which clearly embraced all scientific parties to the cholesterol issue, would have carried more weight, but the authors of the board's report didn't even include an epidemiologist.

The Food and Nutrition Board has been repeatedly chided by consumer groups for its allegedly close ties to industry. It was only to be expected that the consumer advocates would resurrect the charge in order to discredit the cholesterol report, and the board made it as easy as possible for them. The report was wholly financed by industry—a USDA contract fell through after objections from the consumer movement—and the two scientists most prominently identified with the report turned out to have industry connections.

The board's controversial recommendations on cholesterol were issued not as a fully argued scientific report—that is to be published later—but as a mere 24-page abstract. The abstract did not fully explain why the board differed from the reasoning of other authorities, including that of its own Committee on Dietary Allowances. Academy officials contend that there is no contradiction between the two groups, but the chairman of the Committee on Dietary Allowances is one who believes otherwise.

The Academy's review system did not in this instance seem to have worked as well as it might have done. The Report Review Committee appoints special panels to vet reports that could give problems. It reviews more than 10 percent of the Academy's reports, but did not review "Toward Healthful Diets." Both the chairman and vice-chairman of the Report Review Committee read the report, but neither recommended it for review by their committee. Instead, it was assigned for a lower level of review.

Truth is one thing; credibility is another. The two are usually found together but not always. Cassandra was one instance of their separation. "Toward Healthful Diets" comes close to being another.—NICHOLAS WADE

Reprocessing Plans May Pose Weapons Threat

Political resistance and technical limitations will constrain nonproliferation safeguards at nuclear fuel reprocessing plants

The large-scale reprocessing of nuclear fuel being considered in several nations, including the United States, will place substantial pressure on the fledgling system of international safeguards against the proliferation of nuclear weapons. Experts say that safeguards technology is not evolving quickly enough to detect major diversion of weapons-grade plutonium from a commercial-sized reprocessing plant. They add that in any event a trickle diverted from such a plant may never be detectable.

Among all types of nuclear facilities, reprocessing plants pose perhaps the greatest challenge to the international safeguards system. About 150 tons of plutonium would be processed at such plants annually, but it requires only 8 kilograms or less to create a bomb. Illicit diversion is possible because such small amounts are frequently lost in reprocessing plant pipes, to be found only when the plants are inventoried at long intervals, or simply to be chalked up as routine loss beyond the operator's control. Routine, acceptable losses often run as high as 5 to 10 percent of the total plant output. Once the necessary amount of plutonium has been gathered, a weapon can be made in as little as 7 to 20 days; thus a diversion must be almost immediately detected and exposed—a capability not now available.

Britain's reprocessing plant at Windscale, shown here, is being renovated to accommodate more spent reactor fuel from domestic and international customers.

These risks are important in view of a new policy under consideration by the Carter Administration (*Science*, 6 June). Were the policy to be adopted, the United States would grant blanket authority for the reprocessing of nuclear fuel for use in breeder reactor programs between now and 1990. The present U.S. policy is to discourage both breeders and reprocessing by exercising control over much of the world's fuel supply. With blanket U.S. approval, existing plants in France, England, and Japan might reprocess larger quantitites of spent nuclear fuel, and other countries such as Italy, Belgium, Sweden, West Germany, Taiwan, and even the United States, might be encouraged to start constructing new plants (*Science*, 20 June). The new Administration policy would also facilitate designation of international plutonium storage sites, where reprocessing might occur under as yet unspecified conditions. With more reprocessing under

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way, the international safeguards system now supervised by the International Atomic Energy Agency (IAEA) will be sorely strained.

"IAEA will have difficulty assuring the international community that a nation operating a commercial reprocessing facility is not diverting material for weapons," says a recent report by Congress' General Accounting Office (GAO). "IAEA has no experience in safeguarding commercial facilities and believes that limitations of existing international safeguards would prohibit it from detecting material diversions of significant quantities in a timely manner if these facilities were currently operating."

The IAEA, based in Vienna, now inspects four reprocessing plants, each considerably smaller than those on the drawing boards. In a typical plant, spent fuel rods are stored in a cooling pond, chopped into pieces, and immersed in an acid solution; the liquid is separated into different streams; plutonium in one stream is then purified and concentrated, and the wastes in another are stored. Diversion could occur at almost any stage, through an undetected pipe or by collecting normal leakage. Timely detection is nearly impossible, since IAEA inspectors must wait until the plants shut down for maintenance or cleaning in order to measure the quantities of nuclear material, with gaps of roughly 6 months in between. Only through supplemental efforts of physical security and plant surveillance has the agency been able to obtain rough assurance that diversion is not occurring at the four existing plants.

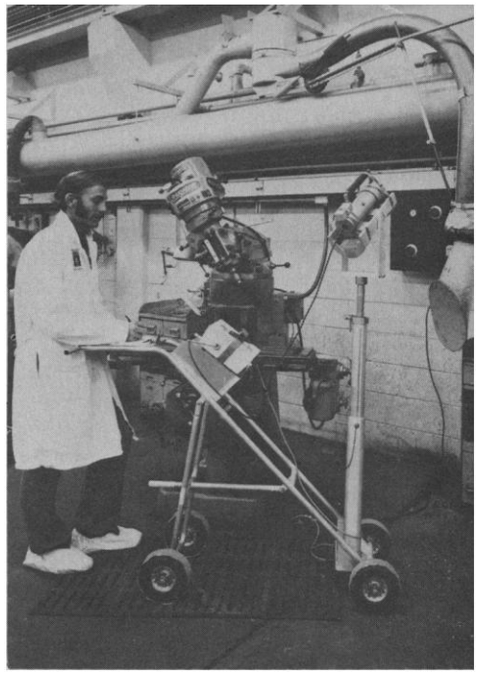
These obstacles become critical at larger facilities, as evidenced by repeated U.S. failures of accounting at large enrichment and reprocessing plants that supply the U.S. weapons program. The Nuclear Regulatory Commission (NRC) has detected huge discrepancies in the amount of nuclear material entering and leaving these plants, many unexplained. According to a recent NRC study, 375 losses of nuclear material occurred within the last 5 years alone. A shortage of 145 kilograms of plutonium that turned up on the accounting books at the military's Savannah River, South Carolina, reprocessing plant from 1955 to 1978, was attributed primarily to inaccurate measurement. Similarly large amounts of plutonium and highly enriched uranium were found to be missing at plants in Erwin, Tennessee, and Apollo, Pennsylvania. Federal investigators publicly said they did not know if an illicit diversion had taken place at Apollo, while rumors persist that part of the missing material made its way to Israel for use in its own weapons program.

Roddy Walton, a group leader for safeguards technology at the Los Alamos national laboratory, points out that measurement techniques have improved dramatically since these incidents occurred in the 1960's, "when the industry did not have the accounting system you see in a Coca Cola plant." Scientists at Los Alamos have developed sophisticated devices that permit the IAEA to detect diversions at several vulnerable points in reprocessing. For example, they pioneered a nondestructive nuclear assay that permits uranium and plutonium measurement while a nuclear facility is in operation. Portable devices just now coming into use by IAEA inspectors compute gamma-ray, x-ray, and neutron emissions from process streams.

These devices are being used to supplement older, more time-consuming chemical analysis techniques. If they were permanently installed in a properly designed plant, they could circumvent the need to await a plant shutdown, satisfying the demand for timely detection. Because of recent and projected improvements in accuracy, they could also limit measurement uncertainties to around 1 percent. Los Alamos scientists say this projection is based on experience with such a system at Los Alamos' own reprocessing plant. But a similar, more advanced system urgently needs testing at a commercial plant, much larger and less carefully controlled than the one at Los Alamos, the scientists say. There were hopes that such testing might be conducted at the new Japanese reprocessing plant near Tokai Mura, which depends on American approval for its initial fueling. But Japanese resistance eventually wore down U.S. negotiators, according to Los Alamos scientists who participated. They add that the Japanese were pressured to resist by the French, the sellers of the plant. The French allegedly opposed the test because they feared it would lead to new design requirements and higher costs for future plants.

The IAEA is not prepared to force anyone to adopt the latest safeguards techniques, according to William Chambers, deputy assistant director for safeguards research at Los Alamos, "partly because the IAEA hasn't got the manpower to oversee it all." The United States also lacks determination to force the technology on others, he says.

Yet in the view of Chambers and his colleagues, the only way the techniques will come into wide use is through successful demonstration at a large plant.



This portable instrument developed at Los Alamos assays plutonium by measuring gamma-ray emissions. It can be wheeled next to reprocessing machinery, ducts, filters, and pipes, obviating the need for a plant shutdown.

They suggest that the United States should restart its own commercial reprocessing—an ironic suggestion because in 1977 President Carter ordered a halt to U.S. commercial reprocessing plans for the same goal of nonproliferation. Now safeguards scientists bemoan the loss of a potential test site for their equipment. "We won't know how to safeguard processing at the international level if we don't use the Barnwell, South Carolina, plant [where construction ceased] to demonstrate some of these techniques," says James Shipley, group leader for integrated safeguards systems at Los Alamos. The GAO notes that better use could still be made of existing or planned military facilities.

Even without a commercial test site, technological improvements can be made. At present, the most critical uncertainty in measuring the plutonium flow occurs in analysis of a spent fuel rod, analysis that now depends on a mathematical formula with an average error of 10 percent. Since the plutonium cannot be accurately estimated at start, detecting a theft by the finish becomes highly problematic. But there is hope ahead. "We are 3 to 5 years away from having an accurate fuel rod assay system," says Chambers.

The GAO comments that such improvements might be available earlier if the Department of Energy (DOE) managed the research better and gave it a higher priority. "The current program lacks management support, direction,

and control," the auditors claim. Responsibility is fragmented among the Argonne, Brookhaven, and Los Alamos labs. DOE admits that safeguards for reprocessing have had a low priority since Carter decided to defer plans for a domestic plant. Chambers comments that "a lot of external pressures for research and development disappeared when the end product was deferred."

With a high priority and adequate management, the scientists say, reprocessing plant safeguards will evolve to the point where a total system can detect a short-term diversion of enough plutonium to make a bomb. The catch is that detection of a trickle diversion may never be possible: "We can't meet the safeguards requirements on long-term diversion, and we may never be able to," says G. Robert Keepin, a Los Alamos engineer who developed many of the nondestructive assay devices. The GAO notes that in commercial-sized plants, even a 1 percent measurement uncertainty "could result in as much as 150 kilograms of plutonium being unaccounted for per year," or enough for numerous weapons.

Should the technical obstacles eventually be overcome, political problems will remain. Advanced safeguards devices will continue to be resisted by nations considered most likely to build a bomb. Numerous suspect states have failed to ratify the international nonproliferation treaties by which safeguards are imposed; these states include India, Pakistan, Israel, and South Africa. No major developing nations except Mexico and Iran have agreed to the safeguards. Harry Rowen, a Stanford economist who opposes reprocessing, says this situation is not likely to change. "Are we really going to have a bunch of people sitting around watching plutonium in Iraq, Pakistan, Taiwan, and South Africa? The safeguards people must be joking. Just think of the political realities." Even the developed countries have resisted the notion of a permanent international inspector in residence at a nuclear facility.

In an attempt to broaden the appeal of safeguards, U.S. experts have recently deemphasized the political implications and promoted their value to internal accounting, which enhances efficiency, reduces radiation hazard, and facilitates quality control. The Los Alamos laboratory sponsored a safeguards training course in May for representatives of the Third World that was presented on this theme. Taiwan, South Korea, and Pakistan, each considered a potential weapons-builder, sent delegates.

But it is obvious that such sales efforts have a long way to go in the world community. Even with wider acceptance, safeguards will not prevent reprocessing plants from posing a proliferation risk.

—R. JEFFREY SMITH

Storm Warnings for R & D Funding

AAAS symposium speakers see short-term pressure, longer term threat to federal science budget

This year's AAAS R & D colloquium was a time for second guessing a "confused and confusing" budget process and for sober second thoughts on longer term prospects for science funding.

"Chaos and disaster" were prophesied for some sectors of the science budget if present tendencies on Capitol Hill persist. In the longer run, R & D was seen as being forced into direct competition with other claims on federal funds and on terms disadvantageous to science.

The theme of the 2-day meeting in Washington was "R & D in an Inflationary Environment" and most speakers subscribed to the view that as a result of inflation and other developments in the economy and of changes in the budget process itself the barriers that previously protected the science budget have been breached.

The background for the discussion was the unfavorable turn in the fortunes of R & D early this year. President Carter's original budget submitted in January provided modest increases in spending on research (*Science*, 8 February). When the surge of double-digit inflation continued, Carter took the unusual step of submitting a revised budget in late March as an anti-inflation measure.

The Administration's revised version shielded R & D from heavy cuts. In the ensuing sharp clash between the White House and Congress over where to make cuts necessary to bring the budget into balance, Congress has been much harder on R & D. The issue is now very much up in the air.

> The old system of congressional committee territoriality, under which science was protected, has broken down.

From House budget committee chairman Robert N. Giaimo (D-Conn.) the colloquium heard a situation report on the budget and a lecture in practical politics. According to Giaimo, a main result of reforming the budget process in Congress has been to break down the old system of committee territoriality under which science and other special-purpose budgets were insulated.

Giaimo acknowledged that the balanced budget was likely to be upset by federal spending in response to the recession, but argued that a balanced budget was not seen as a "cure for inflation," but rather "as a way to get some form of control on federal spending."

The upshot for science was that "When you work within the constraints of a budget in balance you have to compete with other people fighting for their programs."

Inside Congress, said Giaimo, "When we are faced with competition, as we are today, there is a temptation to shortchange the programs where the pressures are more bearable. There's always

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