tive finding is not enough to contradict the satellite. Given the vastness of the area in which the blast may have occurred, and given the smallness of the event, it is conceivable that U.S. surveillance teams simply were not able to find the fallout. A senior administration official said that there have been nuclear blasts before this, confirmed by other means, which were never confirmed by radiation sensors.

The untypically small size of the flash has caused a lot of speculation. Some suggest that it may have been a test intentionally scaled down to conceal it from monitors like the Vela. And one low-ranking defense official speculated that it might have been the signature of a "fizzle" of a large-scale test that didn't work properly—the kind one might get, he said, if one used spent reactor fuel in the bomb.

U.S. officials have refused to say who might have conducted a test, but speculation has focused from the outset on South Africa. It is the only country within the sighted area thought to have the capability to produce a nuclear weapon, and it is one of the potential nuclear powers which has refused to sign a treaty pledging not to join the nuclear club. But in 1977 the South African government, in an exchange of letters with President Carter, did pledge privately not to develop nuclear weapons. The present foreign minister, R. F. (Pik) Botha, asked about the putative nuclear test, responded: "I have no knowledge of such an event." The South African government later suggested that the Soviets, Chinese, or Americans might have set off a bomb, and a Capetown press release pointed out that a Soviet submarine was traveling near the Cape of Good Hope in September.

The mystery, which may remain unsolved indefinitely, has produced one clear finding: there is a deficiency in U.S. monitoring of weapons testing. The Department of Defense insists that the gap is not one that affects strategic policy or the SALT treaty. As one official put it, it was a technical "triumph" to have acquired the scanty data we have in this case: "Finding something like this . . . in a remote part of the world is just completely different from the problem of monitoring SALT." The United States spends several billion dollars a year watching Soviet weapons development, the official said, and only a fiftieth or a hundredth as much watching for nuclear proliferation in other parts of the globe. He was proud of the fact that the Vela spotted this flash "off in a little corner" of the world. There is no question, however, that more money will be spent in the future to watch this little corner.

—ELIOT MARSHALL

House Gives a Nod to Solar Power Satellite

But opposition to pushing the R & D pace is growing; some worry about environmental hazards and a trillion-dollar pie in the sky

Congress is still disposed to think big about high technology, as witnessed by the hundreds of millions appropriated each year for nuclear fusion R & D. But now comes the Solar Power Satellite (SPS), a proposed energy technology that poses an extreme test of congressional willingness to support a venture involving potential costs and economic and environmental risks that could be enormous.

On 16 November, the House of Representatives passed by a vote of 201 to 146 a bill to authorize the spending of $25 million to push exploratory R & D on the SPS concept at a faster pace. But the opposition was much stronger than it was last year when the House approved a similar measure by a vote of 267 to 96. Moreover, prospects for Senate passage are doubtful.

The SPS is still more of a concept than a program, and cost estimates vary wildly. Deployment by the United States of 60 satellites each capable of producing 5000 megawatts—this is the "reference system" now used in SPS studies—could cost from $500 billion to $1 trillion, with the front-end R & D costs amounting to at least $40 billion and maybe twice that.

An SPS program would involve building a new rocket five times larger than the Saturn V used in project Apollo, a powerful space tug, and two new super-duper shuttle-type spacecraft capable of ferrying many engineers and technicians into low earth orbit and from there into geosychronous orbit 22,000 miles above the earth where the satellites would be assembled. To complete the vast and complicated task of assembling the entire SPS system (which would satisfy perhaps one-tenth of U.S. energy needs), some 500 rocket launchings would have to be carried out every year for 30 years.

Each satellite would be an immense structure, about the size of Manhattan Island, with a 55-square-mile surface covered with photovoltaic cells. It would convert solar energy first to electricity, then to microwave energy to be beamed to its own receiving antenna, or "rectenna," on earth. At the rectenna, which together with its buffer zone would require a 74-square-mile site, the microwave energy would be reconverted to electricity for movement to distant population centers over a web of transmission lines. The SPS is, as some observers have commented, the stuff of science fiction.

The SPS concept was first proposed in 1968 by Peter E. Glaser, vice president of engineering sciences at Arthur D. Little, Inc. In 1973, Glaser was awarded a patent for the concept, which became the subject of a feasibility study sponsored by the National Aeronautics and Space Administration (NASA) as early as 1974. By the middle of 1980, the Department of Energy (DOE) and NASA are to report the results of the latest 3-year SPS study.

This "concept development and evaluation" study, on which some $20 million will have been spent, has—according to a DOE policy statement—had the modest aim of achieving "an initial understanding of the technical feasibility, economic practicality, and social and environmental acceptability of the SPS concept." At most, the study is expected to find that no insurmountable obstacles have been identified and that further investigation is in order—or, conversely, that such obstacles do exist and that the SPS should be dropped as an energy option.

The principal sponsor of the bill just passed by the House is Representative Ronnie G. Flippo (D-Ala.), whose district includes the Marshall Space Flight

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Center at Huntsville. At his urging, the Committee on Science and Technology reported out the bill in May, saying that the "paper studies" being conducted by DOE and NASA should be augmented by a program of "technology verification" that would include some "limited space experiments."

Leading the opposition to the Flippo bill was Representative Howard Wolpe (D-Mich.), one of four science and technology committee members who filed dissenting or cautioning views about stepping up the pace of R & D on the SPS. In the House debate, Wolpe told his colleagues that his efforts in committee to eliminate from the measure any reference to "development" had been strongly and successfully resisted by the bill's sponsors.

"I submit that this bill is, in fact, the first step in an effort to commit us to the premature development of the entire solar power satellite concept," Wolpe said.

Wolpe argued that the proper course is to await the DOE-NASA report on the SPS concept next year before considering further action. His position is supported by some 40 solar advocacy and environmental groups who see the SPS as a monstrous perversion of their hopes for widespread small-scale solar applications that would be highly decentralized and socially and environmentally benign.

The Flippo bill is backed by the Sunsat Energy Council, a new Washington lobbying group that is headed by Peter Glaser and that includes on its board of directors people from aerospace companies such as Boeing, Lockheed, and Martin-Marietta. Sunsat is calling for "an expenditure of between $200 and $300 million over the next 5 years [to] cover the research necessary to determine the safety and feasibility of the SPS." According to Glaser, Sunsat members are not "so rash" as to wish to proceed with such development without knowing the potential effects of microwaves—or of lasers or any other alternative means of space-to-earth energy transmission—on communications and ecological systems.

In a letter to President Carter last July appealing to him to consider the SPS in national energy planning, Glaser said, however, that the "unknowns [in the case of the SPS] are fewer and less hazardous potentially than those . . . associated with our initial commitment to the Apollo program or those which still exist in connection with nuclear waste disposal or the carbon dioxide effects of burning fossil fuels." But the fact is, no one knows what the health and environmental effects of the SPS would be.

"We have nothing yet on the chronic health effects of low-dose, long-term nonionizing microwave radiation," Fred Koomanoff, director of the SPS project office at DOE, told *Science*. Experiments to determine these effects are still being designed. While investigations into the effect of microwaves on environmental and communication systems are further along, they remain inconclusive or incomplete. "We know that there will be a problem of interference with radio-astronomy," Koomanoff said, "but can mitigation measures be found?"

Large economic questions must be answered, too. For example, given major uncertainties as to future demand for electricity, there is the problem of matching the size of the SPS system to demand—and of providing backup power for a huge generating system that

Waiting for the Oil Bug

Alga ayatollahphobera is a remarkable organism. It secretes a fine emulsion of hydrocarbons that is convertible to high-octane gasoline at $2.50 a barrel. It grows in saltwater, a medium useless for food crops. It forms its hydrocarbons from carbon dioxide, thus helping to retard the worrisome buildup of the gas in the atmosphere. From nothing more than sea, sunlight, and waste gas, the industrious microorganism produces gasoline almost too cheap to meter.

The alga hasn't quite yet been invented, but with every new political crisis in the Middle East you can see it striving harder and harder to materialize. Oil, after all, came about through photosynthesis, plus a little geological history, and photosynthesis is the most logical way to make more. Congress ardently supports all forms of solar energy, biomass in particular, but its gaze is often focused on the near-term future. Ideas for fuel-producing crops are "exotic 21st century concepts," and the Department of Energy is spending far too much on them, Representative Floyd Fithian of Indiana complained to a House subcommittee on 15 November.

But fuel crops may not be as exotic as Fithian believes. There already exist a tree that produces virtually pure diesel fuel and an alga that generates hydrogen gas. These or other plants may one day lead to an economic fuel crop.

Photosynthesis student Melvin Calvin has been a leading proponent of fuel trees ever since he was caught in a gas line during the oil crisis of 1973. The diesel-producing tree, a native of the Brazilian forest, grows only in tropical climates (*Science* 26 October). Calvin's leading candidate for a fuel crop species is the gopher plant, which makes an emulsion of hydrocarbons that is convertible to a high-grade petroleum fraction at an estimated cost of $40 a barrel.

Miami BG7 represents another possible approach to a fuel crop. It is a blue-green alga that produces hydrogen from sunlight and seawater. Hydrogen has many advantages as a fuel, including the unique cleanliness of a substance that on oxidation forms only water. The alga was discovered, after a deliberate 4-year search, by Akira Matsui of the University of Miami. Other microorganisms that synthesize hydrogen tend to reabsorb the gas, but Miami BG7 is a stable producer. Matsui is now constructing an apparatus for hydrogen production with support from the National Science Foundation. He hopes to attain a solar energy efficiency conversion of 2 percent, which compares favorably with that of many crops.

The new techniques of genetic engineering hold unlimited promise. Might it be possible to design a microorganism in which the energy derived from photosynthesis is used to produce hydrocarbons directly? "Futuristically, it certainly is a very desirable thing to do. I would not say it will never be possible. At this time our lack of knowledge about the genetics of photosynthesis is the major hurdle," notes Ananda Chakrabarty, the University of Illinois microbiologist whose application for a patent on a genetically engineered microorganism is now a test case before the U.S. Supreme Court.

Miami BG7 and the gopher plant are both species that would not compete with food crops for resources. The gopher plant grows on arid land, the alga on seawater. That the economics of fuel crops seem at present unfavorable should be no surprise; it has taken thousands of years of cultivation for almost all present crops to attain efficiency. Conventional plant breeding is one potent tool for improving yields; genetic engineering may provide others. Fuel-producing plant crops may be an exotic concept and yet may lie not so far off as the 21st century.—NICHOLAS WADE

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might be highly vulnerable to breakdown or sabotage.

Senator Henry M. Jackson (D-Wash.), chairman of the Committee on Energy and Natural Resources, plans to hold hearings on the House-passed bill next session. Last year, the committee had the earlier House bill on its agenda but ran out of time and never acted on it. But, according to a Republican staffer on the committee, there was probably enough opposition from a mix of environmentally oriented and fiscally conscious senators to have killed the bill had it ever been brought to a vote. The makeup of the committee has since changed somewhat, but there again seems a strong likelihood that the majority will want to go slow on the SPS, given the environmental unknowns and trillion-dollar scale.—LUTHER J. CARTER

Large Drug Firms Fight Generic Substitution

But small firms point to misleading ads for brand name drugs as evidence that the fight is not fair

Three years ago, the patent expired on Librium, the popular antidepressant made by Hoffmann-La Roche. Immediately, several small firms began marketing their own brands of chlordiazepoxide, which is the generic name for Librium. But even though its generic competitors cost no more than half as much, Librium still dominates the market. It was ranked 23rd on a 1978 list of the 200 most prescribed drugs, whereas the generics did not even make the list. And even though pharmacists in many states can substitute generic drugs when brand names are prescribed, results of a recent survey indicate that most prescriptions are dispensed as written.

What happened with Librium is the norm, says George Schwartz of the National Association of Pharmaceutical Manufacturers, an organization of small firms that make generic drugs. Schwartz claims, and a number of officials at the Food and Drug Administration (FDA) agree, that the large drug companies are successfully using scare tactics to keep doctors prescribing, pharmacists dispensing, and patients requesting the more expensive brand name drugs when there are cheaper generic versions available.

The large companies disagree. They say they have good reasons to disparage small manufacturers and that they are merely pointing out their own good records and reliability when they advertise. More important, however, they question the wisdom of generic substitution, saying that widespread substitution could so lower the profits of the large companies that it could play havoc with their research and development of new drugs.

In recent years, state legislatures and the federal government have actively promoted generic substitution as part of a drive to lower the costs of health care. Thirty-seven states and the District of Columbia have passed laws allowing pharmacists to dispense lower-priced generic drugs when brand name drugs are prescribed, except when doctors instruct them not to substitute.

The states were encouraged to pass these laws by the Federal Trade Commission (FTC), which drew up a model substitution law. The FTC even went so far as to do research on whether doctors are more likely to prohibit substitution if they have to check a box saying "do not substitute" or if they have to explicitly write "do not substitute" on their prescriptions. Since the FTC found that doctors are more likely to prohibit substitution if they merely have to check a box, the agency recommended that states require doctors to write "do not substitute" if they want their prescriptions dispensed as written. To further encourage substitution, the FDA drew up a list of drugs that, in the agency's opinion, are equivalent.

The Department of Health and Human Resources has also gotten into the business of promoting substitution. Under the Medicare and Medicaid programs, pharmacists are reimbursed only for the lowest-priced drug that is widely available and, in the government's opinion, equivalent to the brand name drug.

As a result of these laws and federal programs, pharmacists have suddenly become key people in determining whether generics will be substituted. So drug companies have begun turning their attention to pharmacists and apparently have convinced many of them that generic substitution is too risky to be worthwhile unless the generics are made by the large drug companies. Quite a few generics are made by the large companies, but these so-called branded generics are more expensive than those made by the small firms.

A major theme in this advertising to pharmacists is "product liability." Countless ads have as their theme the assertion that pharmacists could be sued if they dispensed a faulty product. The large companies point out in these ads that they have product liability insurance to cover pharmacists' legal costs in case of suits.

One company, Pfizer, even made a film for pharmacists to hammer home the message that serious legal problems could result from generic substitution. The Pfizer film was made at a convention of pharmacists during a session when several legal experts spoke on product liability. The film starts out on a light note but quickly becomes ominous in tone. Periodically, the camera pans the stony-faced audience of pharmacists, one of whom actually has tears in his eyes. The pharmacists are told they may be sued for substituting products that, unbeknownst to them, may not be therapeutically equivalent to the drugs the doctors prescribed. And even if the pharmacists win the suits, they are told, the time they would have to spend with lawyers and in court could be ruinous.

Peter Rheinstein, a lawyer and director of the Division of Drug Advertising at the FDA, finds this film a bit overblown. To his knowledge, there has never been a lawsuit involving drug substitution. Bruce Brennan, lawyer for the Pharmaceutical Manufacturers Association (PMA), an organization of the large drug firms, agrees that there have been few or no lawsuits but believes that this is because the substitution laws are too new. Thus it may be too soon for these legal consequences to be manifest. "Sometime soon there will be a body of case law on this," Brennan says. "It is legiti-

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