late 1989, as well as 12 from Florida. Another 24 largely civilian flights are scheduled to ferry DOD payloads to low earth orbit, and more than 30 DOD scientific experiments have also been designed to fly aboard the shuttle. These range from measurements of auroral effects, dust, and radiation during the first Vandenberg flight to a major "Star Wars" pointing and tracking experiment presently scheduled for next year. New early warning satellites, defense communications satellites, and navigation satellites have all been designed to fly on the shuttle, although some will undoubtedly be transferred to Weinberger's large, new, expendable rockets when they become available. (Thus far, the Air Force has contracted for only ten at the rate of two per year, but will probably buy more in the wake of the accident.)

The rationale behind the new expendable rockets was explained by Air Force Undersecretary Edward Aldridge in an interview with *Science* in early January. "We felt, and still do, that the shuttle should have a complement. This country could not be dependent upon having only four vehicles for an entire space program. . . . In case we have some difficulties with the shuttle, we'll have some other way to get to space for some of the more critical of the national security payloads, the ones that require launch on demand." These payloads include communications and early warning satellites, "and a lot of classified systems that I can't go into," Aldridge said.

"Suppose the shuttle went down for a year and then all of a sudden you had a failure you didn't expect with a national security payload," Aldridge added. "You'd be bumping everybody off of the shuttles." In retrospect, the assignment of classified payloads to the shuttle in the first place may have been a mistake, he said. "These kinds of missions are better performed where man is not required . . . so that you don't have to worry about bumping people and throwing all kinds of havoc into an already unbelievable schedule."

Ironically, the Pentagon's commitment to the shuttle may increase after 1990, with the completion of a new flight control room behind barbed wire fences at a military base east of Colorado Springs, virtually identical to that used by NASA at the Johnson Space Center in Houston. The purpose of this facility, according to Colonel Robert Dickman, vice commander of the the Air Force's 2nd Space Wing, is to facilitate more routine operations with classified shuttle payloads, including potential shuttle repair missions. In the interview, Aldridge also noted that according to an Air Force edict, all new military satellite systems must be designed with shuttle repair and refurbishment capabilities in mind.

The biggest uncertainty in the military's use of the shuttle may be the "Star Wars" missile shield program. Its director, Lieutenant General James Abrahamson, told the House Appropriations Committee last May that "It is likely . . . that any future SDI deployment would require a space lift system significantly more capable and cost-effective" than either the shuttle or the new DOD expendable rocket. But many are skeptical that the funds to create such a vehicle will be available, particularly in the Gramm-Rudman fiscal environment. The likelihood that the military will remain the shuttle's largest customer is probably high. ■ **R. JEFFREY SMITH**

Local Opposition Halts Biotechnology Test

After 2 years of winding its way through a regulatory maze, a plan to release genetically modified bacteria into the environment is again on hold

Salinas, California. In December, champagne bottles popped at the laboratories of Advanced Genetic Sciences (AGS), a small biotechnology company in Oakland, California. Company scientists were celebrating the fact that, after 2 years of scrutiny, federal and state authorities finally had given them the green light to conduct the first biotechnology experiment of its kind. In the experiment, microbes, which have been genetically altered to prevent frost damage to crops, would be tested outdoors.

"We felt we had jumped through the final [regulatory] hoop," company scientist Trevor Suslow recalls. But now, to its surprise and frustration, the company has suddenly run up against strong opposition to the test from many residents of Monterey county where the test is planned. The experiment is once again on hold.

On 27 January, the Monterey county board of supervisors held a public hearing here and heard a capacity crowd of constituents express fear and suspicions about the test. Representative Leon Panetta (D–CA), whose district includes Salinas Valley, testified that he was concerned. By the end of the day, the board indicated it would use its zoning authority to place a moratorium on the experiment and hinted strongly that the experiment will have to be relocated. AGS officials voluntarily agreed to postpone the test for at least another 30 days and to consider conducting the test at another site.

AGS officials blame themselves for what they describe as a complete failure to inform local citizens about the nature of the test. Scientists and regulators generally agree that this particular experiment poses little, if any, hazard to public health or the environment. But because it would constitute the first deliberate release of genetically engineered organisms into the environment, the test was subjected to lengthy review by government agencies. The experiment gained notoriety because Jeremy Rifkin, an activist and author, asserts that the bacteria to be tested are potentially dangerous to human health and could conceivably alter rainfall patterns. Though his contentions related to this test have been dismissed by most experts (*Science*, 29 November 1985, p. 1015), Salinas citizens reiterated them at the hearing.

"We've been pretty damn naïve about how these issues can be misinterpreted," says Douglas Sarojak, AGS director of marketing. To AGS, the controversy illustrates how the public can become understandably, but unduly fearful when a new technology is not explained and when people feel they have been excluded from making regulatory decisions. The company's problems at the local level, in turn, have made other biotechnology companies nervous about what kind of reception they can expect in the future and highlights a need to explain biotechnology.

The experiment that AGS wants to conduct outdoors is based on extensive testing in the greenhouse. The bacteria, *Pseudomo-*

nas syringae and *P. fluorescens*, are ubiquitous in nature and secrete a protein that acts as nuclei in the formation of frost crystals. By deleting a portion of their genes that code for the protein, the bacteria cannot promote frost formation. AGS now wants to perform an ecological study of the modified bacteria in the field. The altered microbes would be sprayed on 2400 blossoming strawberry plants on a one-fifth acre plot located in north Salinas Valley. Scientists will then monitor the competition between the altered bacteria and the naturally occurring bacteria. Plant blossoms will be collected and studied in the laboratory.

According to Sarojak, the company focused virtually all its efforts on the science in order to satisfy requirements posed by federal and state regulators, while doing little to explain the test to county residents. The experiment has been described in the national press, but little information apparently filtered down to the Salinas area. After the state approved the experiment, the situation "blew up," Sarojak says.

Local sensitivity to the experiment is acute because Salinas Valley is one of the most productive vegetable-growing areas in the country. It is called the artichoke capital, and also grows cauliflower, strawberries, lettuce, celery, and broccoli. Salinas itself, with a population of 30,000, is located 25 miles east of upscale Monterey Peninsula. It is an agricultural town where the rodeo fairgrounds are located next door to the Salinas Community Center, the site of the hearing.

Local residents say that they first learned about the experiment through the media in early December. A small number quickly signed a petition to protest the planned experiment and sent it to the board of supervisors, whose members until then were also unaware of the test. "Local government was ignored," said Walter Wong, county health commissioner. The impression was that something was going on behind their backs, especially when the company refused to disclose the exact location of the test. AGS argues that the location must be kept secret to restrict access to the plot.

From that point, the more residents learned about the test, the more their fears were fueled. Accusations by residents boiled over at the hearing. The board, whose members include two lawyers, two educators, an accountant, and a businessman, but no scientists, chastised officials from the Environmental Protection Agency, the state, and the company for failing to give them notice about the experiment and peppered them with questions. Most citizens spoke against the experiment. If the experiment was not dangerous, then the company would have told them earlier about it, people said. Others, like the local League of Women Voters supported a delay, but no one spoke in favor of the experiment. Growers in the area have been neutral on the subject.

The debate quickly became a battle of the experts. Also appearing before the panel to explain the test were microbial ecologist Robert Colwell, who reviewed the experiment for EPA, and plant pathologist Steven Lindow, who wants to conduct a similar experiment. Both researchers are from the University of California at Berkeley. On the opposing side were attorney Edward Lee Rogers, representing Rifkin, who was asked by local residents to testify but could not attend, and Leibe Cavalieri, a molecular biologist at Sloan-Kettering Institute for Cancer Research, who accompanied Rogers.

Douglas Sarojak of AGS

"We've been pretty damn naïve about how these issues can be misinterpreted."

Although regulators and scientists all said that the potential hazards posed by the experiment were extremely small, the board and residents gave more weight to Rogers's and Cavalieri's assertions that the experiment was too risky because not enough information is known. "I would not want the experiment done in my backyard," Cavalieri said. "The outcome of introducing this bacteria is not predictable." Judy Pennycook, one of the most vocal opponents of the test, charged that the test was the "first step to becoming an international environmental problem."

The board was hardly reassured that the bacteria are harmless when it learned that the applicators, who would spray the bacteria on the plants during the test, would have to wear protective gear and that the test plot would be incinerated afterwards. Betz explained that EPA believes it is prudent to err on the side of caution, but the message that came across to the residents and one board member was that the experiment was dangerous. "We are playing Russian roulette," said supervisor Dustin Petrovic, whose remark prompted a round of applause.

The board also focused on results of one animal toxicity test. In the experiment, rabbits' eyes became irritated when exposed to extremely high concentrations of the bacteria, on the order of 1 billion organisms. The animals' eyes then returned to normal after a couple of days. State scientists said that the reaction was not unusual and that it simply suggested that applicators should wear goggles. But to the board, the findings were troubling.

Federal and state representatives were put on the spot when asked if they actually had visited the test plot before approving the experiment. To the disbelief of the board and residents, they said they had not. It turns out that the plot is located in a more populated area than AGS led officials to believe, said state official Tobi Jones. She and Betz said later that the risk of experiment was considered so minimal that on-site inspection was not considered imperative. In deference to public perception, Betz said that the plot should probably be relocated now.

Sarojak from AGS set the tone for the company's position at the start of the day, saying, "We apologize for not being here earlier." In an interview, he said, "What we saw at the hearing was wrath because they were not part of the process. We didn't anticipate this." He said the company's goal at the hearing was to open up communication with the county, but already the controversy "has done considerable damage to the company's image." Sarojak said the company is now scouting for help in public relations. "We're going to have to ensure that we maintain a more meaningful relationship with the county," he said.

Other researchers are watching the controversy closely. Lindow of UC-Berkeley is planning a similar set of tests in northern California, where he has already held several lectures for local growers to tell them about the purpose of the research. At Calgene in Davis, California, researchers are planning to test genetically engineered plants on local farmland. According to Calgene scientist Robert Goodman, the company has talked with the mayor, other local officials, and growers about their project. And Monsanto Company is conducting a major public relations campaign to explain biotechnology. "An educated public makes better decisions," says Monsanto's director of regulatory affairs Leonard Guarraia. ■

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