Nuclear Proliferation: Stepping Back

Apparently responding in part to American election-year politics, the governments of the United States and France are announcing new initiatives to curb the spread of nuclear materials and technology. President Ford is expected soon to release officially the details of a new anti-proliferation program, whose outline has already been leaked to the press. And the French High Commission on External Nuclear Policy, headed by President Valery Giscard d'Estaing, has for the first time indicated that France might yield to American pressure to bring nuclear exports under international scrutiny.

Until the last few months, international negotiations on slowing the spread of nuclear fuels and fuel reprocessing plants have been conducted without much fanfare. A half-dozen meetings of the exporting countries have produced no earth-shaking declarations, and as the United States grew more reluctant to sell its technology abroad, developing countries turned toward Europe (SN: 1/24/76, p. 59). France agreed to sell a fuel reprocessing plant to Pakistan and two reactors to South Africa. West Germany entered a long-term agreement with Brazil to build a reprocessing plant that could eventually make Brazil a major supplier of atomic fuel. The concern, of course, is that reprocessing plants can produce plutonium for use in making atomic weapons.

Though the 94th Congress argued long and heatedly over various pieces of legislation that might slow international nuclear trade, only one passed—the so-called Symington amendment to the Foreign Assistance Act. Sponsored by Sen. Stuart Symington (D-Mo.), the amendment provided for cutting off U.S. foreign aid to any country that imported a reprocessing plant without the proper safeguards or that refused to put its nuclear establishment under the auspices of the United Nations International Atomic Energy Agency (IAEA). Secretary of State Henry Kissinger reportedly has used the threat of such sanctions to discourage developing countries from entering agreements with other exporting countries.

As the American elections approached, however, the whole issue of atomic power desirability became more visible. Seven states—Washington, Oregon, Colorado, Arizona, Ohio, Missouri and Montana—have antinuclear referendums on the November ballot, with polls showing strong support for the initiatives in at least the first three of those states. Then presidential candidate Jimmy Carter called for a ban on the sale of nuclear reprocessing plants, including those already negotiated by France and Germany (SN: 10/2/76, p. 215). Within a week of Carter's remarks in San Diego, a new administration program on nonproliferation had been approved by President Ford and leaked to selected members of the press.

The program reportedly calls for a three-year international moratorium on the export of reprocessing plants, a halt in previous administration efforts to turn over American reprocessing technology to private industry (SN: 7/5/76, p. 6), and a tightening of the 30 existing U.S. agreements with other countries to cooperate in developing nuclear power. The program is based on the findings of an interagency task force headed by ERDA Deputy Administrator Robert W. Fri, which has been reviewing nuclear policy since July. Nations that cooperate in a more restrictive nuclear program would receive in return a guaranteed supply of atomic fuel from the United States.

France has apparently responded to the mounting pressure by offering, for the first time, to cooperate with other nuclear exporting countries in preventing the spread of technology that could be used to produce atomic weapons, and to consider the establishment of multinational nuclear power installations. The statement, however, is vague, calling only for avoidance of "commercial competition that encourages the proliferation of nuclear weapons," and promising that French nuclear export policy "will reinforce the appropriate rules and guarantees." Calling off the previous agreement with Pakistan is specifically not included.

Despite the vagueness, the French announcement does signal a major shift in nuclear policy. France has never even signed the Nonproliferation Treaty of 1968, which calls for a ban on the international transfer of nuclear weapons. U.S. officials contacted by SCIENCE NEWS said the announcement stems from a recent reassessment by the French of the possible effects of nuclear proliferation, but none would speculate how much the move was in response to American pressure.

Coincidental with the retrenchment on reprocessing plants came an announcement that the French breeder reactor Phénix, considered by some to be the most advanced in the world, had been shut down indefinitely because of a leak inside the heat exchange system. No estimate of the extent of damage was yet available, but authorities say the internal leak presents no danger.

Both the French and Germans have argued that negotiations leading to their sales in Pakistan and Brazil were well advanced before the concern over proliferation of sensitive nuclear technology became a major issue. While Germany has not yet reacted to the French statement, some officials believe that the German philosophy on proliferation is already fairly close to that expressed by French and American leaders, and that as talks on the subject continue, the Germans will agree to restrict exports.

In a related development, the Soviet Union has also made a recent shift in nuclear policy. Early this month, foreign minister Andrei A. Gromyko made an unexpected proposal that may open the way to on-site inspection of underground nuclear explosions. The Soviet Union agreed earlier this year to the principle of on-site inspection of explosions used for peaceful excavation, but allowing such inspection of suspected weapons blasts has been a bone of contention since the early 1960s. In the proposal, submitted to the United Nations, Gromyko again called for a total ban on all underground weapons tests. □

Toxic substances act: Now it's law

President Ford signed this week the long-awaited toxic substances bill, which gives the federal government a chance to screen potentially harmful chemicals before they are marketed (SN: 7/3/76, p. 7).

Under the new law, companies must notify the Environmental Protection Agency 90 days before they plan to manufacture a new chemical or an older chemical for a new use. The law applies to all substances except foods, drugs, cosmetics and pesticides.

The manufacturers must also report the results of safety tests that the EPA will prescribe. On the basis of those results, the administrator of EPA could prohibit or limit manufacture, if the chemical appears to be hazardous or if there is inadequate information about health or environmental effects. Further tests would then be specified by EPA.

The Toxic Substances Control Act also sets up an interagency committee to list chemicals already in use that should be tested. The legislation specifically bans, for two years, manufacture of polychlorinated biphenyls. Reproductive failures, gastric disorders, skin lesions and tumors in laboratory tests with mammals have been caused by PCB's.

During the last five years Congress has written various toxic chemical control bills. Only this year, however, were the House and Senate bills similar enough, and concern over toxic chemicals great enough, for a compromise committee to meet. The committee successfully resolved more than 40 major differences

between the bills.

The last and most difficult compromise was whether the EPA administrator required a court injunction to halt or limit manufacture of new chemicals. The final bill states that the administrator can either get an injunction or put an administrative order into effect. Even with the order, EPA must go to court if the manufacturer objects to the ruling.

Another compromise makes allowances for small businesses. They are partially exempted from the reporting requirements and will pay only $100, rather than $2,500, for registering each new chemical.

The final bill had the support of the Manufacturing Chemists Association and some labor and environmental groups.

The toxic substances law leaves much to the discretion of the EPA administrator. The question now is: How much preventive action will he take? □

Quantized light-emitting diode

It was a relationship among light, solids and electricity, the photoelectric effect, that introduced the concept of the quantum of energy into physics. Light falling on certain solids will eject a stream of electrons, an electric current, from their surfaces. But for each substance there is a threshold frequency, below which the light does nothing; above the threshold electrons come off. This led to the notion that light contains discrete quanta of energy, and that to get loose an electron had to swallow a whole quantum of appropriate size or nothing at all. The energy of the quantum is porportional to the frequency of the light, and the relevant equation is the famous $E = h\nu$.

At the research laboratories of the Ford Motor Co. in Dearborn, Mich., John Lambe and S. L. McCarthy have developed a species of solid-state sandwich that emits light in a kind of converse to the photoelectric effect. Diodes that emit light are not new, but a class that shows a quantum relationship between the frequency of the emitted light and the voltage applied to the diode is unusual, Lambe says.

The diodes are a form of tunneling junction, a device in which electric current "tunnels" its way through a thin insulating layer between two conductors. In each case that Lambe and McCarthy experimented with, one electrode was aluminum. The insulating layer was aluminum oxide formed on the surface of the aluminum. Against this were placed various electrodes of silver, gold, lead or indium. When a voltage was applied, light was emitted from the entire junction area.

These junctions radiate a broad spectrum of light up to a certain cut-off frequency. The cut-off frequency bears a quantum relation to the applied voltage. The energy of the cut-off quantum is equal to the energy of the electron in the current driven by the given voltage, or Planck's constant times the cut-off frequency equals the absolute value of the voltage times the electron's charge. The absolute value comes in because the polarity of the voltage does not matter.

The effect of variation of the cut-off frequency with voltage was plainly visible: "One could observe the emission color change from deep red at low voltage to orange to blue white as the voltage was increased," Lambe and McCarthy report in the Oct. 4 PHYSICAL REVIEW LETTERS. "This showed the effect of the change in [cut-off frequency] in a very striking way."

Lambe and McCarthy attribute the phenomenon to a relationship between the current electrons driven by the applied voltage and plasmons in the surface of one of the electrodes. Plasmons are collective oscillations of electrons within a solid. They have been a little difficult to study, but Lambe and McCarthy were able to make them react with the passing current by roughening the surface of the electrode slightly. So this phenomenon should provide a means for the study of plasmons.

Lambe also expects that devices of this sort, because they introduce a calculable quantum relation between voltage and light frequency, will be useful as secondary voltage standards for calibration and comparison. They will also be useful in a new kind of spectrometer, and in fact one such spectrometer was built as part of the present experimental program. Applications could also extend to places where other forms of light-emitting diodes are also used. □

Mars soil similar at two Viking sites

The two Viking spacecraft on the Martian surface are some 7,400 kilometers apart, on opposite sides of the planet. Lander 2 is more than 1,400 kilometers closer to the north pole than is its predecessor, and the more northerly atmosphere seems to contain at least three times as much water vapor. Yet despite these seeming grounds for difference, and despite the widely divergent appearance of the two sites in Viking orbiter photographs, the first analysis of a surface sample by lander 2 has revealed an uncanny similarity with the soil studied in the Chryse basin by lander 1.

If one selected two earth rocks for the same kind of analysis, says a member of Viking's inorganic chemistry team, he would be hard-pressed to find a pair that matched as closely as the Martian samples. Both are rich in iron, with near-carbon-copy amounts of calcium, silicon, potassium and other elements. The lander 2 sample was taken from an area topped with a crusty layer possibly due to evaporites formed by water-soluble salts. Yet sulfur and chlorine, two elements cited as candidates in such processes, are present in amounts almost indistinguishable in the first few days of study from those in the lander 1 sample.

The Martian samples involved, however, are not whole rocks, but "fines" or dust. In fact, says team leader Priestley Toulmin III of the U.S. Geological Survey, the likeliest implication of the data is that the material must represent the well-mixed products of weathering rather than simply broken up primary rock fragments. Such mixing, he says, would seem to take place on a planetwide scale, and very rapidly compared with the rate at which the weathering products are produced in the first place. "Indeed," he adds, "that inference might lead further to speculate that the entire weathering process is an ancient one, and that what we are now seeing is only a redistribution—mixing and homogenization—of those very ancient weathering products around the planet."

The team's X-ray fluorescence spectrometer, however, measures only elemental abundances; it does not tell how they are combined. That is the job of the human end of the experiment back on earth. "The best agreement that we can find in attempting to model the mineralogy to the chemistry," Toulmin says, "seems to include . . . a very large proportion of iron-rich . . . clays of the montmorillonite group. These are clays which on earth are generally the product of alteration or weathering of mafic, igneous rocks, such as basalts especially. They form either by weathering at the surface or by hydrothermal alteration connected with mineralization." Though they also have been found in deep-sea oozes, he says, their best known source is in the Red Sea, in an area where submarine hot springs have apparently altered the chemistry of the bottom sediments.

The weathering products suggest that, as with the lander 1 samples, the material came from basaltic rather than granitic parent rocks. "The implication would be that if the weathering products are widespread on a planetary scale, their source region must be similarly wide," Toulmin says. "That in turn implies that there must not be a large amount of granitic-type rock exposed at the surface and available for weathering which would go along with the idea that the planet is by no means so highly differentiated as the earth."

The lander 1 samples, meanwhile, under study for a longer time, are starting to reveal their more detailed secrets, notably including trace elements such as rubidium, strontium, yttrium and zirconium. All four have now been detected, but at extremely low levels compared with most terrestrial igneous rocks. Ultramafic