problems of regional cooperation, of paying recurrent costs, and of organizational effectivness could come into play.

The skeptics are in a minority. The program has already been able to stop spraying in Burkina Faso and expects to gain experience there that will allow a successful transition to a maintenance program throughout the region.

Now that achievement of the public health goals of the OCP seem reasonably assured, the question of the future of the organization is coming to the fore. Alisbah notes that one suggestion is to "take the expertise and apply it to the next disease." Another school of thought sees a role for the organization in spurring the economic development that was originally regarded as a corollary of the program.

A number of bilateral aid projects, mostly for agricultural development, have, in fact, been funded for resettled land, but no comprehensive data on the socioeconomic effects of the program are available. In Burkina Faso, which had a larger percentage of land affected by oncho than any other OCP country, some 240,000 hectares were reported to have been reoccupied by last year. Some successes have been reported with cultivation of export crops, but efforts to obtain increased yields with food crops for domestic use have so far been disappointing.

There is increasing awareness that "development hasn't worked as well as the [OCP] program," says Stockard. And at recent meetings of the Joint Advisory Committee the question has been raised, "Shouldn't the Joint Program Committee play more of a role? Are they prepared to alter the mandate, expand it to cover economic development?"

Alisbah, director of West Africa Country Programs for the World Bank, acknowledges that "Now that [the OCP] is succeeding, there is donor pressure for economic follow-up." He says the bank plans to focus a major effort on the OCP region next year "to explore the proper economic follow-up." The aim is "to determine whether there is an effective role for an international group or it is best left to bilateral action."

If consensus is lacking on the future of the organization, there is no serious question of its having improved the lives of millions of people at risk. A point that should not be forgotten is that the oncho project was a gamble. Those present at the creation recall that, despite initial confidence in the technology, there were many uncertainties. A World Bank official remembers that there were even doubts about "whether the valleys were really so green. What other diseases kept people out of the valleys? There was not a terrific database. In the absence of convincing scientific evidence, they went by the passions of Africans speaking of the effects of the disease." He says "it was a matter of emotion." For anyone who travels to a village like Nayé, it still is. ■

JOHN WALSH

Soviet–U.S. Fusion Pact Divides Administration

Afraid the Soviet military will benefit from a world ignition machine, DOD wants Reagan to drop his summit pledge

Six weeks before the Reagan-Gorbachev summit in Geneva last fall, Soviet Foreign Minister Eduard Shevardnadze met with Secretary of State George Shultz in New York. The Soviet official wanted to put nuclear fusion research on the agenda for the November summit talks. Shultz, a former executive of Bechtel Group, Inc., an engineering and energy technology company, took the proposal to President Reagan. A few weeks later Shultz told Kremlin officials in Moscow that Reagan was willing to explore broadening ongoing work with the Soviets related to developing a fusion power reactor.

By the end of the 3-day summit, Reagan and Soviet General Secretary Mikhail Gorbachev were calling for the "widest practicable development of international cooperation" in magnetic confinement fusion. Negotiators at Geneva were not able to agree on a specific mission. Nevertheless, the statement issued by the two leaders has been interpreted by the Soviet and U.S. fusion communities to mean multilateral construction of a major new device—the so-called Energy Test Reactor (ETR).

But 5 months after the summit, the idea of the United States constructing a new test reactor with the Soviets is in trouble. The merits of the Gorbachev-Reagan communique on fusion are heatedly being debated within White House agencies, as well as the Defense, Energy, and State departments. Budgetary impacts, but especially concerns about transferring technology to the Communist Bloc, are fueling a campaign in parts of the Administration to kill or sharply curtail any new fusion project that includes the Soviets.

Seen as the key to reenergizing waning fusion programs in the United States and Soviet Union, this reactor is needed to reach the next frontier in magnetic confinement fusion: the study of burning plasma and the testing of materials eventually to be used in a commercial power reactor. Fusion energy derived by the combination of hydrogen atoms to produce helium has been heralded as potentially providing a limitless supply of energy that is safer and environmentally more acceptable than fission technology.

The challenge facing fusion researchers has been to produce within the confines of a magnetic field a hydrogen plasma with sufficient density and temperature to ignite and burn. Steady progress toward this goal has been made over the past decade, but the cost of major experiments also has increased. The next experiment could cost as much as $4 billion, a burden that neither the United States nor the Soviet governments appear willing to shoulder alone. With the participation of Europe and Japan, though, the cost would fall to about $1 billion per country.

The Soviet Union's Chernobyl power plant disaster, however, may have provided Administration naysayers with a graceful way for the United States to back away from working with the Soviets on an international ignition experiment. According to Stephen Bryen, DOD's deputy under secretary for trade security policy, Defense Secretary Caspar Weinberger will shortly propose to Reagan that the United States substitute an international collaboration on fission power plant safety in place of cooperating with the Soviets in a multilateral fusion experiment.

The Department of Defense is not opposed to the United States jointly building a new test reactor with the Japanese and Europeans. But the department strongly op-

poses including the Soviets for fear that the ideas and know-how on fusion materials, computers, and manufacturing processes would be quickly transferred from their scientists to the Soviet military. Bryen says that an international agreement would require too much information sharing. By working with the West on magnetic fusion, he says, the Soviet Union could enhance its ability to use advanced technologies that its engineers and scientists are struggling to master.

The list of fusion technologies that could tempt the Soviets includes high temperature metals and ceramics, materials resistant to neutron-induced damage, advanced instrumentation techniques, plasma heating methods, computer technology, and special manufacturing methods. "DOD is right to be concerned about it," says James A. Maniscalco, fusion program manager at TRW, Inc. "You are talking about high-technology transfer. It's a sticky one."

TRW, for example, has developed high-power microwave systems for plasma heating and stability control that are related to free-electron laser technology being embraced for the Strategic Defense Initiative (SDI). Nonetheless, Maniscalco favors collaboration with the Soviets, noting that TRW's technology is not far afield from gyrotrons, a radio-frequency technique developed by the Soviets for elevating plasma temperatures.

American fusion program leaders, in fact, say Administration hawks have exaggerated the risks. "Everything in the world is not done here. In many areas we are not ahead," notes John Sheffield, associate director of fusion energy at Oak Ridge National Laboratory. "We got the fact that you could make a gyrotron work from the Russians. All sorts of things came out of the Russian program."

Soviet fusion scientists are generally regarded as being on a par with American, European, and Japanese researchers. Tokamaks, a dominant design configuration in fusion research today, were developed by Soviet Academician Lev Artzimovich of the Kurchatov Institute in the 1950's. Although the Soviet program has produced charge exchange detectors, gyrotrons, and other innovations, some federal officials suggest their research has lagged in part for lack of access to advanced computers and other technology that is confined to the Soviet defense sector. DOD's Bryen, however, questions such assertions, stating that in electronics, for example, technology used by the military is not appreciably superior to that available to the country's scientific community.

A hemorrhage of proprietary domestic technology to the Soviets is unlikely, says Alvin W. Trivelpiece, director of the Department of Energy's Office of Energy Research. "The technology transfer problem is manageable," he contends, noting that details about much of Western fusion technology is published. As for information that is not in print, Oak Ridge's Sheffield says: "If they don't get it from us, they could get much of it from the Japanese or Europe."

American fusion scientists have worked closely with Soviet fusion scientists for 28 years. This has occurred most prominently through INTOR (International Tokamak Reactor), an ongoing advanced reactor design study conducted under the auspices of the International Atomic Energy Agency since 1978. Also, annual bilateral technical exchanges (six each recently) have been conducted since 1974. DOE officials say these visits have been invaluable.

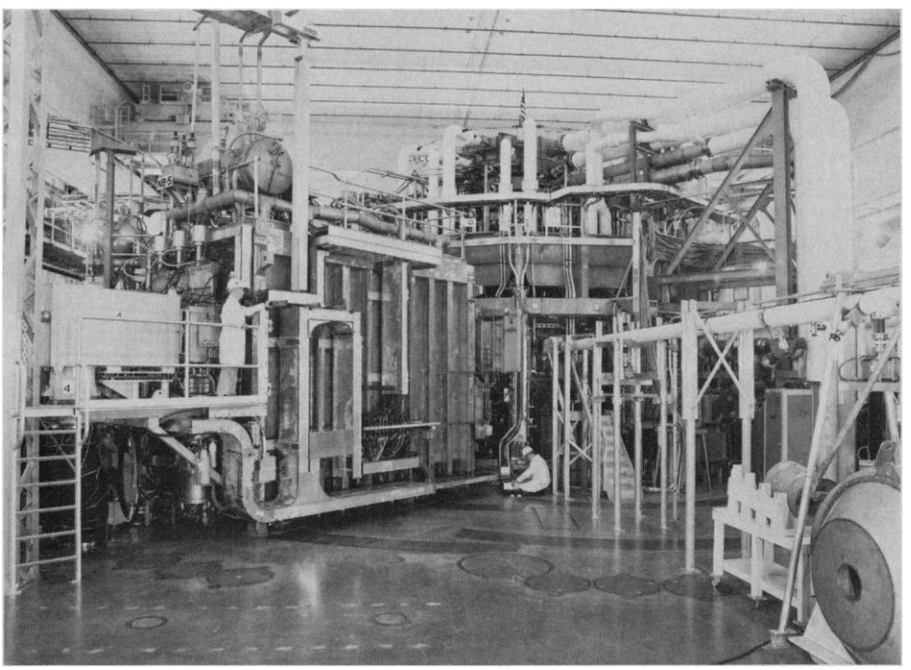
But the value to the United States in some respects is less tangible, serving to confirm work and theories developed and applied at home. Says TRW's Maniscalco, "I don't think we have gained that much information from the technology standpoint, we gained a lot from them in the science area." The director of Oak Ridge's Fusion Energy Division, O. B. Morgan, who has worked with the Soviets for over 10 years, concurs with Maniscalco's observation.

Despite the questions posed by DOD, the National Security Council, and the Office of Science and Technology Policy, Trivelpiece's view that technology transfer can be controlled is shared by a number of State Department, White House, and industry officials. Access to super computers, for example, can be limited with user codes. Advanced manufacturing techniques in most instances would be performed off site. Says Morgan, "I just don't see where there is a large technology vulnerability associated with us working together. I can understand how we are not going to ship Crays [super computers] to the U.S.S.R."

Prior to the November summit, the United States was engaged in multilateral talks with Europe and Japan on building a long-pulse, plasma-burning test reactor. An outgrowth of the 1982 Versailles economic summit, these dicussions have centered on an ETR machine where participants would have equal access to each other's technology and data. But the prospect of the Soviets entering the game has caused the European and Japanese governments to reexamine their goals.

What positions the Europeans and the Japanese finally take on the matter is uncertain, and could take a year or more to emerge. Clearly, the Gorbachev-Reagan fusion pledge may complicate efforts to hammer out an international agreement to construct an ignition device. But it also has added momentum to the sluggish multilateral talks between Western countries. The staff of the Commission of the European Economic Community, in fact, favors building a new machine with the Soviets.

The Europeans have been working on plans to build their own ignition device, the Next European Torus (NET). They could proceed with it if international collaboration



The Tokamak Fusion Test Reactor. *The lead magnetic confinement experiment in the United States, it will cease operations in 1989 following a long awaited break-even test.*

appears to be too slow or costly. But participation by the West German government in other costly ventures such as Hermès, the Space Station, and the Strategic Defense Initiative may dampen support for Europe's embarking on its own ignition device.

The Japanese appear most prepared to go it alone, if necessary. They are planning to build a $2-billion ignition device known as the Fusion Engineering Reactor (FER). For now, says Toichi Sakata, first secretary of the Japanese Embassy in Washington, Japanese officials are prepared to consider international collaboration, but only if three conditions are met. The first is that an international device must be sufficiently bold to yield technical results far greater than Japan's planned machine can achieve.

If the Soviets have their way, Japan's requirement will easily be met. In the first technical meeting held with U.S. government officials, the Soviets proposed building an ambitious machine with a first-wall rating of 5 megawatt-years per square meter—a measure of the reactor wall's resistance to degradation from neutron bombardment. This would push the limits of material science, DOE officials say. INTOR designs have contemplated a lower, but still ambitious 3-megawatt standard.

Japan also insists on a strong, long-term commitment from national governments, including substantial upfront financing. After having suffered political embarrassment when a U.S., West German, and Japanese synthetic fuels project fell apart in 1981, the Japanese are wary of international collaborations. Most importantly, the Japanese say they may oppose any approach that would "black box" segments of an ETR, or that would structure mission tasks in a narrow fashion that tends to limit understanding of concepts and component engineering. Says Sakata, "There must be a free flow of information. If the project is going to be black boxed . . . then we might find cooperating difficult."

The flow of information could be crimped by the West's Coordinating Committee (Cocom) regulations, which prohibit the shipment of high-technology goods to Eastern Bloc countries. So far "nobody in the fusion game has ever had to operate under Cocom," says Alan T. Mense, a former scientist at McDonnell Douglas Astronautics and a principal writer of the Magnetic Fusion Engineering Act of 1980. "It has always been an open exchange with foreign scientists." Cocom's applicability to scientific exchanges has never been clear, but DOD is expected to press for a broader interpretation of the law if a cooperative pact including the Soviets is signed. Even so, says Mense, it will be hard for scientists working side-by-side to withhold knowledge from each other.

Ultimately, proponents of international cooperation say that the United States and other countries must recognize that they have to give up some knowledge to gain anything in return—and if they value Soviet participation. The rising costs of fusion experiments combined with tight budgetary times in Western countries may force collaboration on fusion. "The world seems to recognize that we all are in the same boat financially. We are much more likely to achieve something together than alone," observes John Clarke, DOE's associate director of fusion energy.

"We [the United States] are facing a desert in the future in terms of new facilities."

For the U.S. fusion program, getting an international machine under way is essential. Says Oak Ridge's Morgan, "A lot of what we do in the future will depend on an initiative that is international. Without it my fear is that the national fusion program will face continued budget decreases." Stephen O. Dean, president of Fusion Power Associates, the industry trade organization, notes that unless the program's next step is clearly defined, Congress will have little cause to shelter magnetic fusion from deficit reduction pressures.

The American fusion program already is in danger of losing critical mass. Another budget reduction in fiscal year 1988 could severely damage its broad focus. Despite deep cutbacks and layoffs, it has managed to maintain technological work and support research in alternative fusion reactor concepts such as reverse field pinches, stellarators, and spheromaks. Besides crippling this research, further reductions would probably erode fusion's fragile base of political support. Congress already has chopped its budget from a high of $468.4 million in FY 1984 to $365.4 million in FY 1986. The Administration wants another $32.4-million reduction starting 1 October. As a result, the massive $364-million Mirror Fusion Test Facility (MFTF-B) is expected to be mothballed without being used (*Science*, 31 May 1985, p. 1069).

Smaller fusion experiments at the Massachusetts Institute of Technology, Princeton, and elsewhere are being closed or stretched out while support for university research is being cut back. Except for Princeton's Tokamak Fusion Test Reactor (TFTR) there are no major facilities under way in the United States that can achieve major advances toward a fusion power reactor. Operation of the Princeton tokamak will cease within 6 months of tritium fueling in 1989 for the long awaited break-even test. Delayed for almost 3 years, this experiment is expected to demonstrate that a fusion device can confine a plasma long enough to produce more energy than the reaction consumes.

Looking ahead, DOE's Clarke says, "We [the United States] are facing a desert in the future in terms of new facilities." One faint hope is the proposed Compact Ignition Tokamak, a relatively cheap ignition experiment that would provide useful data for burning plasma experiments, to be conducted in the larger ETR. It would also provide the near-term flagship that the fusion community needs to sustain congressional interest. But to be useful to the ETR design process, construction on the $300-million machine would have to begin earlier than the Administration may want—by 1989. Operation would have to start in 1991.

The fate of both project proposals, however, may hinge on White House support, industry and government officials say. And right now it is hard to tell where the Administration stands. There appears to be little presidential direction at the moment. Except for discussions with Energy Secretary John Herrington and Shultz, Administration officials say privately that Reagan has had virtually no communications with Executive Branch officials on fusion collaboration since the idea was first proposed in October. As a result, agency officials have been left on their own to determine how to proceed on the summit pledge.

"I don't see any support for it in the White House. It looks like it's rhetorical support and not real support," says Senator Bennett Johnston (D–LA), ranking minority member of the Senate Appropriations subcommittee on energy and water. "We will have to see how the summit process plays out," concedes Fusion Power's Dean. "It will only happen if Reagan and Gorbachev agree."

Given the tight budgetary climate and backlog of other major initiatives such as a new space shuttle orbiter and possibly a Superconducting Super Collider, prominent presidential backing for a major new fusion device is seen as essential. Indeed, Congress could have a problem funding a costly new undertaking for fusion, says Representative Tom Bevill (D–AL), chairman of the House Appropriations subcommittee on energy and water development. "Without strong Administration support," he adds, "it won't go anywhere in Congress." ■

MARK CRAWFORD