that has a tube attached to it. Feeding usually coincides with the extraction schedule, which comes every 1 or 2 weeks.

Obtaining the venom is a simple procedure: a snake is brought up to the lab and the handler holds its head over a glass funnel covered with a piece of transparent paper. The snake bites down on the paper and the venom dribbles into a vial. The company mixes the venom of hundreds of snakes together in order to get large quantities of dried venom of consistent quality. Supplies are augmented by imports of venom from an office the company has in Hong Kong. There, the cobras are milked at the market before they are prepared for food. It takes 30,000 cobra extractions to make 1 kilogram of dried venom, which would sell for $32,000. The most expensive venom comes from the yellow-bellied sea snake—that costs $3000 per gram.

Kilmon, who tries to keep up with venom research, does work in cooperation with Johns Hopkins, New York University (his technical adviser is NYU biology professor Joseph F. Gennaro), and the biology division of Edgewood Arsenal, where he aids in the development of antivenin for military use.

He sees a mushrooming market for venoms. At the moment, he says, there are only two drugs available in this country manufactured from venoms, both made by the Baltimore firm of Hynson, Westcott & Dunning. One is Cobroxin (from cobra venom), which, says Kilmon, is a more effective analgesic than morphine. It works by blocking nerve transmission, and only one daily dose is required, whereas for severe pain morphine has to be given every few hours. Unlike morphine, he says, it has no adverse side effects, is not addictive, and there is no problem of the patient building up tolerance to the drug. The other drug is called Nyloxin. Cobra venom mixed with silicic and formic acids, it is used for arthritis pain. Some other venom-based drugs are used abroad. In England, says Kilmon, there is in use as an anticoagulant a drug containing enzymes from the Malayan pit viper. This is alleged to be superior to the anticoagulant heparin in preventing the formation of clots. And over in France, says Kilmon, there is an antiarthritic drug made from bee venom. (He says the Warren Foundation in New York is doing research on bee venom.) More drugs are in the pipeline. Cobra venom shows promise for treatment of amyotrophic lateral sclerosis, better known as Lou Gehrig's disease. There is evidence that enzymes from krait venom can be of use in myasthenia gravis. There have also been experiments using a fraction of cobra venom as an immunosuppressant in myocardial infarctions induced in dogs. The cobra venom factor is supposed to inhibit production of antibodies that the body makes to reject the dead heart muscle, and thereby reduce the extent of the damage. Implications for transplants are obvious.

A drop of venom can be seen at the tip of the exposed fang of a rattlesnake, a member of the viper family. Vipers have teeth that fold back when not in use; cobra fangs are shorter and nonretractable.

Kilmon recently completed some research of his own with opossums. Opossums, it seems, are impervious to snake bites, a fact that Kilmon attributes to a remarkably efficient immune system, a theory reinforced by the fact that opossums also never seem to get cancer. The only effect of snake venom on opossums is a temporary lowering of blood pressure resulting from the venom's properties as a vasodilator. (It is not used for hypertension, though, says Kilmon, because it is so potent and difficult to regulate.) "Every biomedical field has a different application, and an exciting application, for venoms," says Kilmon.

"When you keep these animals you become one of the animals," Kilmon says, and indeed the reptilian layer of his brain seems to be in tune with theirs. He has no illusions about their personalities—the cobra, for example, he characterizes as "sort of dull-witted and hysterical"—but he has fine appreciation for the efficiency and order of nature as manifested through reptilian behavior. Also, "what fascinates me is I am sort of a 'root for the underdog' type of person. Snakes are the underdogs."—CONSTANCE HOLDEN

Nuclear Exports and Proliferation: The French Think They Have a Case

The problem of nuclear proliferation through the export of nuclear fuel facilities has assumed the dimensions of a major policy issue. Publicly, the issue is perceived as a conflict between the United States on one hand and France and West Germany on the other. The French are piqued at the American press for what they regard as the unjustified depiction of France as irresponsible in selling nuclear facilities to countries which might use them to make weapons. At the government level it appears that discussions are being conducted equably. But it is also evident that secret negotiations carried on for well over a year by nuclear exporting countries have not resolved outstanding differences.

The focal point has been the sale of fuel reprocessing facilities to non-nuclear countries by both France and Germany. Reprocessing plants separate spent reactor fuel into fission products, plutonium, and unused uranium. The separated plutonium can be used to make nuclear weapons. The relative ease of "conversion"—the use of plutonium from reprocessed fuel in nuclear devices—is what is causing growing concern among American policy-makers and underlies a reappraisal of policy.

American standard policy has been to urge all countries to become signers of the Nonproliferation Treaty (NPT) and participate in the system of international nuclear safeguards supervised by the International Atomic Energy Agency (IAEA). For its own part, the United States has declined to export fuel facilities—either uranium-enrichment or fuel-reprocessing plants—which could produce weapons-grade nuclear material. And recently, the United States, in effect, began to urge other exporting countries to do the same.

In a statement before a Senate Government Operations panel on 9 March, Secretary of State Kissinger expressed the

rather cautiously worded hope that alternatives to the export of "sensitive technologies" would be found.*

The United States is treading a narrow line, with officials charged with negotiations avoiding mention of an embargo lest this antagonize both suppliers and buyers into noncooperation.

The French and German view with respect to reprocessing is, in effect, that the cat is out of the bag. They note that basic reprocessing technology was declassified by the U.S. Atomic Energy Commission and that any moderately industrialized nation could carry out reprocessing operations, although these might not be either very safe or economic.

The French insist privately that they and the Germans have a nonproliferation position that is more realistic and, in the end, will prove more effective than the American position. Their argument is that it is better to sell fuel facilities and embrace the customer so closely that he cannot divert plutonium for weapons. The French now demand that the bulk of the nuclear material and equipment they export be placed under IAEA supervision and require that such supplies be covered by on-the-spot physical safeguards. (France has declined to sign the NPT.)

The French have also taken the initiative in safeguarding technology. Up to now the American view has been that safeguards could be applied to materials and facilities but not to technology. The French now insist that the transfer of French nuclear technology entails the acceptance by the customer of safeguards for all such technology. A recent statement by French Foreign Minister Jean Sauvagnargues explained the stand thus:

> Lastly—and this is important in the very delicate areas of uranium enrichment, reprocessing of irradiated fuel, and production of heavy water—special, even more rigorous conditions are to be applied.
>
> By these means the technology transferred is to be controlled in the areas of peaceful, nonexplosive utilization. These principles will be applied on the practical level in the following way. Once material or equipment has been exported, every installation built in the importing country that uses a technique similar to the one we have supplied will be considered as having been built with the aid of our technology for a predetermined period—20 years in fact. This installation will therefore be subject to IAEA controls.

The French attached this requirement to contracts for reprocessing plants with South Korea and Pakistan.

The United States believes that it would be better not to export fuel facilities at all. However sound the reasons for the American move toward more stringent restraints by both exporting and importing countries, the emerging American position is perceived as a significant change in position. Since the creation of IAEA in the late 1950's it has been assumed that fuel reprocessing would be an integral part of a nuclear economy. As countries put more reactors into use it was thought that they would build reprocessing plants. The statute creating the IAEA implicitly provides for reprocessing by countries with reactors, albeit under safeguards. The United States is now seen from abroad as championing a change in a commonly understood and accepted policy.

Public knowledge of the negotiations among the United States, France, Germany, and the other nuclear exporting countries is sketchy because discussions of the nonproliferation problems have been conducted under terms laid down by a group of nuclear exporting nations that have been meeting in London for well over a year. The original group of seven countries was expanded to 14 in May.† An understanding that negotiations would be kept confidential has been dutifully observed.

Certainly, however, the progress of the London talks has been influenced by the character of general relations between France and the United States. The old alliance between the two countries has in recent years become a difficult friendship. Elements of national pride and economic self-interest are certainly not unusual in foreign policy, but French policy has been heavily influenced by General Charles de Gaulle's resentful attitude toward *les Anglo-Saxons*, the Americans and British, dating from World War II. De Gaulle's disapproval of much of American policy after the war was tinctured with suspicion that U.S. actions were calculated to maintain American economic dominance.

In the nuclear field, the French particularly resented continuation of the wartime special relationship between Britain and the United States. The French felt that the Americans had deliberately slighted the French after the war by offering little assistance to them in building both their military and civilian nuclear energy programs. As a result, the French have been particularly anxious to see that the considerable investment and effort they have made in the nuclear field pay off. They now see sales of reactors and other nuclear facilities abroad as especially important because the maturing French nuclear industry is assured of orders for five or six new pressurized water plants a year over the next several years for the ambitious domestic nuclear power program (*Science*, 23 July). And the French need an additional two or three foreign orders a year to permit French industry to attain the economies of scale which will make it competitive with U.S. nuclear industry.

In pursuit of international markets for their high technology, notably sophisticated weapons and aircraft, the French have earned a reputation for maintaining the attitude that "business is business." The most recent example is the sale of two power reactors to South Africa. Because reactors are associated in the public mind with nuclear weapons there was criticism of the sale in the Western press because of South Africa's racial policies and the possibility of military conflict with black African nations. Popular and political pressure, for example, caused the withdrawal of a Dutch company from a consortium which was bidding on the reactor contract. The French, who in the past have sold military equipment to the South Africans and managed to maintain good relations with black African countries, took the view that the reactor sale was fully within the spirit and letter of the IAEA statute. They also pointed out that South Africa is an industrialized nation that already has the capacity to make nuclear weapons if it wishes and that the power reactors to be built have no significant effect on that capacity.

In France, the school of thought which holds that the U.S. policy is guided by commercial interests retains influence. Those who espouse this view suggest it is no coincidence that the United States altered its position on the export of nuclear fuel facilities just at the time that France and Germany emerged as serious competitors in the international nuclear market.

United States officials insist that nuclear industry has exercised little influence on policy. There appears to be some confirming evidence for this claim since the major American nuclear exporting companies—Westinghouse and General Electric—are concerned that more rigid restrictions on exports in the nuclear

*"As a result of growing perceptions of the direct proliferation risks, suppliers as well as recipients appear to be exercising increasing restraint in such sensitive areas and have concluded rigorous safeguard agreements. In this regard we greatly welcomed Korea's decision not to acquire a national reprocessing facility and hope that it will enhance multilateral efforts to develop alternatives to national capabilities.

"One course of action which might meet the future reprocessing needs of certain countries in a potentially economic manner—and at the same time alleviate some of our concerns regarding the proliferation of such facilities—is the concept of a multinational fuel cycle center, serving regional needs, to which I gave my personal support before the U.N. General Assembly last year."

†The original seven members were the United States, Soviet Union, France, West Germany, Britain, Canada, and Japan. In June, the exporters' "club" announced that membership had been opened to Sweden, East Germany, Belgium, Netherlands, and Italy and that two other countries, Poland and Czechoslovakia, would join.

power field, which seem to be implied in the emerging U.S. position, would damage their competitive position abroad.

It is not unusual for sensitive multilateral talks to be kept confidential, but the French seem to have been particularly insistent in the case of the London talks. French uncommunicativeness is ascribed primarily to the reluctance of the government of French president Giscard d'Estaing to offend Gaullists in the coalition of parties which he heads. The Gaullists would take a dim view of what appear to be concessions to U.S. proposals on proliferation which might work to the competitive disadvantage of French nuclear industry in international markets.

About the only observation U.S. officials will make is that in the last 2 years or so the French have moved a long way from a position in which they appeared willing to make nuclear sales virtually without safeguards. American officials also tend to acknowledge that the French and Germans have developed a stand on nonproliferation with which the United States may still disagree, but for which a case can certainly be made.

The rapid rise of proliferation as an issue can be dated from 1974 when India exploded a nuclear device using material from a reactor supplied by Canada. Concern here increased when the Germans announced conclusion of a nuclear reactor package deal with Brazil which included fuel reprocessing facilities (*Science*, 25 July 1975). And then the French weighed in with word of deals for reprocessing plants to South Korea and Pakistan. The sale to South Korea was canceled, mainly as a result, reportedly, of heavy pressure applied by the United States on South Korea. It is worth noting, however, that Giscard, on a presidential visit to Washington in June, said that he had taken an active part in ending the deal with South Korea.

The alarm on proliferation has been raised on Capitol Hill by the Senate Government Operations Committee headed by Senator Abraham Ribicoff (D–Conn.). Committee hearings provided the forum for Secretary Kissinger's formal statement on revised nonproliferation strategy. Ribicoff is the author of a July *Foreign Affairs* article on nuclear market sharing in which he makes a proposal under which, as he described in the Senate statement, the United States would "offer to enter into market-sharing arrangements with all the major suppliers to eliminate cutthroat competition from the sale of reactors and to promote nuclear fuel arrangements that will discourage production and stockpiling of weapons-grade material outside the supplier nations."

At the moment, the United States and France are cast in the role of chief antagonists in the proliferation debate and the sale of reprocessing plants is represented as the main point of conflict. This defines the issues too narrowly. What is at stake is the international control of the growing quantities of plutonium in the spent fuel of the increasing number of reactors that are operating throughout the world.

In a sense, the change in U.S. official attitude toward nonproliferation policy reflects a change in attitude toward IAEA safeguards. It is more clearly recognized now that safeguards are designed to detect diversion, not to prevent it.

United States policy now seems designed to buy time in order to find an alternative to the spread of fuel facilities. There is no diplomatic quick fix on the horizon—no neat new safeguards proposal, no test ban treaty or NPT. To be acceptable, any new formula must meet the requirements of both the sellers and the prospective purchasers of nuclear power technology. The era when the United States could call the tune in nuclear affairs because of a virtual monopoly in uranium enrichment capacity and dominance in nuclear technology is ending. New arrangements will have to strike a totally new balance of commercial and political interests.

What are the reasons for the change in U.S. policy? After all, nothing really unexpected has happened. As one U.S. official wryly observed, "The physics hasn't changed." But perceptions obviously have, and perhaps the most plausible explanation of that change is simply that the disturbing implications of proliferation were recognized but were seen as lying somewhere in the future and other problems took priority. Now, as another official said, "The future is here."

—JOHN WALSH

Hospices: For the Dying, Relief from Pain and Fear

This country is pouring zillions of dollars into the war against cancer, but is not paying much heed to the plight of victims once their individual battles are lost.

Of the 700,000 people diagnosed as having cancer each year, two out of three die of their malignancies. For these people dying can be a slow, painful, and very lonely business. Hospitals, geared as they are to aggressive therapy and prolongation of life, do not offer a good milieu for dying. A person is not necessarily better off at home if he is alone or surrounded by an anxious, grieving family ill-prepared to give him proper care.

Despite the growing concern about death and dying in this country, there is not much understanding of the needs of dying people—the needs for comfort both physical and mental, for others to see them as individuals rather than as hosts of their diseases, for someone to breach the loneliness and help them come to terms with the end.

Hospices—homes for care of the dying—are one way to meet the problem. The hospice idea, which originated among religious orders in the Middle Ages, has its modern flowering in England, where a number of such places have been set up for attending to dying cancer patients. These differ from the kind that are still run by charitable religious groups in one significant respect: in addition to loving concern for patients they are undergirded by a solid medical component whose chief characteristic is the sophisticated management of severe pain and other unpleasant symptoms of terminal cancer.

Best known to professionals in this country is St. Christopher's Hospice in London, founded less than a decade ago by Dr. Cicely Saunders. The hospice, which also does some pharmacological and psychosocial research, has become something of a mecca for health professionals interested in terminal care, which Saunders calls a "largely unexplored medical field."

Among the interested is the National Cancer Institute. Last fall, through its Division of Cancer Control and Rehabilitation (DCCR), the NCI sent out a "request for proposal" for interested groups to set up experimental hospices