The danger of military reactors

The Chernobyl accident has prompted a long-overdue evaluation of U.S. military reactors—a lengthy process that could involve expensive changes. The authors believe it would be better to stop production of weapons-grade plutonium.

by David Albright, Christopher Paine, and Frank von Hippel

THE LARGE RELEASE of radioactivity from the accident at the Chernobyl nuclear reactor has resulted in considerable concern about the safety of the five large military production reactors that produce plutonium and tritium for U.S. nuclear weapons. These reactors, operated by the Department of Energy, lack the strong steel or reinforced-concrete "containment" structures such as those that house most U.S. civilian nuclear power reactors. It was such a containment that prevented a Chernobyl-scale release of radioactivity from the 1979 accident at Three Mile Island. One of the U.S. production reactors, the "N-reactor" at the Department of Energy's Hanford site in Washington state, has drawn special attention because, like the Chernobyl reactor, it is moderated by graphite. The four other production reactors, located at the Savannah River site in South Carolina, are moderated by heavy water.

As a result of these safety concerns, Congress and the Energy Department have commissioned outside safety reviews of the production reactors. One such partial review by the Congressional General Accounting Office has already criticized the basis of the Department's conclusion that operation of its production reactors poses an acceptable risk to the public.[1]

The new safety reviews may well recommend large expenditures of funds to upgrade the safety of the production reactors, including construction of containment buildings. The Energy Department estimates that adding containment buildings to all of its production reactors would cost between $2.5 and $5 billion and require shutting down the reactors for several years—if it could be done at all.[2] Furthermore, all these reactors are quite old: the Savannah River installations were completed in 1954 and 1955, and the Department of Energy has projected that the N-reactor will reach the end of its useful life in the mid-1990s.[3] The Department has therefore been studying various plans either to renovate or to replace these facilities.

The combination of the need for major overhauls or replacement of these reactors, along with the possibility of prolonged shutdowns resulting from the current safety reviews, makes this an especially appropriate time to ask whether their continued operation is necessary. Since the United States already has more than enough nuclear weapons to maintain a survivable capability to destroy the Soviet Union as a modern society, the answer would appear to be "no." This answer has not been accepted by the U.S. nuclear weapons policy makers because they, like their Soviet counterparts, have long allowed common sense notions about "how much is enough" to be overriden by official doctrines which assign to nuclear weapons the traditional "counterforce" mission of limiting damage to home and allied territories by destroying the opponent's military forces. As each side's military forces have been hardened against nuclear attack, the requirements for both counterforce weapons and their associated materials have increased. However, if nuclear warfighting is rejected as a dangerous illusion, such "requirements" for ever more effective counterforce weapons must also be rejected.

Concern in both the United States and the Soviet Union about the safety of their production reactors therefore presents an opportunity for reviving the long-standing proposal, put forward by each side at different times, for a bilateral agreement to end the production of plutonium and weapon-grade uranium (fissile materials) for nuclear weapons. This would make possible shutting down all but one of the production reactors in each country. One reactor could be kept in operation in the United States—and probably the Soviet Union as well—to produce tritium, which is used primarily as a source of neutrons to increase the efficiency of the fission reaction in nuclear warheads. Tritium decays radioactively at the rate of 5 percent a year and therefore needs to be periodically replenished.

Presidents Eisenhower, Kennedy, and Johnson all made proposals for an agreement with the Soviet Union to end production of fissile materials for weapons. Faced with the lack of Soviet interest—probably because Soviet stockpiles of fissile material were much smaller than those of the United States at the time—President Johnson finally declared, on April 20, 1964: "We must not operate a WPA nuclear project, just to provide employment when our needs are met."[4] Johnson then ended U.S. production of highly enriched uranium for weapons and, during the remainder of his term, shut down seven plutonium production reactors. Three more production reactors were shut down by the Nixon Administration, leaving only four operating until 1985.

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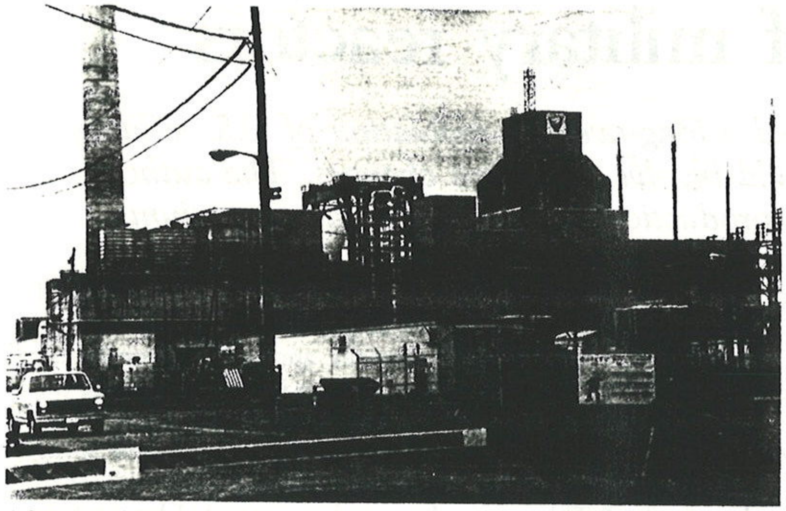

A Savannah River production reactor. Like the Chernobyl reactor involved in the April 26 accident, this reactor is housed in an ordinary building, not a pressure-resistant containment structure. *Photograph by Robert Del Tredici.*

In 1982, the Soviet Union, having built a nuclear arsenal approximately as large as that of the United States, finally announced its support of a fissile material production cutoff agreement. Foreign Minister Andrei Gromyko suggested that the "cessation of fissionable materials for manufacturing nuclear weapons" could be made one of the initial stages of a nuclear disarmament program.[5] This time it was the Reagan Administration that showed little interest.

THE ADMINISTRATION'S disinterest in a fissile production cutoff is related to the fact that the United States is currently in the midst of its biggest nuclear weapons building program in 20 years. Warhead production is averaging 2,000 or more per year.[6] Most of the new warheads will replace older weapons that are being retired. For example, the "silo-busting" warheads of the Trident II submarine's D-5 ballistic missile are being built to partially replace the much less powerful warheads of the Poseidon and Trident I missiles. A large fraction of these new warheads are therefore being manufactured with fissile material recovered from old warheads. There is, however, some net growth in the number of U.S. warheads, because some new types of weapons are being introduced on a large scale, such as nuclear-armed air-, ground-, and sea-launched cruise missiles. Additional requirements for new fissile material have also been generated because some of the more compact or higher-yield new warheads contain more fissile material than the weapons they are replacing. Finally, the Departments of Defense and Energy have long wanted to have reserves of fissile material available for a potential "surge" in U.S. warhead production arising from, for example, a decision to initiate deployment of a large-scale nuclear-armed anti-ballistic-missile system.[7]

According to nongovernmental, unclassified estimates, the United States currently has about 100,000 kilograms of plutonium and 500,000 kilograms of highly enriched uranium already in or available for nuclear weapons.[8] Given an estimated 26,000 warheads in 1983, this would correspond to an average of four kilograms of plutonium and 20 kilograms of weapon-grade uranium per warhead.[9]

To meet the goals of its nuclear weapons buildup, the Energy Department in 1982 converted the Hanford N-reactor to the production of "weapon-grade" plutonium—relatively pure plutonium 239 containing an admixture of only 6 percent plutonium 240. This reactor, which is the only "dual-purpose" (plutonium and electricity production) plant in the United States, had been operated since 1972 primarily to produce electricity. The Department also restarted the PUREX fuel reprocessing plant at Hanford in 1983, after an 11-year shutdown. That plant now recovers the approximately 600 kilograms of weapon-grade plutonium discharged by the N-reactor each year and is also recovering the approximately 4,000 kilograms of plutonium averaging 12 percent plutonium 240 which had accumulated since 1972 in unreprocessed N-reactor fuel. Any recovered "fuel-grade" plutonium (6–19 percent plutonium 240) is being sent to the Savannah River plant, where it is being converted to weapon-grade plutonium by blending it with the "supergrade" plutonium (3 percent plutonium 240) that the Savannah River reactors have been producing since 1981.[10]

The Energy Department is also modifying the PUREX plant so that it will be able to extract plutonium from spent fuel contained in stainless steel tubes. This will make possible the recovery of additional plutonium from, for example, the spent plutonium fuel of the Fast Flux Test Facility, which is part of the civilian breeder development program. This plutonium will either be blended at Savannah River or "cleaned up" to weapon grade in a new special isotope separation (SIS) facility to be built at Hanford. This facility will use the same laser isotope separation technology that the Department has been developing for the next generation of uranium enrichment plants.[11]

Beyond the fuel-grade plutonium in the N-reactor's spent fuel, which is intended primarily for blending, the Department of Energy possesses only about 11,000 kilograms of fuel-grade plutonium. Some 4,000 kilograms of this amount was produced by British civil reactors and, according to a 1964 U.S. commitment, are not intended for weapons purposes.[12]

Seven to 11 thousand kilograms of plutonium would hardly seem sufficient to justify the SIS facility, which is to have a capacity to upgrade roughly 3,000 kilograms of plutonium per year.[13] In fact, when the Energy Department first proposed the facility, it stated that one of its purposes was to recover and convert to weapon grade some of the 80 metric tons of plutonium that had accumulated in the spent fuel that had already been discharged by U.S. commercial power reactors. Concerns over the implications of this proposed action for nuclear weapons proliferation led Congress to pass the Hart-Simpson amendment in 1982, barring the use of such plutonium in nuclear weapons. However, Representative Samuel Stratton, chairman of the

House subcommittee that oversees military plutonium production, has urged the Reagan Administration to seek the repeal of the amendment.[14]

As another part of its effort to increase U.S. production of weapon-grade plutonium, in late 1985 the Department of Energy completed refurbishing and restarted one of the Savannah River production reactors that had been shut down by the Johnson Administration. With the N-reactor and three of the four Savannah River reactors producing plutonium (the fourth is apparently producing tritium), and the blending program, the Department is now producing over 2,500 kilograms of new weapon-grade plutonium each year. While this amount is less than half the amount produced annually just prior to Johnson's production cutback in 1964, it is over twice the annual amount produced during most of the 1970s.

The Department also plans to restart production of weapon-grade uranium in 1988, after a more than 20-year hiatus since Johnson's decision to end production in 1964.[15]

These activities—and the Reagan Administration's unwillingness even to consider giving them up as part of a bilateral fissile production cutoff agreement in exchange for corresponding Soviet restraint—belie the Administration's professed interest in drastic reductions of the U.S. and Soviet nuclear weapons arsenals. A verifiable bilateral production cutoff would be an essential first step toward reductions. It would insure that fissile material from dismantled nuclear that warheads was being converted to nonweapons uses ~~and that~~ ~~it~~ would not be replaced by newly produced material.

GIVEN THIS SITUATION, some members of Congress are considering legislation to cut off funds for U.S. production of fissile material for weapons if the Soviet Union verifiably halts its own production activities. One precedent for such a move is the 1985 congressional vote to cut off funding for testing the new U.S. antisatellite weapon against targets in space as long as the Soviet Union continues its own antisatellite testing moratorium. More recently, members of Congress and arms control lobbying groups have invested considerable effort to enact similar legislation that would halt funding for U.S. nuclear weapons testing if the Soviet Union continues its testing moratorium.

One possible approach to a congressionally mandated fissile production cutoff would be a two-stage process in which the first stage would involve the shutdown of dedicated plutonium production reactors and all nuclear fuel reprocessing plants. These facilities could be shut down verifiably within a few months of the bill's passage, since they are few in number and it would be feasible to verify, by means of satellites and relatively nonintrusive on-site inspections, that they were not operating. The second stage, which could probably be implemented within two years, would involve the application of safeguards against production of nuclear weapons materials at all significant nuclear facilities continuing to operate for other purposes: power reactors, fuel fabrication facilities, and enrichment plants. Any nuclear fuel reprocessing plants required for civilian purposes could be reopened once they were under safeguards. By the end of the second stage, all activities relating to the production of weapon-grade uranium would have ended.

The International Atomic Energy Agency (IAEA) could perform the on-site safeguard inspections required under the cutoff. The IAEA already safeguards nuclear facilities in over 50 non-nuclear-weapons states in order to assure that these countries are honoring their commitments not to use these facilities for the acquisition of nuclear explosives. The United States and the Soviet Union, who worked together to achieve the Non-Proliferation Treaty of 1970, have also already put a few of their own facilities under IAEA safeguards in order to reduce somewhat the discriminatory appearance of the Treaty. When the United States last advocated a fissile cutoff in 1969, at the beginning of the Nixon Administration, it proposed that the IAEA be responsible for on-site safeguards.[16] The Soviet Union made the same proposal in 1982.

During the first months after passage of a congressionally mandated cutoff, the IAEA could deploy a capability to monitor the shutdown of dedicated U.S. and Soviet plutonium production reactors and associated reprocessing facilities. A few inspectors could establish that a production site was not in operation without having complete access to the interiors of all the facilities. For additional assurance, buildings and equipment could be sealed and remote monitoring systems established at key locations on the sites. The space-based U.S. and Soviet monitoring capabilities would provide a check on whether the other country had revealed to the IAEA the locations of all its production facilities.

During the second stage of the cutoff, the IAEA would extend its safeguards to all the significant nuclear facilities in each country. In the Soviet Union, safeguards would extend to the Chernobyl-type reactors which some in the U.S. Department of Energy are concerned might be used to make weapon-grade plutonium.[17]

IAEA safeguards are designed to detect the diversion of enough fissile material to make a single fission weapon—assumed by the IAEA to be 25 kilograms of uranium 235 in weapon-grade uranium or eight kilograms of plutonium. There are legitimate doubts that the IAEA could, in fact, detect the diversion of such small amounts of fissile material from large facilities, such as plutonium fuel fabrication facilities, civilian reprocessing plants, or enrichment plants. In such facilities, material is handled in liquid, gaseous, and powder forms, and measurement errors and losses on the order of 1 percent might be expected. However, given the expected flows of fissile material through the U.S. and Soviet civilian nuclear power sectors, a 1 percent uncertainty should be acceptable. For example, in the early 1990s, all Soviet civilian reactors will require about 35 metric tons of uranium 235 in their fresh fuel and will discharge about 10 tons of plutonium in their spent fuel each year. One percent of these quantities would be 350 kilograms of uranium 235 and 100 kilograms of plutonium 239—about 0.1 percent of the quantities of these materials already in the U.S.

weapons arsenal.[18] Therefore, if the annual diversion of less than the equivalent of 0.1 percent of the fissile material in the U.S. nuclear weapons stockpile is defined as insignificant, significant diversions of material from safeguarded facilities can be detected.

The detectability of an undeclared or clandestine production system is more difficult to quantify. With satellite cameras sensitive at both optical and thermal infrared wavelengths, intercepted radio and microwave communications, and information gathered from emigrés and other insiders, production rates exceeding 1 percent per year of the existing U.S. stockpile should be detectable because of the scale of the activities involved.[19] Activities of one-tenth this scale would be harder to detect promptly, but over a decade or so—or by the time their clandestine output would accumulate to 1 percent of the size of the U.S. stockpile—there would have been significant risk of detecting this activity by intelligence-gathering methods or by someone "blowing the cover" of the operation.

Although production of fissile material for weapons would be ended, weapon-grade uranium might continue to be used in U.S. and Soviet naval propulsion reactors. Because neither nation is likely to allow inspectors in its nuclear ships, the IAEA and the superpowers would have to agree on an amount of highly enriched uranium that each would be allowed to produce for naval reactors at safeguarded uranium enrichment plants. If it were also stipulated that an equivalent amount of irradiated reactor fuel would have to be turned in at a safeguarded facility within a specified number of years, the cumulative amount of uranium 235 in the naval fuel cycle—and therefore the amount that could be diverted—would be kept from growing to beyond a minute fraction of the existing stockpiles. Currently, the demand for uranium 235 by U.S. naval reactors is approximately 5,000 kilograms per year.[20] Since the total shaft-horsepower of the Soviet nuclear navy is comparable to that of the U.S. nuclear navy, and Soviet ships are at sea a smaller percentage of the time, it is unlikely that the Soviet consumption of weapon-grade uranium would be greater. If it were possible to insure that not more than 10 percent of this uranium 235 were being diverted to nuclear weapons, the resulting annual uncertainty would again be less than 0.1 percent of the uranium 235 already in the U.S. nuclear weapons stockpile.

As already noted, unless the superpowers make drastic reductions in the sizes or compositions of their nuclear stockpiles, they will need to continue operating production reactors to produce tritium. The United States could easily make up the losses to radioactive decay of the tritium in its nuclear weapons stockpile (estimated at 45–90 kilograms in 1984[21]) with one production reactor. If we assume the same situation for the Soviets, then one military production reactor on each side could be maintained in operation under safeguards for this purpose.

The tritium production reactor at Savannah River currently requires almost 2,000 kilograms a year of uranium 235, contained in highly enriched uranium, that is, uranium enriched to over 20 percent.[22] The IAEA could safeguard this uranium and the fuel for any Soviet counterpart reactor in a manner similar to that used to safeguard the fuel of civilian power reactors. A 1 percent accuracy on 2,000 kilograms would be only 20 kilograms—less than 0.01 percent of the uranium 235 already in the U.S. weapons stockpile. The IAEA could also use its standard procedures to assure that the tritium production reactor was not clandestinely producing plutonium.

Congress would have to depend upon the executive branch to inform it whether or not the Soviet Union had shut down, or put under adequate IAEA safeguards, all its significant nuclear facilities in parallel with similar action by the United States. If the president had evidence, after the completion of the first stage of the shutdown, that the Soviet Union was continuing to produce plutonium at dedicated military plutonium production reactors or reprocessing plants, or, after the second stage, had not put all its significant civilian nuclear facilities under IAEA safeguards, he could request that Congress resume funding for fissile material production. Congress could commit itself in the cutoff bill to rapid action upon such a request.

According to an estimate by the Swedish government, to safeguard the civilian nuclear facilities of all the nuclear-weapons states—Britain, China, and France as well as the United States and the Soviet Union—would require an approximate doubling of the IAEA's safeguards manpower and budget.[23] Most of this additional requirement would be associated with the safeguarding of the large U.S. and Soviet systems.

In 1985, the IAEA safeguards program involved 265 professional and 170 support staff and cost $36 million.[24] For comparison, the Reagan Administration requested $2.1 billion for the U.S. materials production program for fiscal 1987.[25] Thus, doubling the IAEA safeguards budget would cost about 1 percent of the savings that would accrue to the United States and the Soviet Union as a result of the fissile material production cutoff. It would therefore be appropriate for Congress to vote special assistance to the IAEA to help cover the extra costs of safeguarding a superpower fissile production cutoff.

More than money might be required, however, since some of the additional personnel and equipment required by the IAEA would be quite specialized and not readily available. Both superpowers might therefore also volunteer to supply technical equipment and interim personnel until the IAEA could adequately train and equip its doubled safeguards staff.

Obviously a presidentially negotiated cutoff would be preferable to one initiated by congressional action, but the current Administration appears unlikely to take such action. If the production of fissile material for weapons is to be ended in the foreseeable future, therefore, Congress will have to overcome its traditional reluctance to take the initiative in matters of this kind. Consider, however, the alternative: operating the U.S. fissile materials production complex and renovating it in preparation for additional decades of the nuclear arms race.

Chernobyl has reminded us that accidents at U.S. and Soviet production reactors can endanger the public. But an even graver threat emanates from the output of these reactors when they are operating smoothly. □

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