Policy Forum

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

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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

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Limits on Nuclear Materials for Arms Reduction: Complexities and Uncertainties

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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

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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.