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NUCLEAR CONTROL
INSTITUTE
1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

August 29, 1989

Governor John Sununu
Chief of Staff to the President
The White House
Washington, D.C.

Dear Governor Sununu:

I wanted to be sure you saw the attached op-ed article in The New York Times that I wrote with Milton Hoenig on possible Soviet interest in a mutual halt in production of nuclear weapons materials, including tritium. I will be in contact with you shortly as you suggested at our meeting on August 4.

Thank you again for your interest in this matter.

Sincerely,

Paul Leventhal

Enclosure

cc: Roger Porter
Ed Rogers

The New York Times
MONDAY, AUGUST 28, 1989

NUCLEAR CONTROL INSTITUTE
1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

Mutually Assured Arms Reductions

By Paul L. Leventhal and Milton M. Hoenig

WASHINGTON

The Soviet Union may be signaling to the U.S. a willingness to engage in a complete, mutual halt in production of the essential elements of modern nuclear weapons: plutonium, enriched uranium and tritium.

This unexpected development coincides with the breakdown and shutdown of facilities used by both superpowers to produce nuclear weapons materials. It presents a historic pathway to peace and a way to avoid operating unsafe plants and building costly replacements.

In May, Mikhail Gorbachev proposed negotiating a verifiable mutual halt in production of two of the three nuclear weapons materials — plutonium and uranium. The U.S. has not accepted the offer — presumably because the Savannah River production reactors are shut down for safety reasons. The U.S. can hardly consider an arrangement in which all its military reactors are inoperable but some Soviet reactors produce tritium.

Tie them to the decay of tritium.

Unlike plutonium and uranium, which last for tens of thousands of years and are in abundant supply, tritium decays much more rapidly. Thus, it must be produced regularly to maintain or enlarge arsenals.

Paul L. Leventhal and Milton M. Hoenig are president and scientific director, respectively, of the Nuclear Control Institute, a research center on nuclear arms control.

In June, a Soviet Embassy official, reading his Government's response to a letter we sent to Mr. Gorbachev, told us that the Soviet Union could raise the possibility of halting tritium production if talks were to begin on halting uranium and plutonium production. Responding to our question, the official said that Mr. Gorbachev could raise the tritium question at a summit meeting, depending on "circumstances at the time."

Mr. Gorbachev clearly has severe nuclear headaches of his own. Aside from facing a post-Chernobyl popular uprising against civil nuclear power, he is shutting down his five oldest military reactors by 1991, operating nine others (none probably built after the 60's) and spending billions on three breeder reactors capable of replacing them. This situation presents a major opportunity for Washington.

The U.S. might do well to accept the offer to negotiate a verifiable halt in production of plutonium and uranium for weapons, but on two conditions. First, we must require the Soviets to join the U.S. in an immediate shutdown of all military reactors, effectively halting production of plutonium and tritium, while pledging that civil reactors will not be operated to make these materials. (Each side already has unilaterally halted production of enriched uranium for weapons.) Second, the Soviets should agree to expand negotiations to include an extended tritium halt as well.

An agreement like this would put the superpowers' nuclear materials production on equal ground, while shielding President Bush from accusations of dealing from weakness. Production of weapons materials would be stopped for the first time and the arms race would shift into reverse at a manageable speed, in line with foreseeable arms reductions.

No more tritium need be produced if both sides retire their warheads at a rate that equals or exceeds the decay of tritium: 5.5 percent a year. Each would continue to recover tritium from retired warheads to replenish remaining ones. Tritium replenishment could come from warheads retired under the Strategic Arms Reductions Talks, from weapons in storage or slated for retirement and from more efficient tritium management in deployed weapons. Negotiations beyond Start could reduce both sides total arsenals by at least 50 percent in 12 years if reductions are paced by tritium decay.

Because each side has an abundance of long-lived plutonium and uranium, a cutoff in these materials alone leads to no reductions in arms. But including tritium — because of its steady decay — guarantees an arms reductions payoff, which makes intrusive verification measures worthwhile for both sides.

A complete halt, which requires shutdown of all production reactors, can be verified promptly by satellite and begun immediately on an interim basis. Since each side has a deterrent of more than 20,000 warheads, there is ample protection against cheating during the interim halt.

Verification measures and the first reductions in warheads would have to be worked out by an agreed date, within perhaps two years. Otherwise, the Soviets could stall and put the U.S. at a possible disadvantage if they had a relatively larger tritium reserve.

Assuming agreement was reached, the U.S. could hold its repaired reactors on "cold standby" and the Soviets could hold theirs on standby as well. Tritium production could resume if the agreement broke down or arms reduction could not keep pace with tritium decay. Meanwhile, the superpowers could reduce their arsenals at a steady, meaningful pace for the sake of sanity, safety, economy and peace. □

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FAX TRANSMISSION

FAX NUMBER: ( ) ___-____

TO: JACKIE KENNEDY

FROM: PAUL LEVENTHAL

2 PAGES FOLLOW

MESSAGE:

I would appreciate your bringing the attached to Gov. Sununu's attention. I will telephone later this week, as the Governor suggested at our meeting. Thank you.

NCI FAX NUMBER: (202) 452-0892
NCI PHONE NUMBER: (202) 822-8444

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file Proliferation

NUCLEAR CONTROL
INSTITUTE
1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

August 21, 1989

Mr. John H. Sununu
Chief of Staff to the President
The White House
Washington, D.C. 20500

Dear Mr. Sununu:

With reference to the letter of August 4 from Paul Leventhal, please find enclosed the paper we asked Dr. Carson Mark to prepare.

As you suggested during our meeting, we will be back in touch with you at the end of the month.

Sincerely,

Milton Hoenig

Dr. Milton M. Hoenig
Scientific Director

On the Significance of a Possible Soviet Tritium Surplus

Carson Mark

The United states has not produced any new tritium for over a year. As a result, its reserve supply has been drawn down far below its intended level.

The Soviets have (as far as is known) continued to operate their tritium production facilities throughout this period. It may be supposed that their tritium reserve is fully up to some intended level.

It is not known (at least to the author) just how the intended reserve level relates to the forecast demand rate either for the U.S. or for the USSR; and these need not be the same.

It would seem reasonable to assume that to allow for contingencies a planned reserve would be sufficient to meet anticipated needs for at least a year or so. Indeed, from official statements made concerning our own "tritium crisis" it appears that we must have been carrying a reserve of about two years at least. On the other hand, it is not to be supposed that anyone would find it attractive to maintain a reserve to cover a very much longer period. For example, if one assumes a constant rate of

consumption, and a reserve capable of maintaining that rate for four years after a cut-off of production, it would be necessary to produce about twenty-five percent more tritium than needed to meet the consumption rate just to make up for tritium decay in the reserve. If the forecast were one involving an increasing consumption rate, maintaining a four-year reserve would put one in a situation like that of the Red Queen in "Alice in Wonderland." With a constant consumption forecast, to maintain a four-year reserve would seem at best to make marginal sense. With a consumption forecast declining only as little as five and a half percent a year, no reserve would be necessary.

Of course, we do not know the Soviet's policy with respect to reserves. We may, however, be confident that they act in what they consider to be their own best interest without expending a great deal more effort than necessary. We must assume, further, that at present they have their planned reserve supply on hand. It would seem safe to assume, in addition, that their reserve supply is sufficient to maintain their present rate of consumption for several years: two or three, quite probably; four, possibly; much longer, unlikely.

The situation to be considered, then, is that the U.S. has essentially no

reserve, while the Soviets have several years' supply. In this context the question has been raised as to the effects on our interests -- our own deterrent capability, in particular -- of our offering to negotiate an agreed and verifiable cut-off of tritium production. There are basically two alternatives: 1) they might refuse, or agree to negotiate but in the course of this introduce such self-serving conditions that after some period we would feel we had to withdraw the offer; or, 2) they might accept.

In the first case, the U.S. Administration would earn considerable credit for having taken such an initiative; and some of this credit would remain even if the offer had later to be withdrawn in the face of demonstrable Soviet intransigence. In the case of outright refusal nothing would be changed with respect to our present situation. We would re-start Savannah River production as soon as that might be shown to be acceptable, and we would proceed with plans for new production as deemed necessary and feasible. There would be no real effect on our deterrent capability, even in the event of a quite extended delay in acquiring new tritium.

With respect to the case in which the Soviets accept our offer to negotiate a tritium production cut-off, the U.S. Administration would, as

before, gain credit for having introduced such an initiative. And the Soviets would share in that from having accepted it; but that does no harm to us. In this case an interim halt in production by both sides would appear to be in order, even though a number of important matters (such as verification procedures, certainly; and stockpile numbers, presumably) would still need to be negotiated.

From having little or no tritium reserve, and assuming that new tritium production were suspended, before long the U.S. would have to begin to reduce the total number of warheads in its stockpile at a rate ultimately approaching the tritium decay rate of five and a half percent a year. There would be blood on the floor in the Pentagon as the services squabbled over who was to give up what; but apart from that, the nation's real security would not suffer. In most particular, our deterrent capability would not be threatened. After all, our stockpile numbers have varied in the past, and it is currently planned, for example, to retire a large number of naval tactical weapons. In addition, present START talks discuss the possibility of reduction by some 600 warheads a year over seven years. It is true that our nuclear war-fighting capability would fall below the maximum levels we might otherwise be able to establish;

and it is said by some that a nuclear war-fighting capability is an inseparable part of deterrence. But this is evidently a mindless thought, since nuclear war is just what we are most anxiously striving to avoid. That is the quintessential motive of deterrence.

In contrast to the United States, the Soviets most probably have a reserve supply of tritium on hand. Even after stopping new production they could, in principle, add somewhat to their stockpile, but only at the expense of advancing the time at which they would have to initiate a reduction program. More plausibly, they could defer the time at which reductions would become necessary for those several years their reserve might cover. Perhaps most plausibly, they could initiate reductions in parallel with the U.S. and retain their (decaying) reserve for some unforeseen contingency. In a superficial, bean-counting, assessment this would appear disadvantageous to the United States. But whether this would be seriously, or even meaningfully, disadvantageous is another matter.

We would still retain -- and retain for a very extended period -- a fully adequate deterrent capability. Such a capability is not appreciably affected by modest fractional differences in the size of the stockpile of

an opponent. Indeed, by some estimates the Soviet's current stockpile has about 40% more nuclear warheads than ours. This doesn't seem to call our deterrent capability into question, nor should it. After making worst-case allowances for survivability following a first strike a deterrent force is to a large extent a thing in itself. It is adequate if it is large enough. We, most certainly, have more than enough.

The essence of deterrence consists in maintaining an assured capability to inflict devastating damage on any aggressor even after having been subjected to a surprise first strike; and that capability must be known, and credible. A few hundred weapons on target would reduce any organized twentieth century society to a primitive state. It wouldn't matter if we still had more weapons on hand, nor if we used more. It wouldn't matter if the aggressor had more shiny new weapons in reserve than we had. At present we have more than ten thousand strategic nuclear warheads. If we produce no new tritium for twelve years, we could still have more than five thousand; or for twenty-five years, more than twenty-five hundred -- even if we were not to transfer any tritium from our ten thousand, or so, non-strategic warheads. We would still have a fully adequate nuclear deterrent. Of course, the Soviets have one, too; and

they, also,would still have one under the same conditions.

In terms of simple reality, or, one might say, so far as the physics is concerned, the extra tritium the Soviets presumably have makes no significant difference. It doesn't change the likelihood of nuclear materials being used, nor the outcome if they are. However, with respect to political reality some account would no doubt have to be taken of such an asymmetry. There are a number of possible ways of going about this. and it doesn't much matter which are followed so long as an acceptable result is achieved. For one thing, we know (that is, it would be possible for persons having complete information concerning our stockpile to determine) when and at what rate we would have to remove warheads from our stockpile in the event of a tritium production cut-off. We do not know whether or not the Soviets are as dependent on tritium as we are. and so we do not know whether a tritium cut-off would force them to retire weapons at the time and the rate necessary for us. We could, however, require that they retire (or destroy) warheads at the same rate (presumably percentage-wise) as would be necessary for us. It wouldn't really be important to us whether the weapons they disposed of were tritium-bearing or not. Indeed, if they depended less on tritium, so that

some of the retirees were nontritium-bearing, so far as we would need to be concerned they could use up their tritium reserve to keep their tritium-bearing units alive.

There would, of course, be a need for some additional provisions in conjunction with a tritium cut-off agreement. For example, it would be necessary that retired delivery systems of theirs and of ours be destroyed, so that any reserve or secret stocks of tritium could not be used to change the relative stockpile balance on any short time-scale. There would also be a need of assuring that neither side was fabricating replacement delivery systems. And so on. But such provisions are of the same general type as would seem to be necessary in connection with START, or any stockpile reduction agreement.

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NUCLEAR CONTROL
INSTITUTE

1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

August 4, 1989

Governor John Sununu
Chief of Staff to the President
The White House
Washington, D.C.

Dear Governor Sununu:

Thank you again for the opportunity you gave me and Dr. Hoenig to discuss the tritium question with you today. We have asked our consultant, Dr. Carson Mark, to prepare a brief paper responding to the point you raised about the impact of a Soviet tritium surplus. I will be happy to share it with you as soon as we receive it.

By the way, you might consider contacting Dr. Mark directly if you are interested in obtaining an expert, independent view on matters under consideration in the government. He has the necessary clearances on a need-to-know basis, and, given his 25 years as leader of the theoretical physics division at Los Alamos, he has much to contribute. Of course, the Nuclear Control Institute would be out of the loop if you contacted him directly. His telephone number is 505-662-5025.

Please let me know if it would be useful to have additional copies of the The Tritium Factor book summarizing our workshop with the American Academy of Arts and Sciences. I would be pleased to send them to you.

I will telephone you toward the end of the month, as you suggested. With best wishes

Sincerely,

Paul Leventhal

STANFORD UNIVERSITY
STANFORD, CALIFORNIA 94305-6165

CENTER FOR INTERNATIONAL SECURITY
AND ARMS CONTROL
320 Galvez Street

The Honorable Sam Nunn, Chairman, Armed Services Committee
The Honorable J. James Exon, Chairman, Strategic Forces
and Nuclear Defense Subcommittee, Armed Services Committee
U.S. Senate
222 Russell Office Building
Washington, DC 20510-6050

April 28, 1989

Re: Alternatives to new DOE production reactors:
Views of arms control negotiators.

Gentlemen:

Eminent scientists state that there is no critical shortage of tritium for U.S. nuclear weapons. (See statement of Bethe and others dated April 7,1989:"For a New Nuclear Materials Production Policy: Solving the Military Tritium Problem") If that is the case, we urge that before the Congress authorizes new materials production reactors costing $7.5 billion by DOE's current estimate, the United States should explore with the Soviet Union whether verifiable agreements are possible which would eliminate the need for new reactors and complement the reduction of delivery vehicles being negotiated in START and already negotiated in the INF Treaty.

On April 7,1989, General Secretary Gorbachev announced a halt in Soviet production of enriched uranium for weapons this year and the closing by the end of next year of three reactors for producing plutonium for weapons. He said this move was a "major step towards the complete cessation of production of fissionable materials for use in weapons." The United States is not now producing any enriched uranium or plutonium for nuclear weapons. For many years, we tried to get the Soviets to agree to a mutual cut-off of such production. The Soviets may now be prepared for such an agreement.

Gorbachev did not mention tritium, another key ingredient of nuclear weapons. DOE's request for new production reactors is based on its estimate that the United States will soon have a critical shortage of tritium. The scientists' statement disagrees with this estimate. Instead of authorizing new production reactors for tritium this year, Congress should allow time for a thorough study of their need and for an exploration of the possibilities for verifiable U.S.-Soviet agreements to halt or limit tritium, plutonium and uranium production for weapons.

To those concerned that failure to authorize new production reactors <u>now</u> would weaken American bargaining power to gain Soviet agreement to a mutual halt in such production <u>in the future</u>, we answer that what is important is the credibility of our determination to keep all the nuclear weapons we need fully effective, until there is agreement to reduce specific weapons.

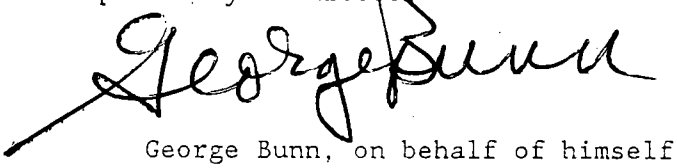
Congress should state (by joint resolution or statute) its intention to authorize the acquisition of new tritium for U.S. nuclear weapons if that becomes necessary. Then, if there is a useful bargaining chip here, the United States would not lose it by putting off the actual authorization and appropriation of new funds for a year. Instead of approving new production reactors now, Congress should authorize funds for a DOE study of both the need and the most cost-effective method for obtaining tritium in the future, when and if additional supplies become necessary.

If the United States and the Soviet Union do not do more to reduce their own stockpiles of nuclear weapons, they will have an increasingly difficult time persuading non-nuclear-weapon countries not to acquire nuclear weapons. This issue has been used repeatedly by some countries to justify their non-adherence to the Non-Proliferation Treaty, and it will be used by those seeking to end that treaty in 1995, when a conference on extending its duration must be held. Indeed, there are likely to be more nuclear-weapon states in unstable areas of the world before the end of the century if matters continue as they now are. And many believe that a nuclear war is most likely to begin in a regional setting involving smaller nuclear-weapon countries than the United States and the Soviet Union.

The INF Treaty requires the destruction of medium-range missiles but not their nuclear warheads. Based on current drafts, the same will be true of the nuclear explosive materials in the strategic missiles to be destroyed pursuant to a START treaty. Is it not time to explore a verified and mutual cut-off in the production of nuclear materials for making weapons--to complement the INF Treaty and a possible START treaty? Should we not explore an agreed transfer to peaceful purposes of nuclear materials taken from missiles destroyed pursuant to agreement?

We urge you to promote prudent planning rather than authorize new production reactors this year. Give time for a meaningful exploration of our options.

Repectfully submitted,



George Bunn, on behalf of himself and the following co-signers, all of whom have experience in negotiating nuclear arms control agreements with the Soviets:

Ralph Earle II
Thomas D. Davies
Philip J. Farley
John B. Rhinelander
Gerard C. Smith

Signers of Letter of April 28, 1988

George Bunn: member, Stanford Center for International Security and Arms Control (CISAC); former employee of the Atomic Energy Commission (AEC) and Nuclear Regulatory Commission; formerly General Counsel, U.S. Arms Control and Disarmament Agency (ACDA) and legal advisor, deputy chairman or alternate chairman (with personal rank of ambassador) of the U.S. delegation to the conference which produced the nuclear Non-Proliferation Treaty.

Thomas D. Davies: Rear Admiral, USN (Ret); formerly Assistant Director, ACDA, head of non-proliferation bureau and chairman, U.S. delegation to test ban and environmental warfare negotiations; formerly, Chief of Naval Development and commander of North Atlantic surveillance operations during Cuban missile crisis.

Ralph Earle II: consultant and chairman of National Advisory Board, Lawyers Alliance for Nuclear Arms Control; formerly Director, ACDA; formerly ACDA representative, alternate chairman and then chairman of U.S. delegation (with personal rank of ambassador)to the Strategic Arms Limitation Talks (SALT II); former partner, Baker & Daniels.

Philip J. Farley: member, Stanford CISAC; formerly on staff of AEC and then State Department backstopper of arms control negotiations; formerly Director of Politico-Military Affairs, State Department, then Deputy Director of ACDA and alternate chairman of the U.S. SALT I delegation (with personal rank of ambassador); formerly Deputy Special Representative for Non-Proliferation Matters.

John B. Rhinelander: partner, Shaw, Pittman, Potts, Trowbridge and Rhinelander; formerly special assistant to Secretary of the Navy; formerly counsel and acting deputy director, Office of Foreign Direct Investments, Department of Commerce; formerly Deputy Legal Advisor, Department of State and legal advisor to the U.S. SALT I delegation.

Gerard C. Smith: chairman of Consultants International Group Inc. and of Arms Control Association; worked on nuclear matters on staff of Atomic Energy Commission and then State Department for many years; formerly Director of ACDA and chairman of the U.S. SALT I delegation (with personal rank of Ambassador); formerly Special Representative and Ambassador-at-Large for Non-Proliferation Matters.

Reprint Series
2 September 1988, Volume 241, pp. 1166–1169

SCIENCE

Policy Forum

The Tritium Factor as a Forcing Function in Nuclear Arms Reduction Talks

J. CARSON MARK, THOMAS D. DAVIES, MILTON M. HOENIG, AND PAUL L. LEVENTHAL

Limits on Nuclear Materials for Arms Reduction: Complexities and Uncertainties

W. G. SUTCLIFFE

The United States and the Soviet Union are presently negotitating reductions in their nuclear arsenals. These negotiations are influenced by many factors, technological and political, and there are opportunities to debate new proposals for arms control. In this Forum, Mark et al. *argue for a mutual halt in the production of the hydrogen isotope tritium, which is an essential component of fission and thermonuclear weapons, to force substantial reductions in the nuclear arsenals. Sutcliffe responds that a cutoff of nuclear materials production carries a number of risks that need further study before such proposals can be considered by the negotiators.*

The Tritium Factor as a Forcing Function in Nuclear Arms Reduction Talks

J. Carson Mark, Thomas D. Davies, Milton M. Hoenig, Paul L. Leventhal

Both the United States and the Soviet Union depend on tritium to boost the yield of their fission weapons and the fission triggers of their thermonuclear warheads. Tritium represents the key to the compact and efficient designs of modern nuclear weapons. Because tritium decays rapidly, declining by half in 12.3 years, tritium charges in nuclear weapons become depleted and must be replaced with fresh charges regularly. Without regular production of new tritium, the large stocks of tritium needed by the United States and the Soviet Union to maintain their nuclear weapons would be depleted at a rate of about 5.5% yearly. Thus, the radioactive decay of tritium—the "Tritium Factor," as we refer to it—provides a potentially powerful means for reducing nulcear arms.

Tritium is unique among nuclear weapon materials in its potential to drive nuclear arms reductions if both sides agreed to a halt in its production. Plutonium, unlike tritium, lasts for thousands of years, and both sides already have enough plutonium to maintain their existing stockpiles of weapons, and even to modernize them (*1*).

The 5.5% annual decay of tritium could serve as a "forcing function" to produce steady, verifiable reductions in the superpowers' nuclear arsenals. Such reductions would result in a comprehensive 50% cut in warheads by about 12 years after an agreement—the year 2001, if the cutoff were to begin now. Thus, the Tritium Factor could be applied to achieving reductions beyond even those now contemplated in the ongoing Strategic Arms Reduction Talks (START) (Fig. 1). At the time a START agreement is concluded, a mutual suspension of new tritium production could be announced in conjunction with it as a confidence-building measure, representing a shared commitment to keep reductions in nuclear armaments

(Continued on page 1167)

The authors are associated with the Nuclear Control Institute, Washington, DC 20036. J. C. Mark is former leader of the Theoretical Division of Los Alamos National Laboratory. T. D. Davies, Rear Admiral USN (Ret.), is a former assistant director of the U.S. Arms Control and Disarmament Agency. M. M. Hoenig is scientific director of the Nuclear Control Institute. P. L. Leventhal is president of the Nuclear Control Institute.

Limits on Nuclear Materials for Arms Reduction: Complexities and Uncertainties

W. G. Sutcliffe

Because tritium in nuclear weapons must be replenished periodically, it has been proposed that the United States and the Soviet Union reduce their stockpiles of nuclear weapons by limiting or halting the production of this material.

Although such limits might be desirable in the future, any proposal to limit nuclear materials as a means of arms control is premature. Rather, one should first establish the value of production or stockpile limits vis-à-vis other approaches. It is not appropriate to look at some of the potential benefits of a halt in nuclear materials production without analyzing the associated risks. For example, asymmetries in nuclear materials production capabilities, design practices, and delivery system capabilities could lead to disparate impacts on the U.S. and Soviet stockpiles, possibly leaving the United States in a vulnerable position. Proposing nuclear materials limits is fraught with great uncertainties about the comparability of effects on the two stockpiles and verification issues because of the unknowns about the Soviet stockpile and production capabilities. Further, the impact on direct arms control negotiations, which focus on delivery systems, could be deleterious. Finally, the question of whether conventional arms reductions should precede further nuclear arms reductions bears on the proper timing for a proposal to limit nuclear materials.

A halt in tritium production would not necessarily lead to a reduced stockpile of nuclear weapons in the future. A limited supply of tritium could lead to a shell game tactic of maintaining the full capability of some systems while not retiring the other less effective or useless systems. Nuclear warheads can be designed that do not depend on tritium. The early nuclear weapons did not use tritium. As a result of the inevitable research efforts, new technology might circumvent or reduce the need for tritium in efficient modern warheads.

A bilateral agreement, by itself, to prohibit the production of tritium would not be sufficient. Multinational agreements and

(Continued on page 1169)

The author is with the Evaluation and Planning Program, Lawrence Livermore National Laboratory, Livermore CA 94550.

(Mark, *continued from page 1166*)

going at a steady pace.

There are a number of compelling reasons for bringing the Tritium Factor into the nuclear arms reduction process at this time:

1) The Tritium Factor provides the only external means to "force" both sides, given the vicissitudes of negotiations, to make steady progress toward sharp reductions in their arsenals.

2) The forcing function imposed by the Tritium Factor would influence the pace of arms reduction talks without putting undue pressure on negotiators. The two sides still would have considerable latitude in deciding which types of weapons to retire to maintain mutually stabilizing force levels.

3) A halt in new production of tritium and plutonium would allay safety concerns on both sides associated with continuing to operate their aging production reactors. In the United States, the N reactor has been shut down, and the Savannah River reactors are now required to operate at half power owing to safety problems identified by the National Academy of Sciences since the Chernobyl accident.

4) With a halt in production, plans to upgrade these reactors could be set aside. The production reactors of both sides would be placed on standby, ready to restart tritium production only if nulcear arms talks break down. The tritium recovered from retired weapons would be used to replenish the tritium supply in the remaining ones.

5) Decisions on costly plans for new production reactors could await an agreement on the level to which arsenals would be drawn down, or a breakdown in the talks. There is now a proposal before Congress by the Department of Energy to build two new production reactors at a presently estimated cost of $6.8 billion, although costs may well be much higher. The DOE plans to put one or both of these new reactors into operation by 1999. Congress could defer action so long as a mutual halt in tritium production were in effect. Eventually, to maintain a minimum effective deterrent, new tritium production at some much lower level might be needed a few decades after the cutoff.

6) The complete suspension of production-reactor operations—for both tritium and plutonium—is verifiable by national technical means supplemented by on-site inspections, as needed.

Of course, there are questions that need to be examined. How can a technical measure like the Tritium Factor be expected to "force" the process of arms negotiations? How can each side be sure that a mutual cutoff of tritium production will have comparable effect on the weapons of the other side? And, how can compliance with such a cutoff be verified?

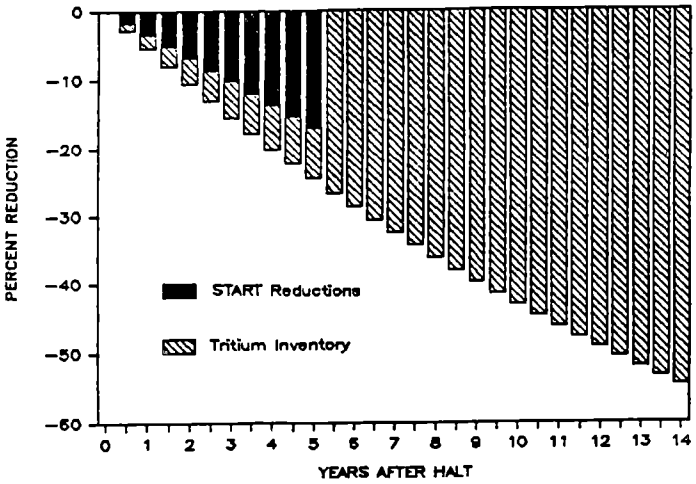


Fig. 1. The percent reduction in a superpower's inventory of tritium for nuclear weapons as a result of radioactive decay following a halt in tritium production. The reduction in the tritium inventory would force a like reduction in the stockpile of nuclear warheads. Under the proposed START agreement, the reduction of 4000 strategic warheads (17% of the U.S. nuclear stockpile) over even the 5-year period proposed by the Soviet Union would not quite match tritium's decay.

Impact on negotiations. The Tritium Factor would serve as a "clock on the table," as in a chess match. It would provide a mechanism for automatically maintaining a minimum pace of reductions. Although negotiators may not like to work against deadlines, historically, when none exist, negotiations tend to drag on interminably and to be overtaken by events.

Each side could begin cautiously because the full impact of a tritium cutoff on weapons reductions could be cushioned somewhat at the outset by the choice of weapons systems to be retired and of available options for tritium management (*2*). There would be a limit to possible reshuffling schemes, however, and eventually the decay of the tritium inventory would force a steady reduction in the number of nuclear warheads.

Weapons reductions at tritium's decay rate would be dramatic over the first dozen years—a 50% cut in the overall nuclear arsenals of the superpowers by 2001, if begun now. Of course, tritium's decay rate remains constant, but the number of warheads retired each year, as paced by the Tritium Factor, will grow progressively smaller as the number of warheads remaining in the stockpiles declines with time. After 12 years, however, sufficient confidence might be built to permit cuts at a rate greater than tritium's decay; if so, tritium's forcing function will have served nuclear arms reduction efforts well.

Some may be skeptical of the Tritium Factor approach to nuclear arms reduction, seeing this approach to be a case of "the tail wagging the dog." Certainly, nuclear materials production policy never has been used to drive nuclear arms reduction efforts. The result to date, however, has been little in the way of arms reduction, but much in the way of materials production that feeds the arms race.

What are the risks if the Tritium Factor approach fails? In the event that arms reduction negotiations break down, the United States, using the output of production reactors held on standby, could restore its tritium inventory to 90% of the initial value in 1 year after a 3-year production halt, and to 83% in 2 years after a 6-year halt (*3*). The tritium recovery capability of the Soviet Union is likely to be comparable. However, to ensure an equivalence of recovery capability, the superpowers could agree on which reactors are to be held on standby and which reactors are to be dismantled.

Comparability of effect. An important question is whether arms reductions based on a mutual halt in the production of tritium would have comparable effect on the Soviet and U.S. nuclear arsenals. Because of the Soviet advantage in missile throw weight, it is possible that the Soviets have not pushed the miniaturization of their fission triggers to the same extent as the United States. Yet, the nuclear arsenals of both sides have a strong dependence on tritium, and Soviet tritium production—like ours—is presumably scaled to meet their continuing needs. Consequently, a tritium production cutoff would affect both sides substantially enough for the Tritium Factor to be an effective approach to mutual arms reduction. At the same time, each side can rest assured that even some 37 years after a tritium cutoff (a period equal to three half-lives of tritium), enough tritium will remain for at least 1000 to 3000 warheads—a credible nulcear deterrent—*without any resumption of production.*

Of course, the weapons laboratories on each side could work on new designs requiring less tritium or not relying on boosting at all (*4*). The design and production of these weapons may take some years, however; and because of their greater weight and size (owing to the need for using fissile material to achieve the same effect), such

(*Continued on page 1168*)

(**Mark**, *continued from page 1167*)

weapons may require new delivery systems. New designs to replace present triggers of thermonuclear weapons would require tests of the complete weapon to confirm the effect of the trigger on the second stage, and new delivery systems also would require testing. Such tests would be subject to detection. A ban on nuclear testing would be desirable, as would a ban on reuse of fissile material from nuclear warheads that would be dismantled by mutual agreement, although these bans would not be essential to implementation of the Tritium Factor.

Verification issues. It should be emphasized first that verification of weapons reductions, whether driven by the Tritium Factor or not, would be by confirmation of destruction of retired weapons. The principal verification problems in this case are the same as those currently being dealt with in connection with implementation of the Intermediate Nuclear Forces (INF) and negotiation of the START treaties. Such verification will require on-site inspection.

The nonoperation of dedicated production reactors can be verified by satellite surveillance in the thermal infrared wavelength region because these reactors are major infrared heat sources when operating. Any undeclared source of thermal radiation could be challenged as a potential clandestine facility and made subject to on-site inspection.

At operating power and dual-purpose reactors, inspectors under international or bilateral auspices would be able to detect dedicated tritium production by utilizing devices for nondestructive irradiation of fresh reactor fuel, targets, and control rods. Such devices could use a beam of neutrons to detect the presence of lithium-6 targets used for tritium production (*5*). In addition, activities in separation plants to recover tritium from irradiated targets would be detected by the monitoring of emissions at the stacks of these plants.

Under conditions in which the destruction of nuclear weapons at agreed rates was being verified, and checked against the number of weapons remaining in the nuclear stockpiles, any secret stockpile of tritium would be of little significance. Any such secret inventory would be decaying while these procedures applied. This factor, along with the absence of new delivery systems that would be required for deployment of additional warheads built from a clandestine supply of tritium, would make any attempt to store or acquire a secret stockpile of tritium unappealing (*6*).

In addition to the superpowers, the other nuclear weapon states (France, Britain, and China) produce tritium for weapons, and there is some commercial capacity (principally Canada, but also France) for recovering tritium from the moderator of heavy-water reactors. However, supplies of tritium from such sources are on a smaller scale than the current requirements of the superpowers, and most of the military tritium production in other nuclear weapons states will be fully committed to meet their own needs, which in any event are on a relatively small scale (*7*).

As to the possible commercial sources, there would be the need for international safeguards barring military use. Civilian power and large research reactors would have to be made subject to International Atomic Energy Agency (IAEA) safeguards or bilateral arrangements (or both) to ascertain that tritium is not being produced in fuel rods, control rods, or blankets or being diverted for weapons purposes from the heavy-water moderator of CANDU-type reactors. It would be difficult to trace gram quantities of tritium, but safeguarding of the kilogram quantities of significance to a large nuclear weapons program should not be a problem (*8*).

Conclusion. An agreed mutual halt in tritium production would confirm the intent of the superpowers to reduce their arsenals significantly. Use of the Tritium Factor to achieve deep cuts at a steady pace would be responsive to people's hopes for an end to the nuclear arms race. It would remove the need to operate aging production reactors or to build costly new ones, either of which would merely continue the arms race. Finally, it would provide meaningful support for an appeal by the superpowers that all nations avoid nuclear materials production programs that contribute to nuclear proliferation and associated risks of nuclear terrorism (*9*).

REFERENCES AND NOTES

1. Energy Secretary James Herrington recently told a congressional committee, "We're awash in plutonium. We have more than we need." Testimony before the House Appropriations Subcommittee on Interior, 23 February 1988. Hearing of the Subcommittee on Interior and Related Agencies of the House Committee on Appropriations for FY 1989, Part VII.
2. For example, a surplus of tritium could be created for a period by initially retiring those weapons that contain the largest tritium charges. Also, tritium reservoirs of weapons could be recycled more frequently and filled with a somewhat smaller quantity of tritium than is currently the practice without sacrificing weapon effectiveness.
3. Here it is assumed that the annual rate of tritium production after restart is 10% of the prestart inventory. For the United States, a realistic situation would be an initial tritium inventory of 100 kilograms (an average of about 4 grams of tritium per warhead) with the three operable production reactors at Savannah River resuming operations at half-power and producing a total of 10 kilograms of tritium annually. See T. B. Cochran, W. M. Arkin, R. S. Norris, M. M. Hoenig, *Nuclear Weapons Databook* (Ballinger, Cambridge, MA, 1987), vol. II, pp. 62–75.
4. Isotopes other than tritium, such as helium-3, have been considered for boosting, but use of these is considered not to be within reach of present weapons technology.
5. A random sampling system could easily be developed to provide sufficient assurance of detection. Inspectors would also be able to sample air and water, but verification by this means may prove to be impractical because of the difficulty in distinguishing between dedicated tritium production and other modes of reactor operation. In particular, at heavy water moderated power reactors (for example, CANDU-type), it would be virtually impossible to detect tritium production in targets against the background of tritiated water vapor normally released from the moderator.
6. It should be noted that even with a secret stockpile of tritium, either side would be in an advantageous position to readily terminate or "break out" of a tritium-cutoff agreement only if it also managed, without being detected, to build or maintain a large secret store of warheads utilizing tritium and of the needed delivery systems—a most unlikely event. A secret tritium stockpile could be applied to building a large number of new tritium warheads, but this would take a period of time and create a "national crisis" situation sufficient to permit the other side to take extraordinary steps to respond in kind.
7. This situation could change if fusion reactors, which would utilize and produce kilogram quantities of tritium, became a reality. However, the lead time for commercial development of fusion reactors is suficiently long to allow the superpowers and the IAEA to develop safeguards and inspection measures sufficient to prevent diversions of tritium from civilian fusion activities to weapons programs.
8. The. United States needs to produce about 5 kilograms of tritium annually to maintain its inventory.
9. See P. Leventhal and Y. Alexander, Eds., *Preventing Nuclear Terrorism*, The Report and Papers of the International Task Force on Prevention of Nuclear Terrorism (Lexington Books, Lexington, MA, 1987), pp. 45–49; Frank von Hippel, in *Nuclear War, Nuclear Proliferation, and Their Consequences*, Sadruddin Aga Khan, Ed. (Clarendon Press, Oxford, 1985), pp. 65, 66, and 74.

(**Sutcliffe**, *continued from page 1166*)

safeguards would be necessary to prohibit the United States and the Soviet Union from obtaining tritium for weapons use from other nations, in particular their allies. Any prohibition would be complicated by the fact that large supplies of tritium will be needed to develop fusion reactors that could then produce more tritium.

The risks (and benefits) of a mutual suspension of tritium production have yet to be analyzed and resolved. It is generally acknowledged that much more is known about the United States' stockpile and production capabilities than is known about the Soviet Union's. This fact coupled with the asymmetries and uncertainties in the potentials for mining stockpiles (for tritium), clandestine production, and prompt resumption of large-scale production might produce an unacceptable advantage for the Soviets.

It cannot be assumed that there is little risk because the United States could restart and replenish its tritium supply. Such an assumption would ignore the asymmetry in the U.S. and Soviet capabilities. In particular, it would ignore the nuclear materials production capability of the Soviet power reactors and the political system that controls their operation. For example, the Soviets could produce tritium from helium-3 (decayed tritium) in their power reactors. It would also assume no problems (technical, economic, or political) in restarting our old reactors.

Although deferring or not upgrading the Savannah River Plant (SRP) reactors or not building a new production reactor (or both) might appear attractive from a financial point of view (*1*), it is not likely that the U.S. would risk its national security in this way. The choice between not producing enough tritium in a crisis and running the SRP reactors at full power is not attractive. Because of the 10 to 20 years to get a new production reactor operating, it cannot be responsive to a crisis in the near term.

A mutual halt in tritium production would not necessarily have a comparable effect on the Soviet and U.S. arsenals. It is acknowledged that the Soviets have an advantage in throw weight that would favor heavier warheads that depend less on tritium. Further, a concomitant ban on nuclear tests would perpetuate the situation, and could only be desirable from the Soviet point of view.

It has been suggested that there is a synergistic relationship between a halt in tritium production and direct arms control negotiations. The value of such a halt as a forcing function for arms control negotiations is debatable. It is arguable that the negotiators would not agree to a halt in tritium production if they were not able to agree on a direct arms reduction. In fact, proposals to halt tritium production might unduly complicate direct arms control negotiations such as the Strategic Arms Reduction Talks (START). For example, additional advisers, experts on materials production, would be required to ensure that the negotiators would not accept or put forth inconsistent or disadvantageous proposals.

Verification problems (with tritium limits, production limits, or production capability limits) are not the same as those being dealt with in the Intermediate Nuclear Force (INF) Treaty and START. Although it is true that these treaties involve on-site inspections, INF and START (up to this time) do not address the fate of the warheads, and so inspection of the materials production facilities is not being agreed to or proposed. Such inspections would have different requirements and problems than those associated with verifying the number of missiles or aircraft. Secret stockpiling of tritium could be significant even if nuclear weapons were being destroyed. A secret stockpile of tritium would mean that a nation could maintain a larger, more modern stockpile of nuclear weapons longer. It would also put that nation in a position to readily terminate or break out of a treaty limiting tritium production.

Prudence requires that verification of direct arms reductions (missiles, aircraft, and so on) will still be necessary, even with an agreement limiting nuclear materials. Thus, such agreements would add another (possibly redundant) verification task.

In summary, a proposal to limit tritium production raises several unresolved issues. The proponents of a tritium cutoff assert that a halt in tritium production would confirm the superpowers' intent to reduce their arsenals (*2*). However, it has not been shown that such a reduction will foster the aims of arms control (in particular, increased stability). They state that costly new facilities ("which would merely continue the arms race") would not be needed. However, caution dictates that the United States maintain facilities capable of responding to possible noncompliance. Rebuilding or even restarting a tritium-producing facility is a very complex undertaking. Although claimed as a benefit, the effect on nuclear proliferation and nuclear terrorism of a halt in tritium production is debatable. If the historical path is followed, emerging nuclear powers are probably not designing weapons that depend on tritium. Finally, any proposal should address how far the United States and Soviet Union would go in moving toward a nuclear disarmament or at least a stockpile less dependent on tritium. This is a critical question because the other nuclear powers of the world cannot be ignored.

Turning to more general considerations, it is incumbent upon those proposing indirect methods of arms control, for example, materials limits or a test ban, to show that their proposal is at least an acceptable if not the best method to attain the aims of arms control. A necessary cogent argument should be attempted as follows:

1) Generally accepted purposes for arms controls or reductions should be clearly stated and the terms defined. Stability is often claimed to be the primary aim. Increased safety and control, and reduced cost and reliance on military power (conventional as well as nuclear) are also important.

2) The risks and benefits (for achieving the aims of arms controls) of limits on launchers and warheads, such as INF and START, should be contrasted with the risks and benefits of less direct methods such as limiting the production of nuclear materials or limiting nuclear tests. Further, the possibility of additional risks or benefits incurred by combining direct and indirect approaches to arms control should be investigated.

3) If limits on nuclear materials appear attractive when contrasted with direct limits, the needs for and problems with defining and verifying proposed limits should be examined. Specific limits (treaties) must be defined (proposed) before verification issues can be adequately addressed. The asymmetries in production and surge capabilities will have to be treated in some fashion.

In spite of the issues and questions raised, it is possible that future agreed limits on nuclear materials in general and tritium in particular might be desirable. For example, it is conceivable that tritium limits could complement direct limits on hard-to-verify systems such as mobile or cruise missiles. Heavier warheads that do not use tritium would greatly reduce the effectiveness of these systems. Heavier warheads could also reduce the number of multiple warhead missiles and thus contribute to stability (*3*). However, as implied above, *many difficult problems must be resolved first*. It would be prudent to let the current arms control talks continue without being encumbered by materials, or other indirect, limits. During this time, necessary analysis, such as outlined above, could be undertaken.

REFERENCES AND NOTES

1. Because of the costs of safeguards and cleanup, shutting down a reactor or processing facility might not be financially advantageous.
2. The size of the stockpile should be dictated by its survivability. The aim is to have enough of the right type of weapons, at the right place, at the right time, to provide an effective deterrent.
3. Multiple warhead missiles appear as lucrative targets to the other side. In a crisis there is an incentive to attack them (with a first strike) before they can be launched.
4. I thank my colleagues, especially P. S. Brown, R. L. Civiak, P. T. Herman, and R. F. Perret, for their thoughtful comments and suggestions.

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May 31, 1989

VERIFICATION ISSUES FOR A NUCLEAR MATERIALS PRODUCTION HALT

Comparison of Verification and Safeguards Requirements in A Comprehensive Halt and a Fissile Materials-Only Halt

SUMMARY

An agreement by the superpowers to halt the production of nuclear materials for weapons would impose new requirements for verification at military production sites and safeguards at civil nuclear facilities. The added effort, cost and intrusiveness would be considerable whether the halt is comprehensive -- involving tritium, as well as plutonium and highly enriched uranium -- or is restricted to fissile material -- plutonium and highly enriched uranium -- alone.

The verification of a halt at military production sites probably would be easier for a comprehensive halt than for a fissile materials halt alone. In a comprehensive halt, the complete shutdown of declared military production reactors would be verified by satellite observation of no infrared signature. This use of national technical means (NTM) would be augmented by challenge-type on-site inspections, including suspected clandestine facilities. On the other hand, verification of a fissile materials cutoff would require on-site inspections to ascertain that no plutonium is being produced in military reactors allowed to operate for tritium production. In the same way, under a comprehensive halt, inspection simply would verify that all military reprocessing plants are shutdown, while, under a fissile materials halt, inspections would be required to verify that allowed reprocessing activities to recover enriched uranium for reuse in driver fuel of tritium production reactors do not involve recovery of plutonium.

Under both production halt proposals, the implementation of safeguards arrangements at the over 150 civil nuclear facilities in the U.S. and the Soviet Union would require a several-fold increase over the International Atomic Energy Agency's current expenditures for safeguarding civil nuclear facilities, and almost certainly would involve, if not be principally dependent on, bilateral safeguards applied by the U.S. and the U.S.S.R. in addition to whatever role the IAEA might play.

Tritium safeguards arrangements could be added on to other inspection activities in a very effective and efficient way. The major activity of tritium safeguards at civil reactors would involve item counting of reactivity control rods. The neutron-absorbing boron usually in these rods could be replaced by lithium-6 for the purpose of tritium production, without changing the operating characteristics at civil reactors. Consequently, the rods must be subject to safeguards, and perhaps even exchange, with each side collecting the other's rods.

Under tritium safeguards at civil power reactors, control rods would be accounted for before insertion and after discharge, with collection, sealing and storage in the spent fuel pond. Fuel assemblies that also could contain lithium-6 targets for tritium production would, in any event, be stored in ponds under seal after discharge under a fissile-only safeguards regime. Control rods and fuel assemblies could be inspected first in the fabrication plants for the presence of lithium, and fresh control rods and fuel assemblies could be assayed for the presence of lithium by non-destructive means before they are inserted into the reactor.

Another place in the civil nuclear cycle where tritium safeguards would have to be applied is at tritium extraction plants, such as Ontario Hydro's plant in Darlington, Ontario, which recovers tritium from the irradiated heavy water moderator of CANDU reactors and promises to be the major commercial supplier of tritium in the near future. Here safeguards would have to be applied by materials balance to tritium in the process stream and in storage, adequate to provide high assurance of detection of a diversion of tritium sufficient to boost about a dozen nuclear warheads. Commercial uses of the extracted tritium would be subject to similar safeguards, and tritium in use and storage at research facilities would be safeguarded, as well. The technical procedures for some of these activities already have been worked out in Canada and at Los Alamos National Laboratory, and their application should not be unduly burdensome for detecting diversions of tritium in quantities that would be of significance to a superpower.

What follows is a concise comparison of verification requirements under a fissile-materials-only and a comprehensive production halt:

May 31, 1989

VERIFICATION ISSUES FOR A U.S.-SOVIET NUCLEAR MATERIALS PRODUCTION HALT

	FISSILE HALT ONLY	COMPREHENSIVE HALT: TRITIUM & FISSILE
Impact on Arms Reductions	Provides no impetus to reduce weapons, without added measures.	Eventually requires boosted warhead reduction at rate of tritium's decay, 5.5 percent annually.
Significance of Initial Cheating	Any secret initial store of Pu or HEU essentially does not decay and retains its significance for possible weapons use indefinitely.	Any secret initial store of tritium decays by half in 12.3 years and, therefore, is of decreasing significance over time for possible weapons use.
Significant Violation	Diversion or clandestine production of one percent of inventory--about 1.0 metric ton (MT) plutonium (Pu) or 6.0 MT highly enriched uranium (HEU)--per year for 10 years.	In addition, diversion or clandestine production of of sufficient tritium over 12 years to make the reduction of the present inventory, due to decay, significantly less than the maximum possible 50 percent. Specifically, the diversion or clandestine production of about 2.75% of present inventory per year--about 2.5 to 4.0 kilograms--so that inventory is reduced by 25% rather than 50% after 12 years.

		Thus, in the event of such a significant violation, still a large decrease in tritium inventory, as compared with an increase in Pu and HEU inventories in similar situation.
Clandestine Production	Detect construction and operation of clandestine facilities for production, reprocessing and enrichment ---by national technical means, by monitoring communications, and by other intelligence means. Invoke challenge inspections of suspect sites.	Same. In addition, same measures used for detection of clandestine facilities for tritium production, separation and purification.
Clandestine Shipments	Use of IAEA-type safeguards at civil and military facilities, supplemented by bilateral inspections and by national technical and other intelligence means, to police against transfers to secret production sites. Third countries covered as potential sources.	Same.
Declared Military Production Sites		
Verification Regime	Each side declares all of its production facilities to the other. Verification by national technical means and bilateral inspection regime.	Same.

Production Reactors	Reactors allowed to operate for tritium production; on-site inspection to verify no plutonium production; augmented by national technical means (NTM).	All production reactors shut down. NTM to verify no reactor operation, augmented by on-site and challenge inspections.
Reprocessing Plants	Reprocessing plants allowed to operate to recover HEU from spent driver fuel of tritium-production reactors and from spent naval reactor fuel, for reuse as driver fuel. On-site inspection and monitoring of krypton-85 emissions to verify no plutonium separation.	All military reprocessing plants shut down. Use of NTM, on-site inspection and monitoring of krypton-85 emissions to detect any clandestine reprocessing. Spent naval reactor fuel turned in to safeguarded facility, but not chemically reprocessed.
Enrichment Plants for HEU	Limited production of HEU in safeguarded facility: about 5 MT HEU per year for naval reactor fuel, with turn-in of equivalent amount of spent fuel to safeguarded facility. Alternative: fuel naval reactors with HEU from weapons stockpile.	Same.
Civil Facilities		
Verification/ Safeguards Regime	All civil nuclear facilities in U.S. and U.S.S.R. placed under IAEA/NPT safeguards, supplemented by bilateral inspection regime.	Same.

Power Reactors	IAEA-type safeguards at civil reactors: safeguards on plutonium and U-235 by item counting of fuel assemblies at reactors and at spent fuel storage ponds, supplemented by non-destructive assay, camera surveillance and application of seals.	Same. In addition, tritium safeguards by item counting of reactivity control rods (burnable poison rods, flux flattening rods, etc. in LWRs and Soviet RBMKs) in which boron could be be replaced by lithium-6 for tritium production. Item counting at reactors and at spent fuel storage ponds, supplemented by non-destructive assay (NDA) and seals. NDA would sample fresh rods, fuel assemblies and suspect blankets for presence of lithium. Also, each side could collect other's rods.
Research Reactors	Conversion of research reactors to low-enriched uranium fuel, wherever possible. Safeguards, inspection and intelligence arrangements at sites where HEU still used.	Same, plus safeguards (per above) to detect clandestine tritium production.
Reprocessing Plants	Once-through fuel cycle with final disposal of spent fuel preferable. Limited reprocessing for fast-breeder research, if necessary.	Same.
	IAEA-type safeguards on any reprocessing of spent reactor fuel to to recover plutonium and uranium. Bilateral inspections and intelligence means to compensate for inherently large uncertainty in materials accounting in large-throughput plants.	Same, plus safeguards, bilateral inspections and intelligence means to detect clandestine tritium separation activities.

Fabrication Plants	IAEA-type safeguards at uranium and plutonium-MOX fuel plants. Bilateral inspections and intelligence means to compensate for inherently large uncertainty in materials accounting at large-throughput plants.	Same. In addition, verify absence of lithium by inspection and NDA, then seal and tag inspected assemblies and control rods.
Enrichment Plants	IAEA, Hexapartite-type safeguards to verify production is limited to low-enriched uranium, by materials balance and enrichment assay augmented by inspection to assure no rearrangement of plant stages for HEU production.	Same.
Tritium Extraction Facilities	Allowed to operate. Presently no IAEA safeguards.	IAEA safeguards developed and applied to plants for tritium recovery from the heavy water moderator of CANDU-type reactors, including plants in third countries. (Example: Darlington, Ontario plant to recover about 2 kg tritium per year.) Safeguards supplemented by bi- and tri-lateral inspections, if possible, and by intelligence methods.

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The Washington Post

TUESDAY, NOVEMBER 29, 1988

J. Carson Mark

The Tritium Factor

LOS ALAMOS—The current shutdown of the nation's weapon reactors at the Savannah River Plant for safety-related reasons is suddenly focusing attention on the importance of tritium in nuclear weapons. Tritium is short-lived, decaying by 5.5 percent a year, so the essential question for national security is how long a tritium production halt we can tolerate without endangering our nuclear deterrent.

The United States has enough tritium in its 23,000 nuclear warheads to sustain a force of about 6,000 warheads for longer than 20 years. A recent Brookings Institution study concludes that a strategic force of this size on each side would meet the most demanding deterrent requirements. Others believe, as I do, that superpower arsenals of 1,000 nuclear weapons apiece would provide an effective deterrent; the United States now has enough tritium to supply this number of warheads for some 50 years.

The Soviet Union may well be burdened with some aging production reactors of its own and, for reasons of age or safety, might welcome an opportunity to shut its production reactors down. We now have a rare opportunity to explore with the Soviet Union a mutual, verifiable halt in tritium production. This could be done as an adjunct to the ongoing Strategic Arms Reduction (START) Talks with the aim of putting real muscle into continuing the arms-reduction process following successful completion of a START agreement.

We and the Soviets both rely heavily on tritium, and a halt in production could be expected to affect the nuclear weapons of both sides comparably. Each side has more of the other weapon-reactor product, long-lived plutonium, than it needs. Like a ticking clock, the decay of tritium—the "Tritium Factor"—would set a pace for arms-control negotiators to reach agreement on steady reductions in the nuclear arsenals beyond a START agreement. Faced with this built-in deadline, negotiators would be likely to approach their negotiations in a serious fashion.

The weapons reactors of both sides, meanwhile, would be held on standby, ready to restart for tritium production if post-START negotiations broke down. The shutdown would be policed by satellite observations supplemented by on-site inspections. Moreover, tritium processing plants are notorious for leaking, and the radioactive isotope could be readily detected on site.

Use of the Tritium Factor to reduce nuclear armaments would eliminate the need for operating the aging Savannah River reactors or rushing to build large new production reactors that can only feed the arms race. The Department of Energy now plans to restart and run the Savannah River reactors while two expensive tritium production reactors are constructed over 10 years. However, a mutual, verifiable halt in tritium production is far preferable to the Energy Department's plan. In any event, the Savannah River reactors should be restarted for tritium production or readied for standby status only after a thorough safety review.

The Tritium Factor could cut the number of warheads in the superpower nuclear arsenals by about one-half within 12 years after a tritium halt begins. Both sides could salvage tritium from the warheads they retire and use it to replenish the tritium charges in the remaining weapons systems. As confidence was established, deeper cuts could be pursued at a rate even faster than tritium's decay. Negotiators could seek reductions in the most destabilizing weapons as they proceeded toward the goal of achieving minimum effective deterrence.

Invoking the Tritium Factor makes sense only if the leaders of the superpowers are truly serious about making arms reductions. There is one way to put this question to the test. When General Secretary Gorbachev meets next month with President Reagan and President-elect Bush, they should agree to begin exploring a suspension of tritium production in the interest of world security.

The writer led the theoretical division at Los Alamos National Laboratory for 25 years and is a consultant to the Washington-based Nuclear Control Institute on the tritium question.

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The New York Times

TUESDAY, AUGUST 4, 1987

The Tritium Factor

By Paul L. Leventhal and Milton M. Hoenig

WASHINGTON — It appears likely that Ronald Reagan and Mikhail S. Gorbachev will get together for a summit meeting to conclude their historic nuclear arms agreement. But will an accord on medium-range missiles also represent the first step toward a dramatic reduction in strategic nuclear arsenals that the two leaders explored at Reykjavik?

If the proposed agreement is not to be another false start in curbing the nuclear arms race, both leaders should be considering how they are going to keep the arms-reduction process going. This continuity is also vital in breathing new life into the seemingly hopeless task of preventing the spread of nuclear weapons to additional nations and to terrorists.

One possibility is for the leaders to explore the potential of the so-called tritium factor, which could provide a verifiable way to reduce the number of nuclear weapons gradually, at the rate of about 6 percent a year.

Tritium is a radioactive form of hydrogen that is produced in nuclear reactors. Small amounts of it are used in most nuclear weapons to boost their explosive yield and for other purposes. The "tritium factor" is a term used to refer to tritium's rapid rate of decay. The few grams of tritium contained in a nuclear weapon must be replaced frequently because tritium depletes by about half every 12 years. By comparison, the other principal nuclear weapons materials, plutonium and uranium, decay over thousands of years.

The two superpowers have produced all the weapons-usable uranium and plutonium they need to maintain nuclear arsenals at present levels of about 25,000 to 30,000 warheads each. But they must continue to produce enough tritium to replace the tritium that has decayed. If they agreed to stop producing tritium, each side eventually would have to begin retiring nuclear weapons at a rate equal to tritium's decay rate of 5.5 percent a year.

This process could be used to establish a minimum rate for retiring weapons. It could serve as a self-enforcing mechanism for achieving steady progress toward significantly smaller nuclear arsenals. Most important, this approach could be made subject to strict verification to insure that all military production reactors, which are used to produce tritium and plutonium, are shut down and that weapons are dismantled at an agreed rate. Both types of verification are feasible, based on existing methods and technology.

Each side could begin cautiously by keeping one or two reactors on standby in case more tritium were needed in the event that negotiations for weapons cuts failed to keep pace with tritium's decay. Assuming the cuts proceeded on schedule, however, no new tritium production would be needed for some time.

Tritium from retired weapons could be concentrated and reused for remaining weapons, and arsenals could be drawn down to a level of minimum effective deterrence, perhaps a few hundred weapons for each side. Then tritium production could begin anew, but in much smaller quantities than before it was suspended, to maintain weapons stocks at the agreed level. The arms reduction process could extend over decades or it could be accelerated over a shorter period.

A verifiable method of insuring mutual security.

The unexpected convergence of two recent developments — the superpowers' near diplomatic success in negotiating an arms reduction agreement in Europe, and new concerns since the Chernobyl accident about the safety of aging reactors used for weapons production — provide a unique opportunity to advance arms reduction efforts.

Both sides, therefore, might welcome this method of continuing reductions in weapons, as well as the resulting suspension of production of other weapons materials. A halt in tritium production would also encompass a halt in production of two other weapons materials, plutonium and highly enriched uranium. Thus, if new supplies of tritium were not needed for an extended period, the Reagan Administration could defer a proposal to build two new reactors at a cost of $6 billion each to be used in production of weapons materials.

The superpowers would gain a further bonus from an agreement to stop production of new weapons materials: They could enhance their credibility in appealing to other nations not to pursue nuclear weapons programs and not to produce weapons-usable plutonium and uranium in civilian programs.

The world is increasingly dangerous not only because of the superpowers' enormous nuclear weapons stockpiles but also because the world supply of plutonium is rapidly growing.

Within a decade, European countries and Japan will have more weapons-usable plutonium for use as fuel in commercial power reactors than the superpowers now have in all their weapons. That surge in supply increases the danger that commercial plutonium might fall into the hands of nations or terrorists who want the bomb. Moreover, much of the growth stems from the poor example that the superpowers have set by failing to limit the growth of their own nuclear stockpiles.

A way to reduce atomic weapons.

The expected summit meeting could present an opportunity for the United States and the Soviet Union to consider a suspension of tritium production as a relatively painless, gradual approach to significant arms reduction. A 6 percent annual reduction in nuclear arsenals, beginning with retirement of about 1,500 warheads on each side, would be considered too slow by some and too fast by others. But it could help build confidence and reduce the number of nuclear weapons by at least 50 percent by the year 2000.

Given the potential for continued arms reductions and the additional benefit of encouraging other nations to turn away from production of nuclear weapons materials, a suspension of tritium production is certainly worth a try.

Paul L. Leventhal is president, and Milton M. Hoenig is scientific director, of the Nuclear Control Institute, a research center on nuclear-proliferation problems.

The New York Times
TUESDAY, JULY 25, 1989

Restart Put Off Till Late 1990 For a Nuclear-Arms Reactor

By KEITH SCHNEIDER
Special to The New York Times

WASHINGTON, July 24 — The Westinghouse Savannah River Company, which operates the Federal Government's Savannah River nuclear weapons plant in South Carolina, has told the Department of Energy it will not be able to restart the first of three shutdown military reactors until September 1990, the Energy Department said today.

The proposed restarting date for the giant plant, which produces a perishable radioactive gas vital to thermonuclear weapons, comes much later than Government officials and other experts envisioned in the spring of 1988 when the last of three operable reactors was taken out of service for safety modifications. Westinghouse submitted the restarting plan June 26.

The Secretary of Energy, James D. Watkins, said in a letter to the company last week that he was dissatisfied with its program for repairing the reactors and that more had to be done to start one reactor before late 1990, a spokeswoman for the Energy Department said.

'Timing for Restart Slipped'

"We have some difficulties with Westinghouse's proposed restart strategy, which we are in the process of trying to work out," said Christina Sankey, a spokesman for the Energy Department.

"My understanding of what's in the proposed restart plan is that Westinghouse's timing for restart slipped several months beyond what they were originally talking about."

The 37-year-old Savannah River Site is the largest and most important of 17 principal nuclear weapons plants and laboratories in 12 states. Three reactors that remain operable at the 300-square-mile plant are the nation's sole source of tritium, a radioactive isotope of hydrogen that enhances the explosive power of nuclear warheads.

Yet tritium, unlike the other principal ingredients of atomic bombs, plutonium and enriched uranium, decays at a fairly rapid rate. Tritium in warheads must be replenished periodically or it ceases to function properly. Just when replenishment is needed is one of the Government's most closely held secrets.

Savannah River has been unable to make new supplies of tritium since June 1988, when the third reactor was shut for maintenance and modifications to safety systems.

In October, 1988, the Energy and Defense departments said that unless one reactor was restarted by the end of 1988, the readiness of the nuclear arsenal could be compromised.

Pentagon officials said old warheads might need to be deactivated to recover tritium for use in higher priority weapons.

Risk Is Considered Overstated

Critics of the Energy Department, including the Nuclear Control Institute, a Washington-based arms control group, said the Government was vastly overstating the risk to the arsenal from lack of new supplies of tritium.

The new data to restart the first reactor at Savannah River, the "K" reactor, is the most persuasive evidence yet that supplies of tritium are adequate, Westinghouse Savannah River, a subsidiary of the Westinghouse Electric Corporation, took over the vast plant April 1.

The plan provides new details about an extensive overhaul of equipment and management of the reactors, Energy Department officials say. The document, say Government engineers who have seen it, expands on a report late last year by the Energy Department that called for $250 million in repairs to the reactors.

The Savannah River plant was built by E.I. du Pont de Nemours & Company. Three of its five reactors have been operating for 35 years. Two were shut in 1964 and 1984 because of cracks that caused radioactive coolant to leak.

John C. Tuck, the Under Secretary of Energy, said last week that parts of the Westinghouse restart plan would be made public. Ms. Sankey said the agency's public information office had not yet seen a copy of the document.

The New York Times

TUESDAY, MAY 16, 1989

NUCLEAR CONTROL INSTITUTE
1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

IN THE NATION
Tom Wicker

How to Upstage Gorbachev

Once again, Mikhail Gorbachev has left the United States looking off balance and recalcitrant in the effort to reduce nuclear arms competition. Here's one American — and I suspect there are many — who'd like to see our side get the jump on Mr. Gorbachev, for a change. And a useful way to do it is at hand.

Administration officials say the Soviet leader's plan for a small cut in his country's short-range nuclear missile force was mostly propaganda. No doubt; it certainly took the headlines away from James Baker's visit to Moscow. Still, these officials argue, President Bush need not compete with Mr. Gorbachev in what they call "P.R." but should hold to a "cautious" course.

So they're calling for more "tests" of the bona fides of a leader who's already made a major cut in deployed weapons in the I.N.F. treaty, agreed to halve the numbers of his biggest, most threatening ICBM, pulled his troops out of Afghanistan, signaled with that token cut in short-range missiles that his big lead in these weapons is on the table too, announced his readiness to make the biggest sacrifice in conventional forces, and laid out a scheme and a timetable for doing so that not even a sour-grapes State Department can call propaganda.

A good opportunity for President Bush to take the initiative.

But if that's not enough, let's do test Mr. Gorbachev again — but with a new American proposal rather than a warmed-over idea from the Eisenhower Administration. Why not announce a unilateral U.S. decision to continue the present halt in the production of tritium, an essential element in nuclear warheads? That would make it hard for the Soviets to reject an accompanying proposal from Mr. Bush that both sides explore the possibility of a verifiable agreement to halt or limit all production of tritium, plutonium and uranium for nuclear arms.

Not only would that grab headlines, however unimportant the Bush Administration may consider them. It also could lead to an arms control agreement vastly reducing the number of nuclear warheads on both sides, as a new SALT treaty and further agreements would presumably cut back on delivery vehicles, Such a proposal, moreover, would not jeopardize U.S. warhead stocks or national security — but it *would* make a real dent in the budget deficit.

This idea, devised by the Nuclear Control Institute of Washington, has been outlined by a group of experienced arms controllers to Les Aspin, chairman of the House Armed Services Committee. The group includes Gerard Smith and Ralph Earle, chief SALT negotiators for Presidents Nixon and Carter.

Congress is already working on this year's defense authorization bill and has been asked by the Department of Energy to put up $300 million in fiscal 1990 — and eventually about $7.5 billion altogether — for construction of two new reactors to supply tritium. Production of the gas has been halted entirely since safety concerns caused the reactors at the Savannah River nuclear plant to be shut down a year ago.

Nor is the U.S. now producing any enriched uranium or plutonium for nuclear weapons. Thus, without sacrifice, Mr. Bush could ask Congress to defer the new reactors, save $700 million (maybe more later), and give him time to find out whether Mr. Gorbachev will agree to halt or limit production of nuclear weapons materials. He's already announced a halt in Soviet production of enriched uranium this year and the closing next year of three reactors producing plutonium for warheads.

That national security would not be risked by deferring the new reactors — which might never be needed if a joint production halt could be negotiated — is attested in a compelling scientific report denying the Energy Department's claim that a tritium shortage exists. The report contends that enough U.S. tritium now is available or recoverable "to sustain a fully adequate weapons stockpile for at least five years."

The 11 scientists who compiled that report are all long experienced in nuclear weapons research and include men who were advisers to Republican as well as Democratic Administrations. Two of them soon will testify before Mr. Aspin's committee.

The arms controllers' letter suggested, however, that Congress make it clear, by legislation or a joint resolution, that if negotiations failed new supplies of tritium would be authorized and produced before the nation's weapons stockpile could be affected.

Halting or reducing production of crucial materials for nuclear weapons seems an idea whose time has come. If both superpowers can agree to cut back nuclear forces, why should either want to build more nuclear weapons?

Stay tuned for another article, with further details on this beckoning opportunity for President Bush. □

The New York Times

FRIDAY, MAY 19, 1989

NUCLEAR CONTROL INSTITUTE
1000 CONNECTICUT AVE NW SUITE 704 WASHINGTON DC 20036 202-822-8444

IN THE NATION
Tom Wicker

Lemon And Lemonade

Is the yearlong shutdown of the reactors at the Savannah River nuclear plant a crisis or an opportunity? Can a lemon be made into lemonade?

The shutdown — for safety reasons — stopped production of tritium, an essential element in nuclear warheads. That's why the Department of Energy sees a national-security crisis it wants to attack by starting construction of two new reactors at a cost of $7.5 billion, before cost overruns.

But wait a minute. The U.S. has "enough tritium in its 23,000 nuclear warheads to support a force of 6,000 strategic warheads for longer than 20 years and a force of 1,000 warheads for some 50 years," according to an eminent, non-governmental team of scientists working with the Nuclear Control Institute.

They want to seize the opportunity they think the reactor shutdown presents, to negotiate with the Soviet Union about a mutual and verifiable halt to the production of tritium, plutonium and enriched uranium — all necessary to the making of nuclear warheads.

The scientists are not advocating negotiation from weakness, since the Soviets are in much the same fix. An assessment by the Los Alamos National Laboratory concludes that Soviet military reactors "are old, obsolete and unsafe" and "will be shut down soon anyway." A few weeks ago, Mikhail Gorbachev announced a halt in enriched uranium production and the closing next year of three reactors producing plutonium for warheads.

The U.S., having enough, no longer needs to produce plutonium or enriched uranium for weapons purposes. Both superpowers have agreed in principle to reduce the size of their nuclear arsenals in the forthcoming Start negotiations, and perhaps in others to follow. Thus, the moment may well be ripe for a negotiated halt in production of nuclear weapons materials.

Tritium is the key. It's a perishable gas used to "boost" the yield of warheads, so that they can be reduced in size and weight. Unlike plutonium and enriched uranium, tritium decays rapidly — at a rate of about 5.5 percent a year. That doesn't affect the yield of the weapon, as long as a critical minimum charge remains; but it does determine how long a weapon can remain operational. Nuclear warheads, therefore, are given an oversupply of tritium to extend their field life; and they must be recharged periodically with a new supply of the gas.

Opportunity in the halt of Savannah River tritium production.

Thus if the field life of nuclear weapons was cut from six to three years before a tritium recharge was needed, the tritium on hand would go twice as far. If some weapons have a current field life longer than six years, a cutback to three years would extend the tritium supply even further.

Recharges consist of the timely replacement of old tritium "reservoirs" in warheads with new ones. Since the old reservoirs are not completely empty, the tritium remaining in them could be recycled into new charges. More tritium could be obtained from the reservoirs in warheads being withdrawn under the I.N.F. treaty, from retired Poseidon submarine missiles and from other warheads being taken out of service for various reasons.

By such steps alone, the scientists estimate, the U.S. could maintain "a fully adequate weapon stockpile" for perhaps five years without additional tritium production or costs for new reactors. Therefore, the Nuclear Control Institute and a group of experienced arms controllers are urging Congress to withhold funds for the reactors while the Administration determines whether:

- Start and other negotiations reduce nuclear arsenals — for instance, by a 50 percent cut in strategic weapons — enough so that current U.S. tritium demands would be reduced to the amount needed for many fewer warheads.
- The Soviets would join in a verifiable agreement to halt all nuclear weapons materials production. If so, both sides then would be forced into steady and verifiable reductions in their nuclear arsenals, owing to tritium's 5.5 percent annual decay rate, until a minimum deterrent level was reached.

At that point, agreed low levels of tritium production could be resumed to maintain both sides' deterrent forces; but the cost for that would be far less than for the new reactors projected by the Energy Department. Congress could make clear that if negotiations failed sufficiently to reduce tritium needs, funds would be available for a timely resumption of production.

Congress is considering the new reactors. Start talks will soon resume. Now's the time for President Bush to make some lemonade, before Mr. Gorbachev begins to squeeze his own lemon. □

The Washington Post

SUNDAY, APRIL 16, 1989

NUCLEAR CONTROL INSTITUTE
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OUTPOSTS

This week, following reports of Soviet cutbacks in production of weapon-grade uranium and plutonium, 11 American scientists propose a halt in U.S. production of all nuclear weapons materials—including tritium, a critical warhead component—while arms-reduction talks continue, without the need for any new reactors or any compromise in national security.

ATOMIC WEAPONS

America's Non-Existent Nuclear 'Crisis'

NEW PRODUCTION of tritium for U.S. nuclear weapons has been at a standstill since the spring of 1988, when the Department of Energy's reactors at the Savannah River plant were completely shut down as a result of safety concerns.

Since those reactors are the sole source of supply of tritium for nuclear weapons, officials of the Departments of Defense and Energy and some members of Congress have stated that production must be resumed in at least one Savannah River reactor this year or our national security will be endangered; they view a longer halt as tantamount to "unilateral disarmament." This concern is based on tritium's relatively rapid radioactive decay, necessitating its regular replacement in warheads.

DOE also has asked for over $300 million in FY 1990 to prepare for construction of two new production reactors with an estimated cost of $7.5 billion. The reactors, to be completed in 10 years, would supply 150 percent of DOE's perceived future tritium requirements for nuclear weapons. They also would be capable of producing weapon-grade plutonium.

It is our considered view that there is no critical shortage of tritium today and that claims of an imminent "crisis" distort the true situation. Congress and the American people should not be stampeded into restarting the Savannah River reactors and building costly new reactors. Instead, the existing tritium supply should be put to more efficient use to meet the nation's military needs in the near-term and proposals for new production should be reevaluated.

There are a number of important reasons to take this cautious approach.

- Tritium, because of its decay rate, is a wasting asset; it makes no sense to produce more than is now needed or to fund facilities capable of producing very much more than will be needed. Plutonium, on the other hand, is long-lived and is in ample supply without new production to meet current weapons requirements.
- Enough tritium exists in present inventory to sustain a fully adequate weapons stockpile, probably for at least five years without new production, if the possible effects of different management arrangements and the possible use of tritium from weapons scheduled for retirement or held in storage are taken into account. Congress needs to obtain complete information on these options from the Departments of Defense and Energy.
- In view of the fact that the leaders of the United States and the Soviet Union have agreed in principle that their nuclear arsenals are much too large, a continuation of the present halt and a delay in proceeding with new production facilities would allow time to ascertain whether the ongoing Strategic Arms Reduction (START) Talks and other arms reduction initiatives will result in significantly reduced tritium requirements.
- If prospects for a START agreement are realized, there would be an opportunity to reassess the need for new tritium production capacity and to take advantage of substantial reductions in the size and cost of new facilities if they are required.
- If it turns out that these arms-reduction opportunities will not be realized, and a new production reactor is eventually needed, plans of the kind currently proposed could be reinstated. The delay of a few years entailed by this approach would not erode the nuclear-deterrent power the nation now possesses, nor pose any other risk to national security. It should be understood that with a stockpile of over 20,000 nuclear warheads, any reference to a "crisis" in tritium supply is quite inappropriate.
- We believe a new production reactor can be built in five years, rather than 10, once planning activities are completed. A great deal more is known now about reactor design and safety than was known in the 1950s, and much time and money can be saved if construction proceeds efficiently after thorough planning and safety and environmental review.
- The nation is now faced with strict limitations on federal spending because of the imperative to cut the budget deficit. Very large sums will be required to upgrade elements of the weapons-production complex to achieve improvements in safety, pollution control and efficiency, as well as to proceed with the necessary cleanup of environmental pollution resulting from 40 years of past operation. Monies now being requested for the construction of new production capacity should be applied, for at least the next few years, to such other purposes.

Maintaining the Arsenal

Tritium, a man-made radioactive isotope of hydrogen, is an essential element in modern, "boosted" nuclear warheads. The fusion of a few grams of tritium with a naturally occurring hydrogen isotope called deuterium provides a burst of neutrons at the crucial moment to amplify ("boost") the yield in fission weapons or in the fission triggers of thermonuclear weapons. Boosted warheads thus weigh less, are more compact and efficient and have lower cost. We are heavily dependent on boosting, and the Soviets use it as well.

Because tritium decays at a rate of 5.5 percent annually (it has a half-life of 12.5 years), the tritium "reservoirs" of U.S. nuclear warheads must be refilled regularly to maintain the weap-

ons' explosive yield. The reservoirs are filled initially with a supply of tritium in excess of what is needed for the weapon to operate properly. When the excess runs down, the reservoir is exchanged for a new one. The surviving tritium in the old reservoir is recovered, purified and recycled. Tritium replenishment cycles vary for different types of warheads: It has been reported that weapons currently in the stockpile have a four- to six-year cycle, whereas the new generation of submarine-launched missiles may be charged for 10 years or more.

Provided that the essential minimum amount of tritium remains in the weapon system, it will still produce the certified yield. The size of the charge determines only the length of time the weapon may remain in the field. To provide a six-year service life after a fresh filling, the tritium loading must have an excess of at least 40 percent over the minimum amount. An eight-year service life requires an excess of 57 percent; 10 years requires approximately 75 percent above the minimum.

A Crisis Mentality

In testimony before the Senate Armed Services Committee, Troy E. Wade, DOE acting assistant secretary for defense programs, said it would be necessary to restart one Savannah River reactor by the end of the year, since by then the need for new tritium would become critical. Earlier, Robert B. Barker, assistant to the secretary of defense for atomic energy, was quoted as warning that delaying restart of the reactors would be tantamount to "unilateral nuclear disarmament." These assertions have led to expressions of congressional concern. Yet a recent internal Pentagon study, reported in The Boston Globe, concludes that there is an adequate supply of tritium for 18 months to two years with no alterations in resupply of weapons or any additional production.

There are a number of straightforward means that could be adopted to stretch out the period for which a given reserve supply of tritium would be adequate. The most obvious and immediately effective step would be to reconsider existing plans for tritium service life. Suppose, for example, that the current schedule calls for refilling a large number of weapons for a six-year service life. According to Troy Wade's testimony, there is only enough tritium on hand to continue the refilling operation for about one year. However, simply by changing to a three-year service life, for which the required excess in the filling is only 18 percent rather than 40, the required amount of additional tritium would be cut in half and the supply extended from one year to two years. For weapons with a service life longer than six years, the extension of inventory would be even greater.

These options would entail a doubling (or more) of the work load at facilities handling the refills. But the increase would take effect gradually and would not be difficult to prepare for. The increased number of reservoirs to be handled also would raise operating costs in the field. But this would be offset by the net savings realized from deferring new tritium production costs.

There are a number of other potential sources of tritium that could be used to avert a short-range tritium supply problem. Among these are: the 500 or so warheads to be withdrawn under the INF Treaty, along with the Pershing 1A missiles to be retired from Germany; the warheads from the Poseidon submarines retired since 1985, along with additional warheads from the two scheduled for retirement in 1989 to abide by the SALT limits; the bombs removed from the B52G bombers converted to conventional missions; some 400 enhanced radiation warheads now in storage (if their large tritium supplies have been kept intact); and the recovery of tritium from used heavy water moderators in storage at Savannah River. All these and similar sources should be exploited before it is concluded that there is any imminent "crisis."

Finally, it should be noted that if the present halt in tritium production were continued for an extended period, the weapons stockpile eventually would have to be reduced at a rate similar to the decrease in the amount of tritium on hand—that is, at the decay rate of about 5.5 percent a year. For about the first five years, such a reduction in weapons is roughly equivalent to the cuts that have been discussed in the START negotiations. Should negotiations continue beyond START with the objective of establishing a minimum effective nuclear deterrent, there would be no need to resume new tritium production for many years. In fact, the United States now has enough tritium in its 23,000 nuclear warheads to support a force of 6,000 strategic warheads for longer than 20 years and a force of 1,000 warheads for some 50 years.

But what if the START and other initiatives fail? As a worst-case scenario, suppose that the United States were to refrain from producing any tritium for five years and that at the end of that time there were no clear prospect of any arms-control agreement. We might then decide that it was essential to build up our nuclear arsenal. Would we then face a crisis in tritium supply?

No. Because even then, other sources would be available. During the non-production period, we presumably would have prepared at least one Savannah River reactor for restart. Operating even at half power, it could supply enough tritium to sustain the arsenal at its present level during the approximately five years required to complete a new production reactor. In the unlikely event that none of the remaining Savannah River reactors can be restarted safely, there are a number of other possible sources: The N reactor at Hanford, now undergoing renovation; the DOE test reactors in Idaho; and even the expedient of commercial power reactors, for which tritium target technology is now under development. Also, tritium might be acquired from France, Britain or possibly Canada.

Recommendations and Reality

Preparations now underway for construction of new production reactors should be deferred to allow Congress to become fully informed about the country's actual needs and to allow time for the START process to produce results.

The United States should not now resume production of nuclear weapon materials that are not needed and can serve only to further stimulate the arms race. Instead, it should move toward a mutual halt in the production of nuclear materials for weapons.

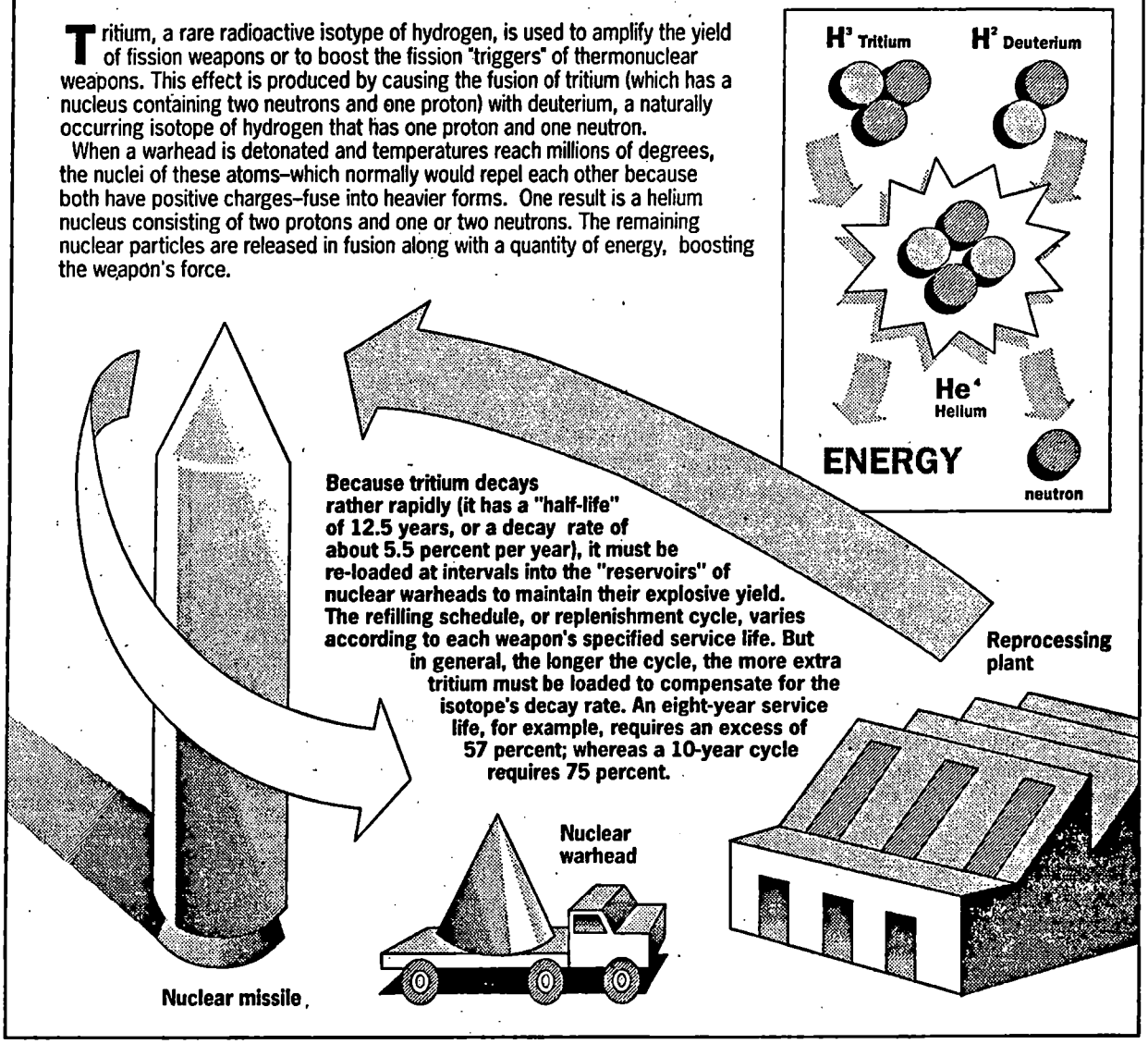
While the present halt in production remains in effect, the United States should consider offering not to restart the Savannah River reactors or to begin construction of new production reactors for a designated period of time to give the Soviet Union the opportunity to reciprocate. The two sides may be able to proceed to a mutual halt in production of tritium and fissionable materials for weapons by a series of reciprocal steps. A mutual production halt could be monitored by national technical means and on-site inspections, supplemented by international and bilateral safeguards on civilian reactors. Such a halt is possible in the context of a START agreement and agreements on deep cuts beyond START accompanied by verification of delivery systems and warheads destroyed and retained.

The United States and the Soviet Union should not let pass an extraordinary opportunity to achieve a mutual end to the production of nuclear materials for weapons. For its part, the United States can exercise restraint and turn the present production shutdown to advantage. It should not be stampeded into premature resumption of tritium production or construction of new production capacity. If we exercise restraint, the arms reduction process can flourish.

TRITIUM AND THE NUCLEAR ARSENAL

Tritium, a rare radioactive isotype of hydrogen, is used to amplify the yield of fission weapons or to boost the fission "triggers" of thermonuclear weapons. This effect is produced by causing the fusion of tritium (which has a nucleus containing two neutrons and one proton) with deuterium, a naturally occurring isotope of hydrogen that has one proton and one neutron.

When a warhead is detonated and temperatures reach millions of degrees, the nuclei of these atoms–which normally would repel each other because both have positive charges–fuse into heavier forms. One result is a helium nucleus consisting of two protons and one or two neutrons. The remaining nuclear particles are released in fusion along with a quantity of energy, boosting the weapon's force.



PETER HOEY—THE WASHINGTON POST

The Authors

The following scientists have signed the tritium policy paper, prepared in collaboration with the Nuclear Control Institute in Washington, from which the above article is adapted:

■ Hans Bethe, a 1967 Nobel Prize winner in physics, formerly headed the theoretical-physics division at Los Alamos National Laboratory and is emeritus professor of physics at Cornell University.

■ Freeman Dyson, professor of physics at Princeton's Institute for Advanced Study, has been a frequent consultant to the Defense Department and the U.S. Arms Control and Disarmament Agency (ACDA).

■ Herman Feshbach, former chairman of the nuclear-science advisory committee of the National Science Foundation and former president of the American Physical Society and the American Academy of Arts and Sciences, is emeritus institute professor of physics at the Massachusetts Institute of Technology.

■ Val Fitch, a 1980 Nobel Prize winner in physics and professor of physics at Princeton University, was a presidential adviser on science policy and arms control in the Nixon administration.

■ Marvin Goldberger, former president of the California Institute of Technology and now director of Princeton's Institute for Advanced Study, chaired the committee on international security and arms control of the National Academy of Sciences.

■ Kurt Gottfried, professor of physics and nuclear studies at Cornell, was an officer of the American Physical Society and a consultant to the Department of Energy's high-energy-physics advisory board.

■ Milton Hoenig, a physicist and scientific director of the Nuclear Control Institute, was at ACDA during the Carter administration.

■ Franklin Long, professor emeritus of chemistry at Cornell, was research supervisor of the National Defense Research Committee from 1942 to 1945 and assistant director of ACDA under President Kennedy.

■ J. Carson Mark, former leader of the theoretical-physics division of Los Alamos National Laboratory, serves as a consultant to Los Alamos and other government agencies.

■ George Rathjens, professor of political science at MIT, was chief scientist in the Defense Advanced Research Projects Agency and in the Office of Special Assistant to the President for Science and Technology.

■ Victor Weisskopf, former group leader at Los Alamos National Laboratory and former director of CERN (the European Center for Nuclear Research), is emeritus institute professor of physics at MIT.

April 7, 1989

FOR A NEW NUCLEAR MATERIALS PRODUCTION POLICY: SOLVING THE MILITARY TRITIUM PROBLEM

Hans Bethe, Freeman Dyson, Herman Feshbach, Val Fitch, Marvin Goldberger, Kurt Gottfried, Milton Hoenig, Franklin Long, Carson Mark, George Rathjens, Victor Weisskopf

This paper was prepared in collaboration with the Nuclear Control Institute, Washington, D.C.

Introduction

New production of tritium for U.S. nuclear weapons has been at a standstill since the spring of 1988, when the Energy Department's reactors at the Savannah River plant were completely shut down as a result of safety concerns.

Since the Savannah River reactors are the sole source of supply of tritium for nuclear weapons, officials of the Departments of Defense and Energy and some members of Congress have stated that tritium production for weapons must be resumed in at least one Savannah River reactor this year or our national security will be endangered; they view a longer halt in tritium production as tantamount to "unilateral disarmament." This concern is based on tritium's relatively rapid radioactive decay, necessitating its regular replacement in warheads to keep them fully functional.

DoE also has asked for over $300 million in FY 1990 to prepare for construction of two new production reactors costing $7.5 billion, according to the department's present preliminary estimate. The reactors, to be completed in 10 years, would supply 150 percent of DoE's perceived future tritium requirements for nuclear weapons. They also would be capable of producing weapon-grade plutonium.

It is our considered view that there is no critical shortage of tritium today. Claims that the United States is confronted with an imminent tritium crisis distort the true situation. Congress and the American people should not be stampeded into restarting the Savannah River reactors and building costly new production reactors. Instead, the existing tritium supply should be put to more efficient use to meet the nation's military tritium needs in the near-term, and any need for new production of tritium over the long-term should be reevaluated.

There are a number of important reasons for taking this cautious approach to new tritium production.

Tritium, because of its relatively rapid radioactive decay, is a wasting asset; it makes no sense to produce more tritium than is now needed or to fund facilities capable of producing very much more than will be needed. Plutonium, on the other hand, is long-

lived and is in ample supply to meet current weapons requirements. There is no need to produce more of it at the present time.

In view of the fact that the leaders of the United States and the Soviet Union have agreed in principle that the superpower nuclear arsenals are much too large, a continuation of the present halt in tritium production and a delay in proceeding with new production facilities would allow time to ascertain whether the ongoing Strategic Arms Reduction (START) Talks and other arms reduction initiatives will result in significant reductions in tritium requirements. As discussed below, if prospects for a START agreement are realized, there would be an opportunity to reassess the need for new tritium production capacity and to take advantage of substantial reductions in the size and cost of new facilities if they are required.

Congress needs to obtain information from the Departments of Energy and Defense on how many years the existing tritium inventory can be extended by more efficient management and use, without new production. We believe, as discussed below, Congress may learn that there now exists enough tritium to sustain a fully adequate weapons stockpile for at least five years, if the possible effects of different tritium management arrangements and the possible use of tritium from weapons scheduled for retirement or held in storage are taken into account.

If it becomes apparent that START and other arms-reduction opportunities will not be realized, and a new production reactor is eventually needed, plans of the kind currently proposed could be reinstated. The delay of a few years entailed by this approach would not erode the nuclear deterrent power the nation now possesses, nor pose any other risk to national security.

In any circumstance, there is no need for the further production of long-lived plutonium for nuclear weapons since already sufficient supplies exist from weapons retirements and scrap recovery.

We believe a new production reactor could be built in 5 years rather than the 10 years now projected by the Department of Energy, once planning activities are completed. A great deal more is known now about reactor design and safety than was known in the 1950s, and much time and money could be saved if construction proceeds efficiently after thorough planning and safety and environmental review. The several-year tritium cushion that now exists for weapons gives the nation time to review its objectives and future needs. It is not in the national interest, therefore, to move ahead precipitously with construction.

Indeed, the nation is now faced with strict limitations on Federal spending because of the imperative to cut the budget deficit. Very large sums will be required to upgrade some elements of the weapons production complex in order to achieve improvements in safety, pollution control and efficiency of operation, as well as to proceed with the necessary cleanup of

environmental pollution resulting from 40 years of past operation. Monies now being requested for the construction of new production capacity should be applied, for at least the next few years, to such other purposes.

Tritium's Significance

Tritium, a radioactive isotope of hydrogen, is an essential element in modern, "boosted" nuclear warheads. The fusion of a few grams of tritium with deuterium provides a burst of neutrons at the crucial moment to amplify ("boost") the yield in fission weapons or in the fission triggers of thermonuclear weapons. Boosting allows reductions in the weight of nuclear warheads, enabling them to be more compact and efficient, and also lowering their cost. We are heavily dependent on boosting, and the Soviets are known to make use of its very significant advantages, as well.[1]

Because tritium decays at a rate of 5.5 percent annually, reducing by half in about 12 years, the tritium "reservoirs" of U.S. nuclear warheads must be refilled regularly to maintain the weapons' explosive yield. The reservoir of a nuclear weapon is filled initially with a supply of tritium in excess of what is needed for the weapon to operate properly. The tritium excess lasts for a specified number of years after the weapon is deployed, and when the excess runs down, because of radioactive decay, the tritium reservoir is exchanged for a new one. The surviving tritium in the old reservoir is recovered, purified and recycled. Tritium replenishment cycles vary for the different types of nuclear warheads in the stockpile. It has been reported that weapons currently in the stockpile have a 4-to-6 year replenishment cycle while the new generation of submarine launched missiles may be charged with a tritium oversupply lasting 10 years or more.[2]

Provided that an essential minimum amount of tritium remains in the weapon system, the size of the initial tritium charge or its radioactive decay do not affect the weapon's operation to the extent of failing to give the certified yield. The size of the charge determines only the length of time the weapon may remain in the field before it becomes necessary to replenish its tritium supply.

For example, to provide a 6-year service life after a fresh filling, the tritium loading must have an excess of at least 40 percent over the minimum amount. This excess represents the extra amount of tritium that must be added to the tritium recovered from a weapon's reservoir, after it is returned from the field, in order to prepare it for being sent back for a further 6-year service life. To refill a tritium reservoir for an 8-year service life in the field would require adding an excess of at least 57 percent of the essential minimum amount, whereas a 10-year service life requires an excess of about 75 percent over what is needed for the weapon to be operable.

The Near-Term Tritium Cushion

In testimony before the Senate Armed Services Committee, Troy E. Wade, DoE Acting Assistant Secretary for Defense Programs, said that it would be necessary to restart one Savannah River reactor by the end of the year, since by then the need for new tritium would become critical.[3] Earlier, Robert B. Barker, Assistant to the Secretary of Defense for Atomic Energy, was quoted as warning that delaying restart of the reactors would be tantamount to "unilateral nuclear disarmament."[4] These assertions have led to expressions of Congressional concern about the prospect of "unilateral disarmament."[5] However, a recent internal Pentagon study reportedly concludes that there is an adequate supply of tritium for 18 months to 2 years with no alterations in resupply of weapons or any additional production of tritium.[6]

The detailed assumptions leading to these somewhat different conclusions were not disclosed. It may be assumed, however, that they were developed on the basis of needs implied by some pre-existing schedule for the resupply of tritium for weapons in the stockpile, along with initial supply for a certain number of new weapons, and that the procedures to be followed were in accordance with some customary prescription concerning service life.

There are a number of straightforward means that could be adopted to stretch out the period for which a given reserve supply of tritium would be able to cover the weapon-filling requirements, without having to declare a state of emergency or resorting to "unilateral disarmament."

The most obvious and immediately effective step would be to reconsider existing plans for tritium service life. By way of illustration, suppose that the current schedule calls for refilling a large number of weapons for a 6-year service life. According to Assistant Energy Secretary Wade's statement above, there is only enough tritium on hand to continue the refilling operation for about one year. However, simply by changing to a 3-year service life, for which the required excess in the filling is only 18% rather than the 40% required for 6 years, the amount of additional tritium required to refurbish the same number of weapons would be cut in half, and the supply of tritium for maintaining the same number of weapons would be extended from one year to two years. If the proposed program includes weapons having a service life longer than 6 years, the change to a 3-year life would result in an even longer extension of the existing tritium inventory.

A further step to extend the existing tritium supply would be to redistribute the tritium already in warheads by filling depleted tritium reservoirs with a portion of the excess tritium recovered from more recently replenished warheads and thereby

shortening the overall replenishment cycle. In this process, recently filled reservoirs would be brought back from the field along with depleted ones, and the weapons would be resupplied with reservoirs having shorter service lives. For example, redistributing the tritium in the stockpile to reduce the tritium service life overall from 6 years to 3 years could extend the tritium supply by yet another two years.

Part of the price for using these means to defer any tritium "crisis" would be the doubling (or more) of the work load at facilities handling the refills. But the increased workload would take effect gradually and would not be difficult to prepare for. The increased number of reservoirs to be handled also would raise operating costs in the field, but this increase, like the higher facility costs, would be offset by the net savings realized from no new tritium production costs.

There are a number of other potential sources of tritium that could be used to avert a short-range tritium supply problem. Among these are the 500 or so warheads to be withdrawn under the INF treaty, along with the Pershing 1A missiles to be retired from Germany; the warheads from the Poseidon submarines retired since 1985, along with additional warheads from the two scheduled for retirement in 1989 to abide by the SALT limits; the bombs removed from the B-52G bombers converted to conventional missions; some 400 enhanced radiation warheads now in storage, if their large tritium supplies have been kept intact; and the recovery of tritium from used heavy water moderator in storage at Savannah River. These all represent possible additional sources of tritium. Some may already have been taken into account, and some may not provide much relief. But certainly these, and any other similar examples, should be exploited before it is concluded that there is any imminent crisis.

Once Congress has complete information available, it would be surprising <u>not</u> to find that tritium requirements to maintain a fully adequate weapon stockpile (as distinct from some past projections of possible future stockpile trends and developments) could be met for a significant period---such as 5 years---without any additional tritium production.

It should not take as long as five years, however, to determine whether the START and other arms-reduction negotiations are likely to produce cuts sufficient to permit continued suspension of tritium production. It is widely assumed that it should be clear within two years whether a START agreement will be successfully concluded, by which time it also should be clear whether post-START negotiations for further deep cuts are in the offing. Still, for the purpose of examining a worst-case scenario, one could suppose that the U.S. has refrained from producing any tritium for a period of five years and that, at the end of that time, there is no clear prospect of any arms control agreement. We might then decide that it was essential to build up our nuclear arsenal. Would we then be in a tritium crisis?

Even in this worst case, the United States could find other sources of tritium to meet its military requirements. Over the interim period we could, and presumably would, have prepared at least one Savannah River reactor for restart. Operating even at half power, a single Savannah River reactor could supply enough tritium to sustain the arsenal at its present level until a new production reactor is completed. The concerted construction phase of a new production reactor would begin immediately and could be finished in 5 years, after having previously completed the design work and the necessary environmental and safety reviews.

In the unlikely event that none of the remaining Savannah River reactors can be restarted safely, there are a number of other possible sources of military tritium: for example, the N reactor at Hanford, which is now undergoing renovation, the DOE test reactors in Idaho, and even the expedient of commercial power reactors, for which tritium target technology is now under development. Also, tritium might be acquired from France and Britain, and possibly from Canada.

However, it should be understood that with a stockpile of over 20,000 nuclear warheads, any reference to a "crisis" in tritium supply is quite inappropriate. Should the hope for agreement on START and follow-on arms reductions fail, any interim measures taken while new reactor construction is being completed -- such as the temporary transfer of tritium from some less essential weapons to more essential ones -- would not diminish our deterrent capability.

Finally, it should be noted that if the present halt in tritium production were continued for an extended period, the weapons stockpile eventually would have to be reduced at a rate similar to the decrease in the amount of tritium on hand---that is, at the decay rate of about 5.5% a year.[7] For about the first five years, such a reduction in weapons is really quite similar to the cuts that have been discussed in the START negotiations. Should negotiations continue beyond START with the objective of establishing a minimum effective nuclear deterrent, there would be no need to resume new tritium production for many years. In fact, the United States now has enough tritium in its 23,000 nuclear warheads to support a force of 6,000 strategic warheads for longer than 20 years and a force of 1,000 warheads for some 50 years.

Recommendations

Plans for new tritium production reactor capacity should be scaled to reflect the country's actual needs. Congress must obtain from the Energy and Defense Departments documented information on what these needs are today, to what extent they can be met from existing inventory, and what they would be in the event of START reductions and reductions beyond START. Preparations now underway for construction of new production reactors should be deferred to allow Congress to become fully informed and to allow time for the START process to produce results.

In the meantime, the United States should not resume production of nuclear weapon materials that are not needed and can serve only to further stimulate the arms race. Instead, it should move toward a mutual halt in the production of nuclear materials for weapons.

While the present halt in production remains in effect, the United States should consider offering not to restart the Savannah River reactors or to begin construction of new production reactors for a designated period of time to give the Soviet Union the opportunity to reciprocate. The two sides may be able to proceed to a mutual halt in production of tritium and fissionable materials for weapons by a series of reciprocal steps.

A mutual production halt could be monitored by national technical means and on-site inspections, supplemented by international and bilateral safeguards on civilian reactors. Such a halt is possible in the context of a START agreement and agreements on deep cuts beyond START accompanied by verification of delivery systems and warheads destroyed and retained.

The United States and the Soviet Union should not let pass an extraordinary opportunity to achieve a mutual halt in the production of nuclear materials for weapons. For its part, the United States can exercise restraint and turn the present production shutdown to advantage. It should not be stampeded into premature resumption of tritium production or construction of new production capacity. If we exercise restraint, the arms reduction process can flourish.

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1. Robert Kelley, "Comments on the 'Tritium Factor' Proposal," Study performed for the Assistant Secretary of Energy for Intelligence, June 1988 (reprinted in The Tritium Factor: Tritium's Impact on Nuclear Arms Reductions, a report on a December 1988 workshop by the Nuclear Control Institute and the American Academy of Arts and Sciences, to be published in April 1989).

2. Michael R. Gordon, "Stretching Gas For Nuclear Arms Studied," New York Times, 24 Oct. 1988.

3. Statement of Troy E. Wade II, Acting Assistant Secretary for Defense Programs, DOE, before the Senate Armed Services Committee, 2 Feb. 1989.

4. Keith Schneider and Michael Gordon, "Reactor Shutdown Could Impede Nuclear Deterrent," New York Times, 9 Oct. 1988.

5. Senator John H. Glenn, "The Mini-Hiroshima Near Cincinnati," New York Times, 24 Jan. 1989; also, transcript of "Today Show" interview, December 28, 1988, 7:17 AM.

6. Fred Kaplan, "Tritium Shortage Isn't Critical Yet, Pentagon Says," Boston Globe, 22 Jan. 1989; "Operator Error at Savannah River Causes Damage to Cooling System," Boston Globe, 26 Jan. 1989.

7. J. Carson Mark, Thomas D. Davies, Milton M. Hoenig, and Paul L. Leventhal, "The Tritium Factor as a Forcing Function in Nuclear Arms Reduction Talks," Science, 2 September 1988, pp. 1166-1169.

SIGNERS OF TRITIUM PAPER

April 13, 1989

Hans Bethe, a 1967 Nobel Prize winner in physics and former head of the Theoretical Physics Division at Los Alamos National Laboratory, is emeritus professor of physics and nuclear studies at Cornell University.

Freeman Dyson, professor of physics at Princeton's Institute for Advanced Study, has been a frequent consultant to the Defense Department and the U.S. Arms Control and Disarmament Agency.

Herman Feshbach, former chairman of the Nuclear Science Advisory Committee of the National Science Foundation and former president of the American Physical Society and the American Academy of Arts and Sciences, is an Emeritus Institute Professor of physics at the Massachusetts Institute of Technology.

Val Fitch, a 1980 Nobel Prize winner in physics and professor of physics at Princeton University, was a presidential adviser on science policy and arms control in the Nixon Administration.

Marvin Goldberger, former President of the California Institute of Technology and now Director of Princeton's Institute for Advanced Study, chaired the Committee on International Security and Arms Control of the National Academy of Sciences.

Kurt Gottfried, professor of physics and nuclear studies at Cornell University, was an officer of the American Physical Society and a member of the Department of Energy's High Energy Physics Advisory Panel.

Milton Hoenig, a physicist and scientific director of the Nuclear Control Institute, was at the Arms Control and Disarmament Agency (ACDA) during the Carter Administration.

Franklin Long, professor emeritus of chemistry at Cornell University, was research supervisor of the National Defense Research Committee from 1942 to 1945 and assistant director of ACDA under President Kennedy.

J. Carson Mark, former division leader of the Theoretical Physics Division of Los Alamos National Laboratory, serves as a consultant to Los Alamos and other government agencies.

George Rathjens, professor of political science at M.I.T., was chief scientist in the Defense Advanced Research Projects Agency and in the Office of the Special Assistant to the President for Science and Technology.

Victor Weisskopf, former Group Leader at Los Alamos National Laboratory and former director of CERN, the European Center for Nuclear Research, is Emeritus Institute Professor of physics at the Massachusetts Institute of Technology.

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NUCLEAR CONTROL
INSTITUTE
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June 26, 1989

Mr. John Sununu
Chief of Staff to the President
The White House
Washington, D.C.

Dear Mr. Sununu:

Today, I and our scientific director, Dr. Milton Hoenig, went to the Soviet Embassy to receive a response from Moscow to a letter, attached, that we sent on March 30 to General Secretary Gorbachev on the subject of a halt in the production of tritium and other nuclear weapons materials. We request the opportunity to meet with you personally to discuss what we regard as a rather significant Soviet position on a proposal contained in our letter.

We believe, on the basis of your position close to the President and your technical understanding of the unique role of tritium in nuclear weapons, that you would have a special interest in the Soviet message to us in the context of prospective talks between the two leaders.

By way of background, I have enclosed a book that summarizes a workshop on our tritium proposal that we conducted last December with the American Academy of Arts and Sciences. Also enclosed are two recent columns by Tom Wicker on the proposal and a paper by our Institute exploring verification issues.

Thank you for your attention to this matter. I look forward to hearing from you.

Sincerely,

Paul Leventhal

Enclosures

NUCLEAR CONTROL
INSTITUTE
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March 30, 1989

General Secretary Mikhail Gorbachev
The Kremlin
Moscow, USSR

Dear Mr. General Secretary:

Soviet and American missiles are now being destroyed under the provisions of the INF treaty, and verification inspections of military facilities in the U.S. and the U.S.S.R. are being carried out on a regular basis. Unilateral cuts in Soviet troops and tanks are being made in Europe, setting the stage for new negotiations between NATO and the Warsaw Pact to reduce conventional arms in Europe. None of these remarkable developments would have been possible without your bold leadership and vision. Changes that seemed impossible a few years ago are occurring today. It is for this reason that we are writing to ask you to consider an initiative that truly could change the course of history by restraining, indeed reversing, the nuclear arms race.

As you are well aware, many people are hopeful and confident that when the START negotiations are resumed they will lead to an early agreement for significant reductions in the strategic nuclear weapons of both superpowers. Yet, it is by no means clear what reductions would be achieved beyond START or that there will be the will on either side to keep the arms-reduction process going. It is essential that, as an adjunct to the START negotiations, the superpowers now look to a new way for assuring continued and deep reductions in the nuclear arsenals. Only in this way can we hope to eliminate the threat of nuclear destruction.

The most important initiative that could be undertaken at this time by either side, we believe, is to unilaterally halt production of the essential ingredients for nuclear weapons, fissionable material and tritium, in the expectation and hope that the other side soon would make the halt mutual. Although we have proposed that our government take the first step, we believe, for reasons noted below, that present circumstances are such that the Soviet Union, under your leadership, is in the better position to take the initiative.

This is the crucial time to announce a halt in weapon materials production. There are some remarkable symmetries

between the situations in our two countries that may never again be repeated. Neither country easily can afford to spend the many billions required to upgrade and replace dilapidated production facilities that are 40 years old at the expense of more essential services and needs.

In the United States, the military reactors that produce plutonium and tritium for nuclear weapons are now shut down for safety-related reasons. According to a recent memorandum prepared by the U.S. Los Alamos National Laboratory, "Soviet military production reactors are old, obsolete, and unsafe. They will be shut down soon anyway."

Further, the United States is now planning to build two new production reactors for tritium, as well as plutonium, that will provide far more production capacity than is needed to maintain the current arsenal of nuclear weapons. Indications from recent French SPOT satellite images are that the Soviet Union is constructing one or two new reactors at the Kyschtym nuclear complex. Each nation also is in a position to turn to its civil power reactors for military tritium and plutonium production but, to our knowledge, neither has yet done so in a major way.

At this time, the United States and the Soviet Union both are in a position to defer plans for rebuilding their respective nuclear materials production facilities in order not to stimulate the nuclear arms race and in order to stimulate the ongoing arms-reduction process. A halt in the production of tritium would, after several years, require the retirement of each country's modern nuclear warheads at the minimum rate of tritium's radioactive decay, 5.5 percent annually, thus reducing the number of warheads by half in 12 years. In addition, both countries have accumulated substantial stocks of plutonium and highly enriched uranium and do not need to produce any more.

This set of circumstances has prompted us, with the assistance of the former head of the theoretical physics division of the Los Alamos National Laboratory and other distinguished scientists, to explore the Nuclear Control Institute's proposal for a "Tritium Factor" approach to nuclear arms reduction. An article by our collaborator, Dr. J. Carson Mark, caught the attention of the Reverend William Sloane Coffin, Jr., who wrote to you last November urging your consideration of a production halt and of tritium-paced arms reduction negotiations. Our proposal has since been the subject of a conference co-sponsored by the American Academy of Arts and Sciences, the proceedings of which soon will be published as a book.

We are writing to add our voice and our expertise to Rev. Coffin's appeal to you, and to suggest specific ways in which you could proceed to make this unorthodox but feasible concept a

reality. We believe a cutoff of fissionable materials production alone does not go far enough because only by including perishable tritium in a production halt is it possible to ensure eventual reductions in nuclear weapons. We also believe that a tritium production halt can be verified by a combination of on-site facility inspections and by confirmation of destruction of delivery systems being retired under START and post-START agreements.

Under your leadership, the Soviet Union could establish a dialogue with the United States on a nuclear weapons materials production halt while the present halt in tritium and plutonium production is still in effect in the United States. Mr. General Secretary: we ask you to do two things for the sake of your nation and ours: first, pending the outcome of START and other arms-reduction negotiations, announce an interim shutdown of all military production reactors in the Soviet Union and a consequent halt in new production of plutonium and tritium for weapons, as well as a halt in further production of highly enriched uranium for weapons; second, publicly declare that the nuclear reactors that now appear to be under construction at Kyschtym are for power production purposes only. (Such an assurance, we have been told, was given privately by the Soviet Government to the U.S. Defense Intelligence Agency.)

The Nuclear Control Institute is making every effort to appeal to the U.S. government to delay both the restart of its shut-down production reactors and the construction of any new production reactors until there is a complete review of the prospect for successful arms reduction negotiations. However, we believe it may be politically and diplomatically impossible for the U.S. to do this at a time of perceived disadvantage caused by the present shutdown. But this situation presents you an opportunity for an historic initiative.

We believe the United States and the Soviet Union should not let pass an extraordinary chance to achieve a mutual halt in the production of tritium and fissionable materials for weapons. The two countries may be able to proceed to such a halt by a series of reciprocal steps. We urge you in the interest of world peace to take the first step.

Of course, we are prepared to follow up in whatever way you may wish to proceed, and to make the experts at our disposal available to those who advise you.

Sincerely,

Paul Leventhal
President

Milton Hoenig
Scientific Director

Q. The Tritium Factor is a technical concept. How might the two leaders announce an agreement based on the Tritium Factor that would put the accord in historical perspective for the lay public?

A. A joint announcement of such an agreement might include the following elements:

"Since the early 1950s, our two nations have been embarked on a course of building and modernizing many thousands of nuclear weapons. We each now possess nuclear arsenals capable of destroying each other many times over. We each have built the industrial capacity to produce enough nuclear materials to maintain and even to enlarge our respective nuclear arsenals. The existence of so many nuclear weapons, and of the capacity to build so many more, increases the threat of nuclear war and endangers the entire world.

"The INF agreement on intermediate and short-range nuclear missiles represents an important milestone: elimination of whole systems of nuclear armaments. The ongoing START talks hold out the hope that soon we may be able to agree on mutual deep cuts in our long-range strategic nuclear weapons.

"These efforts put us within reach of altering the course of human history. As the leaders of the world's two most powerful nations, we share a vital interest in, and a deep commitment to, achieving substantial reductions in our nuclear armaments. We want to make sure that nuclear arms-reduction negotiations do not drag on indefinitely and that steady progress is made.

"In this spirit of good will, we have agreed to establish a framework that will set a pace for the drawing down of our nuclear arsenals by no less than six per cent a year. Accordingly, we have agreed to a mutual halt in production of new materials used in the manufacture of nuclear weapons for as long as we can maintain this minimum rate of progress at the negotiating table.

"Our objective is to achieve deep cuts in nuclear warheads far in excess of the agreed minimum yearly rate. But even cuts negotiated at the modest rate of six per cent a year, if maintained over the next 12 years, will pay a historic dividend: a 50 percent reduction in our nuclear arsenals by the start of the new century.

"Nuclear scientists, who made nuclear weapons possible, also have given us a unique means to put a clock on the negotiating table to pace nuclear-arms reductions and thereby advance mankind's quest for world peace. Tritium, a man-made radioactive material that each side uses to boost the explosive force of its nuclear weapons, decays naturally at the rate of about 6 per cent a year. This decay rate is known as the Tritium Factor. If mutual reductions in nuclear arms can be achieved at this rate or faster, no more new tritium need be produced because tritium can be recovered from weapons that each side destroys and can be reused in remaining weapons as the arms-reduction process continues.

"So long as both sides can agree to maintain at least this steady pace of reductions in nuclear weapons, we also will be able to suspend new production of the other principal nuclear-weapon materials, plutonium and highly enriched uranium. This agreement, therefore, represents an historic opportunity not only to draw down nuclear armaments but to halt further production of nuclear materials used to make nuclear weapons.

"Eventually, our two nations will have to agree on the level to which our nuclear arsenals should be reduced to provide effective deterrence, and production of new tritium then would be resumed in much smaller quantities to maintain the arsenals at that agreed level. However, no further production of plutonium and highly enriched uranium will be required because, unlike tritium, they do not decay at a rapid rate.

"Of course, this agreement has been made subject to strict arrangements to verify that nuclear weapons are destroyed at the agreed rate and that no new materials for weapons are being produced. We also have agreed to maintain on a stand-by basis the reactors needed to resume production of tritium in the unfortunate event that arms-reduction negotiations fail to keep pace with tritium's decay.

"Our hope, however, is that by utilizing the Tritium Factor, we will be able to keep the nuclear-arms reduction process moving forward. Our further hope is that in reducing our own reliance on nuclear weapons, we not only will reduce the chances of destroying each other, but we will set an example that other nations possessing or contemplating nuclear weapons can follow. In this way, we can keep alive the hope that nuclear weapons some day can be abolished from the earth."

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August 4, 1989

Briefing Paper for John Sununu

Summary

The involuntary total shutdown of the Nation's aging military production reactors presents a festering problem for DoE but an opportunity of historic dimensions for the President.

The Soviet Union has major nuclear problems of its own in both the civil power and military production sectors. It is now cooperating with the United States on safety questions in the first area and might conceivably share an interest in cutting losses and eliminating risks in the second area. The Soviet Union has formally proposed to the U.S. the negotiation of a mutual verifiable halt in production of fissile material, and is now indicating to the Nuclear Control Institute that it could be prepared to discuss such a halt in tritium production as well. Indeed, we were told that Gorbachev could raise a tritium cutoff at his first summit with the President depending on "circumstances at the time."

This paper explores how the President, in anticipation of the summit, could seize the initiative and achieve an immediate halt in all Soviet production of nuclear weapons materials. By means of the initiative we propose (page 4), he could bring the Soviets into conformity with the existing U.S. situation and overcome the present perception of the U.S. being in a position of weakness. It could enable the President to announce jointly with Gorbachev an agreement that would be regarded as historic in two respects: (1) it would shut down all production of nuclear weapons materials by both superpowers for the first time, and (2) it would shift the nuclear arms race into reverse gear at a manageable speed, consistent with START and other foreseeable reductions and in a prudent manner that is verifiable and preserves effective deterrence.

In addition, the initiative would produce a number of domestic benefits for the President: It would defuse the sense of crisis and sharply reduce the risks that now pervade efforts to restart the production reactors and to pursue other options for achieving tritium production. It would avoid a premature commitment to construction of new production capacity that may be many times larger and more costly than eventually will be needed. And it would avoid possible production of military tritium in power reactors, a nightmare for the nuclear industry.

Tritium's Special Role

Unlike fissile plutonium and uranium, which essentially last forever and are in abundant supply, tritium decays steadily and must be replenished regularly in boosted and thermonuclear warheads. For this reason, new tritium must be produced to maintain or to enlarge a modern arsenal even if no further fissile material is produced.

No fresh tritium need be produced if warheads utilizing tritium are retired at a rate that keeps pace with or exceeds tritium's decay (5.5% a year) and if tritium recovered from retired warheads is used to replenish the remaining warheads. Of course, a tritium cutoff could be agreed to at the conclusion of talks such as START that produce cuts approximating this pace and that set the stage for additional deep cuts. But a tritium halt also could be agreed to as a confidence-building measure earlier in the process, especially if both sides stand to benefit from the standpoint of cost and safety of their production programs.

An agreement now to halt production of tritium would require each side to shut down all of its military production reactors and associated reprocessing plants and to place some of these facilities on cold standby---an outcome that is not possible with a fissile cutoff alone because of the need to continue producing perishable tritium. For reasons outlined below, each side might welcome such a comprehensive production halt at this time.

What follows is an analysis of the growing problem caused by the involuntary shutdown of the Savannah River reactors, an opportunity for the U.S. prompted by developments in the Soviet Union, and a proposed initiative for the President keyed to the upcoming summit.

Problem

The three remaining Savannah River Site (SRS) reactors, presently the Nation's exclusive source of tritium for weapons, are shut down. Restart of the reactors, after an unsuccessful try last August, has slipped by at least two years to 1990-1991, and the estimated cost of repair has quadrupled to $1.66 billion. Successful restart and safe operation of these old reactors is problematical at best. Another failure at restart or another forced shutdown (conceivably accompanied by a radioactive release) could be quite controversial and could transform SRS from a DoE problem to a Presidential problem---with a possible spillover effect on the nuclear power industry as well.

Alternative options for producing tritium are not readily at hand and are themselves risky and controversial:

o Conversion of the incomplete WNP-1 power reactor at Hanford to dedicated tritium production, according to GAO, will cost a minimum of about $3 billion, will require at least seven years before the first tritium is recovered from still untested LWR target technology, and will raise substantive nuclear safety and proliferation issues.

o Restart of the N Reactor at Hanford will trigger a threatened lawsuit by the Natural Resources Defense Council (NRDC) and will arouse safety concerns.

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Given the problems and risks at SRS, and the unsatisfactory or unavailable alternatives for new production of tritium, is there a satisfactory way out of this mess?

Opportunity

The Soviet Union, its civil nuclear power industry reeling from a series of reactor closings and cancellations caused by public reaction to the Chernobyl accident, also faces problems with its weapons production reactors. Gorbachev and Soviet officials have announced the shutdown of a total of five of the oldest reactors, located at Kysthym, to be completed by 1991; nine other reactors, probably none built more recently than the 1960s, continue to operate at two other sites. Some of them, perhaps two or three, are heavy water reactors used to produce tritium, like the reactors at Savannah River; the rest are graphite moderated reactors, forerunners of the Chernobyl design, presumably used to produce plutonium. Three reactors of advanced breeder design are planned or under construction near Kysthym presumably for power purposes but capable of replacing the shutdown production reactors.

Until quite recently, the Soviets seem to have been interested only in the possibility of negotiating a fissile material halt---an approach that has been developed in a series of exchanges between Soviet academicians and representatives of the NRDC and the Federation of American Scientists (FAS). On June 26, representatives of the Nuclear Control Institute were invited to the Soviet Embassy to receive a message from Moscow in response to a letter NCI had sent to Gorbachev describing its proposal for a "Tritium Factor" approach to nuclear arms reductions and suggesting that the Soviet Union was in a position to shut down its production reactors to match the situation in which the United

States now finds itself. An Embassy official, who explained that he was speaking on behalf of the Ambassador and translating a cable from the Foreign Ministry, stated at one point: "It appears that in the context of [fissile cutoff] negotiations, one could raise the question of a cessation in the production of tritium." When we asked whether this question would be raised by Gorbachev at the forthcoming summit, he responded that it would "depend on the circumstances at the time."

Thus, it appears that the Soviets are prepared to raise the possibility of a comprehensive cutoff of nuclear materials that includes tritium if the U.S. is prepared to enter into talks on a fissile material cutoff. The Soviets probably realize that the U.S. is not likely to agree to a fissile material cutoff with all of its production reactors down while Soviet reactors would continue to operate to produce tritium. Moreover, the Soviets now may recognize that a fissile cutoff alone might hold little appeal for either side because there would be no guaranteed arms-reduction payoff for the acceptance of highly intrusive verification measures (while inclusion of tritium, because of its steady decay, would guarantee eventual arms reductions).

Whatever the reason, the Soviets could now be signaling a willingness to discuss a tritium halt that, in combination with a fissile material halt, would permit both sides to shut down all production reactors and to defer new production reactors. Does this situation present an opportunity for the President? We believe it represents an opportunity for an historic initiative.

Initiative

The initiative we propose could be a "bold stroke"---a personal and confidential communication by the President to Gorbachev, well in advance of the summit, responding to the Soviet proposal for the start of negotiation of a verifiable halt in production of fissile material. The President could inform Gorbachev that the United States would agree to such a negotiation, but only if the Soviet Union would agree to two conditions: (1) join with the U.S. in an <u>immediate</u> halt in the production of fissile material <u>and</u> tritium, including a pledge that power and research reactors will not be operated for weapons material production either; and (2) agree to expand the negotiation to include a tritium production halt. In this way, the President could achieve a prompt shutdown of all Soviet production of nuclear weapons materials in military or civilian reactors, bringing the Soviets into conformity with the existing U.S. situation and thereby overcoming the present perception of the U.S. being in a position of weakness.

If the President's offer were accepted by Gorbachev, the two leaders could announce their agreement at the summit. The agreement would be regarded as historic for two reasons: (1) it would shut down <u>all</u> production of nuclear weapons materials by both superpowers for the first time, and (2) it would shift the nuclear arms race into reverse gear at a manageable speed,

consistent with START and other foreseeable arms reductions and in a prudent manner that is verifiable and preserves effective deterrence.

The President's offer would not be made publicly, so that if the anticipated result were not achieved, it would cause no embarrassment to the President. But the offer would put Gorbachev's sincerity, and his ability to deliver, to the test. If he is sincere in his desire to negotiate a fissile material cutoff, and in his apparent desire to put a tritium halt on the table as well, then he should be willing to enter the negotiation on an equal footing with the President. He cannot seriously expect the President to enter such a negotiation with all U.S. production reactors shut down while Soviet reactors continue to operate. If he is unwilling to enter the negotiation on an equitable basis, or he is unable to deliver his own bureaucracy to the table, nothing will have been lost for the President having tried. And much could be gained if Gorbachev accepts the offer.

Since a comprehensive production halt requires the shutdown of all production reactors, which can be verified promptly by satellite, the agreed halt would take effect immediately on an interim basis, with the understanding that detailed inspection and other verification measures, covering civil as well as military and suspect facilities, would have to be worked out and agreed to by a date certain (perhaps two years hence.) Since it may take this long to achieve the first START reductions, and since each side could rely on more efficient management of tritium in existing weapons and on tritium recovered from any voluntarily retired weapons, there should be no problem for either side to sustain their arsenals during this period. And, it should be stressed, that with each side possessing a deterrent of more than 20,000 nuclear warheads during this period, each is assured of ample protection against the consequences of any cheating that might take place under the interim accord. [See items, submitted separately, that discuss verification and deterrence.]

Beyond shutting down Soviet production of weapons materials and establishing a basis for reversing the arms race, the proposed Presidential initiative, if successful, would achieve the following important domestic benefits: It would defuse the sense of crisis and sharply reduce the risks that now pervade the Savannah River restart effort and all the other options for resuming tritium production. It would give Admiral Watkins the extra time he needs to complete the SRS repairs and to meet all NEPA requirements for holding the three reactors on cold standby as a contingency against a breakdown in finalizing the agreement. It would avoid a premature commitment to construction of new production capacity that may be many times larger and more costly than eventually will be needed. And it would avoid possible production of military tritium in power reactors, a nightmare for the nuclear industry.

Given these substantial benefits of success, and the negligible risks associated with failure, the proposed initiative is well worth pursuing. The opportunity for achieving a comprehensive, verifiable halt in nuclear weapons materials production results from the fortuitous coincidence of the aging of the superpowers' production plants and the current unprecedented easing of tensions between the two nations. It is an opportunity that may not be repeated and should be exploited to the fullest by the President.

Paul Leventhal
Milton Hoenig

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July 7, 1989

Minutes of meeting with First Secretary Sergey I. Kislyak, Soviet Embassy, 11 AM-12:20 PM, June 26, 1989.

Present: Kislyak, Paul Leventhal, Milton Hoenig

Kislyak said he would translate a message sent from Moscow to the Ambassador for conveyance to us in response to our letter of March 30, 1989, to General Secretary Gorbachev.

Before he began, we advised him that we were not acting directly or indirectly for the U.S. Government. We said our proposal for a mutual, verifiable halt in production of tritium as well as fissile materials for weapons was an initiative of the Nuclear Control Institute and was based on our perception that the U.S. and the U.S.S.R. might have an overlapping interest in such an approach at this time.

A summary of Kislyak's translation of the Soviet government's message and of our subsequent discussion of it follows:

Your message to General Secretary Gorbachev "was carefully studied, and we thank you for it." The Soviet Union shares your desire for a "comprehensive solution" to nuclear disarmament. As for your specific proposal about ending the production of plutonium and tritium for nuclear weapons purposes, we are cognizant of this question.

The Soviet Union looks upon stopping the production of fissile material as one component of a program to achieve nuclear disarmament by the year 2000. This would be a major inhibitor of the nuclear arms race and would strengthen the nuclear non-proliferation regime. The seriousness of the Soviet position was enhanced during the Soviet-British summit in London when General Secretary Gorbachev announced a halt in production of highly enriched uranium for the weapons program, the shutdown of one reactor for production of weapons-grade plutonium in 1987 and the shutdown of two more plutonium production reactors. The Soviet Union will not replace them with new capacity.

Furthermore, we call your attention to the fact that the Soviet Union has made a proposal to the United States to agree to begin work on a verifiable cessation of fissionable materials for weapons purposes. General Secretary Gorbachev specifically proposed those negotiations to Secretary of State Baker at their meeting in May.

"It appears that in the context of such negotiations one could raise the question of a cessation in the production of tritium. A comprehensive phased solution to the problem would undoubtedly be a major contributor to nuclear disarmament." It could be discussed.

At this point, there was a discussion of whether the question of a halt in tritium production already had been raised by the Soviet Union. Kislyak said he could not say for sure that it was not raised during the Gorbachev-Baker meeting, but when pressed further, said it probably was not. Nor, Kislyak said, would he say whether it had been communicated to the U.S. Government subsequent to those talks. He said he could say that "when negotiations [on a fissile cutoff] start, your proposal could be raised." He said he personally thinks that "the Soviet position is a reaction to your thoughts and ideas." We asked whether the tritium cutoff would be raised by General Secretary Gorbachev at the prospective summit with President Bush. Kislyak responded that it would "depend on the circumstances at the time."

There was also a discussion of the two new reactors that are understood to be under construction at Kysthym. Mr. Kislyak said he had no information on two new reactors. We reviewed the various indicators of apparent symmetry between the U.S. and Soviet situations concerning the production of nuclear weapons materials---including old, unsafe production reactors and no known new production reactors---and suggested that this apparent symmetry could be maintained if the Soviet Union announced that the two reactors under construction will be used for power purposes only and will not be used for production of either plutonium or tritium for military purposes. We also suggested that the Soviet Union make clear that the plutonium production reactors being shut down will not be replaced by new capacity for production of <u>either</u> plutonium or tritium.

There was also a discussion of whether it was necessary for there first to be a bilateral negotiation on a fissile materials cutoff before the Soviet Union could act to halt production of fissile materials and tritium. We reiterated the proposal made in our letter to General Secretary Gorbachev that he announce unilaterally a halt in all nuclear weapons material production. We said we thought this was the best way to reach a negotiation on a mutual, verifiable halt in weapons materials production---first, for the Soviet Union to announce a unilateral halt, thereby matching the present situation in the United States, and, second, to offer to negotiate the terms of both sides continuing the halt on a verifiable basis so long as negotiated arms reductions keep pace with or exceed tritium's rate of decay.

We said we believed that the verification requirements for such a halt would be burdensome on both sides but quite feasible and well within the capabilities of the two superpowers if they had the political will to engage in such a regime. We also noted that verification of a cut-off of only fissile materials also would be quite burdensome---and in some respects more difficult than a comprehensive cut-off that included tritium---but without the compensating arms-control benefit provided by tritium's decay.

We provided Mr. Kislyak the Institute's paper comparing the verification requirements of a mutual cutoff of fissile materials alone and one that included tritium as well.

We suggested, now that the Soviet position incorporated our proposal for a cutoff in tritium as well as fissile materials, this would be an appropriate time to begin a non-governmental exchange of ideas and papers on the subject by experts from each side. We recommended that the Nuclear Control Institute and an appropriate Soviet counterpart organization engage in such an exchange on the particular subjects of verification and of the pacing effect of tritium's decay on arms reduction negotiations.

Mr. Kislyak said he would pass this suggestion and our others to Moscow. He again thanked us for the letter to General Secretary Gorbachev and said the letter had been "studied very carefully." He said the purpose of the meeting was to give "our thoughts on the issues you raised."

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August 4, 1989

Governor John Sununu
Chief of Staff to the President
The White House
Washington, D.C.

Dear Governor Sununu:

Thank you again for the opportunity you gave me and Dr. Hoenig to discuss the tritium question with you today. We have asked our consultant, Dr. Carson Mark, to prepare a brief paper responding to the point you raised about the impact of a Soviet tritium surplus. I will be happy to share it with you as soon as we receive it.

By the way, you might consider contacting Dr. Mark directly if you are interested in obtaining an expert, independent view on matters under consideration in the government. He has the necessary clearances on a need-to-know basis, and, given his 25 years as leader of the theoretical physics division at Los Alamos, he has much to contribute. Of course, the Nuclear Control Institute would be out of the loop if you contacted him directly. His telephone number is 505-662-5025.

Please let me know if it would be useful to have additional copies of the The Tritium Factor book summarizing our workshop with the American Academy of Arts and Sciences. I would be pleased to send them to you.

I will telephone you toward the end of the month, as you suggested. With best wishes

Sincerely,

Paul Leventhal

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August 4, 1989

Briefing Paper for John Sununu

Summary

The involuntary total shutdown of the Nation's aging military production reactors presents a festering problem for DoE but an opportunity of historic dimensions for the President.

The Soviet Union has major nuclear problems of its own in both the civil power and military production sectors. It is now cooperating with the United States on safety questions in the first area and might conceivably share an interest in cutting losses and eliminating risks in the second area. The Soviet Union has formally proposed to the U.S. the negotiation of a mutual verifiable halt in production of fissile material, and is now indicating to the Nuclear Control Institute that it could be prepared to discuss such a halt in tritium production as well. Indeed, we were told that Gorbachev could raise a tritium cutoff at his first summit with the President depending on "circumstances at the time."

This paper explores how the President, in anticipation of the summit, could seize the initiative and achieve an immediate halt in all Soviet production of nuclear weapons materials. By means of the initiative we propose (page 4), he could bring the Soviets into conformity with the existing U.S. situation and overcome the present perception of the U.S. being in a position of weakness. It could enable the President to announce jointly with Gorbachev an agreement that would be regarded as historic in two respects: (1) it would shut down all production of nuclear weapons materials by both superpowers for the first time, and (2) it would shift the nuclear arms race into reverse gear at a manageable speed, consistent with START and other foreseeable reductions and in a prudent manner that is verifiable and preserves effective deterrence.

In addition, the initiative would produce a number of domestic benefits for the President: It would defuse the sense of crisis and sharply reduce the risks that now pervade efforts to restart the production reactors and to pursue other options for achieving tritium production. It would avoid a premature commitment to construction of new production capacity that may be many times larger and more costly than eventually will be needed. And it would avoid possible production of military tritium in power reactors, a nightmare for the nuclear industry.

* * *

Tritium's Special Role

Unlike fissile plutonium and uranium, which essentially last forever and are in abundant supply, tritium decays steadily and must be replenished regularly in boosted and thermonuclear warheads. For this reason, new tritium must be produced to maintain or to enlarge a modern arsenal even if no further fissile material is produced.

No fresh tritium need be produced if warheads utilizing tritium are retired at a rate that keeps pace with or exceeds tritium's decay (5.5% a year) and if tritium recovered from retired warheads is used to replenish the remaining warheads. Of course, a tritium cutoff could be agreed to at the conclusion of talks such as START that produce cuts approximating this pace and that set the stage for additional deep cuts. But a tritium halt also could be agreed to as a confidence-building measure earlier in the process, especially if both sides stand to benefit from the standpoint of cost and safety of their production programs.

An agreement now to halt production of tritium would require each side to shut down all of its military production reactors and associated reprocessing plants and to place some of these facilities on cold standby---an outcome that is not possible with a fissile cutoff alone because of the need to continue producing perishable tritium. For reasons outlined below, each side might welcome such a comprehensive production halt at this time.

What follows is an analysis of the growing problem caused by the involuntary shutdown of the Savannah River reactors, an opportunity for the U.S. prompted by developments in the Soviet Union, and a proposed initiative for the President keyed to the upcoming summit.

Problem

The three remaining Savannah River Site (SRS) reactors, presently the Nation's exclusive source of tritium for weapons, are shut down. Restart of the reactors, after an unsuccessful try last August, has slipped by at least two years to 1990-1991, and the estimated cost of repair has quadrupled to $1.66 billion. Successful restart and safe operation of these old reactors is problematical at best. Another failure at restart or another forced shutdown (conceivably accompanied by a radioactive release) could be quite controversial and could transform SRP from a DoE problem to a Presidential problem---with a possible spillover effect on the nuclear power industry as well.

Alternative options for producing tritium are not readily at hand and are themselves risky and controversial:

o Conversion of the incomplete WNP-1 power reactor at Hanford to dedicated tritium production, according to GAO, will cost a minimum of about $3 billion, will require at least seven years before the first tritium is recovered from still untested LWR target technology, and will raise substantive nuclear safety and proliferation issues.

o Restart of the N Reactor at Hanford will trigger a threatened lawsuit by the Natural Resources Defense Council (NRDC) and will arouse safety concerns.

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o The only other potential domestic source of tritium is to produce it in licensed nuclear power reactors, using lithium targets being developed for the WNP-1. DoD is openly discussing this option as a contingency if one or more SRP reactors cannot be operated successfully. Exercise of this option would require NRC to reopen licensing proceedings on safety questions and would subject utilities to criticism that nuclear power reactors are being used as nuclear bomb factories---an outcome the nuclear industry dearly wishes to be spared except in a Congressionally declared national emergency.

Given the problems and risks at SRP, and the unsatisfactory or unavailable alternatives for new production of tritium, is there a satisfactory way out of this mess?

Opportunity

The Soviet Union, its civil nuclear power industry reeling from a series of reactor closings and cancellations caused by public reaction to the Chernobyl accident, also faces problems with its weapons production reactors. Gorbachev and Soviet officials have announced the shutdown of a total of five of the oldest reactors, located at Kysthym, to be completed by 1991; nine other reactors, probably none built more recently than the 1960s, continue to operate at two other sites. Some of them, perhaps two or three, are heavy water reactors used to produce tritium, like the reactors at Savannah River; the rest are graphite moderated reactors, forerunners of the Chernobyl design, presumably used to produce plutonium. Three reactors of advanced breeder design are planned or under construction near Kysthym presumably for power purposes but capable of replacing the shutdown production reactors.

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Thus, it appears that the Soviets are prepared to raise the possibility of a comprehensive cutoff of nuclear materials that includes tritium if the U.S. is prepared to enter into talks on a fissile material cutoff. The Soviets probably realize that the U.S. is not likely to agree to a fissile material cutoff with all of its production reactors down while Soviet reactors would continue to operate to produce tritium. Moreover, the Soviets now may recognize that a fissile cutoff alone might hold little appeal for either side because there would be no guaranteed arms-reduction payoff for the acceptance of highly intrusive verification measures (while inclusion of tritium, because of its steady decay, would guarantee eventual arms reductions).

Whatever the reason, the Soviets could now be signaling a willingness to discuss a tritium halt that, in combination with a fissile material halt, would permit both sides to shut down all production reactors and to defer new production reactors. Does this situation present an opportunity for the President? We believe it represents an opportunity for an historic initiative.

Initiative

The initiative we propose could be a "bold stroke"---a personal and confidential communication by the President to Gorbachev, well in advance of the summit, responding to the Soviet proposal for the start of negotiation of a verifiable halt in production of fissile material. The President could inform Gorbachev that the United States would agree to such a negotiation, but only if the Soviet Union would agree to two conditions: (1) join with the U.S. in an <u>immediate</u> halt in the production of fissile material <u>and</u> tritium, including a pledge that power and research reactors will not be operated for weapons material production either; and (2) agree to expand the negotiation to include a tritium production halt. In this way, the President could achieve a prompt shutdown of all Soviet production of nuclear weapons materials in military or civilian reactors, bringing the Soviets into conformity with the existing U.S. situation and thereby overcoming the present perception of the U.S. being in a position of weakness.

If the President's offer were accepted by Gorbachev, the two leaders could announce their agreement at the summit. The agreement would be regarded as historic for two reasons: (1) it would shut down <u>all</u> production of nuclear weapons materials by both superpowers for the first time, and (2) it would shift the nuclear arms race into reverse gear at a manageable speed,

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Beyond shutting down Soviet production of weapons materials and establishing a basis for reversing the arms race, the proposed Presidential initiative, if successful, would achieve the following important domestic benefits: It would defuse the sense of crisis and sharply reduce the risks that now pervade the Savannah River restart effort and all the other options for resuming tritium production. It would give Admiral Watkins the extra time he needs to complete the SRP repairs and to meet all NEPA requirements for holding the three reactors on cold standby as a contingency against a breakdown in finalizing the agreement. It would avoid a premature commitment to construction of new production capacity that may be many times larger and more costly than eventually will be needed. And it would avoid possible production of military tritium in power reactors, a nightmare for the nuclear industry.

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Paul Leventhal
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