

capable of attacking a range of Soviet military targets, such as airfields, submarine ports, utilities, troop formations, armaments plants, and some command links. The Trident II, which costs \$15 billion (or half as much as Carter's plan for deploying the MX missile), has the sole additional capability of attacking Soviet silos and superhard command posts. As Representative Thomas Downey (D-N.Y.) states, this accuracy, plus a relatively short flight time, will make the Trident II "the most destabilizing first-strike weapon ever built, far more than the MX." The Soviets would be



U.S. Navy

### The Trident submarine

*Its equipment for electronics countermeasures can be continually updated.*

less threatened and a superpower crisis would be less harrowing if the Trident II was scrapped.

William Perry says that the question about Trident II should be addressed as follows: "If you're going to be, in a sense, depending on subs for primary deterrence, what do you do that minimizes the attractiveness of the surprise attack? If I were the Soviet planner, I would be deterred from acting even by Trident I, although I don't know the calculus that goes on in that planner's head. I'm not persuaded by the argument that it is necessary to have a capability to kill hardened targets, although it is certainly true that you would be on the safer side to have it. Moreover, it is relatively easy to get." Excessive conservatism and technological wizardry are behind the decision for a Trident II, and the strategic implications are unsettling.

Once the technical objections to submarines—their inaccuracy and supposed vulnerability—are swept aside, there remains a less-stated but perhaps more significant objection. It is that moving from observable land-based missiles to invisible sea-based forces would diminish the political power of America's nuclear weapons. As Harold Brown recently wrote, "Abandonment of the land-based ICBM would signal a retreat in the face of a Soviet buildup of just those forces—a retirement from the competition, a major political-military defeat for the United States, and a very bad precedent,

(Continued on page 832)

## Livermore Wins Laser Battle

In a decision that could influence billions of dollars of investment, the Department of Energy (DOE) has narrowed the choice for the next generation of uranium enrichment technologies. On 30 April, DOE announced that it will build a demonstration enrichment plant based on a laser separation process developed at Lawrence Livermore Laboratory in California. It selected the Livermore process over competing technologies developed by Los Alamos National Laboratory and TRW Inc.

In selecting the Livermore technology, DOE put an end to a 5-year contest over which process is likely to supersede gaseous diffusion, which has been in use since the start of the nuclear age. (The only other process still under active consideration is the gas centrifuge.) But DOE's choice is already proving controversial.

The Livermore process, known as atomic vapor laser isotope separation (AVLIS), was chosen after a 7-month review by top officials at DOE. Last year, however, the Energy Research Advisory Board, DOE's highest level advisory committee, recommended that a decision be put off until 1983 because, it argued, the technical basis does not yet exist to make a choice between competing technologies. It reiterated that conclusion in a second report earlier this year. Richard Garwin, a senior scientist at IBM and a member of the advisory board, last week called the decision "premature." Donald Gaston, a DOE official in charge of the program, says, however, that DOE cannot afford to carry on supporting three competing programs and "elected to take the risk" by choosing now.

In essence, the Livermore process involves subjecting a stream of atomic uranium vapor to a series of very finely tuned laser beams. Energy is absorbed only by atoms of uranium-235, which eventually lose an electron. The resulting uranium-235 ions are then collected by passing the stream through a strong magnetic field, which deflects the ions while the neutral uranium-238 atoms pass straight through.

In contrast, the Los Alamos pro-

cess, which is now being phased out by DOE, would have subjected uranium hexafluoride molecules to finely tuned infrared and ultraviolet lasers. Ultimately, those molecules containing uranium-235 would be stripped of a fluorine atom. And the TRW process, which will still get a small amount of research money "subject to availability of funds," involves the use of radio-frequency energy to selectively excite uranium-235 ions.

The plan now is to build a \$150 million demonstration plant at Livermore by 1987. At that point, according to DOE officials, it should be possible to make a choice between the laser separation process and gas centrifuge technology. (A pilot centrifuge plant is now under construction in Portsmouth, Ohio.)

The Energy Research Advisory Board said in its report last year that it expects the laser process to be more economical than the centrifuge process. This expectation, says Garwin of IBM, should have led DOE to make a different choice. It should have dropped the gas centrifuge program and continued supporting the three competing laser technologies.

—Colin Norman

## Union Carbide Quits Oak Ridge After 40 Years

The Union Carbide Corporation revealed on 3 May that it intends to end its nearly 40-year-old association with the Oak Ridge National Laboratory in Oak Ridge, Tennessee. It has already asked the Department of Energy (DOE) to find another contractor to manage the facilities that spawned the first atomic bomb. The news came as "a great surprise to most of the people here," said DOE spokesman Jim Alexander.

The impact of the change is not yet clear, but as Alexander said, the contractor that replaces Union Carbide will certainly want to bring in new people to take over supervisory positions. Thus, the laboratory and associated weapons facilities at Paducah, Kentucky, are due for a shake-up.

Some have speculated that Union Carbide may have pulled out because some stockholders have objected to its involvement in the nuclear weap-