The Department of Energy's Savannah River Plant Reactors and U.S. Requirements for Tritium and Plutonium for Nuclear Weapons

A Background Paper Prepared by

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The ongoing and expanding scandal at the Department of Energy's (DOE) deteriorating nuclear weapons production complex has raised the issue of whether operating unsafe nuclear reactors at the Savannah River Plant (SRP) in South Carolina is necessary. Government officials have been quoted in the press recently as suggesting that unless the SRP P, K, and L reactors -- currently shut down for safety reasons -- are re-started within nine months, the U.S. will rapidly lose its nuclear deterrent capability.

The government's claims are false. Through prudent and creative measures, some of them admittedly having an impact on certain marginal nuclear capabilities, the U.S. can deal with the temporary shortfall in tritium supply. National security is not threatened to the point where public safety should be further jeopardized. A broader examination of nuclear production plans and needs, trends in arms control, and superfluous nuclear capabilities indicate that reasoned solutions to the current problems created by the Department of Energy could be found.

U.S. nuclear forces will not be imperiled by postponing further production of tritium for at least two years. A START Treaty would provide an additional four to five years, while expeditious retirements of obsolete warheads, scaled back new production, and temporary removal of tritium from certain inactive warheads would further alleviate short-term tritium needs.

Let us take a look at the facts to see why the continued shutdown of the reactors to undergo safety upgrades and environmental review will <u>not</u> jeopardize the nation.

The U.S. Nuclear Weapons Stockpile

The size of the U.S. nuclear arsenal is currently about 23,000 warheads. In 1967, it was 32,500 warheads. Current production rates of new warheads are about 1,200 to 1,500 per year. Current retirement rates of old warheads are about the same, and therefore the size of the stockpile is not increasing.

Tritium Requirements

Tritium is a hydrogen isotope with one proton and two neutrons in its nucleus. It does not occur naturally in significant quantities. In the U.S. it is produced in quantity in reactors at SRP.

Nuclear warheads, such as those the U.S. dropped on Japan, can be constructed without tritium, but the vast majority of warheads in the U.S. stockpile today use tritium as one of their key materials.

Tritium, together with deuterium, is used in nuclear weapons to "boost" the chain reaction, thereby increasing the magnitude of the explosion. In most U.S. thermonuclear weapons, tritium is used to "boost" the fission primary or first stage. Tritium and deuterium are also essential ingredients of enhanced radiation warheads, the so-called neutron bombs.

We estimate that 22,000 warheads in the U.S. stockpile contain tritium. Each weapon has on average about 4 to 5 grams, with neutron bombs requiring a much larger quantity, perhaps as much as 25 grams. Tritium is also used in small amounts in neutron generators in nuclear warheads. The amount is considerably less than a gram per warhead. The total inventory of tritium in warheads is estimated to be about 80-100 kilograms. This includes the tritium in warheads, in the "pipeline," and held in reserve. Unlike plutonium, tritium decays relatively rapidly -- at a rate of about 5.5 percent per year -- and therefore must be replenished in warheads. One SRP reactor operating at full power and dedicated to tritium production produces about 10 kilograms of tritium per year.

To understand the implications of a short-term cut-off of tritium production, we must first review how tritium is packaged and recycled. The official term for a part of a nuclear device or weapon which contains tritium is "limited life component". In all nuclear warheads that rely on tritium -- fission warheads, boosted primaries of thermonuclear warheads and enhanced radiation warheads -- the tritium is physically mixed with deuterium when the warhead is armed and the warhead yield is a function of the amount of tritium that is bled into the core.

The tritium is stored in the warhead in the form of a gas. The deuterium may be in the form of a gas or solid, e.g., as a lithium hydride. Because tritium decays radioactively into helium at a rate of 5.5 percent per year (its radioactive half-life is 12.33 years) in the warhead, it is stored separately from the deuterium in steel containers called reservoirs, bottles or "doughnuts." These containers are periodically removed in the field and shipped to the Tritium Facility at SRP where they are recycled. (Tritium is also recovered from weapon components at Mound Laboratory at Miamisburg, Ohio.) At SRP the tritium, which has become mixed with helium (its radioactive decay product), is removed from the containers, purified, and loaded into new containers. It is then shipped to Army, Navy, and Air Force military first destination sites in the U.S. and abroad, for further shipments to field nuclear sites, where the limited life components are exchanged. The exact frequency with which these containers are refilled is not known and varies among the different types of warheads in the stockpile. In fission warheads and the boosted primaries of thermonuclear weapons, as more tritium is bled into the core from the container, the yield of the warhead will increase as the efficiency of the fission process increases. Eventually at higher efficiencies, a "plateau" will be reached above which the yield will not increase appreciably. It is believed that enough tritium is loaded into containers to enable stockpiled warheads to operate in this plateau region for several years, during which time the warheads will continue to meet their design yield requirements.[1] It is likely that the containers are refilled about every five years on average, give-or-take a year. Thus about 4,000 to 6,000 warheads have their limited life components exchanged annually.

Department of Defense (DOD) officials claim that if the SRP reactors are not restarted, the Department of Energy (DOE) will no longer be able to meet current warhead needs sometime in the summer of 1989 -- that is in about nine months. This assumes there are no changes in the schedules or procedures for reservoir replenishment over those established before the SRP reactors were shut down. If there were no changes in procedure, the statement implies that in about nine months DOE would begin drawing down

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[1] In fact, there is evidence that a warhead will continue to operate successfully even after the amount of tritium has decayed below acceptable age tolerance. According to a Department of Energy sponsored study, "[i]n 1979, on LLNL's recommendation, the DoE and DOD agreed to a complete time-phased retrofit of the W68 stockpile. The DoE weapons-production complex rebuilt all the W68 weapons, a few thousand, replacing the LX-09 with LX-10.

On the basis of the earlier nuclear tests, LLNL was confident of the reliability of the modified warheads, and the Laboratory did not require a new nuclear test. However, as a "final development test," LLNL did test the W68 again after the retrofit. In the test <u>LLNL used a weapon that was in many ways at the edge of acceptable tolerances and that had one limited-life component with an age that was over that of any to be used in stockpile. This extreme test device performed successfully, confirming the Laboratory's confidence</u>" (emphasis added); J.W. Rosengren, "Some Little-Publicized Difficulties With a Nuclear Freeze," Office of International Security Affairs, DOE, October 1983, p. 20.

the tritium in the refill pipeline.

Finding More Tritium

If the reactors do not start next summer, there are alternatives available to DOD/DOE. DOD/DOE do not have to fully fill the reservoirs of warheads during the next two years. If the average lifetime of a reservoir in a warhead is five years, this means that 25 percent of the tritium decays into helium during this period. If only one-half of the tritium that has decayed is replaced, the warheads replenished would still meet their design yield. In other words, the reservoirs of the next 3000 to 5000 limited life component exchanges scheduled could be filled at only 87.5 percent capacity during the next nine-months. The only significant impact would be that instead of remaining in the field for five years, these warheads would have to be returned twice as soon -- after about two and one-half years. Taking this simple step, DOE/DOD could stretch the existing nine-month reserve to 18 months. DOD/DOE also could reduce the limited life component exchange turn around time, thereby reducing the inventory of tritium in the pipeline. Perhaps as much as three to six months worth of tritium supplies could be achieved. These two sources of additional tritium could buy DOD/DOE 21-24 months before the SRP reactors need be restarted and <u>they would result in no degradation in the military characteristics of any warheads in the stockpile.</u>

Additional measures could be taken that would slightly reduce the yield of some warheads in the stockpile, or require temporary removal from the active inventory, but would have negligible impact on U.S. nuclear capabilities. These steps include:

- Permitting the tritium levels of selected warheads to decay such that the yield achievable is only slightly smaller than design standards. For example, if the reservoirs of selected warheads were exchanged after six years rather than five, the yields would be reduced by less than 5.5 percent; alternatively, reducing the tritium inventory in reservoirs of selected weapons by 5.5 percent would have a similar effect.
- Removal from the stockpile of about 1200 warheads that rely on tritium (5.5 percent of the total) would provide one years worth of tritium, assuming the their average tritium loading is the same as the stockpile average. Warheads that could be easily removed from the active inventory include:

  a) the 500 Intermediate Nuclear Forces (INF) warheads. Under provisions of the INF treaty, neither the U.S. nor the Soviets were required to dismantle nuclear warheads. The U.S. plans to store these warheads for possible use on future weapon systems. The U.S. should dismantle these warheads and recycle the tritium they contain, if this has not already been done. The tritium used in these warheads is roughly equivalent to two months output of the three SRP reactors operating at half power.

b) Another 100 Pershing 1A warheads will be available when West German missiles are retired beginning in mid-1991. About 400 enhanced radiation warheads for the 8-inch artillery howitzer and Lance missile are currently stored at Army depots in upstate New York and California. The tritium contained in these warheads is equivalent to perhaps a year's output of the three SRP reactors operating at half power.

• About 240 nuclear bombs recently removed from some 60 B-52G non-ALCM bombers, which were converted to conventional missions in 1988, should be expeditiously retired, if this has not already been done. Other bombs in the strategic and non-strategic forces could also be temporarily retired through the removal of their tritium components. Given cutbacks in tactical aviation (14 carrier air wings rather than 15, 36 tactical fighter wings rather than 40, reduced aircraft procurement), the number of nuclear bombs allocated to non-strategic forces (4100 warheads) could be reduced.

- Since 1985, the Reagan Administration has decided to retire three Poseidon submarines and Congress has further imposed the retirement of three other submarines (one in the FY 1988 budget and two in the FY 1989 budget). These earlier than planned retirements result in the retirement of 960 warheads. In the coming year, the three latest submarines should be expeditiously decommissioned to recoup the warheads and tritium.

In addition, no analysis of tritium needs would be complete without a realistic picture of new warhead production plans. Budget cutbacks in the last three fiscal years, technological problems, and slipped weapons plans have resulted in significant changes in DOE warhead-production schedules:

- Production of the Advanced Cruise Missile (ACM) has been delayed at least two years because of Congressional funding cuts due to test flight failures. The ACM was scheduled for a 1988 IOC and a 1991 FOC with the production of some 1500 warheads during that period.

• The small ICBM has slipped at least one year as a result of FY 1989 budget cutbacks. This is some SOD warheads planned for the early 1990s.

• The second 50 MX missiles with SOD warheads have been further delayed and will not be produced in the next two years as planned.

• Tomahawk sea-launched cruise missile (SLCM) procurement has been slowed, and some 500 warheads are not being produced in the next five years as planned. Complete production has now slipped to the mid-1990s.

These cuts by themselves do not imply that future tritium requirements will be less than present requirements. However, they do suggest that the requirements will not be increasing.

Plutonium Requirements

The U.S. has a stockpile of approximately 100 metric tons (MT) of weapon-grade plutonium. Most of it, about 85 - 90 percent, is in nuclear warheads themselves. The other 10 to 15 percent is available for weapons (i.e. in reserve, in the pipeline, and in scrap). Each SRP reactor operating at full power produces 0.5 MT of plutonium annually. Each warhead in the

U.S. arsenal contains an average of about 3.7 kilograms (kg) of plutonium. Thus, on average one reactor operating at full power for one year produces enough plutonium for about 140 warheads.

Secretary of Energy John Herrington told a Congressional Committee last February that the U.S. is "awash in plutonium" and that "we have more plutonium than we need." Our plutonium stockpile will not be depleted any time in the foreseeable future. Most plutonium for new nuclear warheads comes from the retirement of old warheads, not from new production. Plutonium, unlike tritium, has a long radioactive half-life; about 24,400 years. The existing stockpile of plutonium can be recycled indefinitely.

Successful arms control agreements could further increase the plutonium stockpile. Under the recently completed Intermediate Nuclear Forces (INF) treaty, 500 warheads, from the Pershing II and ground-launched cruise missiles are to be removed by mid-1991. The warheads are not scheduled to be dismantled even though they contain about 1.5-2 MT of plutonium. (This is roughly equivalent to one full year of production at SRP, with all three reactors dedicated to plutonium production and running at full power.) If START negotiations are successful, the U.S. could retire about 4,000 to 5,000 strategic warheads over a six year period--containing some 15 to 20 MT of plutonium.

Should an unexpected need for additional plutonium arise, DOE has multiple options for obtaining the material, including:

• Plutonium Reserve. DOE has set aside a reserve of plutonium, perhaps as much as five MT to meet contingencies.

• Plutonium Scrap. DOE has roughly 10 MT of plutonium scrap, generated during nuclear weapons production. DOE is planning to accelerate recovery of plutonium from scrap.

• Hanford N Reactor. Last February DOE, citing decreased U.S. plutonium requirements, decided not to restart a plutonium production reactor at the Hanford Reservation in Washington state. DOE is currently upgrading the N Reactor at a cost of more than $100 million and will place it in standby status for use in an emergency. Operating at full power, it is capable of producing some 0.6 - 0.7 MT of plutonium annually.

• Accelerated Warhead Retirements. Senator Mark Hatfield (R-OR) stated in his October 1987 "Plutonium Cushion" Report that a substantial amount of plutonium could be made available for weapon production if the Department of Defense accelerated the retirement of obsolete warheads as Congress has urged it to do. "[B]y returning to earlier levels of retirements, we can significantly increase the amount of plutonium available for new weapons production and thereby become less dependent upon production from our reactors," wrote Hatfield.

Conclusion

The safety problems at the SRP reactors present the U.S. with the opportunity to assess the need to continue to produce nuclear materials before rushing ahead with construction of new facilities or the restart of existing unsafe ones. In an era of arms control and budget deficits, DOE has a responsibility to demonstrate to the public its need for new production of tritium and plutonium for nuclear weapons.

Until such a such a need is demonstrated, operation of potentially unsafe reactors and the construction of new ones should not be accepted.

The hysterical sounds of alarm about impending unilateral nuclear disarmament should be replaced by a rational debate about the future of nuclear weapons production in this country.

a) A boosted fission weapon

b) Thermonuclear warhead with boosted fission primary

c) Enhanced radiation warhead

Figure 1. Idealized schematics of nuclear weapons relying on fission.

Figure 2. Warhead yield as a function of tritium boosting.