

disastrous meltdown or explosion, the Three Mile Island incident would not be too damaging to the industry and might even turn out to be a plus by demonstrating that safety backup systems had ultimately worked. In fact, if nuclear power does not go into a decline after Three Mile Island it may be only because coal is the only other near-term alternative to oil and natural gas for power generation,

and coal is dirty. "If it weren't for coal, we'd be dead," a nuclear industry official told this reporter last year, long before the present uproar.

By the same token, the proponents of energy conservation and solar energy see the Three Mile Island crisis as an opportunity to win support for a greater national effort in these fields. The Council on Environmental Quality will, ac-

cording to Gus Speth, a council member, be working within the Administration to that end. A recent CEQ publication *The Good News About Energy*, which stresses the advantages of conservation, indicates that economic prosperity through this century is possible without building any more coal-fired or nuclear plants than the number now under construction.—LUTHER J. CARTER

Low-Level Radiation: A High-Level Concern

The federal government is gearing up to reevaluate its research and regulatory responsibilities

Over the past year, in what some regard as a rather impressive shift, the federal government has made it clear that the problem of low-level radiation is an important one that needs to be addressed in a more orderly and responsible manner than has hitherto been the case.

The question everyone wants an answer to is this: Are current exposure limits, for workers and the general public, safe? At the same time, two broad institutional issues require sorting out. One is related to setting exposure guidelines and the degree of centralization there should be in promulgating specific regulations. The other, which promises a sustained period of interagency wrangling, is related to the question of who in the federal government should have primary responsibility for research on the health effects of radiation. This has long been the domain of the atomic energy establishment, now embedded in the Department of Energy (DOE). Many think it is time for the Department of Health, Education, and Welfare (HEW) to take the leading role.

Low-level ionizing radiation has become the focus of one of the longer-running scientific debates of our time. Although the major mistakes—notably, exposure of troops and civilians to radiation and fallout from aboveground atomic tests—are now in the past, their legacy persists in the form of simmering uranium mine tailings, cancer deaths allegedly caused by radiation, and perhaps most pertinent to the present, pervasive public mistrust of the DOE and the Department of Defense, agencies believed by some observers to have covered up the true extent of the hazards.

Nature supplies half the radiation the average human being is exposed to in a lifetime. Of man-made radiation, 90 per-

cent is generated in medical uses. The other 10 percent is accounted for by occupational exposure, mostly in jobs in the nuclear fuel cycle (from uranium mining to nuclear waste disposal) and nuclear weapons testing.

It is the last 10 percent that has been the focus of most of the controversy. Two developments have contributed largely to turning the issue from a chronic, low-visibility one into a chronic, highly publicized one. The first has been DOE's decision (and its clumsy explanation for it) to terminate a long-term research contract with Thomas Mancuso of the University of Pittsburgh. Mancuso was cut loose shortly before he started coming up with findings linking some cancer deaths among workers at the government's Hanford Reservation with their exposure to low-level radiation.

The other development was the finding by HEW's Center for Disease Control that troops who had participated in a 1957 bomb test called Smoky had twice the number of leukemia deaths (eight instead of four) as would be expected from the prevalence of the disease in the general population.

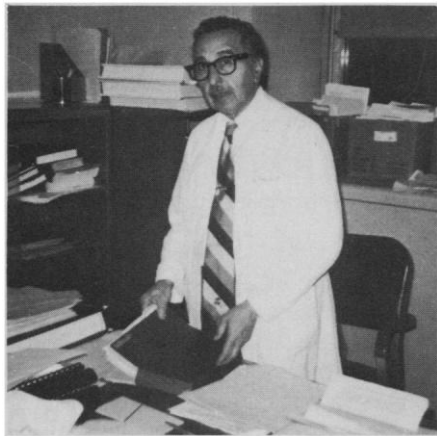
The President, responding to rising concern in Congress, last summer appointed an Interagency Task Force on Ionizing Radiation, headed by HEW general counsel Peter Libassi, to figure out what the federal government's approach should be to the problem of the health effects of low-level radiation. The group's report, issued in March, has produced a number of initiatives. First, Donald S. Fredrickson, head of the National Institutes of Health, has been assigned to oversee a comprehensive evaluation of all federal research on the biological effects of radiation, a job that will probably enlist the services of the Na-

tional Academy of Sciences (NAS). In addition, William Foege, head of the Center for Disease Control (CDC), is to design a research program on occupational exposure to radiation. This will include a study of deaths among employees of Portsmouth Naval Shipyard in New Hampshire, which is already being conducted by the National Institute for Occupational Safety and Health (NIOSH, part of the CDC). In addition, the Food and Drug Administration is to work harder with state governments and medical groups to develop ways to lower overall public exposure to medical x-rays. Still to come is a task force report outlining ways in which institutional arrangements can be changed to make for better coordination in both research and regulation.

The reports, although detailed, are predictably cautious. (The group "drew a conclusion, and that is that the science is inconclusive," said Libassi.) They were the subject of a recent Senate hearing at which they were criticized by some witnesses, including Edward P. Radford, chairman of the NAS committee on the Biological Effects of Ionizing Radiation (BEIR), who said that "bland, noncontroversial reports of this kind are the rule in the science policy area, unfortunately." Nonetheless, it is significant that the President put HEW in charge of assessing the research. In the opinion of a spokesman for the International Association of Machinists and Aerospace Workers, which has 25,000 members in nuclear occupations, issuance of the reports "was the beginning of an admission by the government that we've got a hell of a problem."

The political and scientific issues are inseparable, as illustrated by the Mancuso affair. In 1964 Mancuso was

awarded a contract by the Atomic Energy Commission to conduct what has become the largest and longest-running study ever made of the human health effects of low-level radiation. His subjects were 35,000 former and current employees at the Hanford (Washington) Reservation and 112,000 workers from three installations run by Oak Ridge Associated Universities (ORAU) in Tennessee. The trouble began in 1974, when Wash-



Thomas Mancuso

ington state epidemiologist Samuel Milham, in a survey of death records in the state, found what appeared to be an excess of leukemia deaths among workers at the Hanford facility. The AEC's response to this finding was to urge Mancuso to refute it and to publish the negative results of his own preliminary analyses of the Hanford data. This Mancuso refused to do, saying he still did not have enough information. In March 1975 the AEC decided to phase out the Mancuso contract by mid-1977 and transfer the project to its in-house human health study group at ORAU.

According to documents later obtained through the Freedom of Information Act by Mancuso's lawyer, officials at AEC (later the Energy Research and Development Administration, or ERDA) were feeling uncomfortable about Mancuso's study throughout the 1970's. Even though peer reviewers consistently affirmed the validity of the project, AEC officials were writing memos to each other complaining about the "inordinately slow rate" at which findings were published, calling Mancuso "ineffective" as principal investigator, and expressing doubts that any useful information at all could be gained from the study. In 1976, Mancuso announced that analysis of the Hanford data indicated that 6 percent of the cancer deaths of Hanford employees (about 30) could be attributed to low-level radiation. ERDA, once eager to have Mancuso come out with something in

writing, tried to delay publication of the findings, which appeared in the *Journal of Health Physics* in December 1977.

Even though the decision to terminate the Mancuso contract was made a year before he announced positive findings, environmental groups in 1976 jumped on ERDA, charging that the termination "reflects a well defined pattern of harassment and intimidation of scientists who do not agree with promoters of radiation technology."

Such was the fuss that had built up that the House health subcommittee, then chaired by Paul Rogers (D-Fla.), held 2 days of hearings in February 1978 in which the Mancuso matter was discussed at great length. The DOE did not come out looking good. James Liverman, then DOE's assistant secretary of environment, claimed that Mancuso had been dropped because of his "imminent retirement" from the University of Pittsburgh. Mancuso was 62 in 1975, 8 years under the Pittsburgh retirement age. It was also disclosed at the hearings that the transfer of the project to Oak Ridge had not been preceded by a request for proposal, that there was no peer review of the contractors, no research protocol, and no principal investigator. Rogers subsequently wrote a brusque letter to Energy Secretary James Schlesinger asking what he was going to do about the "serious management deficiencies" in DOE's radiation health effects research program.

DOE's inspector general subsequently reported that the handling of the Mancuso termination was proper; then the General Accounting Office, at Rogers' request, reviewed the inspector general's report. It criticized the decision to transfer the research to in-house labs, but did not find evidence that the contract termination was scurrilously motivated.

But the matter festers on. Mancuso and his supporters, including several labor unions, continue to believe he was cut off because he was finding things the DOE did not want to know, and further—a claim bolstered by old AEC correspondence—that the only reason for funding him in the first place had been "political"—to quell the public's fear about radiation and fend off compensation claims from people who believed they had radiation-induced illness.

It seems clear to DOE's critics that Mancuso was left to shift for himself just at the point where he was prepared to draw some solid conclusions from the Hanford data. Mancuso, now limping along with private funds (he hopes to get some money from HEW), says it will not

be long before he has essentially completed the Hanford analysis—all he needs to do is get data on deaths in the late 1970's. He expects that his 6 percent figure may undergo an upward revision because the new data will be from workers who were younger than the ones already analyzed and who held jobs that exposed them to more radiation than the older workers.

Meanwhile, Mancuso's former funds have been transferred to ORAU for the Oak Ridge studies and to Battelle Labs for further analysis of the Hanford data. The Oak Ridge portion still does not have a principal investigator, although they are said to be looking for an epidemiologist; people at Battelle are conducting their own analyses, which Mancuso says are flawed because the investigators are not controlling for internal radiation. (Some workers also inhaled or ingested radioactive particles, but internal radiation has not received much attention so far, partly because the affected population is small.)

Although Mancuso is not now particularly happy, he can take solace in the fact that his case has helped coalesce a good deal of the current pressure to reduce the role of DOE in health effects research. The radiation research community has lived almost entirely off the energy and defense establishments. The situation is conducive to a monolithic approach to research and makes for at least the appearance of a conflict of interest. It also means that for anyone seeking objective scientific advice it is practically impossible to find someone knowledgeable who was not trained with AEC money.

Last month the DOE monopoly came in for some raps at 2 days of hearings conducted by John Glenn (D-Ohio), chairman of the energy subcommittee of the Senate Governmental Affairs Committee. Radford, chairman of the BEIR committee, noted that DOE controls 78 percent of the government's \$17 million budget for research on human health effects of radiation. Most of the rest is from HEW. He said that 36 percent of the money has gone to government labs, 39 percent to the Hiroshima-Nagasaki studies, and 13 percent to in-house research. This has left only 5 percent for university researchers and 5 percent for nongovernmental groups.

"The science is in the wrong hands. The DOE budget (for health effects research) should be cut by 90 percent," a scientist who did not want to be quoted told *Science*. "The DOE says they don't have enough data, but whose fault is that?" Other observers have complained that DOE puts too much money into ani-

mal studies and not enough into long-term human studies. Says Robert Alvarez of the Environmental Policy Institute, "the only large populations that have been studied are rats, fruit flies, and A-bomb survivors."

Environmental groups are not the least bit mollified by DOE's recently announced plans to have Johns Hopkins University conduct an enormous study of the effects of radiation on the health of 250,000 current and past employees of seven shipyards around the land. It will go back to the 1950's, when they first started putting nuclear power plants in boats, and is supposed to take 2 to 5 years. Ruth Clusen, DOE's assistant secretary for environment, extolled the study as "the largest study of its kind ever undertaken" and proudly noted that Johns Hopkins was above suspicion, having "no previous relationship" with DOE. Chief investigator Genevieve Matanoski explained that it was an "ideal study" because the total exposed population of 90,000 could be matched with an unexposed control group who otherwise had exactly the same sorts of jobs.

Nonetheless, the study has been widely criticized. On 15 March the machinists' union sent a letter to 71 members of Congress accusing the DOE of "tenuous" motivations, criticizing the shipyard study as duplicative and of questionable value, and reiterating its de-

Mancuso also says shipyards are not a very good choice because there are more toxic and carcinogenic materials to distort the findings at a shipyard than at an energy facility. What's more, he says, there is no evidence that the radiation monitoring has been reliable. In short, the study represents to many, including Carl Z. Morgan, of the Georgia Institute of Technology, the "father of health physics," nothing more than a bid by the DOE to hang on to its near monopoly on health effects research.

Science tried to get the DOE side of the story from Liverman, an old-timer who has been intimately involved, but he refused to talk even over the telephone. Clusen, now his boss, told *Science* that all the arrangements are appropriate and proper. She has repeatedly dismissed concerns about conflict of interest on the grounds that her office is not involved in developing nuclear energy. If people persist in seeing such conflict, "that's in the eye of the beholder," she said.

The lines are less clearly drawn on another major institutional issue—regulation of radiation exposure. The Environmental Protection Agency (EPA) has responsibility for establishing the basic exposure limits, which have long stood at 5 rems for occupational exposure and 500 millirems for the general population (natural background radiation is 100 millirems). Responsibility for writing occupational regulations lies in many hands.

tional-regulation setting (including that for the military) in OSHA, but this would meet opposition from DOE and DOD, many of whose nuclear activities are closely entwined and who like to run their own show.

The EPA, which in the past "has been fought tooth and nail by AEC and ERDA," according to an EPA official, may need additional support in exerting its authority over environmental radiation exposures—that is, exposures for the general public. The agency is getting a gradually expanded purview—in 1978 Congress told it to regulate radioactivity in the air, which puts it in potential conflict with the NRC—but it had to fight hard recently to put through a standard limiting environmental emissions from facilities in the nuclear fuel cycle to 25 millirems.

The substantive question, of course, is whether the 5-rem exposure limit is safe. The DOE says it is. The HEW Interagency Task Force says that there is not yet any evidence indicating that it should be lowered. Mancuso thinks it should be lowered by a factor of 10 (bringing it in line with the exposure limit for the general population). Morgan thinks the limit should be cut in half for now, as a more drastic reduction would kill the nuclear power industry.

Differing risk estimates arise from the fact that scientists are split three ways over the "linear hypothesis," which postulates that the dose-response relation based on findings at high doses of radiation can be extrapolated in a straight line to predict risks from low doses. Before the first BEIR report was issued in 1972, many thought that linear extrapolation overestimated the risk of low-level radiation—that is, they believed there was a threshold below which there would be no ill effects. Now most experts tend to accept the linear hypothesis. But there are a number of scientists who lean in the opposite direction—toward the belief that the linear hypothesis underestimates low-dose risks. Mancuso is the chief proponent of this view.

Although the debate over allowable exposure has often been couched in terms of what is an acceptable risk in view of the benefits to be gained from radiation, Robert Minogue, commissioner at the NRC, makes a telling point: "What's conservative is not self-evident." If the linear hypothesis understates the risk, then lowering the limit could be unwise because it would result in more people being exposed to low-level radiation because more people would be required to do the jobs that entail such exposure. On the other hand, if the hy-

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mand that Mancuso be allowed to complete his project.

The DOE study has been called redundant because NIOSH is already busy expanding and analyzing data on one of the installations, Portsmouth Naval Shipyard, that were originally collected by Boston epidemiologist Thomas Najarian (Johns Hopkins will be feeding the NIOSH information into its own study). Mancuso calls the DOE project a "diversionary study" which may "convey the misleading impression to the public that you have to wait 20 or more years" for conclusive data when his data are already here. (He is assuming the study will be extended because 5 years is too short a time for significant findings. The two oldest shipyards, Portsmouth and Groton, have been installing nuclear power plants only since the late 1950's.)

The major agencies are the Nuclear Regulatory Commission (nuclear facility and certain nuclear materials workers), the Department of Defense (naval shipyards), the DOE (manufacture and assembly of nuclear weapons), the Labor Department's Occupational Safety and Health Administration (OSHA) (hospital x-ray technicians and industrial employees who use radiation in manufacturing processes), and Labor's Mine Safety Administration (uranium mining).

There is much sentiment in favor of centralizing regulatory authority in one agency. Some have recommended the creation of an expanded and more powerful version of the old Federal Radiation Council, whose responsibility for recommending exposure guidelines was transferred to EPA in 1970. There is considerable talk about centralizing all occupa-

pothesis *overstates* the risk (as some pronuclear advocates believe) "we should lower the standard right now because that implies a quasi-threshold" beneath which there would be no detectable risk.

This is the sort of stuff that will be grappled with this summer when the EPA, NRC, and OSHA hold hearings to reevaluate radiation protection standards. Everyone is still waiting for the latest BEIR committee report to supply risk estimates.

An issue that has been riding along on a separate track from the occupational exposure debate is the matter of medical radiation. X-rays are on the increase, although the patterns of use have changed somewhat since the 1950's. Twenty years ago x-rays were used routinely for treatment of benign conditions such as acne, ringworm, and tonsillitis. Research since then has linked low doses of x-rays with increased risk of cancer. One major finding was made by Alice Stewart of Birmingham University, England, who is now working on the Mancuso project. In the "Oxford survey" she established that children whose mothers had been given low-dose diagnostic x-rays showed a higher incidence of leukemia and other cancers. Other studies have linked thyroid tumors with stray radiation—amounting to perhaps 6 or 7 rads—from high doses used to treat ringworm.

Estimates of how much unnecessary diagnostic radiography is going on vary widely. Ralph Nader has said 50 percent is unnecessary; Otha Linton of the American College of Radiology says the figure may be more like 10 percent. The FDA's Bureau of Radiological Health says maybe 30 percent. Superfluous exposures result from many things—faulty or outdated equipment, bad clinical judgment, bad training, pressure by patients, and fear of malpractice suits.

It is well to note that although x-rays are on the increase, the average diagnostic dose is now a fraction of a rad, three or four times less than it was 20 years ago. Better equipment, faster film, electronic image intensification, and more sophisticated use of the technology are responsible. A mammographic breast examination used to deliver several rads—now most exposure has been reduced to less than 1 rad.

Nonetheless, since medical radiation accounts for 90 percent of man-made radiation, the pressure is on to reduce it. The FDA since 1974 has issued standards of performance for x-ray equipment but has no say over its use. There has been considerable discussion about the desirability of requiring licensing for x-ray

technicians—at present only three states have active licensing programs. The HEW Task Force, in view of the paucity of federal leverage, has recommended a vast public education program and the development of model guidelines for accrediting technicians and standard dosages for x-ray examinations.

The amount of medical radiation seems very high in comparison with the occupational dose limit, particularly in view of the fact that more than half the population of the United States is x-rayed in any given year. Linton, however, says the two types of exposure are not readily comparable because the circumstances, timing, and energy levels and characteristics of the radiation are all different. Besides, a medical x-ray is a calculated risk designed to benefit the subject and not a gratuitous dose.

Questions surrounding hazards of low-level radiation are as important as they are tedious because their resolution is essential in redefining the limits of all radiation technologies. Sharper answers will also have to be found if the issue of government compensation for allegedly radiation-caused illness is ever to be settled. So far only a handful of awards have been made to veterans, shipyard workers, and uranium miners. Reducing the occupational exposure limit would weaken the government's defense against claims and against lawsuits such as those now shaping up against the DOE. Last September, 35 Utah cancer victims and their families initiated claims for damages, alleging government negligence in the conduct of bomb tests in the 1950's. The number of claimants, all of whom live in a 90-degree arc around the Nevada Test Site—the same area in which increased rates of leukemia among children have been found—has now grown to 500.

Cancer is, so to speak, the bottom line when it comes to health effects of radiation. There are many other effects, including genetic damage and alterations to the immune system, but these disorders would be extremely difficult to trace to radiation. Another imponderable, about which research has yielded little information so far, is the extent to which various toxic and carcinogenic substances interact synergistically with radiation. So complex are the variables that a colossal amount of research is required to achieve even a small reduction of uncertainty. As an EPA official put it, "when you say when will we get an answer to this question, that is tantamount to saying when are we going to have an answer to cancer."

—CONSTANCE HOLDEN

Supreme Court to Hear Case of Deaf Nurse

Frances Davis is a licensed practical nurse in North Carolina who has been plying her trade since 1967. She is also partially deaf. In 1976 she successfully completed a 1-year preparatory course so that she could enter training to become a registered nurse. But when she applied to the RN program at Southeastern Community College, she was turned down on the grounds that her severe hearing disability would make it impossible for her to pass the state licensing exam.

So Davis went to court. She lost the first round and appealed. The appeals court told the college to reconsider its decision. The college instead asked the Supreme Court to take the case. Now the Davis suit, scheduled to be heard later this month, has become a cause célèbre for the nation's handicapped people as the first Supreme Court case related to controversial section 504 of the Federal Rehabilitation Act of 1973.

Section 504 states that "no otherwise qualified handicapped individual . . . shall, solely by reason of his handicap, be . . . subjected to discrimination" under any federally assisted program.

Davis, who is being aided by the legal defense fund of the National Association for the Deaf, claims that the college, rather than judging her by her demonstrated capabilities, made an arbitrary judgment that her handicap rendered her unfit. According to her lawyer, Cy DuBow, the college based its decision chiefly on a statement from the director of the North Carolina Board of Nursing, who said that Davis's "hearing disability can preclude her being safe for practice in any setting allowed by a license as an RN or by license as an LPN." The director had not met Davis, nor was she aware that Davis had already been working as an LPN.

Twenty-seven states have filed an amicus curiae brief on behalf of the college, as have a number of associations representing higher education, including the American Council on Education and the Association of American Medical Colleges (AAMC). One state—California—has filed a brief supporting Davis. Although a