lations had been put into effect without good scientific data to support them. Now, instead of beefing up the science, they are pulling back on all fronts. Says Drayton, "We were on the cutting edge of one of the most critical learning curves in our society. Now we are destroying our capacity to understand what we are doing, let alone do anything about it." Douglas Costle, the EPA administrator under Carter, has expressed the fear that proposed cuts will "cripple" the agency so that it may take "at least a decade to recover."

Now even staunch supporters of Reagan have been voicing dismay over the perceived dismantling of an agency that many thought had earned a permanent niche in the federal landscape. Most telling perhaps are recent remarks made by Dan W. Lufkin, former commissioner of environmental protection in Connecticut and the man who headed Reagan's environmental task force during the campaign. In an open letter to the President, Lufkin, a Republican, businessman, and States' Rights advocate, accused the Administration of an approach to environmental regulation that was "at best extreme and at worst bizarre." Wrote Lufkin: "What the Administration is doing in environmental affairs is crazy."

The Senate Environment and Public Works Committee, disturbed by cries of alarm over proposed budget cuts, interrupted action on the Clean Air Act to arrange for a hearing on the matter on 15 October. In a letter inviting Gorsuch to testify, committee chairman Robert T. Stafford (R–Vt.) said he had "considerable concern about the continuing ability of EPA to perform its statutory duties" if major cuts are made.

—CONSTANCE HOLDEN

Weapons Builders Eye Civilian Reactor Fuel

A laser isotope separation process could make plutonium from spent fuel suitable for bomb production

The Defense Department's plans to build a new generation of nuclear weapons in the 1980's will require a major increase in the production of bomb-grade plutonium. So great is the demand that, even with defense reactors running at full capacity, some analysts have predicted that shortages will appear by the end of the decade. Consequently, officials in the Department of Energy (DOE) have been eyeing a source of plutonium that has previously been politically and technologically off limits: the spent fuel rods from commercial nuclear reactors.

Although DOE officials insist that there are at present no firm plans to use commercial wastes for weapons production, there are several indications that such a possibility is under serious consideration. In particular, DOE has recently stepped up work on a key program to separate plutonium isotopes. This will be essential to upgrade plutonium from commercial wastes to the quality required for use in weapons. Moreover, DOE officials, including Secretary of Energy James B. Edwards, have recently been floating the idea in public pronouncements.

The very idea of linking the commercial nuclear power program to weapons production has provoked a storm of protest in the United States and abroad. If carried out, it would end three decades of careful separation of military and civilian nuclear programs. "The whole notion goes against our nonproliferation policy," argues Gerard C. Smith, former chief U.S. negotiator at the Strategic Arms Limitation Talks. By essentially turning its own power reactors into bomb factories, the United States would find it difficult to dissuade other nations from using their peaceful nuclear programs for military purposes, opponents of the move argue. Even the nuclear industry is wary of the idea, for it would almost certainly breathe new life into the antinuclear movement.

The demand for weapons-grade plutonium will rise sharply in the next few years as a result of plans to build a new generation of compact warheads for cruise missiles, neutron weapons, MX missiles, and Trident rockets. A majority of existing bombs and warheads use uranium-235 as the fissile material, but the new weapons will be based mostly on plutonium because plutonium explosives can be made smaller in size. Insufficient plutonium will thus be available from obsolete weapons, and production will have to be stepped up, according to testimony delivered last March before the House Armed Services Committee by Charles F. Gilbert, acting deputy assistant secretary for nuclear materials in DOE. In addition, demand for tritium will rise, partly because large quantities will be required for neutron warheads, which are believed to rely on a deuterium-tritium fusion reaction triggered by a plutonium explosion.

Defense analysts have warned for some time that weapons-grade plutonium may be in short supply in the late 1980's, and in its final months the Carter Administration adopted plans to boost production. The three reactors currently in operation at DOE's Savannah River plant in South Carolina are being increased to full power and a fourth, which was shut down in 1968, will be restarted in 1984. Another reactor, the so-called N reactor at Richland, Washington, is being converted from the production of fuel for the breeder program to the manufacture of weapons-grade plutonium (*Science*, 19 January, p. 146).

These initiatives were reckoned to be sufficient to meet demand for the weapons program as it was then envisaged. But the Reagan Administration's plans for a more rapid military buildup may increase the requirements for weapons-grade plutonium. Hence the interest in wastes from the commercial nuclear power program.

Some 70 tons of plutonium are contained in spent fuel rods from power reactors. These are now being stored in pools at reactor sites around the country, awaiting either reprocessing or a more permanent means of disposal. Speaking at a meeting of the Energy Research Advisory Board on 3 September, Edwards said he would like to see the fuel reprocessed. "There are so many advantages to reprocessing," he argued. "One of the advantages, for example, is that we are going to be needing some more plutonium for our weapons program, and the best way I can see to get that plutonium is to solve your waste problem. Reprocess it, pull out the plutonium."

This was not the first public expression of interest in using commercial

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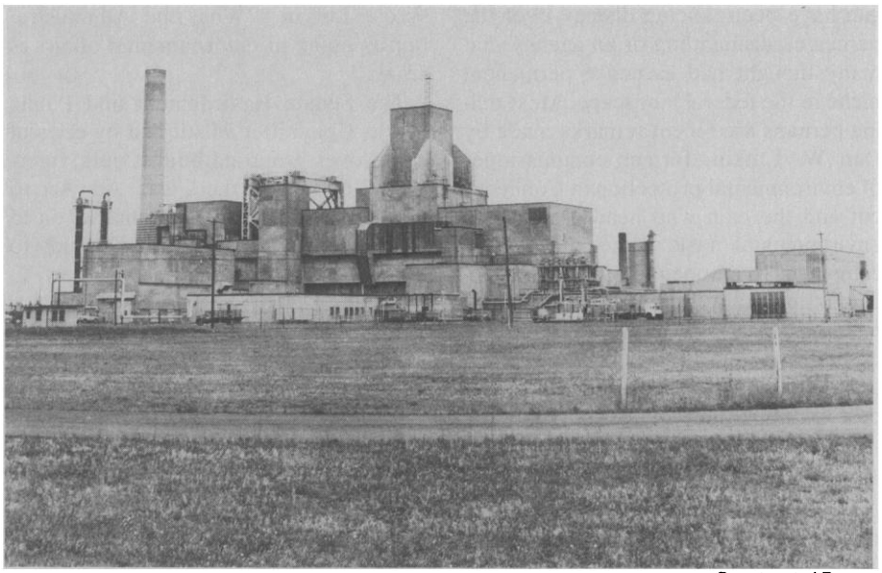

Department of Energy

Fueling a debate

The Department of Energy is looking for a source of weapons-grade plutonium to supplement production from defense reactors like this one at its Savannah River plant.

wastes for the military, but it indicated that the discussions have reached a high level in DOE. Another indication of the seriousness with which the idea is being pursued is the recent expansion of a program at the Lawrence Livermore Laboratory to develop the use of lasers to separate isotopes of plutonium.

Weapons-grade plutonium contains at least 93 percent of the plutonium-239 isotope, but plutonium derived from power reactor spent fuel contains about 20 percent plutonium-240, together with smaller quantities of plutonium-238, plutonium-241, and plutonium-242. Although a bomb can be fashioned from reactor-grade plutonium, the undesirable isotopes depress the yield and, because they are radioactive, they would make weapons hazardous to fabricate and store. Because the isotopes are extremely difficult to separate, spent fuel from the civilian power program has previously been deemed unsuitable for military purposes. (The undesirable plutonium isotopes are formed when the fuel rods are left for a long time in the reactor core. Military power reactors operate on relatively short fuel cycles.)

The advent of a process for separating plutonium isotopes would radically change the picture. The Livermore program is an offshoot of an effort to use lasers to separate uranium isotopes. In fiscal year (FY) 1980, work on plutonium separation received $6.6 million, but in FY 1981 it was boosted to $30.5 million, and in FY 1982 it is scheduled to receive another $25.8 million. The program is going so well that DOE now expects to have a full-scale plutonium separation plant in operation by FY 1989. In testimony before a House Interior subcommittee on 1 October, Gilbert revealed that the entire program, including construction costs, will soak up $560 million.

Although details of the Livermore process are classified, Gilbert says that it is very similar to the method being developed for separating uranium isotopes. In essence, it consists of subjecting a stream of atomic plutonium vapor to a series of very finely tuned laser beams. Energy from the lasers is absorbed only by atoms of selected isotopes, which eventually lose an electron. The resulting plutonium ions can then be separated from the uncharged atoms by electrostatic precipitation.

DOE spokesmen have claimed that the process is being developed primarily to reduce the plutonium-240 and plutonium-241 content of existing weapons stockpiles. This would reduce the radioactivity of plutonium warheads, which can be a cause for concern when weapons and people are crammed together on nuclear submarines. Another claimed justification is to produce plutonium-238, which is used as a power source on some spacecraft, such as those on the Jupiter and Saturn flybys. Finally, DOE officials say that the process could be used to convert some of the plutonium already produced by the N reactor at Richland to weapons-grade material.

But Thomas B. Cochran, a staff scientist at the Natural Resources Defense Council, who was the first to raise the alarm about the potential use of commercial fuels for weapons production, calls these justifications "totally ludicrous." He argues that DOE cannot justify spending $560 million for those purposes, and claims that "the real objective is to go after commercial spent fuel." Radioactivity hazards can be reduced more cheaply by better shielding, he says; plutonium-238 is not needed in sufficient quantities to justify the program; and by the time an isotope separation plant is in operation, there will be little unused N reactor plutonium left.

The isotope separation program will clearly give DOE some flexibility in its potential sources of weapons-grade plutonium. If demand for fissile material does increase beyond current production capacity, a new source would have to be found. One option would be to build more defense reactors, but these would cost up to $3 billion each, and they would not be in operation until the mid-1990's. Moreover, existing defense reactors were all built in the 1950's and will soon be approaching the end of their productive lives.

These considerations, coupled with the expansion of the laser separation program, have alarmed arms control advocates. "If we breach the distinction between military and civilian nuclear programs, it makes it much harder to preach that separation to others," says Joseph Nye, who coordinated nonproliferation policy in the Carter Administration.

Paul Leventhal, president of the Nuclear Club, a nonprofit group concerned with nuclear proliferation, said in testimony to a House Interior subcommittee on 1 October that "utilizing commercial plutonium for nuclear weapons would destroy the most basic principle of Atoms for Peace and invite other nations to do the same. The basic principle that civilian nuclear materials and facilities never be used for military purposes . . . is the very foundation of the Nuclear Non-Proliferation Treaty and the safeguards system of the International Atomic Energy Agency. If the United States abandons this principle, the entire international nonproliferation structure is vulnerable to collapse like a house of cards," he warned.

These concerns have not been lost on some members of Congress. Representative Edward Markey (D–Mass.) has already introduced a bill prohibiting the use of civilian nuclear spent fuel for weapons programs, and Senator Gary Hart (D–Colo.) may offer similar legislation in the Senate. "The Department of Energy has raised a trial balloon that many of us will try to shoot down," Markey warned.—COLIN NORMAN