tion. At the outset, however, a special office would have to track down the origins of all materials and components in existing weapons. It is crucial that the sources be traced "all the way back, so, for example, an American distributorship is not listed if the source is actually a foreign supplier"—a common error in present records. Having traced parts to the first origins, the new data-keepers would attempt to identify a domestic source, if any. If there were none, the item would be carried on a "critical parts list." After the initial chore of building a file, the parts office would watch for patterns of growing dependence, taking action only if an item turned up in many systems or in increasing volume.

The report is less exact in proposing remedies. Gansler said the vagueness is deliberate, for he thinks it would be a terrible mistake to impose blanket restrictions on imports. As much as the U.S. semiconductor companies might like it, it would be expensive and unnecessary, Gansler says. To succeed, new restrictions will have to be selective, and the terms of selection cannot be set in the abstract.

However, the BAST report suggests some remedies, such as stockpiling critical parts, creating standby U.S. production capacity, lining up substitute sources, and redesigning weapons to exclude foreign parts. These precautions should be taken only if analysis shows that their cost is outweighed by the need for security. BAST estimates that these measures could add 1% to the price of a weapon.

Over the long term, it may be necessary in some cases to "stimulate a totally new technology to ensure that the United States is in the forefront of a field." Candidates for this treatment are gallium arsenide semiconductors, advanced display screens, and lithium batteries. In such critical fields, according to BAST, the Defense Department may have to consider making "significant investments" in capital equipment or advanced production processes, even to the point of creating an entire "subsector of an industry."

This could grow into a major program to subsidize electronics manufacturing. It would certainly cost "tens of millions of dollars," the report estimates.

Some members of Congress may shrink from spending so much for insurance against unlikely supply shortages. But in BAST's view, the price for boosting key domestic manufacturing processes looks "extremely small" when taken in the context of the entire budget at the Pentagon, "where acquiring a new weapon typically costs more than $100 billion annually." By this measure, almost any price is insignificant. ■

ELIOT MARSHALL

Gene Splicing Dominates Review of Weapons Pact

Fears of the military applications of biotechnology have prompted signatories of the Biological Weapons Convention to strengthen its verification procedures

Geneva

INTERNATIONAL agreement was reached in Geneva late last month on a series of steps aimed at reducing the possibility that genetic engineering techniques will be used to develop a new generation of biological weapons.

These steps, which have been approved both by the United States and the Soviet Union, will include an exchange of information about all high-containment facilities where genetic engineering research is being carried out, and a requirement that details of unusual outbreaks of toxin-related diseases be reported to international authorities. There will also be greater encouragement given to scientists to publish the results of research into protection against such diseases, and to arrange exchange visits between their laboratories.

Pugwash has argued that fears that biotechnology will be used for weapons purposes are "largely misplaced."

The list of procedures was agreed to at the end of a 3-week conference held in Geneva to review the operation of the 1972 treaty banning the development, production, and stockpiling of bacteriological and toxin weapons—usually referred to as the Biological Weapons Convention.

A special meeting of scientists and technical experts will be held in Geneva next spring to decide on the precise form in which information and data on current research programs related to the convention will be exchanged. The information will eventually be reported to the United Nations Department of Disarmament Affairs in New York.

U.S. officials doubt whether the new provisions will, in themselves, be sufficient to prevent signatory states from carrying out clandestine research programs into new biological weapons if they wish to do so. They remain convinced, for example, that the Soviet Union has a number of institutions carrying out such research, a charge the Soviet officials have consistently denied.

This is primarily because of the difficulties of verification. "The convention, in our judgment, cannot be made effective through amendment or design," H. Allen Holmes, assistant secretary of state responsible for the Bureau of Political-Military Affairs, recently told a congressional committee.

The United States also shares with most other Western nations the feeling that opening the convention up to new amendments risks weakening the effectiveness of what has already been agreed, and could interfere with separate negotiations on achieving a chemical weapons treaty.

The hope, however, is that the new procedures will reinforce what Holmes described as the "international norm" against biological weapons represented by the treaty, and that the new investigatory procedures will make it easier to establish a consensus behind claims that the treaty is being violated. The United States has so far been unable to establish any consensus over allegations that mycotoxins have been used in Southeast Asia.

The Biological Weapons Convention came into force in 1975 and has attracted 103 signatories. It is widely quoted as "the world's first disarmament treaty," since it is the only one that outlaws the production and use of an entire class of weapons of mass destruction.

One of the factors that made it easier to reach agreement on banning biological weapons (in contrast to their chemical counterparts) is that their effects are more difficult to control on the battlefield, making them less attractive as military devices. And the consequent lack of military interest was, in turn, the principal reason why it was not felt necessary at the time to include detailed verification procedures.

Over the past decade, however, advances in genetic engineering have led to a general revision of this perspective. Theoretically at

least, it is now possible to produce "designer biological weapons" tailored to meet precise military specifications. For example, these could be highly virulent, antibiotic-resistant bacteria, against which an aggressor's forces are protected by specific vaccines, or even bacteria that are selectively effective against certain ethnic groups.

How plausible these scenarios are in practice—and how far they should be allowed to influence the debate not only on biological weapons, but on the social control of biotechnology more generally—is in dispute. A statement issued earlier this year by the executive committee of the Pugwash Conference on Science and World Affairs says fears that biotechnological techniques will be misused for weapons purposes are "largely misplaced." Their potential for misuse, it said, is no greater than that of "standard microbiological techniques which have existed since the inception of the 1972 convention."

Pugwash Secretary-General Martin Kaplan suggests there is danger in even encouraging public discussion of the potential weapon applications of biotechnology, since this could legitimize requests for increased funding by military research workers in both the East and the West. It might also help stifle other civilian fields of biotechnology research, he says.

At the other end of the spectrum, social activist Jeremy Rifkin of the Foundation for Economic Trends in Washington, D.C., has been claiming that the potential military uses of genetic engineering are one of the most hazardous—and thus the most socially significant—applications of recent research in biology.

Most of the governments represented at the Geneva review conference fell between the two camps. No delegates were prepared to go as far as some political groups in Europe, such as the West German Greens, who are demanding a moratorium on all militarily sponsored research using genetic engineering techniques.

Yet virtually all agreed that technical developments since the convention was signed in 1972—and the growing list of applications since the last review conference in 1980—have produced a situation in which scientific advances risk outpacing the provisions of the convention, simultaneously reinforcing its need and increasing the difficulty of ensuring that it is being complied with.

"Advances in the biological sciences since the convention entered into force may have made biological weapons a more attractive option to military planners than hitherto," the head of the Australian delegation, Richard Butler, told the review conference. He added that "verification provisions of the convention have increasingly been recognized as inadequate by today's standards."

Even the traditionally cautious British government, in a background paper on advances relevant to the implementation of the convention, administered some mild self-criticism over skepticism it had expressed in 1980 about the military applications of biotechnology. "In the event, the rapid pace of development across a range of peaceful activities indicates that there is greater potential than was perhaps evident at the time," it reported.

Most significant in terms of reaching a final agreement, however, were the positions of the U.S. and Soviet delegations at Geneva. Relations started frostily. U.S. ambassador Donald Lowitz pulled few punches in his opening statement, explicitly accusing the Soviets of violating the convention both by maintaining an offensive biological warfare program, and supporting the military use of toxins in Laos, Kampuchea, and Afghanistan.

Soviets Discuss Sverdlovsk

The Chernobyl syndrome seems to be catching. The Soviet Union used last month's review conference in Geneva for the 1972 Biological Weapons Convention to present an unexpectedly detailed description of the events surrounding a 1979 anthrax outbreak among those living in and around the town of Sverdlovsk.

The United States continues to insist that the outbreak was the result of the accidental escape of anthrax spores from a secret biological weapons research establishment at Sverdlovsk. On the first day of the review conference, the head of the U.S. delegation, ambassador Donald Lowitz, used the incident to back up U.S. claims that the Soviet Union has been contravening the convention, which allows research only for prophylactic purposes.

Soviet officials, in turn, have been equally insistent that the anthrax outbreak resulted from distribution of contaminated cattle feed. Until last month, they had refused to discuss details of the outbreak with foreign scientists or U.S. officials, maintaining that it was purely a domestic problem that had no relation to military research.

During the review conference, however, the tone shifted. The Soviet delegation offered Western delegates the opportunity to put questions on Sverdlovsk directly to Nikolai Antonov of the Ministry of Public Health in Moscow.

Antonov subsequently presented what some of those present later described as the most complete version to date of the Sverdlovsk events. He pointed out that there had been at least 150 outbreaks of anthrax in the Soviet Union in 1978, and provided detailed descriptions of the medical care provided to victims and the cleanup techniques that were subsequently used.

The United States has charged that the outbreak must have been the result of an aerosol discharge, since many of the victims appeared to have been suffering from pulmonary anthrax. But Antonov later told *Science* that this charge is inconsistent with the fact that the disease did not occur simultaneously among its victims; symptoms appeared over a 7-day period.

He also said it had been necessary to decontaminate the area around Sverdlovsk because contaminated meat had been thrown into open garbage containers by some "undisciplined workers." The United States has argued that only an airborne virus would have required such cleanup techniques.

The expanded explanation of the Sverdlovsk incident is being handled cautiously by Western officials. Many imply that classified intelligence information exists to support the U.S. charges, and warn that the Soviets' new willingness to discuss the incident, after having rejected a series of earlier requests to do so under Article V of the Biological Weapons Convention, could be just an elaborate smoke screen.

At the same time, however, U.S. arms control officials admit that they were surprised in Geneva by the strength of the Soviets' insistence that they are now willing to let the Sverdlovsk incident be discussed between scientific experts from both sides. "The offer was completely unexpected" says one.

The hope of both Western and Eastern delegates to the review conference is that if another Sverdlovsk-type incident should occur in the future, measures agreed to in the final declaration will make it easier for outsiders to know precisely what happened. ■ **D.D.**

His Soviet counterpart, Victor L. Issraelyan, denied the charges equally energetically. He called claims about the violation of the treaty "ungrounded and farfetched," and described U.S. allegations as "inventions from beginning to end."

Both sides, however, made clear that they wanted to see the effectiveness of the Biological Weapons Convention enhanced. The Soviet delegation suggested that this might best be done by adding a supplementary protocol to the convention listing specific verification measures.

The United States, wary that an excessively formal agreement could merely be used as an extra mask for clandestine research, pushed instead for a detailed description of individual "confidence-building" measures to be included in the final declaration.

After a week of negotiation, the latter view, supported by many other Western countries, appears to have prevailed. The final declaration makes no mention of the need for a new protocol, or for arrangements for a special conference to decide on its content, which some delegations had recommended. However it does contain the agreement of the signatory countries to:

- exchange information on the name, location, and principal activities of research laboratories meeting "very high national and international safety standards"—a description interpreted as referring to P4-level containment laboratories;
- exhange information on the outbreak of unusual toxin-related diseases;
- encourage the publication of results of research related to the convention; and
- encourage the active exchange of scientists involved in such research.

There was no agreement on proposals that some countries had been proposing which would give the Secretary-General of the United Nations, or perhaps some outside bodies, the power to investigate complaints without having to pass through the Security Council, as laid down in Article V of the convention.

However, the final declaration does say that, after a complaint has been lodged with the Security Council, the council may request the advice of the World Health Organization in carrying out an investigation, given the technical agencies' acknowledged expertise in dealing with toxins.

In a brief statement to journalists at the end of the meeting, U.S. ambassador Lowitz said that the United States had approached the conference in both a "critical and constructive way," and he hoped the measures approved in the final declaration would lead to "greater transparency and openness" in the operation of the convention. ■ **DAVID DICKSON**

Red Tape Snarls Soviet Research Ship

An effort to encourage international participation in an oceanographic research cruise was foiled by snafus in obtaining docking permits

San Francisco

An ambitious and unusual Soviet attempt to attract international cooperation in oceanography and marine geology has run smack into a wave of frustrating red tape. On 4 September, the big white research ship Akademik Aleksandr Vinogradov, under U.S. Coast Guard order, was sent summarily back out into the fog sweeping San Francisco's Golden Gate Bridge. It had been in port 2 days.

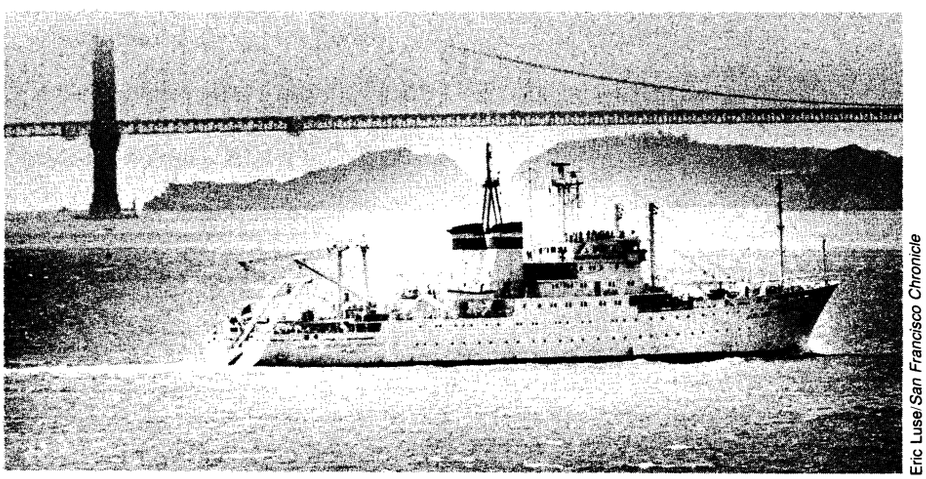
The twin-funneled ship, according to its schedule, is now sampling water and bottom sediments a few hundred miles off the Oregon coast in an area of ocean-floor spreading called the Juan de Fuca Ridge. The area the ship is working is just beyond the American Exclusive Economic Zone, where U.S. researchers are doing similar work.

If proper permits can be obtained, the ship's complement hopes for a return port call in San Francisco, or a stop in Los Angeles, or perhaps Vancouver, British Columbia, before returning to the Soviet Union later this month. The confusion over its itinerary is consistent with its experience so far.

The Coast Guard told the ship's master to leave port 2 days earlier than its crew plus scientific staff of some 110 people expected. The episode is just the latest of what is, for the scientific chief on board, a most frustrating voyage. Nobody, it seems, really wanted the ship to leave San Francisco so abruptly, most particularly U.S. researchers eager for a longer visit and the approximately 80 men and 30 women on board who had been poring over San Francisco tourist guidebooks for weeks.

If nothing else, the affair shows how easily international science schemes can founder on a few errors in paperwork. In both Japan and the United States, hoped-for rendezvous with foreign specialists invited to spend time at sea on the ship were missed—in Japan because the ship failed to get proper clearance to tie up in port, in San Francisco because somebody on the Soviet side neglected to tell the U.S. State Department how long the Soviets wanted to remain.

Rather than the anticipated 30 foreign scientists on board during the course of the voyage, the Soviets wound up with one so far—Ronald K. Sorem, a retired geology professor from Washington State University in Pullman and now a consultant on mineral resources and economic geology. He went aboard in July in Hilo, Hawaii, after earlier missing the ship in Japan, and is still there.



Eric Luse/*San Francisco Chronicle*

The Akademik Aleksandr Vinogradov. *Summarily dispatched back into the fog sweeping the Golden Gate Bridge.*