

to be growing agreement among economists that efficiency in the economy is being significantly hampered by arrangements favoring special interests and by sheer bureaucratic meddling.

There was not much sign at the summit of an impending great leap forward in economic theory. Of course, no Marxist or New Left economists were invited to the Washington session. There is concern among many economists about finding ways to assess the increased impact of international economic developments on the American economy and also to understand domestic economic behavior that doesn't accord with the assumptions which govern orthodox economic policy decisions. But no new "general theory"

appeared to be threatening the Keynesian conventional wisdom.

Macroeconomics, the study of the economy as a whole, which might be expected to produce promising ideas for public policy, seems to be in something of a recession. Microeconomics, the study of portions of the economy, on the other hand, is where many professional economists say the most interesting work is being done these days. Microeconomic study, not only of business firms or particular industries, but of such things as crime, marriage, welfare programs, and environmental problems seems to be yielding illuminating results.

Econometric model builders have had serious disappointments with big

mathematical models of the U.S. economy. Some observers think that, when ways are found to aggregate the new data from the microeconomists into the big models, it will prove possible to improve the quality of the forecasting which is so important to making Keynesian policy work.

It may be that the results of perfecting Keynesian policies would be only academic in the face of the quadrupling of oil prices. The lesson taught by experience with the New Economics of the Kennedy-Johnson era and the Nixon New Economic Policy is that economic theory often gives way to political reality, and this may prove true, in spades, of Fordian economic policy as well.—JOHN WALSH

"Transient" Nuclear Workers: A Special Case for Standards

Buffalo, New York. For the Buffalo area's unemployed laborers, for the moonlighters, college students, and the young men recruited from small farming towns south of the city, the guarantee of half a day's pay for a few minutes' work was an offer they couldn't refuse. Attracted by the prospect of easy money, they flocked by the hundreds to the Nuclear Fuel Services company between 1966 and the middle of 1972 to perform some of the dirtiest jobs in what one official of the Atomic Energy Commission (AEC) calls "the dirty end of the nuclear business."

The business of Nuclear Fuel Services (NFS) is the chemical extraction of uranium and plutonium from the highly radioactive spent fuel rods of nuclear power reactors. Situated in pastoral, wooded hills 40 miles south of Buffalo, the chemical plant was the nation's first commercial fuel processing facility. Although the technology it used was far from experimental, the NFS plant proved less than a smashing technical success. Almost from the time it opened in 1966 until it ceased operating in June of 1972 (for a major repair and enlargement program to be finished in 1977) the plant suffered repeated breakdowns and leaks of radioactivity. To clean things up and make repairs, the company relied heavily on the Buffalo area's abundant labor pool.

During 5½ years of operation, according to correspondence between NFS and the AEC, the company each year hired an average of 1400 "supplemental" workers from surrounding communities, making up a temporary, continually changing work force that outnumbered the plant's permanent, trained operating staff by more than 10 to 1. With an apparent minimum of instruction in safety procedures and the potential hazards of their jobs, the supplemental men were put to work decontaminating equipment and working areas, burying low-level nuclear waste, and repairing radioactive equipment.

Some of these workers were as young as 18 and others are alleged to have been recruited from bars for an afternoon's work. Some would last a week or more on the job. Others reached legal exposure limits within minutes and were promptly paid off—half a day's pay (at around \$3 an hour)—and replaced, in the derisive phrase of a former full-time employee, by "fresh bodies."

On the average, according to AEC inspection reports, the plant's temporary workers received a whole-body radiation dose of 1.73 to 2 rems, an amount not considered harmful, but the equivalent nevertheless of five chest x-rays. This is less than the maximum

the AEC allows for full-time radiation workers but much more than the industrywide average of 0.2 rem per year and more than the 0.5 rem allowed for members of the general public.*

The temporary workers, like the plant's permanent staff, also were exposed to small airborne concentrations of plutonium and other radioactive fission products whose hazards are under debate (*Science*, 20 and 27 September).

At one time the plant and its radioactive effluents were the focus of environmental protests, but these objections largely subsided, first as waste treatment improved and later when the plant closed. The company's public relations efforts have generally been effective, and a predominantly blue-collar region now seems to regard NFS as a welcome source of jobs. Local opposition to a planned tripling of the plant's capacity thus have been limited to a handful of conservationists and a few families whose sons worked at the plant. It is expected to reopen in about 3 years, at which time, AEC officials say, the plant will be much cleaner. If it isn't, one official adds, "we're in trouble."

Dormant as it is right now, the NFS plant provides a particularly vivid example of a common and long-standing practice in the nuclear industry. The AEC has long condoned the use of

* Federal radiation protection guidelines in force since 1960 recommend that individuals in the general population receive no more than 0.5 rem per year of nonmedical radiation to the whole body. Nuclear workers are limited to 5 rems per year, but the guidelines allow a worker to accumulate unused exposure according to the formula $5(n-18)$ where n is his age. The worker may draw on his "body bank" at a rate up to 3 rems per quarter or 12 rems per year.



Photo by R. Gillette

Nuclear Fuel Services' chemical reprocessing plant near Buffalo, New York, is dormant now but plans to expand and reopen in 1977.

virtually untrained supplemental or "transient" workers in potentially hazardous radiation jobs, as long as they received some instruction in safety procedures and close supervision. One important effect of the widespread use of temporary workers, however, is to blur a traditionally sharp distinction between radiation workers and the general public. Nuclear workers are allowed to receive ten times more radiation than everyone else. But should there be no limits on the extent to which nuclear facilities may spread the burden of occupational exposure?

Any sharp restrictions on temporary employment would no doubt cause considerable anguish in the nuclear industry, for indications are that transient workers comprise a large portion of the industry's labor force. According to figures compiled by the AEC's division of operational safety, 54,675 persons left their jobs at government and private nuclear facilities in the 4 years between February 1969 and December 1972; of this number, 16,165 or 30 percent were employed less than 3 months.

To some degree the revolving-door character of the industry stems from demands for welders, pipefitters, and other craftsmen who are not always available within a company's full-time staff, or at least not in sufficient numbers. As an illustration, AEC officials say that some utilities (notably Consolidated Edison in New York) have occasionally had to hire 50 to 100

welders to complete a small number of welds in a radiation environment. Each welder works for a few minutes until he is "burned out"—that is, until he reaches his dose limit for the quarter—and a new man takes his place.

The practice is well enough established, in fact, that no one in regulatory circles seemed to raise an eyebrow in the summer of 1969 when the AEC's Rocky Flats plutonium fabrication plant near Denver brought in outside cleanup crews in the wake of a devastating \$45-million fire. The Rocky Flats weapons plant, run for the AEC by the Dow Chemical Company, hired 60 college students that summer to help decontaminate the plutonium shop where the fire occurred.

Few nuclear facilities, however, have felt the need to raise quite so large an army of the untrained to keep things neat and clean as NFS did. Company officials at Buffalo blame their need for battalions of outside workers partly on the nature of the business and partly on problems of plant design.

The chemical plant is perched on a hillside amid the meadows and woods of a 3500-acre nuclear storage and waste burial site owned by the state of New York. The dominant building is a chunky concrete box with a smokestack on top for releasing gaseous wastes such as krypton-85. Barbed-wire and chain link fences mark the plant perimeter, giving it a distinctly military look. Inside, behind massive concrete

partitions and leaded glass windows 4 feet thick, is a kind of nuclear refinery.

Spent or "irradiated" nuclear fuel is shipped to the plant in heavy casks for storage in a deep pool of water. After a cooling period, a heavy crane hoists up the long, squarish bundles of fuel rods, which emit a blue Cerenkov glow under water, and transfers them, one at a time, to a cavernous "cell" where a remotely operated shearing machine slices the bundles into small pieces. From here steel baskets carry the chopped fuel to another cell, to be dissolved in a vat of nitric acid. Then a series of chemical extractions separates the dissolved uranium, plutonium, and waste fission elements.

In a little more than 5 years of operation the plant processed 600 tons of fuel containing upward of 2 billion curies of radioactive material. Company officials say that with all this radioactivity passing through the plant, a little of it was bound to come out in undesirable places from time to time, and it did.

A certain amount of spillage and leakage was anticipated. But a fundamental design decision in the early 1960's appears to have compounded the problem of human exposure resulting from normal contamination. Evidently in an effort to hold capital costs down to around \$32 million, NFS and its design firm, the Bechtel Corporation, decided not to make use of "remote-maintenance" technology developed at the AEC fuel processing plants at Hanford, Washington. NFS and Bechtel opted instead for a "contact" maintenance approach, which meant that when equipment needed repair it would have to be moved by crane, decontaminated by workers, and repaired by hand. The inevitable increase in exposure was further compounded by equipment failures that made contact maintenance necessary more often than originally expected.

The net result was that by 1971 the average yearly radiation dose for the plant's permanent operating staff of around 100 men had crept up to 7.2 rems—a dose that was within the law, but one so high as to be almost without precedent in a major nuclear facility. To make matters worse, a number of workers at the plant (most of whom apparently were permanent staff) suffered repeated overexposure to radiation, some through accidental inhalation of plutonium and other radioactive elements.

By 1972, the AEC's periodic inspec-

tion reports had begun to sound a continuous note of dismay at the performance of the plant—and of its management. In November 1971, AEC regulatory officials accused the company of a “failure to adequately instruct or effectively train employees and other personnel in the radiation hazards involved in their job assignments.”

The AEC said further that efforts to control the spread and buildup of contamination in the plant and immediately around it had been “ineffective,” and that the “data . . . do not seem to show any improvement in the exposure controls or the radiological safety conditions over the operating history of the plant.”

These, then, were the circumstances under which the company hired its hundreds of supplemental workers. Essential maintenance had to be done. And, as plant manager James Duckworth saw it, there were only two choices: The plant could divert trained operators from their usual jobs and risk pushing them up to their quarterly dose limits, at which point they would have to be furloughed; or it could hire temporary help.

In a recent interview, Duckworth explained it this way:

Say you have a ventilation pump that needs replacing, and it's “hot,” and the sooner you get it out the better off everyone will be. There is no sense in using our qualified personnel to take three bolts off the base of an ordinary pump. And you might really create a safety problem by dosing up [a trained operator] and putting him off the job temporarily. No matter who does it, it'll take the same amount of exposure. So we have contractors who get us outside help.

The company relied mainly on a local labor contractor, the Benz Construction Corporation, and the Buffalo branch of a nationwide temporary labor firm, Manpower, Inc. Former employees of NFS and Buffalo officials of the International Association of Machinists and Aerospace Workers (IAM), which represented NFS's full-time employees, say that the two contractors drew heavily on moonlighters, students, and men seasonally employed at area automobile plants. In addition, Anthony J. Nitkowski, a district official of the IAM, said that between a third and half of workers hired by Manpower for jobs at NFS could have been described as “down-and-out” men from skid-row areas.

But William O'Rourke, of Manpower's Buffalo office, denies that his firm recruited men from skid-row areas.



Photo by R. Gillette

“We're too sophisticated for that. Maybe some of these mickey-mouse storefront operations do that, but not us.”

Qualifications for temporary employment at NFS were, in any case, not stringent. One had to be 18 years or older and physically able to do the job.

The procedure was simple. Upon arriving at the plant, workers would fill out a form for exposure records required by the AEC, then wait in the lunchroom for an hour or two. As each worker's turn came, he was escorted to his job, given protective clothing and instructions—how to clean a wall, which bolt to turn—and then would work for a predetermined number of minutes, so as to limit his exposure.

Views as to the quality of instruction and supervision vary. Says Duckworth:

No, we didn't give them a course in atomic physics. Yes, we did indoctrinate them. We tell a guy where he's going to work, how to do it, what exposure he'll receive, what equipment he's to wear. Sometimes we use mockups or pictures to show them what they'll be doing. And they're supervised by a health and safety man and an operator.

I've used six guys to get one nut off. Each guy may work 3 minutes, but he's paid for 4 hours. And we have [an exposure] record for every damn one of these people.

O'Rourke, of Manpower, Inc., says that he was given to understand that temporary workers could receive no

more than a tenth of the radiation allowed by the AEC (which would be 0.3 rem per quarter). Duckworth says that every effort was made to hold exposures to 1 rem. According to an AEC inspection report dated September, 1972, temporary employees at NFS “work until a whole body exposure of 2 rems per calendar quarter has been received.”

Over the years, AEC inspectors found many things wrong with the reprocessing plant and its management; but the handling of transient help was not one of them. James P. O'Reilly, the commission's chief regulatory officer for the northeastern states, said in an interview that supervision appeared adequate and instructions were “clear and reasonable.” O'Reilly acknowledged that federal regulations do require that training be commensurate with risk in radiation jobs, but he said that, “with someone looking over your shoulder, the risk may be less. . . . In fact these people received a hell of a lot of attention. Control usually was tighter over them than on full-time people.”

This is somewhat at variance, however, with circumstances described by half a dozen former employees at NFS, some of whom supervised supplemental laborers. As these workers described it, temporary men were told virtually nothing about the potential hazards of their jobs. They were generally left in the charge of men with no special training in health and safety procedures. And they often could not be seen or directly monitored by the men who “supervised” them.

The experience of David R. Whitehead, an elementary school teacher from Boston Spa, New York, who signed on for work one summer, appears to be typical.

A few days after applying to the Benz company, Whitehead was called to the plant to help decontaminate a crane room. He and several other men were suited up in protective clothing—two pairs of coveralls, rubber gloves, shoe covers, a paper hat and hood, and an air line for breathing. Instruction, he recalls, centered on the use of a hose and brush outfit:

I don't recall a lecture about safety procedures as such. Mainly someone told us about the tools we would be using, that we had to remove some particles [from the walls] and they [NFS] didn't want to burn out their technicians on the job.

We worked in a team, rotating one at a time, 10 minutes in the room, half an hour out. You'd be all alone in there.

Senators Seek Delay in Plutonium Recycling

Two Democratic senators have called on the Atomic Energy Commission (AEC) to postpone the introduction of plutonium as a fuel for nuclear power plants until the questions surrounding the health effects of plutonium and its security against theft can be more clearly resolved.

In a 26 September letter to AEC chairman Dixy Lee Ray, Senator Walter F. Mondale of Minnesota and Senator Philip A. Hart of Michigan expressed "grave reservations" about the AEC's apparent intention to approve the use of plutonium as a nuclear fuel within the next few months. Hart and Mondale said that the emergence of a commercial plutonium fuel industry in the late 1970's "would dramatically increase the risk" that terrorists or other criminal groups might steal the radioactive metal for purposes of blackmail or to fashion an illicit nuclear weapon.

Plutonium is generated as a by-product of uranium in the fuel currently used by nuclear power plants. A typical 1000-megawatt power plant produces about 200 kilograms of the metal each year. Until now this plutonium has merely been stored for later use, but the AEC is moving rapidly toward a decision to let the nuclear industry recycle plutonium into fresh nuclear fuel. By 1990, the AEC estimates, recycling will reduce projected demands for uranium by 10 percent. Recycling will also pave the way for a major use of plutonium in the late 1990's as breeder reactors begin to produce it in large amounts.

According to a draft environmental impact statement the AEC issued in August as a prelude to its decision, the commission believes that a large new commercial plutonium industry will require "significant" improvements in the safeguards against theft currently in force. The AEC has not decided—and says that it will not for another year or so—what these improvements will entail. But the AEC has suggested such things as a special federal "nuclear security force"; the use of incapacitating gases and other automatic means of foiling thefts; and "spiking" plutonium with highly radioactive elements to make it more dangerous to steal.

An Undesirable Trade-off

The AEC staff has a "high degree of confidence" that a combination of such measures will provide adequate security for recycled plutonium, but the two senators—along with several environmental groups—are not so sure. Hart and Mondale said they feared that such security measures "may force choices between personal safety and civil rights—trade-offs the country should not have to make." The senators could envision a nuclear security force making background checks on anyone who might conceivably have an opportunity to steal the material.

In a news conference, Hart and Mondale also associated themselves with a critique of plutonium recycling prepared by the National Resources Defense Council (NRDC), an environmental law group that contends that

both health and security regulations covering plutonium are far too lax. The NRDC also questions whether any form of security could be both adequate and acceptable to the public, but neither senator was willing to go quite that far. Hart said that neither he nor Mondale were making "any ultimate judgment as to whether plutonium recycling might someday be acceptable . . . but we need to pause to get some answers."

Delaying a decision on plutonium for 2 or 3 years, Hart and Mondale said, would work no hardship on the energy industry.

In recent months the issue of nuclear safeguards has achieved a new visibility in Congress, partly as a result of India's nuclear explosion last May and the American offer to sell reactors to Egypt and Israel in June, and also as a result of a campaign to strengthen U.S. safeguards undertaken by Senator Abraham Ribicoff (D-Conn.). Ribicoff has urged—successfully, thus far—that the legislative charter of the proposed new federal regulatory agency for nuclear energy (to be formed from the AEC) give safeguards the same prominence and priority as it does to the operating safety of nuclear reactors.

A "Large and Growing" Danger

Ribicoff's case has been strongly enhanced by the publication of several thoughtful books on the subject this year, including one by the Ford Foundation's Energy Policy Project. Equally helpful were the findings of a special internal study group organized by the AEC to examine safeguards problems. Their report, obtained and released by Ribicoff last April, concluded that the "danger is large and growing" that terrorist groups might obtain nuclear explosive material (if not a bomb) and that the AEC's present attention to countermeasures was "entirely inadequate."

"The seriousness of the problem demands a clear commitment by the AEC," said the study, "to bring the risk to the public from safeguards problems down to the level of risk associated with the operation of nuclear power plants."

Many in the nuclear industry nevertheless continue to regard nuclear theft as a "phony issue." And in recent weeks the White House Office of Management and Budget (OMB) has rejected most of an \$88 million supplemental budget request from the AEC to improve its safeguards programs as the special panel had demanded. The OMB cut \$56 million from a \$74 million request to improve security in weapons and R & D programs, and the budget agency killed all of a \$13 million request to hire some 100 new staff for the AEC's safeguards division.

Both Ribicoff and Senator Henry M. Jackson (D-Wash.) have protested these cuts, and it now appears that the congressional Joint Committee on Atomic Energy may restore some \$5 million of the original request, though none would go for added AEC staff. Even this amount faces additional hurdles in the appropriation committees and, ultimately, at the White House, which may or may not choose to spend it.—R.G.

The technician was outside, on the other side of an airlock and around a corner.

Did he feel that instruction and supervision were adequate?

I don't know how much supervision is necessary, but I trusted them. I guess I was too dumb to be frightened. But if I'd known more about what I was getting into I would have been more wary on the job.

After 3 days the company told Whitehead that he'd reached his exposure limit. That was the end of his job.

David Pyles, a former laboratory supervisor at the plant, said that many of the temporary workers were openly disdainful about the hazards of radiation, while others were apprehensive. Still others, he said, seemed simply unalert.

You'd see all these people sitting around the lunchroom—that was the real gravy, getting paid to sit—and you felt that a lot of them shouldn't even be in the plant. They were risking not only their own health, but everyone else's.

Some were really afraid, and they'd ask a lot of questions, I just tried to talk them into going home, but they wanted the money.

Said Michael Lord, a former laboratory technician at the reprocessing plant, "The prevalent feeling was that these people were nuts for going in there and doing what they did."

For an industry that prides itself on being one of the safest and most closely regulated in America—and one that is growing rapidly—continued reliance on temporary workers for the hot and dirty jobs raises questions of the industry's prudence. The AEC's position is that there is nothing inherently unsafe about employing untrained men in a radiation environment if instruction and supervision are adequate. But what assurance is there that brief instructions are understood, that potential dangers are appreciated, that supervision is in fact effective?

Roger Mattson, the AEC's newly appointed assistant director for health and site standards, acknowledges that present regulations do not specify the kind of instruction and supervision transient workers are to have; nor is there a requirement for testing or other means of demonstrating that workers have understood what they have been told.

"The regulations now leave a lot up to the licensee's judgment," Mattson said in a recent conversation. "It has occurred to us that they could be a lot more explicit."

Regulatory officials also say they are concerned about the possibility of workers receiving a full quarterly dose at one plant then picking up still more in the same quarter somewhere else. Robert Alexander, the chief of occupational health standards, says that a review of the AEC's central record files on transient workers shows that only a very few men have actually done this. Even so, Alexander says, "We feel we haven't gone far enough to control this problem."

Four years ago, however, one possible solution to this problem—and to the blurred distinction between nuclear workers and the public—was suggested by the National Council on Radiation Protection and Measurements (NCRP), a leading advisory group on radiation standards since the 1930's.

The NCRP, whose proposal has not been adopted by the AEC, recommended in January of 1971 that persons doing only "occasional radiation work" be given special consideration in radiation protection standards. The NCRP said that persons whose occupational exposure was "truly sporadic"—a description that would fit the vast majority of men who passed through the Buffalo plant—should be limited to the same radiation dose as the general population or one-tenth that of full-fledged nuclear workers.

Recently, the AEC has begun to discourage the industry from spreading the burden of exposure to droves of part-time workers, but this discouragement has taken the form of a "regulatory guide" (issued last April) which is not subject to enforcement. Moreover, the AEC continues to regard anyone who accepts employment "inside the fence" of a nuclear installation as a full-fledged nuclear worker, whether he works for 3 minutes or 3 years.

In the meantime, the Environmental Protection Agency has begun a cautious and methodical review of the basic federal radiation protection guidelines dating back to 1959, under which the AEC still operates. One of the key issues to be examined, says Luis Garcia, the EPA official in charge of the review, "is this dichotomy of occupationally exposed people" recommended by the NCRP. "We will look at [the proposal] in light of its practicality."

Distilled to its essence, the question of transient workers in the nuclear industry becomes one of risk and benefit. Whether a worker receives his quarterly maximum of 3 rems in 3 months or in

3 minutes may make no biological difference. But if, as is generally assumed, every exposure carries some discrete risk of genetic damage or illness, then the full-time worker who earns 3 months pay for 3 months' radiation benefits considerably more than the worker who accepts the same risk—knowingly or not—for half a day's pay.

In some ways the nuclear plant that hires men not for their skills but for their capacity to absorb radiation seems not so very different from the commercial blood bank that pays premium prices for a pint of plasma. Both solicit, and profit from, a small sacrifice. Both raise questions as to the ethics of drawing indiscriminately on the human population as a biological resource.

—ROBERT GILLETTE

RECENT DEATHS

George D. Gammon, 72; retired chairman, neurology department, University of Pennsylvania; 9 May.

Paul E. Guenther, 58; professor of mathematics and statistics, Case Western Reserve University; 28 April.

William Z. Hassid, 76; professor emeritus of biochemistry, University of California, Berkeley; 28 April.

Jack W. Keuffel, 55; professor of physics, University of Utah; 23 May.

Regis J. Leonard, 61; professor of education, School of Education, Fordham University; 26 May.

Walter C. Lowdermilk, 86; professor emeritus of agriculture, Israel Institute of Technology; 6 May.

John H. Mulholland, 73; former professor of surgery, New York University; 6 May.

Philip A. Munz, 82; former professor of botany and horticulture, Graduate School, Claremont College; 13 April.

Hubert J. Sloan, 70; acting deputy vice president for agriculture, forestry, and home economics, University of Minnesota; 1 May.

O. E. Van Alyea, 87; professor emeritus of otolaryngology, University of Illinois; 10 May.

Richard Wagner, 86; professor emeritus of clinical pediatrics, Tufts University; 19 April.

David R. Waldbaum, 37; associate professor of geological and geophysical sciences, Princeton University; 15 April.