Briefing:

Sensitive Nuclear Technology Escapes Detailed Export Review

Sensitive nuclear technology, some of which could be useful for manufacturing nuclear weapons, has been transferred to at least one foreign nation without adequate screening by the Department of Energy, according to a study by the General Accounting Office. In a 78-page report released on 15 May, GAO blames the department for failing to establish standards for uniform evaluation of requests to export nuclear technology.

Testifying before a House subcommittee on energy conservation and power, Patricia Abel, a nuclear engineer at GAO, noted that DOE is in an awkward position because it has a dual role of promoting nuclear technology and policing its international transfer. It is responsible for approving or denying export of information and technology related to uranium enrichment, reprocessing, heavy water production, and plutonium fuel fabrication.

Applications to export nuclear technology frequently escape detailed interagency review because DOE places them in a so-called "general authorization" category, GAO says. The result, according to the report, is that American companies are able to "develop and provide to foreign countries proprietary documents that not only include previously published information, but also incorporate the experience and special knowledge of the firm." When the information is enhanced in this way, GAO observes, it may then become "sensitive nuclear technology," a designation requiring specific export authorization.

In preparing its report, GAO focused on seven incidents that occurred between 1980 and 1985. The areas of prime concern were nuclear fuel reprocessing studies and reviews conducted for Japan by Bechtel Group, Inc., and for South Korea by Battelle's Columbus laboratory. In the case of South Korea, a report contained new analyses of nuclear fuel reprocessing together with data citing how coprocessing affects production of plutonium, which can be used for nuclear weapons.

Under the general authorization provisions, companies are explicitly prohibited from supplying documents to foreign countries that contain analyses or conclusions. According to GAO, the Subgroup for Nuclear Export Coordination, an interagency task force, concurs with GAO's finding that "significant assistance to foreign nuclear programs" appears to have been provided.

The report, prepared at the request of Representative Edward J. Markey (D–MA), who chairs the House energy conservation subcommittee, recommends that Secretary of Energy John Herrington overhaul general authorization regulations to include only literature that has been previously published and is readily available. GAO also suggests that any new documents, even if compiled from public data, be subject to review by DOE. Edward V. Badolato, deputy assistant secretary for security affairs at DOE, says the department will soon be adopting tighter procedures for screening exports of nuclear data and technology. ■

MARK CRAWFORD

A Math Image Problem

Mathematicians have an image problem. Most people, the mathematicians lament, think their field is abstruse and fail to appreciate how even the most abstract mathematics can be crucial to important problems in other disciplines. It was to help remedy this situation that the National Academy of Sciences' Board on the Mathematical Sciences held a symposium on 12 May, called "Mathematics: The Unifying Thread." Their goal

Steven Weinberg. *Some mathematicians write in "a lapidary style."*

was to inform journalists and policy-makers of "the essential element linking . . . diverse scientific endeavors—mathematics."

But the attendance at the meeting amply demonstrated the image problem. Out of 40 Washington area journalists invited, only five showed up. Three of the five were from the AAAS, one was from a math society, and one was from the Voice of America.

The lecturers at the symposium, all Nobel laureates, were Allan Cormack of Tufts, who spoke on CAT scans, Herbert Hauptman, president and director of the Medical Foundation of Buffalo, who spoke on x-ray crystallography, and Steven Weinberg of the University of Texas at Austin, who spoke on elementary particle physics.

Weinberg, in particular, stressed what he termed the "spooky" connection between math and physics. String theory, for example, the hot topic in elementary particle physics today, makes use of highly abstract math as its very language to describe the strings and speak of their interactions. Yet this math, the topology of fiber bundles, was developed by mathematicians who had no thought of physical problems in mind. Weinberg takes delight in using pure math in his work and told his appreciative audience that he particularly enjoyed referencing a paper by the English mathematician G. H. Hardy, who studied number theory and wrote a book, *A Mathematician's Apology*, in which he bragged that his work is of absolutely no practical use to anyone.

Yet during a panel discussion following the talks and at the dinner that concluded the meeting, at least some explanations of the mathematicians' image problem emerged. Weinberg pointed out that mathematicians sometimes seem to be purposely inaccessible. "When physicists write an article, they generally start with a paragraph saying, 'Up until now, this has been thought to be the case. But now so-and-so has pointed out this problem. In this article, we are going to try to suggest a resolution to this difficulty.' " But in mathematics, says Weinberg, "I have seen not just articles but *books* in which the first sentence in the preface was, 'Let A be a nilpotent subgroup.' Those books are written in what I would call a lapidary style. The idea is that there should be no word that is not absolutely necessary inserted merely to help the reader understand what is going on."

Mathematicians also seem to fail to understand what the press considers news. They believed that having three Nobel laureates speak at their symposium should, by itself, draw the press. "Don't you think it is news when three Nobel laureates get together to talk about how mathematics is important to their work?" one mathematician asked *Science*.

And, finally, mathematicians are inexperienced in translating their work for the general public and for policy-makers. At the symposium, they distributed copies of a pamphlet called "Mathematical Sciences: A

Unifying and Dynamic Resource," that was meant to explain, in lay language, some of the recent exciting advances in several fields of mathematics. But it is written in what is a sort of layperson's lapidary style.

For example, the opening section, entitled "D-Modules," begins by defining the three broad general areas of mathematics and then starts discussing D-modules themselves in paragraph two: "Algebraic geometry has been one of the most lively areas of research in algebra during recent decades. It is the study of geometric objects that are the loci of points satisfying polynomial equations in two or more variables, such as the familiar cones from classical geometry." From there, the author quickly moves to define Lie groups. "A continuous symmetry group such as the latter example is called a Lie group. Lie groups can also be viewed as certain groups of matrices with their usual matrix multiplication."

This pamphlet, the mathematicians hope, will open the eyes of policy-makers to exciting and important advances in mathematics. ■ GINA KOLATA

EPA Approves Second Genetic Test

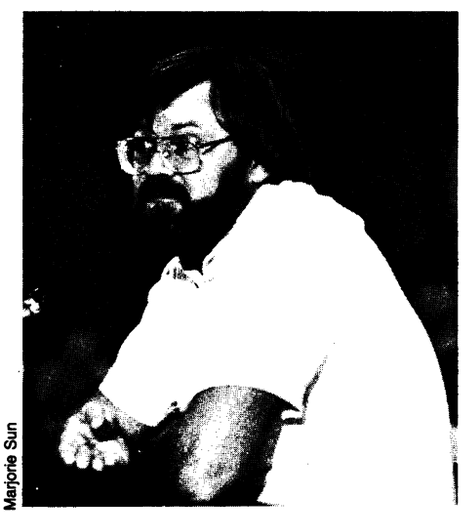
The Environmental Protection Agency recently approved a second experiment that will involve a field test of genetically engineered microbes designed to prevent frost formation on plants. However, local opposition to the test is brewing.

On 13 May, EPA granted permits to University of California researchers Steven Lindow and Nickolas Panopoulos to test altered strains of *Pseudomonas syringae* on potatoes at two sites at the school's research farm in Tulelake, Calilfornia, near the Oregon border. The bacteria normally secrete a protein that initiates the formation of ice crystals, but, in the modified strain, scientists have deleted the gene that codes for the protein. The permit allows the researchers to begin testing immediately and to conduct experiments over a 3-year period.

The test has some community support, but might eventually be blocked. The same day EPA gave the go-ahead to Lindow, the Siskiyou County board of supervisors voted not to delay the experiment, said board chairman George Thackeray in a telephone interview. But the two test sites are located in different counties and the other county board has not yet acted. It is expected to take up the matter shortly. In the meantime, a petition calling for a delay of the test has 460 signatures, said Eva Edgar, a local organizer.

Local opposition is a factor that has delayed a similar experiment downstate in Monterey county. Last November, EPA gave permission to Advanced Genetic Sciences to test altered *Pseudomonas* on strawberry plants outdoors. The county board voted to delay the test. Then EPA suspended the company's permits before the test began. The agency discovered that, prior to approval, the company had injected the modified *Pseudomonas* into test trees that were located outdoors on the company's rooftop in Oakland, California, in violation of EPA rules.

In approving the university scientists' experiment, EPA inspected the lab notebooks of Lindow and co-workers and inspected the test sites at Tulelake, two things that the agency did not do in its review of Advanced Genetic Sciences' proposal.



Marjorie Sun

Steven Lindow: *waiting for 2 years to conduct a field test of genetically altered microbes.*

Lindow has been waiting for federal approval for nearly 2 years. Environmental activist Jeremy Rifkin blocked approval in 1984 by suing the National Institutes of Health, which initially reviewed the test proposal. Earlier this month, however, NIH and Rifkin settled the matter out of court, agreeing that EPA is the proper authorizing agency, and the federal court dismissed the case.

In a separate, but related matter, EPA said on 13 May that it will defer a decision regarding a plan by Monsanto Company to conduct a field test of other altered *Pseudomonas* strains. EPA wants more data on the test organisms. Monsanto changed common soil bacteria to secrete a toxin that is lethal to cutworm, which attacks the roots of corn plants. ■ MARJORIE SUN

DOD Declines to Consider Impact of Nuclear Winter

In a move that aroused some anger on Capitol Hill, the Department of Defense recently declined for the second year in a row to address the policy implications of a potential climatic phenomenon known as "nuclear winter." Its latest report on the subject, released on 13 May, states that "the uncertainties are still much too great even to begin" to assess the potential strategic consequences of extreme darkness and cold brought about by fires in a major nuclear war.

Late last year, Congress ordered the Pentagon to produce a report on these topics by 1 March, largely out of concern that they were inadequately addressed in the Pentagon's first "nuclear winter" report (*Science*, 15 March 1985, p. 1320). Discovery of the climatic phenomenon a few years ago led to speculation that it would render civil defense useless; that it might incapacitate key items of military equipment, such as satellites and airborne command posts; and that it might turn a "first strike" into a suicidal act, through the worldwide distribution of dust, soot, toxic gases, and fallout.

The gist of the Pentagon's 5-page response, which missed a congressional deadline by a month and a half, is that none of these matters can be considered until the scientific basis for a "nuclear winter" is firmly established. A cover letter by deputy secretary of defense William Taft, IV, predicts that this will take "years of research," and says that in any event, "the case at issue, i.e. whether possible climatic effects make a difference, depends critically" on what the Soviets think. "Because we will probably never be confident of knowing the Soviets' real views," he adds, "we must continue to provide against the possibility that predicted climatic effects would have little impact on [their] behavior in an extreme crisis situation." In short, he believes that the Pentagon must continue along its present course.

Taft's letter takes brief notice of the two major scientific studies of "nuclear winter" that appeared in the past year. One, performed by the Royal Society of Canada, determined that the threat of nuclear winter is credible and recommended prompt study of the potential consequences for military policy. Another, performed by a committee of the International Council of Scientific Unions, pointed out that climatic perturbations could be significant far from the nuclear detonations. But Taft adds that "more recent results" which have "not yet been fully subjected to peer review" indicate that