

people weren't brought up that way, and it requires a change of attitude for them to come around to this point of view."

The stress on profit has had a restraining effect on Harwell's taking on the sort of social problems that have been singled out as suitable for national laboratories in the United States. One exception is air pollution, which has been under study since 1967 by the Health Physics and Medical Department. Work has been done on atmospheric conditions in a heavily industrialized area in the north, but, as one

of the officials of the division put it, "No industry wants to pay us to tell them what a mess they're making of the atmosphere. And we get pressure, in odd remarks, about the need for all parts of Harwell to be profit-minded. We argue back that there's an economic return to be had from stopping pollution, but that it is a long-term one and it cannot be easily measured. Our work goes on," he said, "but there is no question that pollution in the U.K. is still pre-political as compared with the United States."

What lessons does Harwell's appar-

ently successful venture into new fields hold for the national laboratories of the United States? Not many, according to Marshall. "There is no role for a U.S. government laboratory in the field of industrial research. There are other means of handling such research there. But, more important, America's problems are social, not economic, and that, it seems to me, should determine the direction of the national laboratories. Here, our problems are economic. We have to improve the performance of industry, and that comes ahead of everything."—D. S. GREENBERG

Radioactive Pollution: Minnesota Finds AEC Standards Too Lax

In a move that could have national repercussions, the Minnesota Pollution Control Agency (MPCA) announced last month that it will limit radioactive discharges from nuclear reactors to levels considerably below those currently allowed by the Atomic Energy Commission (AEC). If the proposed state restrictions are put into effect, as seems likely, and if they survive a possible court test, the action taken by Minnesota could serve as a precedent and catalyst for further efforts to crack down on radioactive contamination at the state level.

The Minnesota situation is worth examining in some detail for several reasons. For one thing, control of radioactive pollution is expected to become an increasingly important issue throughout the nation as the numerous nuclear power plants now under construction or on order start going into operation in the 1970's. For another thing, a nationally known consultant called in by Minnesota has cast doubt on the adequacy of existing AEC regulations to cope with radioactive effluent from the expected proliferation of new reactors. In a detailed critique, the consultant claims that existing AEC standards treat each reactor as an isolated entity, whereas effective pollution control demands consideration of the combined effect of radiation from multiple sources. Finally, the crack-down proposed by Minnesota has raised important legal questions as to

whether the states can enforce more stringent rules than the AEC, or must simply accept the AEC's judgment as infallible.

The MPCA's "get tougher" policy culminates more than a year of public debate and controversy over pollution from a nuclear generating plant now under construction near Monticello, Minnesota (pop. about 1500), some 33 to 37 miles upstream on the Mississippi River from the water intakes for the "Twin Cities" of St. Paul and Minneapolis. The plant is being built for Minneapolis-based Northern States Power Company (NSP) by the General Electric Company. It will use a single-cycle boiling water reactor, with a net power capability of 545 megawatts, and is scheduled to go into operation in May of 1970. The reactor will be located in a largely agricultural area. The nearest residence is about half a mile away; some 4000 persons live within 5 miles.

The Monticello project at first encountered no particular difficulties. Detailed construction plans were approved routinely by the AEC, the U.S. Public Health Service, the Federal Water Pollution Control Administration, and, at least tacitly, by the Minnesota State Board of Health. Nor was there much hint at an AEC construction permit hearing in May 1967 that the proposed Monticello plant would run into vigorous opposition from the public.

But controversy erupted when the

power company sought a waste disposal permit from the MPCA, a new state agency empowered to protect the public from air and water pollution. At a February 1968 meeting of the fledgling agency, two University of Minnesota scientists—Dean E. Abrahamson, assistant professor of anatomy, and Charles W. Huver, associate professor of zoology—offered sharp and unexpected criticism of alleged pollution perils from the Monticello plant. Soon other scientists joined the cause, including such notables as Maurice B. Visscher, professor and former chairman of physiology at Minnesota; and Eville Gorham, head of the botany department, who gained fame in the radiation field when he first reported the unusual capacity of lichens to absorb fallout and thus increase the radiation hazard in the Arctic food chain.

The concerned scientists laid down a steady barrage of criticism in the press, at public meetings, and in private conversations with MPCA members. Ultimately, many of them joined in a formal organization known as the Minnesota Committee for Environmental Information, which at last count had some 100 dues-paying members, including a smattering of lawyers and other laymen. Abrahamson is president of the organization.

Critics of the reactor voiced some concern over thermal pollution and over the possibility of an accident, but most of the criticism focused on the discharge of low-level radioactive wastes, particularly liquid wastes, during normal operation. Some critics argued that the plant should not be allowed to release any radioactivity to the surrounding environment since all radioactivity is dangerous to some degree. Others urged that radioactive discharges be held to a bare minimum. They charged

that the plant, as designed, might exceed the AEC's effluent standards; that the AEC's standards are too lax anyway; and that plans for monitoring the plant's contribution to environmental radioactivity were inadequate. Several critics accused the AEC of a conflict-of-interest because it is supposed to promote the use of nuclear power as well as protect the public.

In rebuttal, the power company took out full-page newspaper advertisements in which it advanced the rather telling argument that its nuclear plants "will meet every applicable safety standard established by the Atomic Energy Commission." The company said it was "prepared to spend whatever is necessary to insure the protection of the public health and safety," but added that it also had "an obligation to the public and to our customers to make certain that money is not *needlessly* spent to meet arbitrary and unnecessary restrictions."

The company also claimed, in a press release, that liquid discharges from the Monticello plant would contain a lower concentration of radioactivity than domestic tap water; and that a person living adjacent to the nuclear plant would receive radiation equal to about half of what the average American receives from watching television.

Consultant's Recommendations

Faced with a complex technical issue, the fledgling MPCA at first indicated it would defer to the experts at the AEC. But as public pressures grew, the agency reversed itself and hired an out-of-state consultant to help resolve the issue. The consultant chosen, after examination of competitive proposals, was Ernest C. Tsivoglou, professor of sanitary engineering at Georgia Tech, who was chief of radiological water pollution control, U.S. Public Health Service, from 1956 to 1966. Last month Tsivoglou's 192-page final report was made public. It called for stiffer pollution limits and a new philosophy of regulation.

The AEC's existing standards are adapted from the recommendations of the International Commission on Radiological Protection (ICRP), which is considered the world's leading authority on radiation safety. The ICRP has developed a set of numbers representing the maximum concentrations of radioisotopes that should be allowed in air inhaled and water consumed by work-

ers exposed continuously to radiation on the job. Since it is commonly accepted that the public should receive less exposure than workers, the ICRP recommends that these occupational limits be divided by ten to determine the limits for individual members of the public. Similarly, the AEC divides the occupational maximums by ten to determine the concentration of radioactivity allowed in gaseous and liquid effluent from nuclear plants (although variances are often granted). Thus, even if a person drank directly from the effluent pipe of a nuclear plant, he should, in theory, ingest no more than one-tenth of the recommended limit for occupational exposure. And if he drank the water downstream, the radioactivity should be still further diluted.

For years these ICRP and AEC standards have been regarded as more or less sacrosanct. But Tsivoglou argues that Minnesota should get tougher, both because of local circumstances and because of deficiencies in the standards.

The local circumstances he cites are the proximity of Monticello to the Twin Cities and the likelihood that there will soon be many more reactors in the same area. NSP has announced plans for at least four additional nuclear plants in the upper Mississippi basin within 30 miles of the Twin Cities. Tsivoglou says the ICRP/AEC standards neglect the problem of multiple sources of radioactive pollution. He recommends that radioactive discharges be more severely curtailed so that there is room to develop additional nuclear facilities in Minnesota and other Mississippi basin states without endangering the public.

On more general grounds, Tsivoglou claims the existing AEC standards are deficient because they apparently fail to consider potential harm to lower organisms, and because they represent additions to the natural background radioactivity, which may be unusually high in some areas (though not at Monticello). Tsivoglou also argues that radioactivity should be minimized so as to leave a reserve capacity in the environment in case of nuclear accidents, the resumption of nuclear weapons testing, or new findings concerning the dangers of radiation.

To ease the burden on the environment, Tsivoglou recommends a change in the philosophy of radiation control. At present, he says, the AEC's standards are often regarded as permissible dumping limits, despite disclaimers to

the contrary. What is needed, Tsivoglou adds, is a new policy of restricting radioactive discharges to the full extent that is both technologically feasible and economically reasonable.

Proposals for Minnesota

For Minnesota, Tsivoglou recommends that the MPCA establish statewide standards that would limit radioactive discharges from nuclear facilities to about one-third the concentrations permitted by the AEC. On top of that, he recommends that the MPCA require individual nuclear plants to keep radioactive discharges as far below these statewide limits as seems practical.

In the particular case of the Monticello reactor, for example, Tsivoglou recommends that limits on radioactive effluent be tied to figures predicted for actual operations by the contractor and the power company. For the liquid effluent, this means that radioactive concentrations would be limited to values well below Tsivoglou's proposed statewide standards. For gaseous effluent, the plant would be given a limited variance from the proposed statewide standards, but it would still be held below existing AEC allowances. Tsivoglou does not see his regulations as in "conflict or basic disagreement" with the AEC, but as a "proper and suitable" extension of the AEC requirements to meet local needs.

Tsivoglou also recommends that the MPCA consider imposing other requirements on the power company, including demineralization of liquid wastes, and charcoal filtration of gaseous effluent to remove radioiodines, which tend to concentrate in milk. In addition, he recommends a more comprehensive monitoring program, and a requirement that power companies obtain approval from the MPCA before plans for a facility become fixed. Critics of the Monticello plant have complained that construction was well under way before the public and the MPCA became aware of it.

Whether the restrictions recommended by Tsivoglou will make much immediate difference to the Minnesota environment is a subject of disagreement. Huver, one of the original critics, notes that, even though the standards proposed are stiffer than the AEC's, the Monticello plant will still be allowed to discharge essentially the same concentration of radioactivity as the power company originally estimated would be discharged anyway.

Similarly, Clifford K. Beck, deputy director of regulation for the AEC, says that virtually all nuclear reactors actually discharge only about 1 percent of the AEC's radioactivity limits for liquid wastes, so reducing those limits to one-third of their former value might have no practical effect on the radioactivity actually discharged.

So why has the power company called Tsivoglou's recommendations "unnecessarily strict?" Because, says A. V. Dienhart, NSP's manager of engineering, the company wants a margin of error so that it is not subject to legal action if the plant fails to perform as expected, or if an operating emergency causes radioactive discharges to increase above the expected level. Dienhart told *Science* that while the plant will probably discharge only about 1 percent of the AEC's radiation limits during normal cooling operations, these percentages may rise by a factor of 10 during periods of low river flow. At such periods the discharges would thus be of the same

order of magnitude as Tsivoglou's recommended standards. Dienhart is also concerned that the company may have to analyze precisely what isotopes are released, instead of treating the effluent as a gross mixture, as AEC allows.

Legal questions have been raised as to whether the MPCA has the authority to put Tsivoglou's recommendations into effect. Both Howard K. Shapar, the AEC's assistant general counsel for licensing and regulation, and Richard A. Emerick, special assistant attorney general for Minnesota, have expressed opinions that the states do not have jurisdiction to regulate radioactive effluent from nuclear reactors. But Harold P. Green, professor of law at George Washington University and a leading authority on nuclear matters, has suggested that, while the Atomic Energy Act clearly prohibits state standards that are less stringent than the AEC's, it is less clear that the act prohibits state regulations that are more stringent. Green suggests that the question should be litigated.

Meanwhile, according to Robert Tuveson, MPCA chairman, Minnesota is "going to rely on Tsivoglou's recommendations and try to implement them," let the legal chips fall where they may. Neither the power company nor the AEC has yet threatened to go to court, so the regulations might well go unchallenged. If so, Minnesota will apparently have the stiffest radioactivity safeguards in the nation.

This prospect pleases some of the original critics of the Monticello plant, but others feel the regulations will still be too lax. They seek a complete ban on radioactive discharges, a concept Tsivoglou rejects as unnecessary and unrealistically expensive. But even if the critics don't get everything they want, there is no question that the Minnesota protest movement—in which local scientists took the lead and challenged the expertise of distant authorities—has had a significant impact on the MPCA and on public opinion.

—PHILIP M. BOFFEY

Development in the Poor Nations: How To Avoid Fouling the Nest

For the poor nations the word *development* has carried the connotation of something necessarily good—of "progress," of a break with traditional, "backward" ways and adoption of the ways of the technologically advanced countries. A political leader who, with the help of a modern donor nation and the international agencies, can have his country build an Aswan Dam and a "Lake Nasser" clothes himself and his regime with conspicuous symbols of progress and modernity. Although some scientists and conservationists are now worried, it seems that, in the past, little thought has been given to the environmental problems that headlong development may bring.

The price of development has included pollution problems, loss of farmlands and habitat (for people as well as wildlife), and even the spread of disease. Some environmental disruption is an unavoidable concomitant of development, but, as ecologists and other environmental scientists insist,

harmful effects can often be anticipated and minimized if development is preceded by ecological studies and careful planning.

Though the poorer nations remain intent on development goals, and though the industrialized countries continue to encourage them in this, signs are appearing that the commitment to change may come to be tempered with caution. For example, last September, in Paris, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) held a conference on rational use and conservation of the biosphere, and among delegates of the 63 participating nations there clearly was awareness that development often has led to environmental problems.

In December the U.N. General Assembly decided to convene, in 1972, a conference on the human environment, and this meeting, too, will be concerned partly with ecological problems arising from economic development. It may

soon be the vogue to view environmental problems in a world perspective. A recent Sierra Club advertisement in the *New York Times* bore the heading "Earth National Park" and warned that unless his global habitat is better protected, man himself will become an endangered species.

Late last year the Conservation Foundation (a Washington-based organization serving as a "bridge between ideas and action" in the field of conservation) and the Center for the Biology of Natural Systems, of Washington University in St. Louis, sponsored a 3-day conference on the "ecological aspects of international development." This meeting, held at a conference center near Washington, is believed to represent the first ecological "post audit" of international development ever conducted.

The conference participants, numbering almost 70, were mainly scientists (mostly biologists) and social scientists from the United States and abroad. They included such people as S. Dillon Ripley, secretary of the Smithsonian Institution; E. B. Worthington, scientific director of the International Biological Program (IBP), London; Gunnar Myrdal, internationally known Swedish economist; and Barry Commoner, director of the Center for the Biology of Natural Systems.