many preclinical departments, more student teaching could be done without seriously detracting from the other important activities of the professional faculty, and that small increments in numbers of teachers can result in large increments in numbers of students (*13*). While this view does not go unchallenged, enrollments of upward of 200 students per class are not uncommon in the United States, now. There are no reasons to suspect that such numbers would not be realistic for British schools.

The fundamental principle of the Todd commission recommendations is the "divided" school, with preclinical teaching in one place, and clinical teaching in another. This is as Oxford and Cambridge used to be. The Oxbridge schools are now building to the day when they will be able to provide all clinical instruction for their students in their own clinical facilities. With regard to London, the results of my survey, and the alternative proposals that have been discussed, would imply that the Todd commission recommendations for increased school size make good long-range planning, but that removal of the preclinical departments from proximity to their parent teaching hospitals is misguided and, in the long run, ruinous to the preclinical departments.

Finally, the Todd commission recommendations with regard to London have relevance to other medical educational problems in the United States. London is a great metropolis with 12 medical schools, and it is the only city in Great Britain with more than one medical school. In the United States, there are many cities with more than one medical school and six cities have three or more. Competition, conflicts, and duplication are inevitable in these situations. The Todd commission recommendations on London provide a model, albeit imperfect, of overall planning for medical education and, therefore, for health care, in American cities with more than one medical school. While "Todd pairing" has many opponents, in those instances where such pairing is already being put into effect there are many evidences of the pairs gaining mutual benefits, including the centering of excellence in certain clinical disciplines at one institution or another, and long-range planning for shared or coordinated laboratory and teaching services.

Conclusion

In the United States, circumstances still permit each university to set its own course under relatively broad and generous guidelines. The options for our faculties are relatively unrestricted and they can play important roles in determining university policy. We need never reach a stage which many can label "crisis," if events are predetermined by appropriate planning. The survey described herein points to the need for specific long-range planning of the future of preclinical departments in each university. The overall health care system is clearly involved in the problems described in Britain. The coming of a new order of health care in the United States should cause planners to accelerate their work.

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NEWS AND COMMENT

Plutonium (I): Questions of Health in a New Industry

Will Martin is an assembly-line worker at an automobile plant near Buffalo, New York. He is a genial and soft-spoken bachelor of 29, and a troubled young man. Doctors have told him that he has little reason for concern, but Martin worries nonetheless about the possible effects on his future health of an unusual and very modern kind of industrial accident he suffered 7 years ago.

It happened one September afternoon in 1967 while Martin was employed at a nuclear fuel reprocessing plant located in the green rolling hills south of Buffalo and owned by Nuclear Fuels Services, Inc., a subsidiary of the Getty Oil Company. The $35 million plant, which is closed down now for repairs and a major enlargement, chemically extracted uranium and by-product plutonium from the used fuel rods of nuclear power reactors. Simply put, Martin's accident amounted to breathing at the wrong time and place (see page 1028), with the result that he inhaled a massive dose of airborne plutonium.

He left the plant in 1968, but much of the plutonium is still inside him. He remains in apparently robust health, but he wonders about the future. It is true, doctors have told him, that plutonium is one of the most potent carcinogens known, at least in animals. But it is also true, they have pointed out, than in 30 years no human malignancy or other illness has been tied to plutonium inhalation. But the doctors aren't sure why, and Martin continues to worry that the mildly radioactive "hot spots" in his chest and underneath his sacrum may, in time, lead to cancer.

"What does this really mean for me, that's what I want to know," he said

in a recent conversation in the living room of his parents' home. He answers his own question: "I guess I won't know what's going to happen until it happens."

"Will Martin" is a pseudonym, to protect the man's privacy, but his experiences and his anxieties are real. In many ways he is typical of a small but growing number of Americans—a little more than 200 out of some 10,000 who have worked with plutonium—who have accumulated a "body burden" greater than radiological health authorities consider safe or pru-

On Inhaling Plutonium:

It was less of an "accident" in the ordinary sense of the word than an indiscretion, a momentary lapse of discipline whose consequences thus far have been either nonexistent or too subtle to detect.

Martin had gone to work in 1965 at the Nuclear Fuels Services reprocessing plant at the age of 19, directly from the Army, and 2 years out of high school. Lacking any special skills in nuclear matters, he was designated as an "unlicensed operator" and assigned an assortment of tasks such as decontaminating equipment, helping to load reclaimed plutonium and uranium for shipment and storage, and taking samples from the plant's chemical process lines. All of these tasks involved a relatively high risk of contamination in a plant that was quickly gaining a reputation for such accidents.

On the afternoon of 9 September 1967, Martin's assignment was to enter the "Sample Extraction Aisle"—one of many airtight, concrete corridors in the plant's massive, windowless main building—to fill seven glass vials with plutonium nitrate for laboratory analysis. The sample area was known to be heavily contaminated from leaks and spills, and regulations called for a "contamination suit." More a cocoon than a suit, it consisted of two pairs of coveralls, multiple layers of plastic and rubber gloves and shoe covers, a cloth hood, and a heavy rubber "respirator" that looked like a gas mask.

Martin recalls that temperatures in the sample aisle that day hovered near 90 degrees. His task took more than an hour. The air that came through the face mask filter was hot and stale and smelled of rubber and sweat. Perspiration streamed down his face and steamed the window of the mask. At 4:35 in the afternoon, as he stepped through an airlock and out of the aisle, the foremost thought on his mind was to breathe fresh air, and that was his undoing.

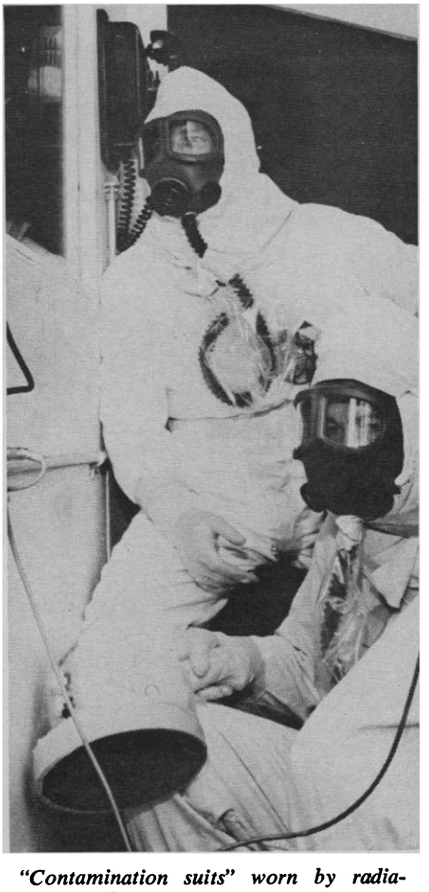
His suit was laden with plutonium dust by now, and to avoid inhaling it meant following an elaborate minuet of disrobing. First would come the outer shoe covers and gloves, followed by the outer coveralls. Then, without breathing, would come the face mask and hood, to be sealed in a plastic bag. Then and only then was breathing allowed.

Martin couldn't wait. He got as far as the first shoe covers, then pulled off his hood and mask and gulped fresh air. As he moved toward the radiation monitors, the alarms went off.

Someone stepped toward him with an alpha radiation counter. It buzzed madly near his hair and hands. Plutonium dust was up his nose and down his throat. A technician held the microphone-like probe near his mouth. Martin exhaled and the instrument's counter swung off scale. Even his breath was radioactive.

Health and safety technicians sped Martin to an emergency room for decontamination. Several hours later, after repeated "nasal douches" with saline water and several shampooings to remove external plutonium dust, Martin was sent home. No one yet knew how much he had inhaled and how much was left in him, but he remembers that someone told him that night to drink beer—that urination would help remove whatever remained. Martin replied that he didn't drink.

It was an unsettling experience, but Martin continued working at the plant as health technicians awaited the results of a urinalysis. A few days after the incident the results came back from a Buffalo laboratory: ordinarily one "alpha count" per minute from a liter of urine indicated some degree of inhalation; Martin's registered 7800 counts per minute, indicating an inhalation of 40 to 50 times the maximum permissible lung burden.



"Contamination suits" worn by radiation workers.

By now the AEC had begun to look into the incident, and company doctors decided to hospitalize Martin for treatments to accelerate his excretion of plutonium. It was to be as alien an experience for the Bertram Chaffee Memorial Hospital in the small rural town of Springville, New York, as it was for Martin. To the medical staff, he was a source of trepidation and an object of curiosity. Here, he began to learn first hand about the mystique, and the stigma, that is part of being a radiation accident "victim."

"All they knew was that I was a contamination case. They didn't know what to make of it," Martin said in a recent conversation. "They covered the walls and corridors in plastic, I guess because they thought I'd spread the stuff."

Treatment consisted of several intravenous, 1-gram doses of a chelating agent called DTPA (diethylene tri-

dent for this metal. It would be an exaggeration to say that their lives are in jeopardy, or, alternatively, that they have absolutely nothing to worry about. Some reassurance can be gleaned from the fact that detailed medical studies of some 25 GI's heavily dosed with plutonium at Los Alamos during World War II have revealed no signs of disease over a period of 30 years. But the truth seems to be that the long-term occupational health effects of plutonium are still very much a mystery.

It is not a trivial mystery, for a small commercial plutonium industry now

One Man's Long Story

aminepentaacetic acid) that chemically captures heavy metal compounds and aids in flushing them through the kidneys and intestinal tract.

Martin lay in bed for a week, feeling fine except for the needle in his arm and the doubts and uncertainties that had begun to settle upon him. Company officials, fearing that events might seriously upset Martin, briefly barred AEC investigators from interviewing him. While the AEC was barred from his room, Martin recalls, nurses and other hospital staff peered in on him more often than seemed necessary. "They seemed to think something was happening to me, maybe that I was changing, growing vampire teeth, or something."

Several years later, the hospital's administrator would confide to an AEC official that he and his staff were a bit leery of treating contamination victims from the nuclear plant. The administrator guessed that perhaps half the medical staff would be willing to respond to a radiation emergency at the plant.

By October, Martin had returned to work but was restricted from further contact with plutonium. He had begun the first of a series of "whole-body counts"—six scanning sessions, all with negative results, would ensue in the next 4 years—but the story does not end there.

Martin says the company assured him that he was "clean," but before long he began experiencing crushing headaches that he attributed to a new sensitivity to radiation. The headaches would last 3 and 4 days, and the best his doctor (who was also the plant physician) could suggest was that he needed an eye examination. Martin's solution instead was to leave the NFS plant, in October 1968, for a new job that involved no contact with radioactivity.

Although assured that he was free of plutonium, the company continued to contact him occasionally for additional whole-body counts. A seventh came in July 1972. This time the results left Martin badly shaken. The first six had been negative, but this one showed plutonium deposits in his ribs and lungs—as much as 98 nanocuries, or 2.5 times the maximum permissible body burden.

For several weeks Martin brooded about this turn of events. He confided to friends that he was worried about leukemia. He broached the subject of workman's compensation to a lawyer acquaintance, but the lawyer, noting that he was in apparent good health, told him it was a rather "strange" case and one that he was not qualified to pursue. Then in early February 1973 he appealed to the AEC for help. It was a long, handwritten exegesis of the accident and subsequent events and it ended by saying that "I never had the shakes before, but now since I have been told this I am shaking frequently. I appeal to you for help in my case."

The letter was addressed only to "Atomic Energy Commission, Washington, D.C.," and it posed a test of the severest kind for a large bureaucracy. In this case, the AEC responded swiftly and beyond the bare requirements of the law.

Within a few days the letter had reached James P. O'Reilly, the commission's chief regulatory officer for the region covering Buffalo; he and his inspectors were intimately familiar with the NFS plant and its long history of contamination incidents. O'Reilly sent inspectors to the plant to dig up Martin's files and interview the principals in the case. Later, the commission hired a medical consultant to review these records and the new analyses that would be made. New radioanalyses of urine were performed. The AEC made arrangements for Martin to travel to the Monsanto Corporation's Mound Laboratory in Dayton (a major weapons facility) for another, authoritative whole-body count. The conclusion now was that Martin retained 40 nanocuries, the maximum permissible body burden. AEC officials say they discussed this with him, and assured him that there is very little chance of harm resulting.

The AEC had gone to considerable expense to set Martin's mind at ease. To headquarters, O'Reilly justified it on grounds that it was useful research—another bit of data to calibrate internal dose measurements. He also had a more personal justification: "When a guy gets different answers from different people and he's frightened to death, then it's time for the government to step in."

Martin says he was impressed with the way the AEC stepped in without taking sides. He seems to harbor no real bitterness toward the company, which bore the cost of the initial treatment and subsequent tests. And still, questions remain. Clutching a thick sheaf of papers from the AEC's medical consultant, which explained the test results in rather technical terms, he still wonders what it all means. "How do they know nothing's going to happen? Who's going to compensate if something does? I feel that I'm at a standstill in this now," Martin says.

The record of 30 years of human contact with plutonium is strongly in his favor, but statistics are cold comfort to a man in doubt. And he is not alone. A friend, who underwent a similar experience at the same plant in 1973, was briefly hospitalized shortly thereafter for an emotional disturbance. Martin's friend believes that a contributing factor was the gnawing and persistent uncertainty that goes with being "contaminated." However little physical basis there may be for such concerns, it is a Promethean punishment that they share. "He will always be questioning himself, always wondering," says the friend.—R.G.

stands at the threshold of a major expansion in the 1970's, as the stuff of bombs takes on an important new role as a fuel for generating electric power.

The vast majority of human exposures and overexposures to plutonium during the past 30 years have occurred, in the name of national security, in the half-dozen huge and quasi-secret industrial plants from Hanford to Los Alamos to Denver and Dayton and Aiken, South Carolina, that comprise the nation's nuclear weapons complex.

In the past few years, however, a new pattern has begun to emerge. Increasingly, and with a frequency that seems disproportionately high, incidents of plutonium inhalation are being recorded from a small group of privately owned and operated facilities engaged not in weapons work but in reclaiming plutonium from reactor fuel and recycling it in new reactor fuel. The Nuclear Fuels Services plant near Buffalo is one such plant. Two others are the Nuclear Materials and Engineering Corporation (NUMEC) plant near Pittsburgh and a Kerr-McGee plant at Cimarron, Oklahoma. Both are engaged in making plutonium fuel—mainly for the Atomic Energy Commission's Fast Flux Test Reactor at Hanford, Washington, a key element of the government's breeder reactor program.

A fourth company, Gulf United Nuclear Fuels, produced small amounts of plutonium fuel at a Long Island laboratory between 1970 and 1972, then dropped out of the field after a fire and explosion on 21 December 1972 injured one worker, contaminated two, and, according to AEC's investigative report of the accident, "grossly contaminated" a working area with plutonium.

The three remaining companies, plus five others waiting in the wings, form the vanguard of a budding new "commercial" plutonium industry. In spite of a strikingly blemished safety record chalked up by the active three, and in spite of the continuing uncertainty of the occupational health hazards involved, the AEC is moving now to encourage a major expansion of the plutonium fuel industry.

Having thought about it since the mid-1950's, the commission has concluded that the time is ripe at last for "plutonium recycling." By the time this new industry hits its stride in the late 1970's, the AEC expects to have licensed three large fuel reprocessing plants and eight big new fuel fabrication plants handling a flow of 7000 kilograms of plutonium a year—a vast increase over the present-day trickle of a few tens of kilograms. With the advent of breeder reactors in the 1980's, the AEC predicts, the flow will swell to several tens of thousands of kilograms a year. The justification for all of this is that not recycling spare plutonium to generate electric power would be a waste of a natural resource; and using it in present-day reactors is expected to reduce the nation's annual demand for uranium by as much as 10 percent.

Because of its extreme toxicity and its tendency to burn spontaneously, plutonium is customarily treated with a degree of caution accorded few other substances. When possible, it is handled by remote control; when human hands are necessary, it is handled in clear plastic or glass glove boxes, with arm-length rubber gloves built into access ports. Working areas are briskly ventilated and air is finely filtered. Air samplers and radiation monitors abound and, ideally, they work.

The safety record compiled by the three main commercial processors is subject to differing interpretations, but from a review of inspection reports made public by the AEC, it is hard to see that any of them is quite in command of the technology.

The record reveals a dismal repetition of leaks in glove boxes; of inoperative radiation monitors; of em-

NSF Gets a Record $768 Million

The National Science Foundation (NSF) budget for the current fiscal year will be $768 million—a record high and about $100 million above last year's figure. Some $666 million of the total was included in a regular appropriations bill signed on 6 September by President Ford and the rest provided in special energy R & D funds. Although NSF must now work out the apportionment of the money to programs with the Office of Management and Budget, NSF officials expect a substantial increase in funds for the agency's basic research budget as well as for energy research.

NSF's RANN (Research Applied to National Needs) program is scheduled for another big increase this year with $149 million earmarked for the program. Congress voted a $50 million limit on RANN research not related to energy this year. Last year, RANN spent a total of about $93 million with nonenergy research limited to $47 million.

The time may not be far off when a beginning will be made in shifting energy research projects from NSF authority. The assumption has been that RANN would initiate research in major problem areas and then transfer the R & D programs to operating agencies. Passage of a bill creating an Energy Research and Development Administration (ERDA), which is now before a House-Senate conference committee, would create a new base for energy R & D.

Science education, a section of NSF which hasn't shared the rising trend in the agency's budget in recent years, will actually have its funds reduced from $67.5 million last year to $65.15 million for this year. Also singled out for restraint was research in the social sciences. As a result of misgivings over the record of social science research in NSF expressed in Senate hearings, particularly by Senator William Proxmire (D–Wis.) (*Science*, 16 August), it appears likely that expenditures will be held at about last year's level of $41.8 million.

NSF officials expect a sizable increase in funds this year above the $291.3 million spent last year in scientific research project support, which goes primarily to fund basic research in the universities. Despite spending floors and ceilings imposed on certain portions of the NSF budget by Congress and cuts decreed by the Executive, as much as $50 million more may be available for basic research. Inflation, of course, will reduce the effects of any increases.

Congress this year has been more active than usual in attaching instructions for spending on specific programs. As a result, NSF officials regret having less flexibility in allocating funds among programs, but in general seem pleased with the size and shape of this year's budget.—J.W.

ployees who failed to follow instructions; of managers accused by the AEC of ineptness and failing to provide safety supervision or training to employees; of numerous violations of federal regulations and license requirements; of plutonium spills tracked through corridors, and, in half a dozen cases, beyond plant boundaries to automobiles, homes, at least one restaurant, and in one instance to a county sheriff's office in New York.

The following compilation of exposure incidents is based on interviews and on inspection and investigative reports made public by the AEC:

Nuclear Fuels Services. At least 15 separate incidents between late 1966 and early 1973 exposed at least 38 persons to "excessive concentrations of radioactive materials" and all inhaled or ingested these materials. Amounts generally were below maximum permissible lung or body burdens, although measurements often proved faulty or imprecise.

An incident at the NFS plant on 5 January 1973 seems typical, although it occurred after the plant had closed for decontamination and enlargement. As two workers were pumping contaminated water into a tank, the hose slipped free, spraying one with radioactive sludge from a decontamination pit.

"I ducked but it caught me right in the face," the worker told *Science* in a recent interview. (He and others were located in spite of the fact that the AEC deletes workers' names from reports it releases to the public.) "The water had filter medium in it that catches fission products from the pit," the man explained. "I remember that it tasted gritty."

A Geiger counter held near his face registered 15,000 counts per minute. This contamination was removed by repeated scrubbings, but later analysis showed that he had inhaled or swallowed small amounts of radioactive ruthenium, cobalt, cesium, and 12 percent of the maximum allowable lung burden of plutonium.

Kerr-McGee. Since April 1970 the company's plutonium plant, employing 100 workers, has reported 17 overexposure incidents involving a total of 73 persons. An AEC spokesman noted that fewer than 73 *individuals* were overexposed, but that some persons were involved in more than one incident.

The most serious of these was a fire on 5 March 1973 which broke out

A "Giant Step" in Power Pricing

A recent decision by the Wisconsin Public Service Commission may prove to be the opening wedge toward changing the traditional declining block rate structure employed by utilities throughout the country.

The commission, in considering an application for a rate increase by the Madison Gas and Electric Company, said the system of reducing unit charges for electricity for bulk users should be modified in favor of "flat" rates, except in cases where the declining rate can be proved to encourage the most efficient allocation of energy. It also ordered the company to inaugurate a system of peak load pricing, with higher rates set for summer months when air conditioning puts the greatest stress on the system.

What started out as a routine application for rate increases was turned into a precedent-breaking proceeding when two consumer groups, the Environmental Defense Fund (EDF) and a local group called Capitol Community Citizens (CCC), intervened in the case. The commission agreed in all essential respects with the EDF-CCC brief, which argued that a system of "marginal cost pricing" based on estimates of "long-run incremental cost" to the company would lead to efficient energy used at the most equitable cost to consumers. Simply put, this means prices should be set to reflect the actual cost of production and transmission of a customer's gas and electricity and should not be designed, as the declining block rate structure is, to stimulate consumption by reducing unit (kilowatt-hour) prices as consumption increases. Higher unit costs during peak load times reflect the fact that auxiliary generating facilities are inefficient and, therefore, more costly to operate. The immediate effect of marginal cost pricing is to make users aware of the actual costs of their electricity, with the result that sensible decisions by the individual customer are reflected in more efficient energy allocation by the producer. The long-run effect of this policy should be to curb expansion by utilities because price structures will discourage profligate power use and reduce peak demands.

In addition to calling for a winter-summer price differential, the commission directed that different day and nighttime rates be implemented for large industrial users. The cost of metering appears to prohibit time-of-day pricing for small users, but the commission has ordered the company to study and experiment with this policy as well.

Utilities have so far shown little interest in dropping their time-honored rate structure in favor of marginal cost pricing. Yet they may find it to their advantage as fuel becomes more expensive and it becomes clear to them that the days of uninterrupted growth—a phenomenon on which the industry is based—are past.

As the commission chairman pointed out, the Wisconsin case, which took 2 years to wrap up, has become a "national test case on electric rate design." It has received considerable notice among economists as well as environmentalists, and a number of other state public service commissions have asked the EDF, which has already been intervening in selected rate cases around the country, to present its reasoning at similar proceedings.

David Freeman, who heads the Ford Foundation's Energy Policy Project, calls the Wisconsin case "a gaint step out of the promotional age and into the conservation age." It is also tangible evidence of the dramatic shifts in the economy in recent years. Ernest R. Habicht of the EDF points out that the Wisconsin decision embraces well-known economic theories "that have lain on the shelf for the past 75 years." Now, says Habicht, resistance to change has been eroded by the fact that utilities are being "eaten alive" by inflation. Utilities have run out of economies of scale and there is no new technology imminent to reverse the dismal trends. This being so, the declining block rate structure has changed from a lift to a drag.—C.H.

spontaneously in a bag of plutonium waste, contaminating seven persons and a large working area. No overexposures at Kerr-McGee were felt to be "significant," the AEC spokesman said, adding that definition of this term "is something of a gray area."

NUMEC. Figures are imprecise, but the record shows that at least 30 persons (among a working crew of around 100) were overexposed to airborne plutonium in at least 13 incidents from late 1969 to the present. Six of these exposures resulted from repeated leaks in the same piece of equipment—a plutonium oxide sintering furnace—in a 1-month period in the summer of 1973. Fourteen other workers near the furnace were found to have fresh plutonium in their nasal passages but none was counted as having been overexposed.

AEC officials make the point that reports of overexposure do not necessarily mean that a worker has inhaled more than regulations allow. This is because AEC licensees are required to report every instance in which ambient air concentrations of plutonium (and other radioactive substances) exceed prescribed limits, regardless of whether excessive uptake by workers is detected. Mindful of this caveat, S. H. Smiley, the AEC's deputy director of licensing for fuels, says that on the whole "We've had a rather excellent record compared to other industries. These exposures are mostly minor stuff. Nothing in the way of a 'problem' has come to our attention that would cause us alarm, although anything we can do to reduce these incidents, and is practical, is worth doing."

Indeed, the AEC's official registry of radiation overexposures—encompassing events from 1968 to this May—lists only five plutonium inhalation incidents. Two occurred at AEC weapons facilities, one at NFS (the hose incident), and two at NUMEC.

There is an important reason for this disparity, apart from the fact that some overexposures truly represent an intake no larger than that caused by normal, chronic inhalation. It also happens that the registry counts only those overexposures in which inhalation is unambiguously confirmed. And confirming that inhalation has actually taken place—to say nothing of measuring the amount inhaled—is difficult and fraught with opportunities for error.

There are two methods of confirmation and measurement. One is to analyze an exposed worker's urine or fecal voids for plutonium and the other is to scan his body with special radiation counting instruments to pick up emissions characteristic of this element. Both methods—"bioassay" and "counting"—have often produced results of questionable reliability and lung counting equipment is notoriously insensitive. AEC reports contain a number of instances in which "bioassay" data have been lost, mislabeled, or otherwise rendered useless. Moreover, the minimum amount of plutonium detectable by lung scanning instruments often equals half or more of the maximum burden permitted.

"You can measure external radiation doses simply, directly, and unambiguously," Gen W. Roy, the AEC's chief of radiological and environmental health for operations, acknowledged in an interview. "But internal doses are a horse of another color. Quantifying this is extremely difficult."

The end result of this difficulty is that the finding of "less than detectable" amounts of plutonium in an overexposed worker may mean very little, except to disqualify him from inclusion in the official registry.

Given the uncertainties of long-term effects of quantities that are difficult to measure, how does the AEC justify a major expansion of the commercial plutonium industry?

Smiley, among others, contends that most overexposures are minor, and he says that new and more sophisticated plants coming up for licensing will be far cleaner than their predecessors. "There will be more automation, less human contact," he says. "I would look for the number of these incidents to decline in the future."

Roy is similarly sanguine about future plants. "There has been a recognition of this kind of problem. And so much is known now about the design of [plutonium] plants that wasn't known in the early '60's."

Improving the technology of plutonium confinement may help, but past experience suggests that technology isn't everything. At least as essential is an enlightened corporate management, willing to spend money on employee training, on maintenance of equipment, and on adequate staffs of health and safety technicians.

The record thus far depicts a continuing struggle between the managers of the three commercial plutonium plants and AEC inspectors, with the latter scoring only mixed success.

Three times in 1967 and 1968 the AEC presented the NFS plant near Buffalo with the choice of closing down temporarily or being closed down to remedy health, safety, and environmental violations. The denouement of several years' struggle came in a meeting between the two sides at NFS headquarters in Rockville, Maryland, in February 1972. There, AEC officials accused the company of a "failure to make reasonable efforts to maintain the lowest levels of contamination and radiation . . ." and of a "failure to adequately instruct or effectively train employees . . . in the radiation hazards involved in their job assignments."

Three months later the plant began what company officials describe as a long-planned shutdown. Whether it would have been allowed to keep running is problematical. "They were heading for a shut-down," one AEC official said.

At the Kerr-McGee plutonium plant in 1973, AEC inspectors found 16 violations of plant license requirements or federal radiation regulations, all of which regulatory officials attributed to a "lack of management controls" and to inadequate staffing.

Although the AEC has been empowered since late 1971 to levy civil fines for safety violations, regulatory officials say that present policy is to do so only when a licensee fails to take prompt remedial action or seems willfully to disregard AEC regulations and license requirements.

Such apparently was the case this year with NUMEC. In June, the AEC fined the company's Pennsylvania fuels plant $12,000 for 16 separate violations relating to health, safety, and security. This was the first time the commission had fined a nuclear fuel facility. In a 5 June letter to NUMEC, James P. O'Reilly, the AEC's chief regulatory officer for the northeastern states, explained this unusual action by noting that the company's performance during the previous 20 months "indicates a history of repeated violations and unfulfilled commitments to correct violations."

Six days later a pinhole leak in a plutonium glove box at NUMEC contaminated one worker. The amount inhaled was said to be "significant" but nevertheless "far below" the level that would impair his health.

All in all, it would seem that the long-heralded debut of a "plutonium economy" has been less than auspicious.

—ROBERT GILLETTE