementation of the agreement on additional reductions in strategic offensive arms and the elimination of all MIRVed ICBMs recorded in the June 17 Washington Summit Joint Understanding. The Joint Understanding represents an extremely important agreement of immense benefit to the United States. All substantive areas associated with the Joint Understanding have been resolved. The only remaining task is to turn the agreement into appropriate treaty language. Any interpretation of the Senate Foreign Relations Committee condition that would require new provisions, thus reopening the scope of the new treaty, or that links the implementation of the new treaty to an agreement on fissile material production or weapons stockpiles, risks at least a delay and possibly the unraveling of the important accomplishments of the Washington Joint Understanding. Thus, the administration would oppose any interpretation of this condition that required the administration to seek an additional agreement within the new treaty, or that linked the ratification or implementation of the new treaty to the requirement for an additional agreement to be negotiated.

Senator WARNER. Mr. Graham, in your prepared statement, you say that "We could not . . . identify a practical way to effectively verify actual warhead elimination even with an unacceptable degree of intrusiveness." Is it possible, in open session, for you to elaborate on the requirements for on-site inspection, for example, which violate a threshold of intrusiveness into the U.S. nuclear weapons program?

Mr. GRAHAM. The basic problem is one of nuclear weapons design information. Any verification method capable of clearly identifying that the warhead to be dismantled is a specific type of operational warhead, or perhaps even a specific warhead itself, would require such intrusive techniques that two types of national security information could be compromised. The first involves design information which is of proliferation value in that such information would increase another country's technical capabilities for developing or improving weapons. The second involves design information which might be used to exploit potential U.S. weapons vulnerabilities, thereby undermining the effectiveness of the U.S. nuclear stockpile.

Senator WARNER. Mr. Graham, in his statement before the Armed Services Committee last week, General Powell stressed the verification and monitoring measures available to ensure compliance by Russia and the other three new states with the START Treaty. However, I think you will agree that a key element of monitoring is access to sites and systems. What happens to the verifiability of the treaty if this access is denied because Russia and the three new states are unable to reach agreement on the issues covered by the Lisbon Protocol.

Mr. GRAHAM. While our primary vehicle for monitoring compliance with START, as with all arms control agreements, is NTM, the START verification regime was built on the assumption that the United States would be able to exercise its inspection and monitoring rights. The United States has fully exercised its inspection and monitoring rights under the arms control treaties it concluded with the former Soviet Union. The monitoring and inspection rights of the United States under START will be necessary to help verify treaty compliance. Thus, the verifiability of START would be reduced if access to facilities were denied.

We do not expect such access to be denied, however, as we expect that the four states will have agreed on implementing arrangements before entry into force. This does not mean, however, that the conclusion of a formal agreement among the four states on implementing the Lisbon Protocol is a prerequisite for START entry into force. The treaty could function effectively if an agreement were delayed, or even in its absence as long as the other Parties concerned permit the United States to exercise its rights on their territories. We have, for example, continued to exercise our rights under the INF Treaty even though we do not have the equivalent of the Lisbon Protocol for INF, let alone a formal INF implementing agreement among the States of the former Soviet Union that we regard as successors to the Soviet Union's obligations under the INF Treaty.

Senator WARNER. Mr. Graham, the nuclear testing language adopted by the Senate last night requires for the first time that the U.S. identify the weapons in the inactive stockpile reserve. Is it in the national interest to identify these weapons?

Second, will the weapons in the inactive reserve be kept ready with tritium for use if needed?

Mr. GRAHAM. No, it is not in the U.S. national interest to identify weapons in the inactive stockpile reserve. Such information compromises some of the uncertainty that complicates potential opponents targeting strategies.

By definition, the inactive stockpile reserve weapons are not equipped with tritium reservoirs. The Department of Energy maintains a capability, upon notification and with Department of Defense priorities identified, to re-equip the weapons with tritium reservoirs should they be required.

Senator WARNER. In the absence of maintaining a capability to deliver covertly produced and/or stored warheads, does it make much sense to maintain such a stockpile? What does a requirement for an inventory and verification of warheads and fissionable material bring to the table?

Mr. GRAHAM. Elimination of the means to deliver warheads is the most meaningful and verifiable way of reducing strategic nuclear forces. Once launchers are eliminated, missiles and their warheads no longer pose the same imminent threat to U.S. security that they do today. For this reason, we chose, in drafting START, to limit the means to deliver warheads, such as ICBM and SLRM launchers and heavy bombers. Rebuilding such delivery means would be extremely expensive, would take a long time, and, in comparison with warheads, would be relatively easy to monitor.

We found that we cannot effectively verify compliance with inventory limits or production constraints on warheads or fissile material, even with levels of intrusiveness that would pose serious and unacceptable risks of disclosure of sensitive U.S. technologies. We are unsure how many warheads the former Soviet Union has produced and we are not completely sure of the numbers and capacity of production or storage facilities of warheads in the former Soviet Union. Given that nuclear weapons are nearly two orders of magnitude smaller and lighter than ICBMs, which are themselves difficult enough to monitor, it would be virtually impossible to verify compliance with a warhead limitation regime.

Senator WARNER. Dr. Birely, the issues addressed in the Biden Condition are being discussed in the context of the SSD discussions with Russia. Significant progress has been made in some areas of those discussions to allow unprecedented access by the United States to Russian facilities and information, such as the agreements relating to the science centers. What progress has been made in achieving Russian agreement for on-site access to warhead production or dismantlement facilities? And what is your prognosis for future progress in the area within the context of the SSD talks?

Mr. GRAHAM. The Russian side has from the beginning of discussions, stated that they had no need for U.S. technical assistance in dismantlement or disablement of warheads.

However, the Russians have recognized the requirement for "transparency" in those areas where they have requested U.S. aid. For example, the overall agreement with Russia provides for a U.S. ability to examine the use of any material, training, or other services provided by the United States and to inspect related documents and records. Similarly, Russian representatives have acknowledged that the United States will require certain monitoring rights with regard to a fissile material storage facility, should the United States decide to support construction of the facility. The extent of these rights would be part of the agreement concerning the funding and construction of the facility.

#### QUESTIONS SUBMITTED BY SENATOR STROM THURMOND

Senator THURMOND. Secretary Gallucci, the START Treaty prohibits the transfer of ICBMs or launchers, heavy bombers, and long range nuclear air launched cruise missiles to third countries.

Considering the current state of affairs in the former Soviet Union, where hard currency will buy almost anything, together with recent comments of Russian officials about the need to obtain hard currency through arms sales, can we prevent the sale or transfer of these systems? Does the START Treaty contain any provisions which will help prevent arms transfers?

Mr. GALLUCCI. START has no provisions designed to verify directly the ban on transfer of strategic offensive arms. However, we believe that those transfers banned by START would not go unnoticed. In addition, START requires notifications on the number, location, and movements of heavy bombers and ballistic missiles. This information is subject to confirmation by on-site inspection. While these provisions provide no guarantees, they could act as a deterrent to the widespread

illegal transfer of strategic offensive arms to third countries. Although not originally intended for this purpose, these START provisions can provide an additional inventory control mechanism that might help alert START parties to the possible unauthorized, illegal transfer of heavy bombers and ballistic missiles to third countries by individuals or groups within the former Soviet Union.

Senator THURMOND. Mr. Graham, in accordance with the treaty, the Parties agree not to interfere with the National Technical Means of verification. The treaty further provides for cooperative measures to enhance National Technical Means. What are the cooperative measures that the Department is considering to enhance the use of National Technical Means in the verification process?

Mr. GRAHAM. Article XII of the treaty specifically provides for cooperative measures that a Party must carry out upon request to assist the other Party in its verification efforts using reconnaissance satellites. Article XII provides for cooperative measures applicable to road-mobile launchers of ICBMs, rail-mobile launchers of ICBMs, and heavy bombers. A Party may request up to seven cooperative measures per year. Such measures include displays in the open without concealment and opening roofs on fixed structures for road-mobile ICBMs. The administration intends to avail itself of all types of cooperative measures to assist our verification efforts.

Senator THURMOND. Mr. Graham, the July 1991 report to the Congress on Verification of Nuclear Warhead Dismantlement and Special Nuclear Materials Control states: "However, even the full suite of National Technical Means, inspection arrangement, and site monitoring techniques probably could not provide verification of Special Nuclear Materials quantities or the absence of clandestine production facilities without a significant margin of error."

Based on this assessment, what steps if any is the administration taking to correct this significant verification problem?

Mr. GRAHAM. The administration's priority has been on implementing the SSD effort with the former Soviet Union, which is proceeding without a formal verification regime. We do not expect any near-term breakthroughs that would advance the prospect of an effectively verifiable agreement on special nuclear material inventories or production with any acceptable degree of intrusiveness.

Senator THURMOND. Virtually every report I see on the size of the Soviet nuclear stockpile includes a cautionary footnote indicating that the figures are only estimates. To what degree of accuracy do we know the size of the Soviet Nuclear Stockpile to be?

Mr. GRAHAM. [Deleted.]

[Whereupon, at 4:55 p.m., the committee adjourned.]

