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Tritium:

The environmental, health, budgetary, and strategic effects of the Department of Energy's decision to produce tritium.

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Introduction

Tritium is a radioactive isotope of hydrogen which has both commercial and military applications.[1] Tritium's commercial uses include medical diagnostics and sign illumination, especially EXIT signs. However, commercial tritium use accounts for only a small fraction of the tritium used worldwide.[2] Tritium's primary function is to boost the yield of both fission and thermonuclear weapons.[3] Contained in removable and refillable reservoirs in the warhead, it increases the efficiency with which the nuclear explosive materials are used. Although no official data are publicly available, each warhead is estimated to require an average of approximately four grams of tritium. However, neutron bombs, designed to release more radiation, have been estimated to require more tritium (10-30 grams).[4]

Tritium's relatively short half-life of 12.3 years and low concentration in nature due to a low natural production rate necessitates artificial production. However, due to safety and health concerns at its aging facilities, the Department of Energy (DOE) has not had an operating tritium production facility since 1988. The DOE estimates that it must have a new facility operating by 2011 in order to maintain the U.S. nuclear arsenal without compromising the five year tritium reserve.[5] Figure 1, from the DOE's Programmatic Environmental Impact Statement (PEIS), graphically represents the Department's projected tritium requirements.

[1] Tritium (commonly denoted by the letter T) has a nucleus of one proton and two neutrons (ordinary hydrogen has just a single proton and no neutrons). Like all radioactive isotopes, the tritium nucleus is unstable and decays. Tritium decays into helium-3 by emitting beta radiation (electrons). Its half-life is 12.3 years. This half-life means that each year 5.5% of the tritium decays to helium-3.

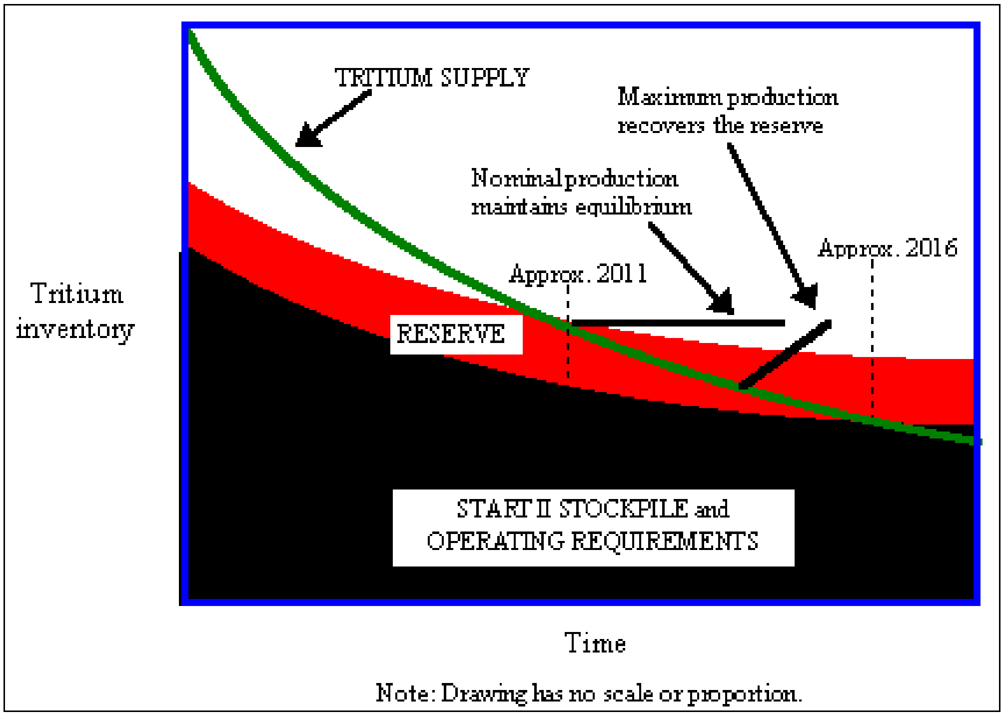
[2] Commercial tritium demand is 400 grams/year (Kalinowski and Colschen 1995, p. 140). In comparison, the current U.S. arsenal of approximately 10,000 warheads requires approximately 2.2 kilograms/year (at four grams of tritium/warhead) to offset decay.

[3] Thermonuclear weapons (also known as fusion or hydrogen bombs) have a primary and a secondary stage. The primary stage is identical to a regular fission weapon and it is this stage which uses tritium.

[4] Kalinowski and Colschen 1995, p. 142. The Department of Energy classifies numbers concerning the production, inventory, and use of tritium for national security purposes. Analysts use a variety of sources to estimate tritium numbers. The data and estimates used in this paper are drawn from estimates made by the Natural Resources Defense Council, Martin Kalinowski, Lars Colschen and others.

[5] The *Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE 1995b) lists four possible tritium production technologies: Light Water Reactor, Heavy Water Reactor, Modular High Temperature Gas-Cooled Reactor and Accelerator Production of Tritium. The chosen technology would be either at the Savannah River Site, Idaho National Engineering Laboratory, Nevada Test Site, Pantex Plant, or Oak Ridge Reservation. The National Environmental Policy Act (NEPA) requires the DOE to prepare the Programmatic Environmental Impact Statement (PEIS) before making a decision on tritium production.

Figure 1: DOE Timeline for Tritium Production[6]



Due to the DOE's estimate of up to 15 years to plan and construct a new facility, it is currently in the process of deciding upon a new tritium production technology.[7] The final PEIS was released at the end of October 1995 and a Record of Decision was issued in early December. Secretary of Energy Hazel O'Leary decided upon "dual-track" approach. The Department will pursue a "commercial reactor option" while funding accelerator research. Under the "commercial reactor option" the DOE would either purchase a civilian reactor or contract with a civilian reactor operator to purchase irradiation services. The accelerator, if constructed, would be located at the Savannah River Site (SRS) in South Carolina due to its long experience with tritium production and the location of the tritium recycling facility at SRS. The final decision is expected to be made in three years following the assessment of each approach.[8]

The DOE decision leaves open a third option, the new so-called "triple play" reactor. Such a reactor would be fueled by surplus military plutonium and would generate power for civilian consumption.[9] It would pose additional environmental, economic and proliferation risks, according to its opponents. It could still be an option, however, as it still has its proponents in Congress and the nuclear industry.

Determination of the date that the DOE would require a new tritium production facility is driven by the assumed size of the future U.S. weapons stockpile. For a given stockpile

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[6] Reprint of Figure ES-4 from DOE 1995b, p. ES-9.

[7] The DOE's estimates are actually less than 15 years, with no delays, for all the technologies. A commercial reactor could be ready by 2005, assuming no institutional barriers. If the DOE were to assume institutional barriers could be overcome in an emergency, it could postpone its tritium production plans by six years. See DOE 1995d Chapter 4.

[8] "Energy Department Favors Dual-Track Strategy to Meet National Security Requirements for Tritium." DOE Press Release, October 10, 1995.

[9] Surplus military plutonium could only be used if the Storage and Disposition of Weapons-Usable Fissile Materials PEIS results in a decision to use reactors for plutonium disposition.

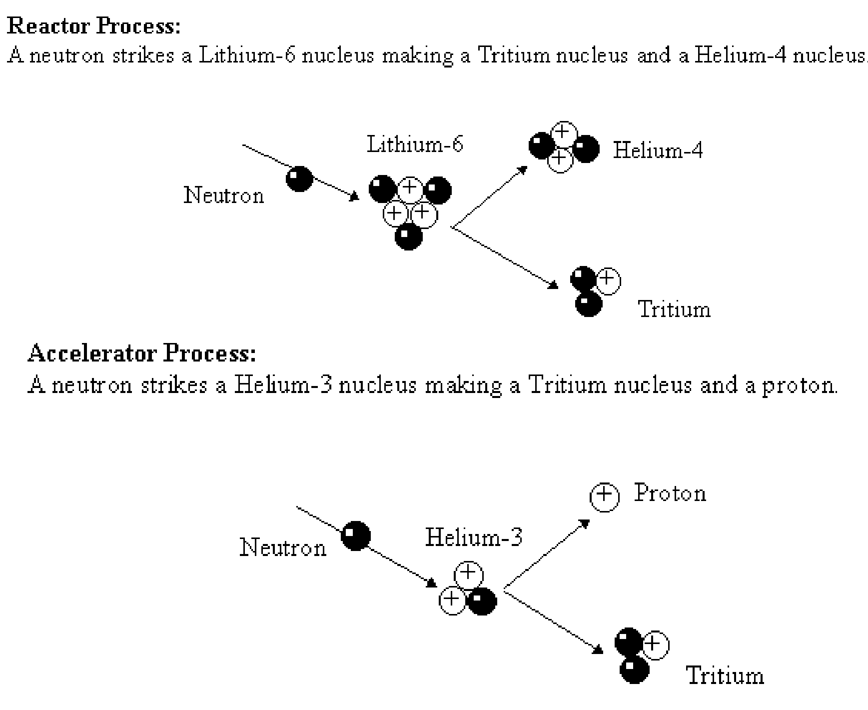
composition, a greater number of warheads will require more tritium. However, a decision about tritium production must consider a number of crucial factors, including:

- the health and environmental effects of tritium production;
- United States nuclear posture and strategy;
- non-proliferation policy and adherence to Article VI of the nuclear Non-Proliferation Treaty (NPT).

Background

Tritium occurs naturally due to interactions between the atmosphere and cosmic radiation.[10] However, it occurs in very small quantities (the steady-state global inventory is approximately 2.65 kilograms). Tritium must therefore be artificially produced for use in warheads. Total U.S. tritium production since 1955 has been approximately 225 kilograms, an estimated 150 kilograms of which have decayed into helium-3, leaving a current inventory of approximately 75 kilograms of tritium.[11] In the U.S., tritium has been produced in reactors operated for tritium and plutonium production. In reactors, the basic technique of tritium production usually involves bombarding lithium-6, a naturally occurring non-radioactive element, with neutrons. Accelerator production of tritium, a new use of accelerator technology unproved on a large scale, would bombard helium-3 with neutrons. The two basic nuclear processes are shown in Figure 2.

Figure 2: Tritium Production Processes[12]



[10] Eisenbud 1987, p. 157
[11] Albright et. al 1993, p. 34, Cochran et. al 1987 p. 179-181, and Paine 1992.
[12] Reprinted from DOE Factsheet, "What is Tritium?"

Until 1988 the DOE produced tritium at the Savannah River Site for both new weapons and depleted tritium reservoirs in the stockpile. Smaller amounts of tritium were also produced at the Hanford Reservation in Washington State. However, in 1988 the DOE shut down the last of its production reactors for upgrades to address age and safety concerns. The high cost of improvements and the end of the Cold War led the Department to abandon plans to re-start the reactors and they have been permanently shutdown.

SRS is still operating its tritium recycling facilities. In this process, reservoirs are removed from warheads in the stockpile and shipped to SRS, where the remaining tritium is removed and placed in inventory. The reservoirs are refilled with tritium and then sent back for replacement in the warheads. Tritium requirements are currently being met by the surplus inventory from retired warheads.

Health and Environmental Effects of Tritium Production

Tritium, even in low levels, has been linked to developmental problems, reproductive problems, genetic abnormalities, and other health problems in laboratory animals.[13] Additionally, there is evidence of adverse health effects on populations near facilities which utilize tritium (e.g. the Darlington tritium extraction facility in Ontario, Canada).[14] Tritium most commonly enters the environment in gaseous form (T_2) or as a replacement for one of the hydrogen atoms in water (HTO, called "tritiated water," instead of ordinary, non-radioactive H_2O). Tritiated water can replace ordinary water in human cells (approximately 70% of the soft tissue in the human body is water).[15] It can also enter fetuses through the placenta due to its similarities to ordinary water. Once in living cells, tritium can replace hydrogen in the organic molecules in the body. Thus, despite tritium's low radiotoxicity in gaseous form and its tendency to pass out of the body rather rapidly as water, its health effects are made more severe by its property of being chemically identical to hydrogen.[16]

Tritium contamination exists in the groundwater, surface water, and soil at SRS, among other sites, from both operational releases and accidents.[17] It should be noted that according to the DOE's analysis, all radiological and hazardous chemical effects from new tritium production will be within federal regulations.

In addition to the potential problems from normal and accidental tritium releases, there are the health and environmental effects that are normally associated with reactor operations. Should the DOE decide to pursue the reactor option, it would generate from 68 to 105 metric tons of heavy metal in spent fuel per year.[18] This would be added to the over 2,600 metric tons of heavy metal in spent fuel currently awaiting disposal by the DOE.[19] Additionally, there would

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[13] See the bibliography in Straume 1991 for a list of studies that have been conducted on the health effects of tritium.

[14] Makhijani et. al eds. 1995, p. 97

[15] Straume 1991, p. 4

[16] Tritium is considered to have low radiotoxicity, compared, for example with radium or cesium, because it emits relatively low energy beta particles which cannot penetrate the skin.

[17] Makhijani et. al 1995, p. 250

[18] DOE 1995a, p. S8. Calculated for a new small to large Advanced Light Water Reactor (ALWR). As all commercial plants in the United States are light water reactors, this is representative of the range of heavy metal to be expected.

[19] DOE 1995c, p. 8. This does not include spent fuel from commercial power reactors.

be low-level radioactive waste, hazardous waste, and other wastes produced by a reactor during normal operations.

Although an accelerator would not produce spent fuel, it would produce other waste products, including low-level radioactive waste. The coal or natural gas facility needed to power the accelerator would also create environmental problems, including emissions of sulfur dioxide, carbon monoxide and nitrogen oxides. These pollutants contribute to the problems of acid rain and global warming and have adverse health effects.[20] Still, according to the DOE, the environmental effects of accelerator production of tritium would be less than those from a reactor. This was a factor in their decision to designate the accelerator as one track in their preferred option.

Budget Consequences

A new tritium source could cost billions of dollars over its lifetime. Costs vary depending on the technology chosen and the production capacity. Even the "low-cost" commercial reactor option would cost $1.2-5.1 billion. A new reactor would cost approximately $2.7-7.6 billion, and an accelerator is estimated to cost approximately $4.8-6.1 billion.[21] The department already spent $2.3 billion between 1988 and 1992 in an attempt to restart the K-reactor at SRS.[22] The DOE plans to spend approximately $50 million next year on research and development, as it did this year, with funding requests rising in subsequent years.

The costs of producing tritium are likely to adversely affect other programs. In a time of limited resources, large construction and operating costs for materials production could reduce funds for programs to clean up the Department's weapons sites. Additionally, new tritium production would actually *increase* clean-up and waste management costs through the operation of another facility. However, cost estimates for the facility were not included in the Draft PEIS upon which the public was asked to comment. Cost figures were not released until a month after the public comment period was closed and only ten days before the release of the final PEIS.

Analysis

Christopher Paine, Senior Research Associate at the Natural Resources Defense Council (NRDC), has analyzed various aspects of the DOE's tritium production. Paine calculated the DOE's present and future tritium requirements, based upon the best possible estimates from publicly available sources. His analysis, summarized in Table 1, estimates tritium levels for various arsenal sizes down to 1,000 warheads.[23] We have extrapolated his analysis for lower arsenal sizes in Table 2.

The amount of tritium required by the DOE and the Department of Defense (DoD) for the nuclear weapons stockpile is determined basically by three factors:

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[20] DOE 1995b pp. 40-478 and 40-480

[21] DOE 1995d. The range of numbers includes two different production levels and possible revenue from the sale of electricity. The figures given are the mean discounted total life cycle costs calculated for the DOE PEIS. See Chapter 6 of DOE 1995d for a further breakdown of the possible costs of tritium production.

[22] Kalinowski and Colschen 1995 p. 143

[23] Paine 1992

- **The size of the nuclear arsenal**. Obviously, a smaller arsenal would require less tritium and the tritium freed by dismantling warheads could be fed back into the inventory for the active arsenal. The DOE's estimate that new tritium production would begin in 2011 is based on an operational stockpile level of approximately 5,000 warheads. The second Strategic Arms Reduction Treaty (START II) allows the United States to retain approximately 3,500 active strategic warheads. The United States also plans to retain 950 tactical warheads.[24] Spares and replacements will add another 5%-10% to the stockpile. The United States currently plans to retain a reserve of 2,500 warheads for a total of 7,500 warheads.[25]
- **The amount of tritium required to operate the tritium pipeline**. The pipeline includes the tritium needed to operate purification and loading facilities and the tritium tied up in the reservoir exchange process. Currently, these facilities require a large amount of tritium for their operations because they were designed for a stockpile that numbered in the tens of thousands. NRDC's analysis assumes that by 2026 the pipeline will be upgraded and modified to support a smaller stockpile and will require approximately 2.0 kilograms of tritium to operate.
- **The amount of tritium needed per warhead**. Each warhead is assumed to require a minimum of three grams of tritium but contains an average of approximately four grams of tritium.

Table 1 shows various stockpile levels and related tritium requirements. Note that for a stockpile of 1,000 warheads a new tritium facility would not be needed until approximately 2024, using the current tritium pipeline. Modifying the pipeline would push the date for new tritium production back even further, to 2032.

Table 1: Stockpile Levels and Tritium Requirements

Number of Warheads	Tritium Inventory Required (kilograms in warheads and pipeline)	Year of New Tritium Production[26]	Comments
4700	28.5	2011	approximately the size of the START II stockpile plus tactical and spare warheads.
3500	22	2015	number of START II strategic warheads.
1000	12.1	2024	Current Tritium Pipeline
1000	7.0	2032	Tritium Pipeline reduced to 2.0 kilograms

Further reductions in the nuclear stockpile would delay the need for a new facility. However, below a certain number of warheads, the size of the tritium pipeline becomes a crucial factor in determining the date by which tritium production would be required. Decisions about tritium production and handling facilities (including the size of the pipeline) are primarily driven by assumptions about stockpile size. Therefore we assume that if the stockpile is reduced below

[24] The line between strategic and tactical warheads can sometimes be blurred. However, in general tactical warheads are used to change the course of a battle. That is, tactical warheads are short-range and are used in a limited manner.

[25] Cochran 1995, p. 8

[26] The year in which new tritium production would be required is calculated using a decay rate of 5.5% per year, a 1992 tritium inventory of 88.2 kilograms, yearly commercial sales of 0.15 kilograms and five grams physically in each warhead for levels below 1,000 warheads.

1,000 warheads, the pipeline design and requirements would also be lower. While the size of the pipeline would depend partly on its design, we have assumed for purposes of illustration regarding dates that the size of the tritium pipeline would be proportionally reduced (i.e. if a stockpile of 1,000 warheads would require 2.0 kilograms in the pipeline, a stockpile of 500 warheads would require 1.0 kilograms).

Another factor driving a tritium production decision for low stockpile numbers is commercial sales of tritium by the DOE. Such sales would begin to substantially affect the requirement for new tritium for scenarios with a few hundred warheads or less. By 2042 the amount of tritium sold for commercial purposes (approximately 0.15 kilograms per year) would equal the amount of tritium lost to decay. Table 2 provides dates for new tritium production both with and without commercial tritium production. Tritium sales are assumed to cease when the stockpile is reduced below 1,000. For illustrative purposes only, this is assumed to occur in 2032 when the tritium inventory can no longer support a 1,000 warhead stockpile (see Table 1 above).[27] Eliminating tritium sales would push the requirement for tritium production back by at least four years, and, if the stockpile is reduced drastically, by as much as 101 years. Only minor financial losses would result from eliminating tritium sales.[28] Commercial tritium sales could also be substantially reduced or eliminated if new technologies are developed for replacing tritium over the next few decades.[29]

Table 2: Stockpile Levels (Below 1,000) and Tritium Requirements

Number of Warheads	Tritium Inventory Required (kilograms in warheads and pipeline)	Year of New Tritium Production (with commercial sales)	Year of New Tritium Production (no commercial sales)
500	3.5	2040	2044
200	1.4	2047	2060
100	0.7	2050	2073
1	0.007	2054	2155

Nuclear Strategy

The Pentagon's assumptions about the role of nuclear weapons in its military strategy are central to the decision on whether and when tritium production is required. The size, capabilities, and function of the nuclear arsenal are major determining factors in calculating the tritium requirement. It is therefore necessary to understand the various arguments about arsenal sizes and their potential relations to U.S. military postures.

It is important to note that no role has been established for nuclear weapons in the post-Cold War strategy, even within the military-political establishment. For instance, there is a great deal of debate over what number of warheads, if any, are required in order to meet U.S. strategic requirements. This debate began, to some extent, during the Manhattan Project to build the first

[27] The DOE actually ceased commercial tritium sales in October, 1995 (personal communication with Kathy Flayler, Sales Marketing Representative at Mound, January 2, 1996). However, this decision is reversible and in order to be conservative we have not taken this into account in our calculations. If sales do not resume tritium production could be delayed even further (approximately five to ten years).

[28] Revenue losses should be below $10 million per year based on the fact that tritium sold for between $13,000 and $26,000 per gram in the 1980s.

[29] It should also be noted that incidental tritium production in Canada's CANDU reactors alone is approximately 3.5 kilograms/year, which easily satisfies worldwide commercial tritium requirements (Kalinowski and Colschen 1995, p.138). The possibility of purchasing tritium from Canada has been raised as an option. However, Canadian law bans the use of Canadian tritium for military purposes.

atomic bomb, but intensified almost immediately after World War II. However, it has assumed a new and perhaps more urgent meaning with the end of the Cold War and the disintegration of the Soviet Union. For the purposes of this paper, the various schools of thought can be classified into four groups: the Pentagon and its supporters; those who wish to eliminate tactical warheads; minimum deterrence proponents; and those wanting the U.S. and other nuclear states to achieve disarmament.

The number of warheads that the Pentagon has considered adequate to fulfill its requirements has varied widely over the years and has included a mix of both strategic and tactical warheads. For example, in 1954 the Strategic Air Command, under the command of General Curtis LeMay, estimated that after an attack of just 600-750 warheads "virtually all of Russia would be nothing but a smoking, radiating ruin at the end of two hours."[30] In the mid to late 1950s, during the 1960s, and then again in the 1980s, the number of targets proliferated, especially with the addition of Soviet warheads and missiles (counterforce strategy) and leadership and command structures (countervailing strategy) as targets. The number of strategic targets in the National Strategic Targeting Database doubled from 25,000 to 50,000 between 1980 and 1985.

The end of the Cold War brought changes in the Pentagon's requirements. Between 1990 and 1992 the Pentagon's "minimum" requirement fell from over 10,000 to 3,500 strategic warheads.[31] As Ivo Daalder points out in his analysis, "Stepping Down the Thermonuclear Ladder: How Low Can We Go?," there is no agreed upon minimum and the Pentagon's changes have been driven by arms control agreements. The minimum requirement varies because there is no generally agreed upon strategic doctrine to achieve for nuclear deterrence.

Tactical nuclear weapons (such as nuclear landmines and neutron bombs) formed a large portion of the nuclear arsenal during the Cold War. However, tactical nuclear weapons, due to their portability, pose high security risks, especially in Russia under present conditions. President Bush, in 1991, recognized the risk that tactical warheads could be stolen in the former Soviet Union. His unilateral reduction in U.S. tactical warheads was made in the hope that the Russians would follow suit, which they did. However, the danger of a black market in tactical warheads still remains due to Russia's economic situation and concerns over nuclear safeguards at Russian facilities. In order to persuade Russia to eliminate its tactical stockpile, the United States must take the initiative by dismantling its tactical stockpile. An elimination of the approximately 1,000 tactical warheads (950 active plus spares) scheduled to remain in the U.S. arsenal would also delay a tritium decision by three or four years.

Many analysts, some with extensive military experience, advocate a theory known as "minimum deterrence." These analysts postulate a minimum number of warheads and certain conditions which make a surprise first strike nearly impossible and assures a second strike capability. Minimum deterrence treats nuclear warheads as being categorically different from conventional weapons and assumes a much lower threshold of acceptable damage on both sides. Enough damage and fatalities would occur with anywhere from 1 to 1,000 invulnerable warheads that the risks would be unacceptable. This would allow the United States to deter attack by posing a credible second strike threat with much lower numbers. The table below lists some of the suggested minimum deterrence numbers, their major proponents and the comments of each.

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[30] From the notes of Navy Captain William Brigham Moore at a Strategic Air Command briefing on March 15, 1954. Reprinted in Rhodes 1995, p.563-564.

[31] Daalder 1993, pp. 6-7

Table 3: Minimum Deterrence Levels and Proponents

Minimum Strategic Warhead Levels	Tritium Production Date	Proponent	Comments of Proponents
1,000	2024-2032	National Academy of Sciences	After START II and various confidence and security building measures were in place.
200	2047-2060	Jonathan Dean, Ambassador to the Mutual Balanced Forces Reduction talks	Warheads must be separated from delivery systems.
100	2050-2073	Robert McNamara, former Secretary of Defense	Must be invulnerable to attack.
1 to 100	2050-2155	Herbert York, first director of Lawrence Livermore Laboratory	Must be invulnerable to attack.

A minimum deterrence force of 1,000 warheads, using a modified tritium pipeline, would not require tritium production until about 2032. Planning for tritium production would not have to be made until 2017. Reductions to a level of 100 warheads would delay production until at least 2050 and delay planning until 2035.

The argument has been made for retaining a large stockpile of nuclear warheads in order to deter governments considered to be unfriendly to U.S. interests and which the U.S. government has determined to be a proliferation risk. Assuming, for the moment, the legitimacy of the argument, a very small number of warheads would be sufficient for this purpose. A single warhead would devastate the capital of any country.[32] There is no credible argument for hundreds, much less thousands, of warheads for such a purpose.

Warheads numbering in the thousands could only be relevant in the context of confrontational U.S. and Russian military postures and do not adequately factor into policy the new situation created by the collapse of the Soviet Union. This new situation is evidenced by the fact that the U.S. and Russia have already agreed to target their warheads towards the ocean (though, of course, this symbolic step can be reversed in a short time). Retaining a large U.S. stockpile of thousands of warheads may be oriented towards the resumption of nuclear warfighting postures of the early 1980s. On the other hand, the vast destructiveness of even a single warhead indicates that deterrence, by the threat of retaliatory attack, can be accomplished with a stockpile of 1 to 1,000 strategic warheads. This would delay the need for tritium production by at least thirteen years (1,000 warheads and no modification to the pipeline).

Tritium production would be an entirely academic discussion in the event that the U.S. and other weapons powers decide to honor their commitments under Article VI of the Non-Proliferation Treaty, which states:

> Each of the Parties to the Treaty undertakes to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

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[32] The smallest warheads to remain in the post-START II stockpile will have yields comparable to the bomb dropped on Hiroshima. There will also be warheads with much greater yields retained.

The “Principles and Objectives For Nuclear Non-Proliferation and Disarmament,” a final document of the 1995 Review and Extension Conference of the NPT, reaffirmed this commitment.

However, a new tritium facility’s sole purpose would be to maintain a nuclear weapons stockpile well into the next century. Establishing the infrastructure to maintain a large U.S. arsenal would most likely be seen as a violation of the spirit of the NPT and would raise objections by non-nuclear NPT signatories. The Non-Aligned Movement, consisting of over 100 UN member-states, has taken a strong stand for disarmament, including participating in a current World Court Case to have nuclear weapons declared illegal. It would be in conformity with the spirit of Article VI for the United States to forego planning for new tritium production as part of its good faith efforts towards nuclear disarmament. Ratification of START II by Russia and negotiations for further reductions, generally referred to as START III, would be widely seen as further good faith efforts by the nuclear powers.

The decision by the DOE to plan for tritium production by the year 2011 reflects the Nuclear Weapons Stockpile Plan, a planning document prepared by the DOE and the Department of Defense.[33] Current Department of Defense and DOE planning ignores stockpile reductions below START II which are compatible with alternate concepts of minimum deterrence and progress towards multilateral nuclear disarmament.[34] The future role of nuclear weapons in U.S. military strategy and foreign policy is a crucial question and should be the subject of vigorous public debate. However, work on a new tritium production facility tends to perpetuate a large weapons stockpile and puts non-proliferation and disarmament options on the back burner, including the urgent question of eliminating all U.S. and Russian tactical warheads. It would also silence any national debate over the future of nuclear weapons in U.S. military and foreign policy. Deferment leaves all options open and would mean, at most, a temporary tritium shortage for a small portion of the thousands of warheads currently planned for the U.S. stockpile. There should be a clear understanding of the health, environmental, budgetary, and policy implications of tritium production before it is pursued further.

Recommendations

- **The plans for a new tritium source should be put on hold and an informed public debate over the size and function of the nuclear stockpile should precede any decision on tritium production**. This debate should take into account differing views of minimum deterrence, U.S. adherence to the spirit of the NPT and the health, budget and environmental consequences of a new tritium source.
- **The U.S. should persuade Russia to eliminate its tactical nuclear warheads by unilaterally eliminating its own tactical warheads**. This urgent action is necessary to reduce the risk of a black-market in nuclear warheads. This creates a three to four year extension of the tritium reserve, during which a national debate on nuclear strategy could be carried out.
- **Nuclear weapons states should take concrete steps towards nuclear disarmament, as required by the NPT**. Such a course is unlikely unless the United States and Russia reduce

[33] DOE 1995a p.2-1

[34] It should be noted that many minimum deterrence theorists see minimum deterrence as only a stage towards eventual abolition according to the obligations of the NPT.

their nuclear arsenals to around 1,000, roughly the same number as that of the other three powers combined. France, Britain, and China would then be more likely to enter the disarmament debate. Building a new tritium source now, or expending large resources in planning for it, would create a momentum in favor of large arsenals. Confrontations over the implementation of the NPT may result, and hence prevent the smooth functioning and progress of the non-proliferation regime.

- **Tritium inventory numbers and use numbers should be de-classified**. Only by declassifying these numbers can a free and open public debate take place. The DOE asked for public comment on its tritium production plans as part of the NEPA process without giving enough information for the public to make an informed judgment of their plans.

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