RESISTING MISSILES IN INDIA • SPOTLIGHT ON PANTEX

SCIENCE FOR THE PEOPLE

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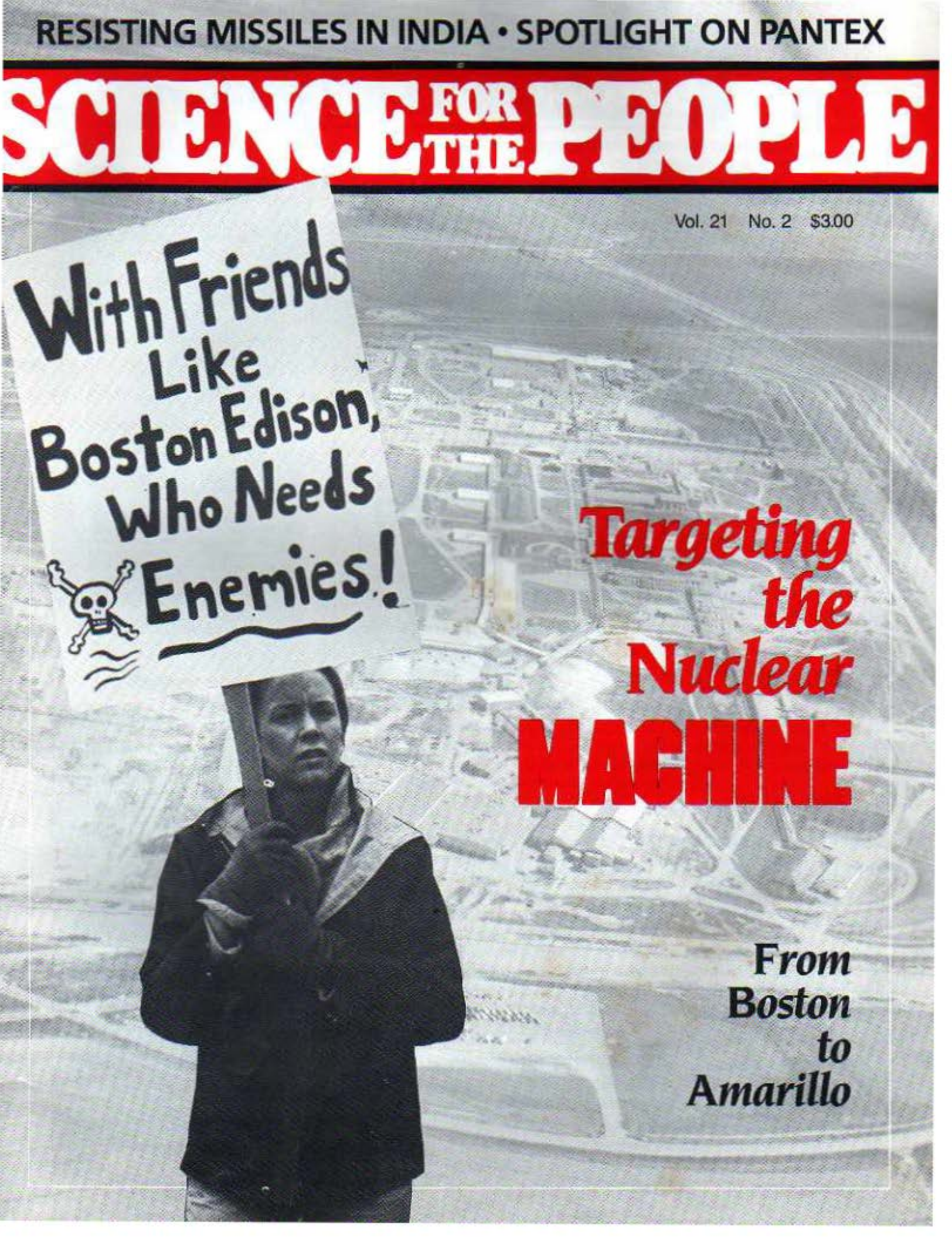

Targeting the Nuclear MACHINE

From Boston to Amarillo

Preview

The Department of Energy's nuclear weapons production facilities are suffering from 30 years of active neglect. Although the DOE is taking some public steps to improve its practices, including the establishment of several new oversight bodies, it is not yet clear whether they have the money, the people or the will to put safety and environmental concerns before bombs.

In the midst of this turmoil the Pantex plant, final assembly point for the nation's nuclear arsenal and one of the DOE's most polluted facilities, has so far escaped major public scrutiny. Greg LeRoy's investigations of Pantex in this issue reveal major environmental hazards, inadequate environmental monitoring and disregard for worker safety. According to a DOE spokesman, the Pantex plant has received little national attention not because it is environmentally benign, but because the people of Amarillo, Texas form a "different political climate." What is this climate? A. G. Mojtabai interviewed Amarillo residents and Pantex workers to find out.

The DOE is turning to the commercial nuclear power industry for help in this crisis. But the industry itself is torn over safety concerns, environmental hazards and what may finally prove decisive: cost. Bruce Biewald and Donald Marron systematically dismantle the myths of inexpensive nuclear power. Far from being "too cheap to meter," nuclear energy has cost far more than it is worth even before many of the hidden costs, like spent fuel disposal and decommissioning, have been felt.

Activists in Sacramento, California have turned this economic argument into political clout. In a major victory for antinuclear activists, Sacramento voters shut the Rancho Seco plant. It was the first time a citizens' referendum in the U.S. was able to close a working nuclear power plant. The closing marks a victory, but not the end of the struggle. *Science for the People* takes a look at activism and the industry at five commercial reactors around the country.

Magazine Notes

We are pleased to note that *Science for the People* has been nominated for two Utne Reader awards, one for general excellence and one for special interest magazines. Congratulations to our editorial committee and particularly to our editor emeritus, Leslie Fraser.

Our production schedule was disrupted this past spring due to major financial difficulties. We've spent much of the spring reorganizing and fundraising and are now returning to a normal production schedule. We thank you for your patience and support during this time.

With the next issue, *Science for the People* will celebrate twenty years of analysis and activism. This special double issue will inaugurate our new design, taking advantage of desktop publishing tools to move ourselves into the nineties.

SCIENCE FOR THE PEOPLE

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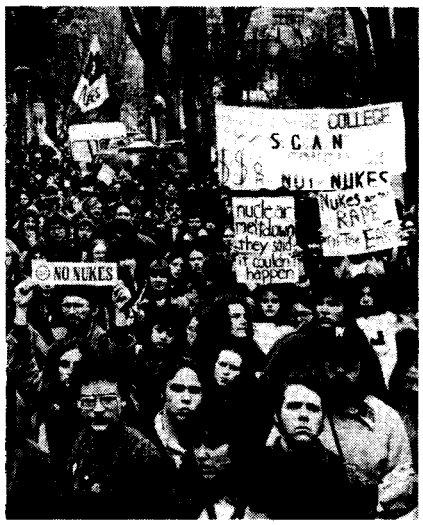
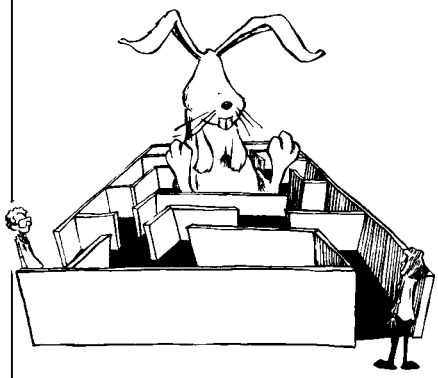
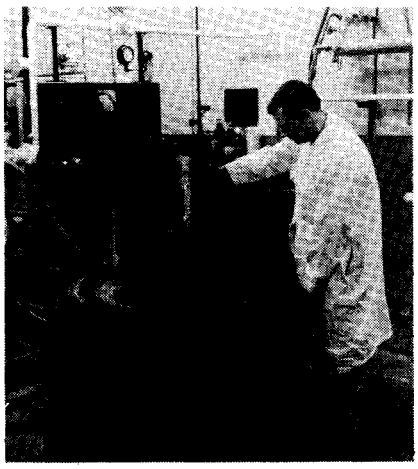


CONTENTS





ANIMAL RIGHTS IN CAMBRIDGE

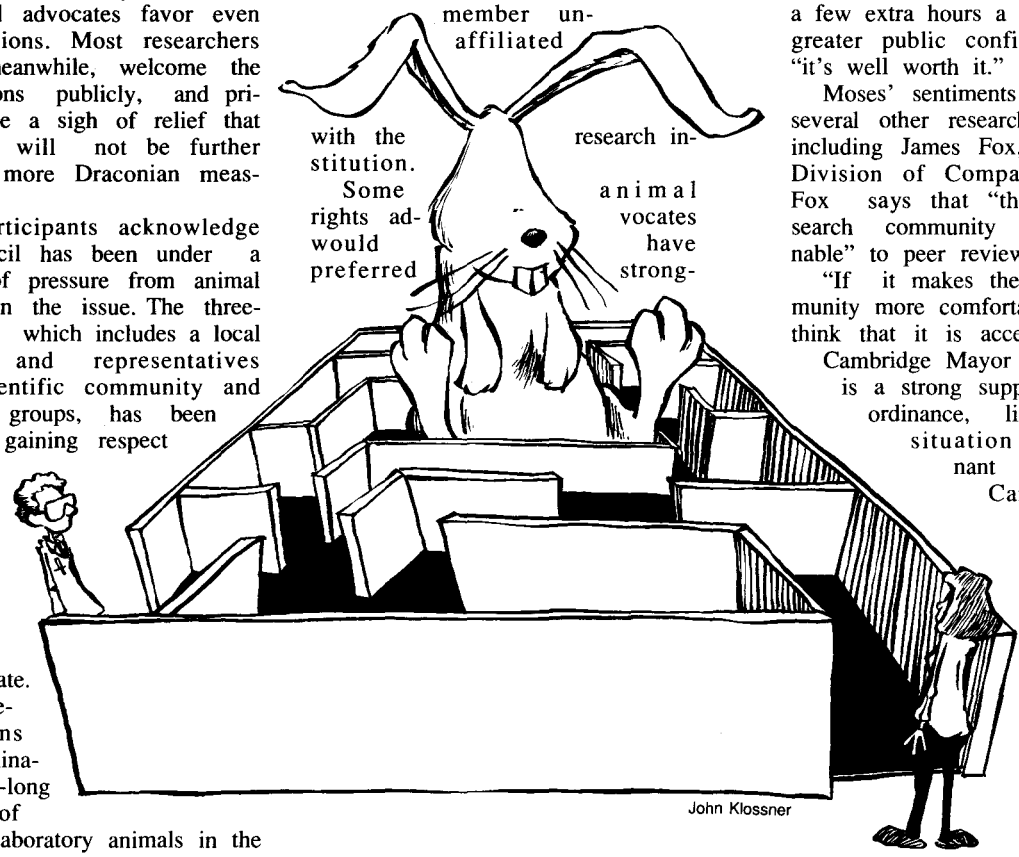
In an historic move, the city of Cambridge, Massachusetts has passed the nation's first local ordinance governing the care of laboratory animals. On June 26, before a packed crowd of animal advocates and representatives from the research community, the Cambridge City Council voted unanimously to enact the recommendations of its blue-ribbon panel in the form of a local ordinance. The ordinance includes the establishment of a city "Commissioner of Laboratory Animals."

The City Council decision to heed the panel's advice was greeted favorably by most quarters. Animal right's groups claim the move toward local regulation as a victory, although some animal advocates favor even stricter provisions. Most researchers in the city, meanwhile, welcome the new regulations publicly, and privately breathe a sigh of relief that their research will not be further restricted by more Draconian measures.

Most participants acknowledge that the council has been under a great deal of pressure from animal groups to act on the issue. The three-member panel, which includes a local veterinarian and representatives from the scientific community and animal rights groups, has been successful in gaining respect from opposing sides in the debate and has been praised by members of both sides for the quality of its work to date. The panel's recommendations are the culmination of a year-long investigation of the care of laboratory animals in the city (see *Nature* 338;534).

In what is perhaps the most dramatic provision, the legislation calls for the city to appoint a Commissioner of Laboratory Animals vested with the authority to "make unannounced visits to inspect animal and research facilities as needed." The Commissioner will make at least one annual visit to each research institution in the city.

In addition, the ordinance requires all research institutions in the city to conform to federal statutes and regulations concerning the care of laboratory animals. At present, most of the city's laboratories merely conform voluntarily to federal guidelines. The ordinance also expands federal laws to cover rodents, birds, fish, reptiles and amphibians, which were formerly exempt from the federal Animal Welfare Act forbidding unnecessary and cruel treatment of animals. Furthermore, the legislation mandates that each research institution maintain an "autonomous animal care and use committee with the power to disapprove or restrict research" in accordance with federal laws. Each of these care and use committees will be required to include a member unaffiliated with the research institution. Some animal rights advocates would have preferred stronger regulations. Members of the Cambridge Committee for Responsible Research, the original sponsor of the ordinance, supported an amendment to the ordinance that would have permitted the comissioner of lab animals to appoint an animal welfare advocate for the animal care committees. The council instead approved a more limited amendment that will allow the commissioner of lab animals veto power over animal welfare appointments made by the head of each research institution.



John Klossner

John Moses, an MIT physician who heads the university's animal care committee, and who represented the scientific community on the blue-ribbon advisory panel, calls the ordinance "a necessary step to give the city and the local community the accountability that they need" about the treatment of laboratory animals. He calls the regulations "very simple," "inexpensive" and "easy to live with."

"The idea that there will be no new bureacracy in this area is a fantasy," says Moses, adding that the legislation can help build public trust and stave off more rigid community regulation. "If researchers have to spend a few extra hours a year to achieve greater public confidence," he says, "it's well worth it."

Moses' sentiments were echoed by several other researchers in the area, including James Fox, Head of MIT's Division of Comparative Medicine. Fox says that "the biomedical research community is certainly amenable" to peer review of animal care.

"If it makes the Cambridge community more comfortable," he adds, "I think that it is acceptable."

Cambridge Mayor Al Vellucci, who is a strong supporter of the new ordinance, likened the current situation to the recombinant DNA debate in Cambridge ten years ago in which he played a key role. Vellucci told the packed meeting that in the former debate, "Nobel laureate scientists told us how damaging our regulations would be to their research; but once we passed it, they acknowledged that they could live with it." So, says Vellucci, will it be today with the care of laboratory animals.

The Cambridge City Council agrees.

Seth Shulman

Newsnotes

ENVIRONMENTAL SWAT TEAM

Who you gonna call" when corporate polluters are ruining your groundwater? Now Massachusetts joins the ranks of a small handful of other states and municipalities to offer an answer. Declaring that industrial polluters in the state have fouled water supplies in more than 100 districts and created more than 1,000 toxic dumps, a legion of top state officials, including Massachusetts Governor Michael Dukakis, recently unveiled an environmental "strike force" replete with undercover agents, search warrants, and aerial surveillance.

The new 34-member team, billed as the most far-reaching program of its kind in the nation, will include scientists, lawyers and undercover police officers drawn from various state agencies. Their mission will be to ferret out polluters and build cases against them.

Announcing the new plan, Dukakis justified the stepped-up law enforcement activity by calling industrial environmental offenses "violent crimes." Industrial polluters, he explained "do violence against neighborhoods and against the water we drink and the air we breathe."

In addition to the new environmental enforcement team, Dukakis pledged to file legislation later this year to stiffen the state's environmental penalties for industrial polluters. But most officials, hailing the new team, claim that the major problem has not been the lack of tough laws, but rather lack of enforcement.

According to Daniel Greenbaum, head of the state Department of Environmental Quality Engineering, as many as 50% of those people and firms discharging pollutants into the air and water may be doing so illegally, without the requisite state permits. Of those firms with environmental permits, according to Greebaum, many routinely violate the terms of the regulations but, until now their actions have often gone undetected because of lack of state oversight.

As far as all of this goes, it sounds like something that might have hopped right off of these pages. Massachusetts' Attorney General promised that the new programme "will bulldoze right through the bureaucracy;" and the state's secretary for environmental affairs told reporters: "The strike force is the jewel in our environmental enforcement crown." We couldn't be more pleased to see corporate polluters taken seriously for the criminals that they are. But, alas, words are cheap; effective environmental swat teams are not.

Rhetoric aside, the much-touted program will receive no new funds. Instead, we are told, it will get underway by shuffling and consolidating personnel and funding from existing agencies. The lack of appropriation is blamed on the state's dismal fiscal situation, but, it seems to us, to really give it teeth the program needs its own funding. Without money to back up the laudable intent, we can't help but remain skeptical until we see some results.

UMASS UNITES AGAINST MILITARY

Opposition to military-funded research on campus ignited at the University of Massachusetts this spring as hundreds of students held demonstrations and more than one hundred and fifty students and community activists were arrested after occupying university buildings on several occassions. The occupations, several lasting more than thirty hours, demanded an end to military funding of research.

The protests focused particularly upon the research of Curtis B. Thorne, a microbiologist at the university who studies the anthrax bacillus with funding from the U.S. Army's Biological Defence Research Program. Thorne's research was targeted specifically in part because it was cited in the Army's Draft Environmental Impact Statement on the biological defence program. As required in such statements, the consequences of "the most serious credible accident" were outlined for Thorne's research in which laboratory workers could conceivably contract anthrax if an error was made while conducting a —Bacillus anthracis— "mating experiment."

A special hearing before the local Board of Health heard testimony on a proposed ordinance to ban from the town of Amherst, Massachusetts "the testing, storage, transportation, and disposal of biological materials if funded in full or in any part by the U.S. Army's Biological Defence Research Program." Nearly two hundred students, residents, and outside experts drawn from the region gathered for more than three hours to debate the ordinance which would effectively outlaw Thorne's research from the town limits.

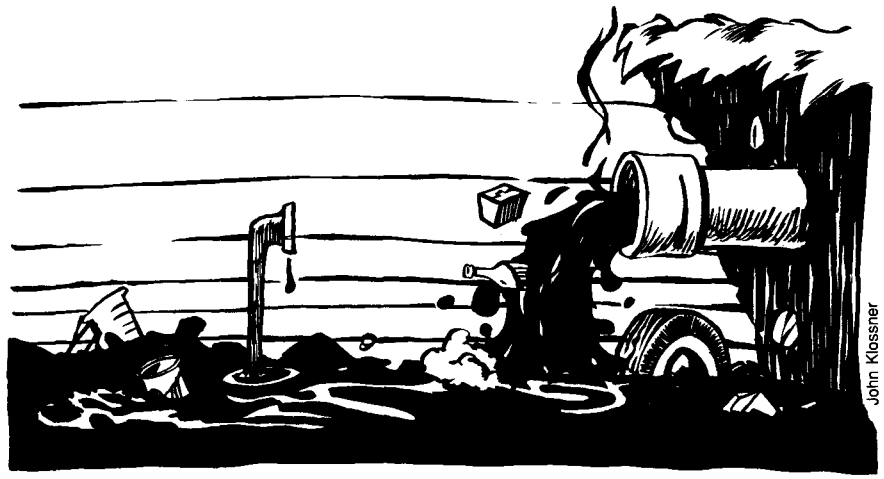
University of Massachusetts Chancellor Joseph Duffy declared in a written statement issued at the hearing that the school would fight to "protect the right of our faculty to conduct any research they choose as long as the scope, methods and results can be fully and freely disclosed," adding that the policy would not be negotiated with students.

But students at the hearing and at earlier demonstrations vowed to continue their increasingly vocal protests against the military-funded work of Thorne and others at the university. At the hearing, the students' concerns were supported by the testimony of a number of researchers, including Richard P. Novick, molecular biologist and Director of the Public Health Research Institute in New York. Novick, a well-known authority on biological agents and an opponent of the biological weapons defense program, asserted that Thorne's research presented a legitimate health threat to the community and "could not be construed as for peaceful purposes."

Thorne, who did not attend the hearing of the health board, denies that his five-year, $600,000 research contract poses a safety hazard. He says that the issue of safety is not the protesters' real concern, and that his research is being used merely as a tactic to force a debate on "the larger issue" of "whether it's moral or immoral" to accept funding from the military—a debate Thorne says he will not participate in.

Newsnotes

HIGH COST CLEANUP



Officials from the United States Energy Department and from Washington state signed an agreement last week that sets in motion a massive, thirty-year project to clean up Washington's Hanford Military Reservation, the nation's most environmentally troubled nuclear fuel production facility. The agreement outlines the legal and technical details of the clean up, establishes a timetable for the project, and commits the Energy Department publicly to the effort. It does not, however, include an appropriation of money to do the job, which must come from Congress.

The Hanford agreement was greeted positively by almost all quarters. In a written statement, Energy Department Secretary James D. Watkins declared Hanford's clean up to be "of utmost importance" and added that the agreement "properly emphasizes" the attention that the job requires from the federal agency. Washington Governor Booth Gardner hailed the fact that the clean up would begin "at long last." And representatives from environmental groups and from the regional office of the Environmental Protection Agency say the agreement can be used as a model to guide the clean-up efforts at other Energy Department facilities around the nation.

But all parties are concerned about the feasibility of the clean-up agreement because of the expense involved. By all accounts the scale of the effort will be unprecedented. According to the Energy Department's own estimates, the project could cost as much as $57 thousand million, requiring a sustained federal outlay of close to $2000 million per year to get the job done on time. It is an amount which is almost inconceivable for a single site in the current fiscal environment according to several Congressional insiders, especially because Hanford is only one (albeit the largest) of the clean-up projects that will be required at the Energy Department's sixteen weapons production facilities. By way of comparison, the Energy Department's entire budget for fiscal year 1989 is roughly $14 thousand million.

The enormous cost of the project stems in large measure from the amount of waste involved. Located at the Hanford Reservation is an estimated 30 million cubic feet of nuclear waste and perhaps as much as one hundred times that amount of contaminated soil—the accumulation of more than four decades' of radioactive byproducts of plutonium production at the facility. Workers at the Hanford site conducted the world's earliest large-scale effort to produce weapons-grade plutonium, and manufactured the plutonium used in the bomb dropped on Nagasaki, Japan in World War II. Following the war, Hanford served as a key location for military plutonium production and processing, housing a total of nine production reactors, all of which have since been shut down.

But aside from the scale of the clean up at the 560-square-mile facility, the astronomical cost of the project also reflects the high level of radioactivity present in some of the waste involved, and the difficulty of handling it in its current state. For instance, more than 500,000 gallons of high-level liquid wastes are known to have leaked from at least 58 underground tanks at the site, and much more leakage is suspected at another 100 tanks. The leached waste liquid and the remaining sediment in the tanks themselves—both extremely radioactive—present a daunting technical dilemma for the environmental restoration project. So far the Energy Department has yet to even offer a range of specific technical options for this aspect of the project.

The high cost of the project is also due to the many disparate kinds of clean-up activities required. In addition to the high-level liquid wastes found on the site, Hanford's nuclear reactors themselves contain radioactive residues and must be dismantled. Last month, the Energy Department issued a 300-page environmental impact statement which detailed the enormity of this component of the clean up alone, with costs estimated at nearly $200 million.

While environmentists involved in the issue generally reacted favorably to the Hanford agreement, representatives from several groups expressed dismay over what they see as "lax provisions" in addressing current practices at the site. Lindy Cater, executive director of the Hanford Education Action League (HEAL) which is credited with publicly disclosing many of the environmental problems at the site, complains that while the agreement addresses past wastes, it "fails to address ongoing waste production at Hanford's PUREX plutonium processing facility." HEAL had urged previously that the clean-up agreement be tied to a cessation of plutonium processing at PUREX, which according to one estimate produces 23 million gallons of water containing low levels of radioactive and chemical wastes during every day of operation.

In a concession to these concerns, the state of Washington announced that, in addition to the agreement, it will take part in a 14-month investigation of the current waste stream from Hanford's ongoing plutonium processing facility. Officials said that this investigation will seek to determine the threat posed by this waste stream, and whether the state will call for a halt to processing activity prior to the 1995 deadline slated in the agreement.

All Newsnotes by Seth Shulman

SHIPPINGPORT

BY SETH SHULMAN

A milestone for nuclear power was reached outside Pittsburgh, Pa. when the reactor vessel of the Shippingport Atomic Power Station was hoisted out of its underground site as part of an effort to dismantle the plant. The reactor's removal is perhaps the largest single step in the Energy Department's five-year, $98 million project to decommission the power plant, the first such undertaking in the world for a commercial nuclear reactor.

Department of Energy (DoE) representatives hailed the successful removal of the reactor vessel as a landmark. It comes after three years of work dismantling the plant which closed in 1982 after twenty-five years of operation. Dan Butler, spokesperson for DoE says the project serves as a model for utilities across the country and around the world and shows that nuclear power plants "can be decommissioned safely and without danger."

The Energy Department has attempted to use the Shippingport reactor as a model program for decommissioning because of the power plant's unique status. Built in 1957 as part of then President Eisenhower's "Atoms for Peace" program, Shippingport was the world's first nuclear reactor to operate solely for the production of electricity. The 72-megawatt Shippingport reactor was constructed in a joint venture between the now-defunct Atomic Energy Commission (AEC) and a private utility and has been subject to heavy government involvement ever since then. Because the plant was the first of its kind, it was agreed at the time of its construction that the government would be in charge of its decommissioning.

Despite DoE's involvement at Shippingport, however, future nuclear reactors in the United States will be decommissioned by the utilities that built them. Many utility representatives and some specialists from other countries have been frequent visitors to the Shippingport site to monitor the decommisioning process, according to DoE sources.

But some critics stress Shippingport's limited relevance and shortcomings as a model, stating that the experience at the plant will not be analagous to the future decommissioning efforts necessary as many of the world's oldest nuclear power plants begin to reach the end of their designed lifespans. In the United States, fifteen plants are expected to be ready for decommissing by the year 2000. These observers believe that the Shippingport exercise only underscores the huge

PHOTO/Ellen Shub

obstacles faced by those in charge of decommissioning future reactors.

The most glaring of these obstacles is that all the radioactive refuse from the Shippingport plant will be deposited at military dumpsites. In the United States there is still no high-level nuclear waste repository for spent fuel rods from commercial reactors, and virtually no place to deposit low-level waste either. All three low-level facilities that are now in operation are close to capacity and nearing the end of their designed lifespans. Even aside from the high-level waste made up of spent fuel, a standard, 1,100 megawatt reactor would generate 18,000 cubic meters of low-level radioactive refuse, according to one source, roughly 1400 truckloads of material. For commercial reactors at this point and in the foreseeable future, disposal of radioactive refuse from a decommissioned plant would be impossible.

But even beyond the disposal problem, critics fault DoE for its methods, saying that the department isn't making as much of the exercise as it could for testing and evaluating techniques needed in the future. The most significant of these objections is that DoE decided to remove the reactor vessel in its entirety rather than cutting it into pieces on site as will be necessary for larger plants. Says Cynthia Pollack Shea, researcher at the Worldwatch Institute who specializes in decomissioning and nuclear issues, "by DoE's decision to remove the reactor vessel whole, we are not going to learn anything about the vital remote control technologies that will be necessary for future efforts." Future commercial efforts will be using untried techniques.

John Schreiber, the department's Shippingport program manager, defends the decision to bury the vessel intact because of the cost savings involved. Cutting the reactor vessel into pieces, he says, would have cost significantly more and exposed workers to more radiation.

Even with the reactor vessel's removal, the job is far from over. On the Shippingport site, two more years of work are expected. For the 1,000 ton reactor vessel itself, the recent maneuver was only the start of a long journey. The reactor was placed on a special flatbed transport vehicle from which it will be moved onto a barge that will travel a total of 7,800 miles via the Ohio and Mississippi Rivers to the Gulf of Mexico, through the Panama Canal, and along the full length of the pacific coast of the United States to its final earthen burial on the government-run nuclear reservation in Hanford.

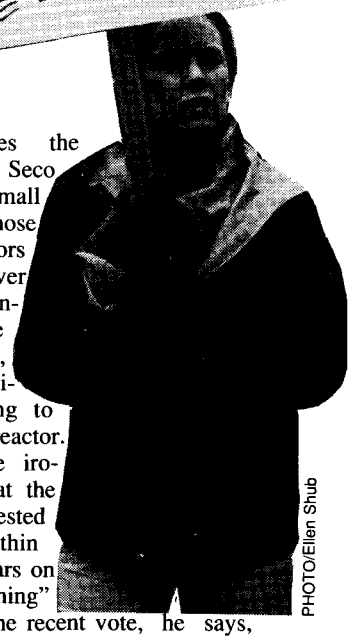
RANCHO SECO

BY SETH SHULMAN

Citizens' voices have finally been heard over the din of the nuclear industry. A majority of residents in Sacramento, California voted last week to shut the Rancho Seco nuclear reactor. It was the first time, despite similar referenda in numerous states around the US, that a plebiscite prevailed to shut a working nuclear plant.

Many observers say that the 53.4 to 46.6% vote to shut the plant turned more on the issue of economics than on concerns about safety or the environment. The troubled Rancho Seco plant, completed in 1974, has consistently operated well below average capacity for nuclear reactors in the US, and as of 1988, was producing electricity at roughly twice the price per kilowatt hour of electricity generated by other sources.

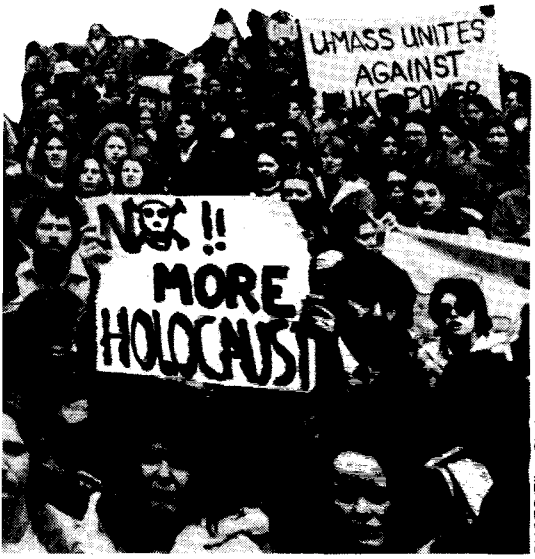
Rancho Seco opponents hailed their victory as a "shot heard around the world," and hastened to add that voters rejected the plant despite the fact that the nuclear industry spent more than a half a million dollars in their lobbying campaign to keep the reactor running. Not surprisingly, however, the nuclear industry prefers to paint the referendum as a "unique situation." Scott Peters, spokesperson for the Council for Energy Awareness, the nuclear industry trade association, says that Sacramento residents voted "not so much against nuclear power as against a poorly operating plant and an inefficient board of directors."


PHOTO/Ellen Shub

Peters stresses the fact that Rancho Seco was run by a small public utility whose board of directors was itself split over whether to continue operating the plant. This fact, he says, was ultimately devastating to the fate of the reactor. Peters stresses the irony of the fact that the utility had invested $400 million within the past three years on a "mass refurbishing" of the reactor. The recent vote, he says, does nothing to address the problems of pollution that will be generated by nuclear power's alternatives, or to relieve the increased electricity demand faced in several parts of the country.

In fact, however, the state of California currently faces no shortage of electricity according to most reports. Because of this, at least in the near term, the Sacramento utility that owns Rancho Seco plans to purchase more than half of its power from neighboring utilities. In the longer term, a plan is being considered to install gas-fired boilers to drive plant's existing steam turbines.

Some experts on the economics of nuclear power predict that the economic problems that toppled Rancho Seco are not unique and may return to haunt many other plants as well. Pe-



PHOTO/Ellen Shub

ters and others disagree. But with the announcement earlier this year that a Colorado utility would shut its poorly operating Fort St. Vrain reactor, not to mention the planned abandonment of the Shoreham reactor in Long Island, New York, there is little question that the Rancho Seco closure is a major setback for the nuclear industry.

Seth Shulman is a freelance writer and a member of SftP's editorial committee.

PILGRIM

BY LISA GREBER

The troubled Pilgrim-1 nuclear power plant in Plymouth, Massachusetts continues its on-again, off-again progress towards full power amid growing concerns over its human and economic costs. After an almost three year shutdown plagued by delays and mismanagement and the defeat of a citizen's initiative to keep the plant closed Pilgrim achieved criticality on December 30, 1988.

Since the restart, Pilgrim has had six unplanned shutdowns. Difficulties have ranged from problems with the air system valves to a bearing vibration of the turbines to a failure in the water-regulating system.

In addition to mechanical difficulties, the plant continues to have a low level of worker safety. In April, four workers were contaminated with radioactive water from a 50-100 gallon spill.

Plant officials insist there is no cause for public concern, but critics, including local elected officials, are wary. Even the NRC is expressing concerns. According to the most recent NRC release (June), the regulatory agency considers Pilgrim among the six worst plants in the country. The plant has "weaknesses that warrant increased NRC attention." Boston Edison officials claim the rating is due to the plant's recent restart. But the NRC insists the current category two rating reflects the plant's terrible performance as an operating reactor, not it's start-up status. NRC spokesman Karl Abraham expressed his opinion clearly in the Boston Patriot Ledger: "I don't care what Pilgrim is saying. They are on the list because in the judgement of NRC management that is where they belong.

Boston Edison is trying to add insult to injury through a proposed $85 million rate hike. At least 40% of the proposed rate increase is to cover Pilgrim's repair costs. Alan Nogee, an energy analyst at the Massachusetts Public Interest Research Group, is angered that consumers would have to pay for the "mismanagement" that led to the plant's 32 month shutdown.

The combination of Pilgrim's mechanical, management and economic problems over the past three years may be enough to rekindle activists' momentum. Joseph Kriesberg of the Massachusetts Citizens for Safe Energy (MCSE) expresses the frustration of many citizens in Plymouth and throughout the state: "[After so much time] they still don't have it right. At what point do you say 'Enough is enough?' In our view, we have clearly reached that point."

Before coming to SftP, Lisa Greber worked for the MCSE.

SEABROOK

BY DAN GROSSMAN

Two weeks after the Seabrook nuclear power plant began low power testing and sixteen years since it was first announced the plant is closed once more. In a move that suprised many NRC critics, the regulatory agency suspended the plant's low-power testing license. The suspension came after plant operators had failed to manually shut down the plant following a pressure rise in Seabrook's nonnuclear side. The NRC was angered that operators ignored plant procedures as well as the suggestions of NRC test observers on the scene. William Russell, head of the NRC regional office, insists the plant will not resume testing until there is complete documentation of the incident and short and long-term corrections are reviewed with the NRC.

Eight years after it was expected to be operational, the facility has yet to produce any electricity. Originally envisioned as a two unit, 2300 megawatt, complex costing $2 billion, the price tag has risen to $5.8 billion for only a single unit.

The grass roots protest group Clamshell Alliance, which has opposed the plant through non-violent civil disobedience, can claim some credit for the soaring cost and endless delay in putting the Seabrook plant on line. The group staged a final attempt to stop low power testing in early June; some 700 activists were arrested. Intervener groups, including Massachusetts Attorney General Shannon, are complimenting Clamshell's efforts by bringing legal challenges to the plant's evacuation plans.

Dan Grossman is a freelance writer.

THREE MILE ISLAND

BY ERIC EPSTEIN

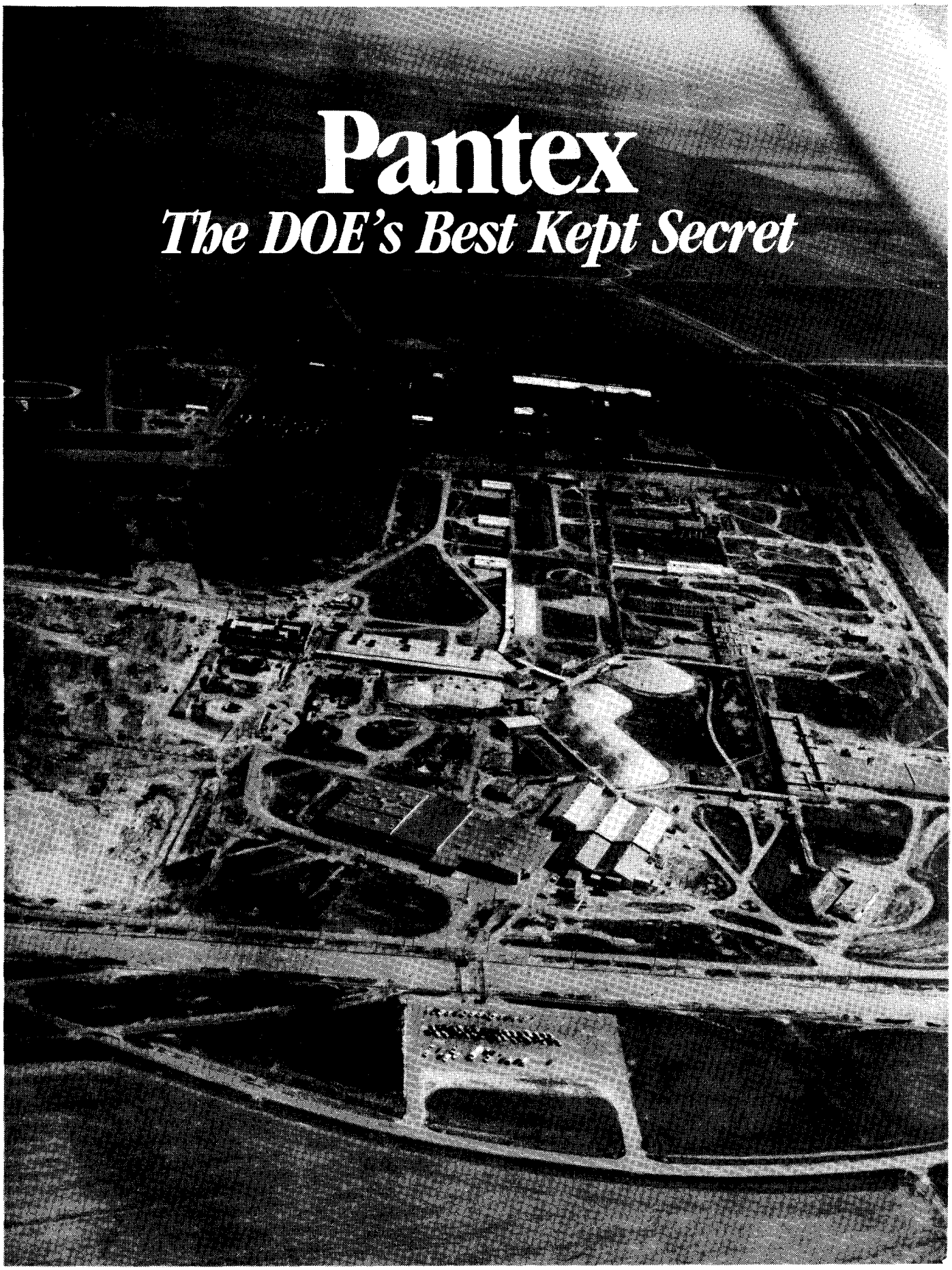
The Three Mile Island accident ignited a fierce national debate over the viability of nuclear power as a safe, reliable and economic energy source. Although many communities successfully used the accident as a catalyst to oppose construction and licensing of nuclear generating stations, for the TMI community, the nightmare that began early in the morning of March 28, 1979 lingers.

Some of the nightmare comes from uncertainty; noone knows just how much radiation was released at the time of the accident. During the accident General Public Utilities (GPU) reported that monitors went off the stack, filters became clogged and radiation monitoring devices were "missing". In 1984, Dr. Jan Beyea noted in his review of dose assesments at TMI, that dose estimates to the whole body range "from 276 to 63,000 person-rem delivered to the general population within 50 miles." He observed doses from radioiodine released from 15 to 30 curies to as much as 5100-64000 curies. Beyea found the doses from radiocesium to be "suspect because too many readings from differ-

CONTINUED ON PAGE 24

Pantex

The DOE's Best Kept Secret



BY GREG LEROY

The Department of Energy's (DOE) nuclear weapons production facilities have been in the spotlight for the past year. As the mainstream press unveils a story of thirty years of institutional disregard for the health and safety of people and the environment, the Pantex plant in the Texas panhandle has thus far managed to escape major public scrutiny. Pantex has been relatively immune to investigation, according to a DOE plant operator, not because it is environmentally benign (it is one of the top seven DOE polluters) but because the people in the Amarillo area form a "different political climate."[1]

Originally built in 1942 by the Army Ordinance Corps for loading conventional munition shells and bombs, the Pantex Plant was given over to the Atomic Energy Commission eight years later. By 1976 there were 288 buildings in the complex whose "principal operation" is assembling all the nuclear weapons made in the US.[2]

Approximately 2,600 people are employed by Mason and Hanger, Silas Mason Co. Inc., a private corporation which runs the plant under contract for the DOE. In 1981, payroll and purchases totaled approximately $106.4 million.[3] Annual expenditures are now estimated to be over $125 million.

Pantex encompasses 13,267 acres. About 80% of this is used for agricultural research purposes through an agreement between Texas Tech University and the DOE.[4] Underneath this area lies the Ogalla aquifer, the main water source for much of Northern Texas and other nearby states.

The plant is located about 7 miles Northeast of a large primary/secondary school and 17 miles northeast of Amarillo. 288,900 people reside within a 50 mile radius. As many as 30 communities are subject to possible exposure from radioactive releases at the Plant.

Toxic and radioactive waste at Pantex are produced from its many operations, including fabrication of chemical high explosive (HE) components for nuclear weapons, nuclear weapons assembly and disassembly, nuclear weapons modification and repair, and surveillance testing and disposal of chemical HE and nonradioactive components.[5] Contaminants which may be released in these processes include "significant quantities of uranium, plutonium and tritium, as well as nonradioactive potential pollutants."[6] Many materials are regularly released "untreated" into the local environment.[7]

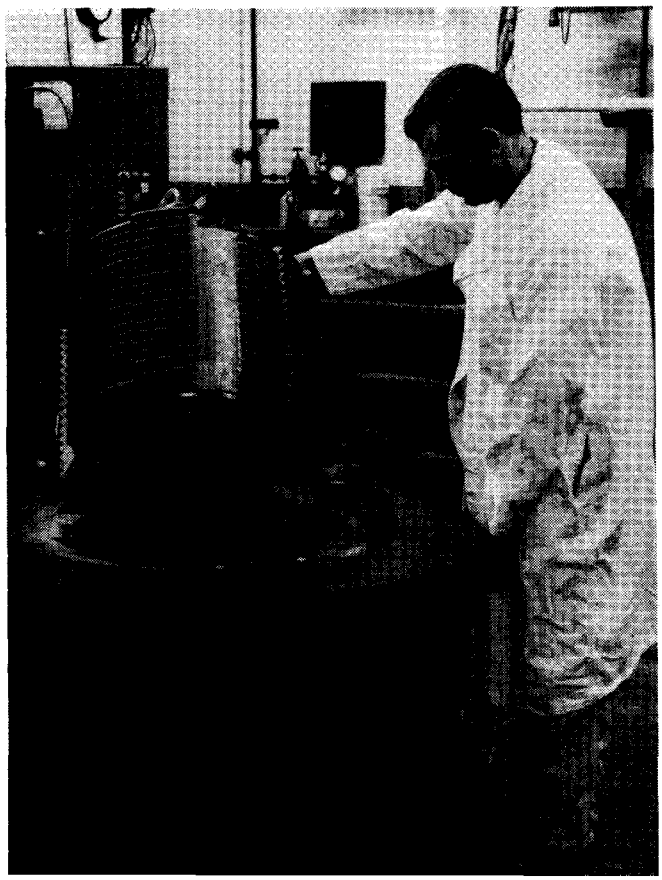
Test firing of the chemical high explosives used as "detonators" to initiate fusion is one of the major contributors to pollutant production at Pantex. Pantex has 24 sites for testing these detonators which include radioactive materials. There have been tens of thousands of outdoor test firings with as much as 36,000+ pounds of uranium 238. Many early tests may have been conducted with much more dangerous highly enriched uranium. The DOE admits to "one small" enriched uranium test shot in the past as well as test firings with "several classified materials."[8] The debris is, according to a DOE spokesman, "just scattered on the ground" in over 20 different sites.[9]

America, of course, is a signatory to the Partial Test Ban Treaty of 1963 which made it illegal to detonate nuclear weapons above ground. One reason behind the treaty was to limit exposure of civilian populations to radioactive fallout that increasingly was being recognised as dangerous. While the "test fires" conducted at Pantex were not nuclear explosions, they certainly did add large quantities of dangerous radioactive isotopes into the environment.

Weapons modification and repair also contribute substantially to pollution at the plant, and in particular, to workers' radiation exposure. Levels of tritium in the air at the plant, for example, are always hundreds to tens of thousands of times above normal background levels.[10] Tritium, a short lived hydrogen isotope with a half-life of only about 12.5 years, is one of the most important elements in a hydrogen warhead. It is used to "boost" the yield or power of a nuclear weapon. Tritium lost to radioactive decay is generally replaced every seven years in an active warhead's life. It was formerly believed that the high tritium levels were a result of the plant's participation in tritium replenishment, however, it now appears this replenishment is not part of the plant's ongoing activities and the elevated tritium levels result from other work with hydrogen weapons.

In addition to pollutants from its own nuclear activities, Pantex bears a disproportionate burden of the nation's nuclear weapons waste. For many years Pantex has been the acknowledged "staging" area for Nuclear Weapons Accident Residue as well as residue from decomissioned warheads. All

Contaminants which may be released from Pantex include uranium, plutonium and tritium, as well as nonradioactive potential pollutants. Many materials are regularly released untreated into the environment.



Greg LeRoy is the director of Public Search, a nonprofit public interest group in Houston. This article was adapted from a Public Search report.

Far left: aerial view of the main production area, looking north. Left: Technician at helium pressing, fabricating the high explosive components necessary to assemble, repair and test nuclear weapons. Both photos courtesy of DOE.

damaged nuclear weapons are sent back to Pantex for repair or disposal. The weapons themselves aren't officially "stored" at the site but "staged" for a period of time. Yet the fact that absolutely no accounting has been given for the quantities of materials which must have been interned or shipped offsite, suggests that some of this material can not be acounted for at Pantex. It seems likely that much of this material is buried on the Plant grounds.

A DOE representative admits that there may be significant quantities of high and low level radioactive waste (including plutonium 239 and uranium 238) still buried at Pantex, and improperly identified as benign waste.[11] The spokesman admits that many years ago this type of waste was simply buried in cardboard boxes or other temporary containers, practices that have led to some of the most polluted sites at other DOE plants.

Finally, tens of millions of gallons of solvents and other forms of highly toxic materials have been disposed of at Pantex over the last 25 years. As much as 10 million pounds of radioactively contaminated solvents and material has been summarily burned in the open on "impermeable pads."[12] Close to 6 million pounds of residue from these burning operations were simply left in the open pits and dirt thrown over them. No serious effort was made to monitor the transmission of radionuclides or other hazardous emissions into the environment.

Environmental monitoring of Pantex and the surrounding communities is important because the plant is located relatively close to urban areas and has potential ecological pathways for pollutant transfer to humans, including air, groundwater, underground aquifers, animals and agriculture. Existing monitoring, however, is inadequate. The same corporation which runs Pantex under contract for the DOE (Mason and Hanger, Inc.) publishes their own annual Environmental Monitoring Report. Our evaluation of these reports has uncovered statistical methods of questionable merit, substantial missing data, and many explanations for excessive radioactive fallout that are specious at best.

At Pantex, almost none of the necessary monitoring of relevant physical or chemical parameters -- for example, air-flow rate or chemical composition of the effluent stream -- is done. The fifty areas monitored are disproportionately sited away from the south side of the plant, reflecting prevailing wind patterns but not the peak gusts which travel predominantly toward the south and southwest. This leaves many areas unmonitored, including the highly populated city of Amarillo.

Uncharacteristically pronounced radiation readings . . . were dismissed as "worldwide fallout from atomic or nuclear weapons tests...(from the Chinese) ... and not from Pantex plant activities."

Even the areas which are selected for monitoring often are not adequately tested. In 1978, the Pantex Environmental Monitoring Report stated that "no air sampling was performed for the last six months."[14] Air sampling or collection was supposed to occur weekly. It was noted in 1985 that "offsite environmental soil samples were collected quarterly, weather permitting."[15]

In spite of inadequate monitoring, anomalously high radiation readings have been observed, but are summarily dismissed. Uncharacteristically pronounced radiation readings in 1977 were dismissed as "worldwide fallout from atomic or nuclear weapons tests...(from the Chinese) .. and not from Pantex plant activities."[15] Three years earlier, an "increase in total uranium in soil and vegetation" in 1982 was attributed to "a change in contractor laboratories."[16]

Every year specific (and often different) monitors indicate abnormal readings (often 5, 10 or 25 times above preceding years). Air counts for highly toxic Plutonium 239 registered this variance during the years 1977-1980.[17] These abnormal readings are never explained, although the reports consistently claim that there are no plutonium releases at the plant.

Finally, the overall impact to the public is calculated using average annual radioactivity release rates and meteorological data, not actual emmissions, making these presumptions, not substantiated data.

The need to view these reports with skepticism is underlined by the fact that some 20-30 known accidents are never acknowledged in their annual reports. This is a serious oversight. A follow-up investigation by DOE, for example, found that an "incident involving weapons accident debris brought to Pantex potentially could have caused internal deposition of plutonium."[16] This was never discussed in the annual reports, nor were any of the large fires or explosions, nor workers' high level exposure to radiation.

The inadequate monitoring and reporting makes it difficult to encapsulate the most significant sources and the extent of hazardous waste and radioactive emissions from the Pantex plant. Although 46 Superfund sites have been identified at Pantex, this may be a gross underestimate. Many areas at Pantex were "not evaluated" or found "not applicable" for the hazard ranking score used to get on the Superfund list, including "old high explosive contamination sites," "solvent leaks," "chemical burn pits," and onsite contaminated playas and ditches.[17] In other words, sites which have the potential to be among the most polluted at Pantex. With these sites included, Pantex could easily be among the top 3 or 4 most polluted DOE facilities in America.

Although the true extent of the damage can be debated, one thing is clear. Before 1973, there was "infrequent" hazardous waste management at Pantex, and limited concern for the health and safety of plant workers and the effect of plant policies on the environment and surrounding communities.[18] Before 1963, records of employee radiation exposure weren't even kept. The obvious conclusion is that Mason and Hanger, under the guidelines of the DOE (and its predecessor agencies) had little concern for radioactive contamination, no obligation to dispose of waste material properly, and were disinclined to assume such costs.

Mason and Hanger, Inc. do not appear unduly concerned about the possibilities of buried toxic wastes migrating towards underground water supplies. The company policy is to minimize the volume of radioactive waste generated "to the extent tech-

nically and economically feasible".[19] Translated into practice that means something on the order of 1/2 of 1% ($250,000 out of some $125 million) of the annual budget is being allocated to protect workers, the environment and the surrounding communities. For comparison purposes, according to DOE estimates, cleanup at Hanford is expected to cost at least $57 billion over the next 30 years and "background levels" of radiation at Pantex are admitted by the DOE to be 24 millirems higher than at Hanford. Because there has been so much radioactive contamination of both sites, background radiation levels could reflect past radiation releases or improper staging techniques.

The DOE insists that there is "no environmental impact" from current practices.[20] However, a 1986 DOE report recommended "additional evaluation" of such current disposal practices as burning ground landfills and the entire waste water system. The effects of past practices have yet to be determined, however the DOE acknowledges that there are grave concerns about "the potential for groundwater contamination, or to surface waters, or to the public."[21]

These surface waters are the reservoir playas, large cavities up to a mile in diameter about 50-60' below the surface but above the Ogalla aquifer. Many of these playas, both inside and outside the plant perimeter, have already been contaminated with solvents, radioactive chemical high explosives, and uranium, although the exact quantities are unknown.[22] One playa is thought to have received plutonium residue as well.

For years Mason and Hanger and the DOE have claimed that a "surface layer of clay 18 to 24 meters deep forms a barrier to surface moisture and prevents deep percolation from surface contaminants."[23] Is this true? Is the Ogalla aquifer still "the largest and most prolific underground fresh-water supply in the United States?"[24]

The DOE spokesman in charge of the environmental program at Pantex says, "There's no way we can say."[25] However, one might point to the eight or nine "supply wells" that are on the Pantex site which directly tap into the Ogalla aquifer. At Hanford during the mid 1940's - 50's, contaminants were often just pumped down these wells. In another instance a large subterranean body of radioactive fluids crashed through the walls of the well and emptied all of the contaminants into the aquifer. Whether this occurred at Pantex is still unknown but there is some evidence to support such a belief.

Comparing DOE maps of Pantex one finds that four "supply wells" which were active in 1980 had been abandoned only six years later.[26] All were in the northwest quadrant where the majority of hazardous wastes have been stored and the test firing sites are located. The DOE argues that closure was a result of "well deterioration" and has nothing to do with the quality of water.[27] As early as 1972, however, Mason and Hanger's own reports found these same wells to be heavily contaminated with lead, chromium, cadmium and copper.[28] High explosive residue and radioactive nuclides were not monitored. **These wells are close to Playa #1 which may have received as much as 5-8 billion gallons of contaminated water.**

Another playa is approximately 4 miles northeast of the plant site and is called "Pantex Lake." DOE admits abandoned waste sites in this area may contain extrememly hazardous wastes, but says that the responsibility for their cleanup lies with the US Army, the original creator of the dumps. The Army feels that Texas Tech University, the current "owners" should take care of any waste problems.

Any potential hazards at Pantex Lake should be of immediate and special concern because the water wells that supply the city of Amarillo with drinking water border this property. While Pantex claims that a thick layer of caliche and clay entrap the liquid wastes, there is no certainty that the geologic conditions are uniform. How has Mason and Hanger been permitted to endanger the Ogalla aquifer? The answer is related to lax DOE waste disposal regulations and the fact that, according to the DOE, no "EPA National Pollutant Discharge System Permit is required because none of the discharges reach offsite surface water."[29] The DOE has not asked Mason and Hanger to stop diverting manufacturing and processing wastes into the playas, so it is still being done.

The DOE does agree that the playas are potentially hazardous. They recently acknowledged that pumping water from these playas off-site may be unsafe, and that the long-standing practice of pumping large amounts of playa waters for use in agriculture and lifestock should be "evaluated".[30] From their previous performances at Pantex and other nuclear weapons production facilities, we might predict that these "evaluations" will be meaningless unless an informed and enraged public demands that our health and safety not be crushed under the exigencies of "defense," a defense that will leave us with a scarred and inhospitable planet.

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BLESSED ASSURANCE

BY A. J. MOJTABAI

Three men are waiting in the conference room: Paul R. Wagner, Department of Energy representative and ranking federal officer at Pantex; his assistant, Claud Gay; and Charles R. Poole, Plant Manager for Mason & Hanger. I choose a seat with my back to the two large photographs of mushroom clouds, one green, one violet. Are they of test shots? Or of the actual explosions at Hiroshima and Nagasaki? There is to tell. They could be anywhere. They are nowhere.

I have not really come for statistics, but they provide an easy start. In 1982, at the time of my first and only visit to the plant, the operating budget is $97 million. (In 1985, the operating budget is $118.8 million. The projected operating budget for 1986, estimated in January 1986, is $121.5 million. Funding for building construction increases from $42 million to $52 million between 1984 and 1985.) The number of full-time employees is 2,300-2,400 in 1982. (It is to be 2,600 in 1984, and 2,800 in 1985 — a slow, but steady accretion.)

I ask how many other people are employed by independent subcontractors for construction and repair on a short-term or part-time basis. From talking to people in Amarillo, I gathered there were many. "We don't have those numbers," says Poole.

There are, however, ways of estimating these numbers. A Los Alamos National Laboratory study of the impact of a theoretical termination of current operations at Pantex, made in 1982 projected a loss of 4,800 basic and nonbasic jobs, and the Texas Industrial Commission projected a loss of over 8,000 nonbasic jobs statewide.

Pantex makes a contribution to the community through supplies and services, payroll, purchases, and sales tax. Its utility bill alone in 1981 was $3 million. The federal government makes a contribution through school districts, as it does wherever military bases are located. In 1982, political economist Lloyd Dumas estimated that Pantex generated 25 percent of the local economy, and thus "has placed the city's economic survival almost directly on the continuation of the arms race."

The entrance hall of the Pantex administration building, studded as it is with plaques, trophies, banners, and certificatesof merit, testifies to the extensiveness of the plant's community involvement: largest single contributor to United Way of Amarillo, contributor to the American Legion, to the United Negro College Fund, sponsor of Atomic Merit Badge programs for Boy Scouts and Girl Scouts...Why would anyone want to attack such a good corporate citizen? Bishop Matthiesen has done so, and when I ask what the impact of the bishop's call to the conscience of nuclear armament workers has been, Wagner calls it "a great None."

There is an intricate balancing act among the three men: one speaks, another modifies or changes the subject. But Paul Wagner is chief spokesman. Bespectacled, graying, mild of face — there is nothing authoritative in Wagner's appearance, but his manner is commanding. Much of his career has been in the military. An Annapolis graduate and a much-decorated career naval officer, Wagner retired from active duty with the rank of lieutenant commander in 1965. A year later, he joined the Atomic Energy Commission in Albuquerque, New Mexico, as a nuclear production program engineer.

Wagner likes to refer to Pantex as the "General Motors" of the nuclear weapons industry. It is not involved in development as is the Lawrence Livermore Laboratory; it is not high tech, simply a very solid engineering enterprise.

Radiation exposure presents no special problem. At most, Wagner claims, it is 40 percent of the accepted maximum of five rems a year. "There are radiation-monitoring instruments in the working areas, monitoring air and wall surfaces," adds Poole. Badges containing film sensitive to radiation are worn by employees and are normally checked on a monthly basis.

Here, Wagner breaks in with some vehemence: "We don't have any radiation exposure here. Anything we handle here we can handle with our bare hands on the top of the table. And I have done so!" Wagner, who served as a nuclear weapons officer on an aircraft carrier, has no qualms about radioactive contamination. "Hell, people sleep on those things," he says of nuclear weapons. "I have—when that's where your bunk is. I probably got five rems a night and am still here."

"We would never have used unstable fuel in nuclear weapons... we may be crazy, but we're not stupid!"

Paul Wagner
DOE Representative and Ranking Federal Officer at Pantex

Poole boasts that the accident record at Pantex is probably ten times better than in any comparable industrial operation. There have been awards from the National Safety Council. However, a plastic-bonded fuel, LX-09, was involved in a 1977 explosion, killing three workers. Asking whether that "unstable fuel LX-09 is still used" yields an emphatic "No."

Q: No? I thought it was used in the Trident?

A: In the Poseidon.

Q: Then it is still used?

"We would never have used unstable fuel in nuclear weapons," Wagner says, raising his voice. "We may be crazy, but we're not stupid.!" In a slow, counterbalancing gesture, Poole takes out his nail file and begins to use it.

Responses are layered. When I ask about the transport of nuclear weapons, whether planes are used, Wagner replies carefully, "We don't transport them by plane." There is an ever so faint emphasis on the "we." What he means is that the Department of Energy does not transport them by plane. When I catch on and ask who does, the reward is a real answer: "What the Department of Defense does — that's their business."

The intricate shell game continues. Are nuclear weapons stored at Pantex? To find out, the question must be asked in three different ways. Are any nuclear weapons temporarily stored at Pantex? ("We only have weapons on-site which have recently gotten off the assembly line or will be going back on...") What does it mean to "stage" a weapon? ("Temporarily holding.") Are any nuclear weapons "staged" at Pantex? Finally: "Yes."

Pantex officials maintain that plant operations generate only a low level of contaminant waste — tissues, gloves, containers and the like, which they package and ship off to Nevada. It puzzles me why this waste should be sent off elsewhere, while nuclear weapons accident residue from all over the world (from a B-52 bomber crash over Palomares, Spain, from another bomber crash in Thule, Greenland, and from a missile silo explosion in Arkansas, for example) is sent to Pantex.

"That debris from Palomares and Thule — it's leaving someday," Wagner answers. "It's here because it was sent here."

"Why," I ask, "was it sent here? Why was Pantex singled out for this honor?"

"Some honor!" Wagner replies. "It all came here — all this weapons debris-because it's unknown material. It's radioactive material from nuclear weapons mixed with chemical high explosives." Pantex knows how to handle high explosives.

Clearly, Pantex officials have not been pleased with this particular consignment. Their nuclear warheads, if used, will be used in some other place. But deadly debris right here, moldering in their own backyard, is a different story. And by 1985, all the weapons debris will be placed in permanent storage at the Nevada test site.

Time for one last question. Having nothing now to lose, I venture the one that matters most to me. These officials will be sure to find it foolish, for it is a what-if, a counterfactual conditional, posed to people who pride themselves on their unflinching fidelity to the factual. To make this question even less welcome, I want to ask each of them separately — individually and personally — which is precisely what this interview has been structured to avoid.

They agree to give it a try. Turning to Wagner first: "What woud you like to be doing if there were no need for a nuclear armaments business?" I ask. I am hoping against hope that he will burst out with something like: "Fishing! For the longest time, I've had this yen to go fishing." But, no, he answers matter-of-factly: "At my age, nothing. I was a career military man. I would have pursued the military with or without nuclear weapons. It doesn't make any difference to me — nuclear weapons or not."

From Poole: "I don't even give it a thought. Nuclear weapons are part of our armaments. There's no such thing as an ideal world."

And Gay: "I've been involved in defense all my life. I've been associated with nuclear weapons thirty years, all my adult life. I guess I haven't given it a great deal of thought."

With this, my time is up. Although I have no camera, I press for the full tour, the ride around the inner fence, granted to photographers. "All you'll get is different angles of the fence," Wagner promises. Whatever is available - I want it. There are handshakes all around, and Larry Lifton is summoned to drive me around in his security jeep.

The tour that follows reveals little more than what I have seen before on the approach to the plant. The buildings are squat, multiform, with several structures resembling warehouses of World War II vintage. I have outdistanced the jackrabbits and the cows,

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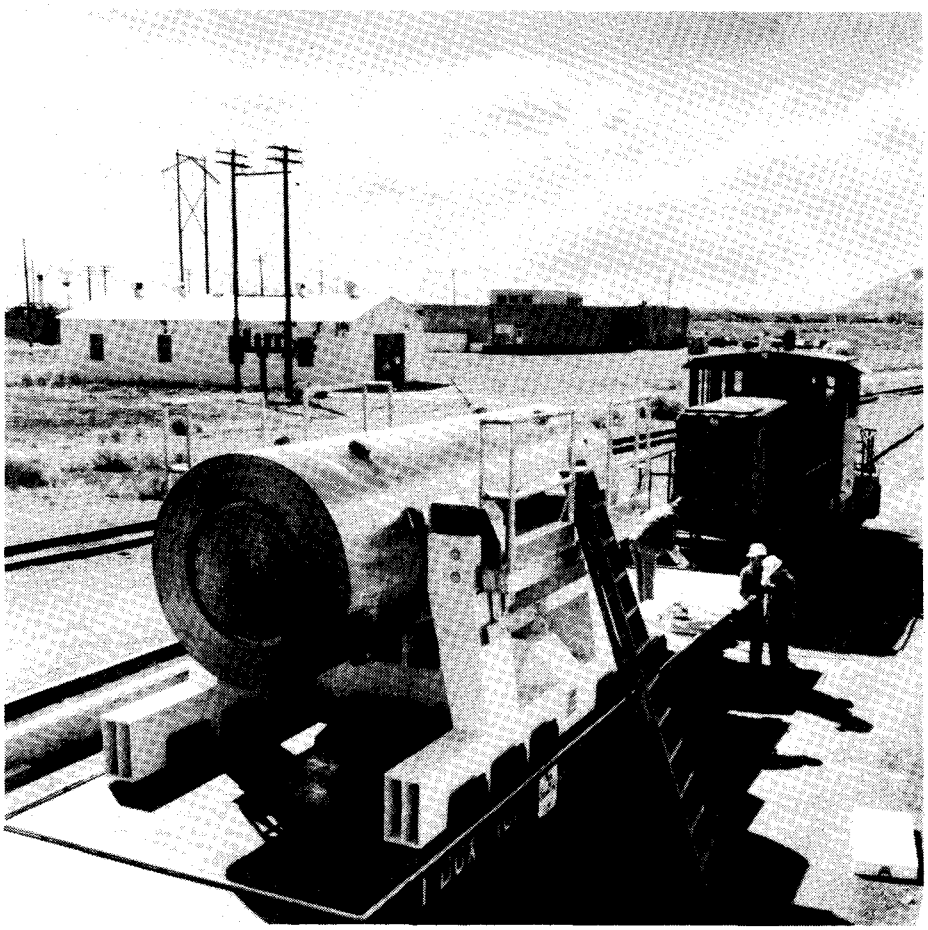
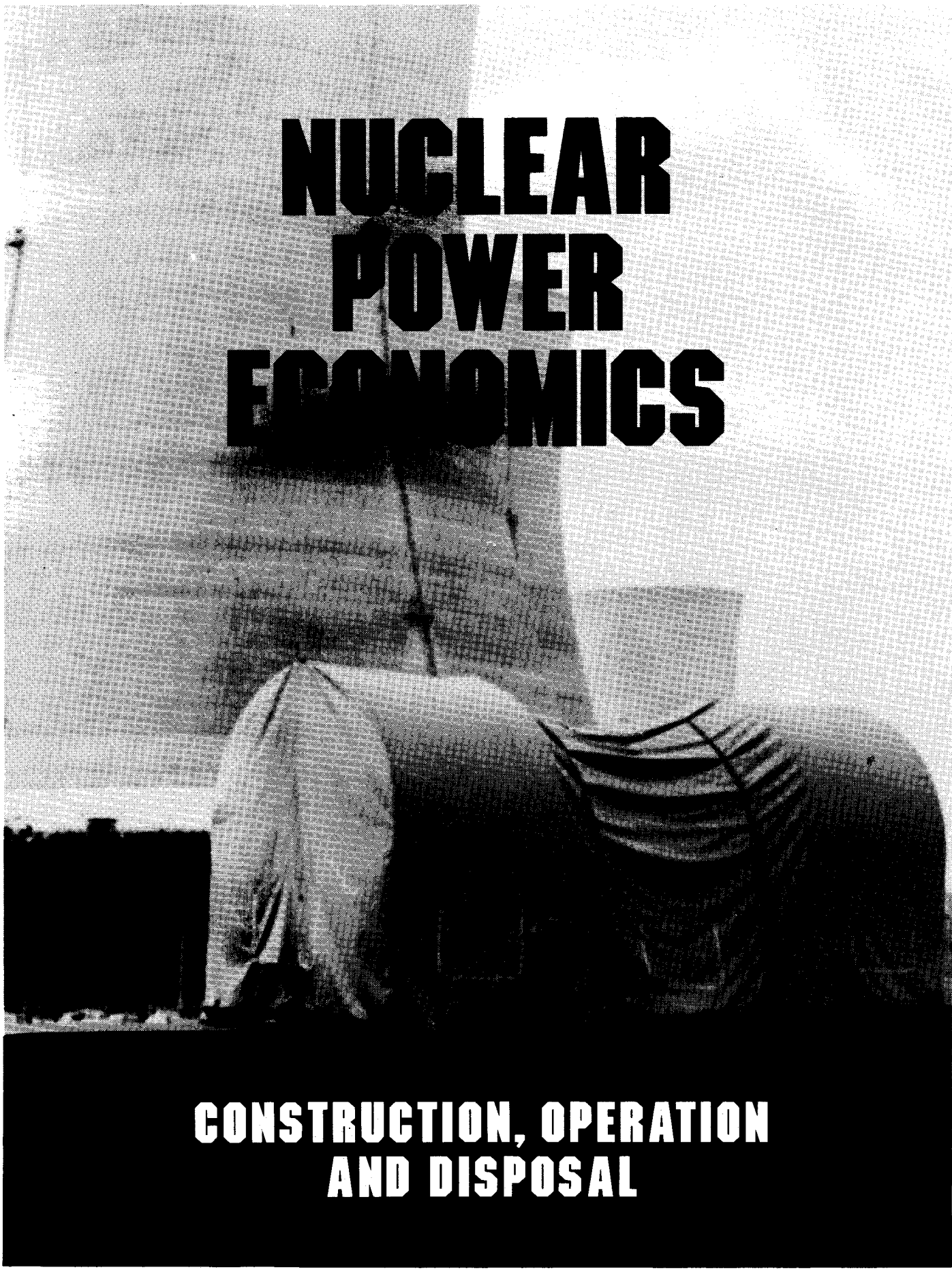


America's nuclear industry in transit: Fuel and structural core materials from TMI are shipped by rail to the DOE's Idaho National Engineering Laboratory. Photo courtesy DOE.

NUCLEAR POWER ECONOMICS



CONSTRUCTION, OPERATION AND DISPOSAL

PHOTO/U.S. DOE

BY BRUCE BIEWALD AND DONALD MARRON

As we mark this tenth anniversary of the Three Mile Island nuclear accident, the time is ripe for a reevaluation of our country's nuclear policy. With only a few straggling units left to go on-line, the nuclear construction industry is essentially dead. Having survived the era of spiralling construction costs and huge rate increases, we now face a number of serious problems caused by the operation of existing nuclear units. The continuing rapid escalation of nuclear operating costs, for example, should encourage us to consider closing those units that are uneconomic. At the same time, we should also consider the vast array of problems that will arise (in the not-so-distant-future) when we begin cleaning up after this first generation of nuclear plants. The potential problems (and costs) associated with nuclear retirement, decommissioning, and waste disposal are huge, yet they remain far from resolved. At the same time, prospects for a second round of nuclear plants are receiving an increasing amount of attention from energy policy makers.

NUCLEAR CONSTRUCTION

Since the birth of the atomic energy industry 35 years ago, U.S. utilities and government agencies have ordered 259 nuclear generating units. Of these, some 120 have been cancelled, 109 are currently operating, and 15 have been retired after some period of operation (TMI unit 2 holds the record for the shortest operating life — a little over 11 months).[1] Of the 15 units that remain in the construction pipeline, it appears unlikely that more than six or seven will ever enter commercial operation.[2]

The nuclear industry has thus managed to bring on-line only about half of its planned units. This high failure rate is all the more striking when we analyze the time pattern of nuclear plant orders and cancellations. As shown in Figure 1, the nuclear construction industry declined sharply after 1974. Over a hundred units were ordered during the years 1972 to 1974. That number dropped to 4 in 1975, and to 2 in 1978; none have been ordered since.[3] As the number of orders dropped, nuclear cancellations, unknown before 1972, became commonplace. By the end of 1978 (just before the accident at TMI), more than fifty units had been cancelled; by the end of 1982, that number had doubled to more than a hundred. Even more striking: *none* of the 47 units ordered since January 1974 have or will ever operate; they have all been cancelled.

It is clear from these figures that the accident at TMI did not itself destroy the nuclear construction industry. Instead, TMI provided the coup-de-grace to an industry already mortally wounded by financial problems. The cost of nuclear generating capacity had escalated out of control since the late 1960's. As a direct result, the ability of utilities to attract investment capital had deteriorated to a point at which utility bond issues were considered risky investments.[4] By the mid-1970's, many utilities had thus become unable to finance nuclear investments. In addition, the oil price shocks of 1973-4 led to dramatically reduced demand for energy. As a result of these factors, new nuclear orders disappeared, and many existing orders were cancelled.

Figure 2 illustrates the rapid escalation of nuclear power plant construction costs that has plagued the nuclear construction industry. Whereas the direct costs (i.e., excluding financing costs) of nuclear generating capacity were about $550 per kilowatt (kW) for units coming on-line in 1971 (in 1987 dollars), that cost had risen to about $3,200 per kW for units on-line in 1987. Nuclear direct capacity costs thus escalated by about 11.6 percent per year in *real* (i.e., inflation adjusted) terms from 1971 to 1987. Over the same period, the time to construct the plants also increased dramatically, causing the financing costs of nuclear plants to increase even more rapidly than the direct costs.[5]

"The largest managerial disaster in business history" forced the gaze of the nuclear industry and its critics from construction to operation.[6] They have discovered that despite the huge sums spent to operate them, nuclear plants are performing, on average, far below the levels once projected by industry proponents. In fact, many plants are even performing below the levels required to make their operation economic.

Nuclear plant operating costs can be broken out into three major components: fuel costs, operation and maintenance costs (O&M), and capital additions costs.[7] The original attraction of nuclear energy lay in the low level of its fuel costs. Nuclear advocates believed that fuel cost savings (resulting from the low cost of uranium as compared to fossil fuels) would more than offset the large up-front costs of nuclear construction. Such reasoning unfortunately ignored the actual impact of nuclear O&M and capital additions costs.[7] In practice, these non-fuel operating costs have come to more than offset the low fuel costs that nuclear plants still enjoy.

Figure 3 shows how non-fuel nuclear operating costs have risen since 1970. In *real* terms, industry average non-fuel operating costs have escalated at a rate of 11.6 percent *per year*. Whereas nuclear operating costs were about $20 per kW in 1970 (in 1987 dollars), they cost about $115 per kW in 1987.[8] Like the escalation of construction costs, this six-fold increase in operating costs can be attributed to a variety of factors. The lack of standardization in plant design and the ever increasing size of nuclear units (with associated increases in complexity) likely caused some of the cost increases.[9] Regulatory burden also played a role, although we should note that many of the new regulations resulted directly from the continued discovery of new technical problems at the plants. The gradual ageing of nuclear plants may also have contributed.

Many pressurized water reactors (PWRs), for example, have experienced water chemistry problems that have eroded pipes in their steam generators.[10] At many plants, these problems have been or will be severe enough to require steam generator replacements at a cost of $100 million or more (estimates for the steam generator replacement at the D.C. Cook plant, for example, put the tab at some $160 million). Boiling water reactors (BWRs) have experienced their own problems with pipes cracking; in a number of cases, BWR pipes have had to be replaced. Such pipe replacements have cost in the $20 — $80 million range.[11] While these specific examples are particularly glaring, they are indicative of the general operating problems (and resulting costs) that have permeated the nuclear industry.

The steady, rapid increase in nuclear operating costs has eroded the operating cost advantages nuclear plants once enjoyed over fossil-fired plants.[11] A 1985 Study by the Tennessee Valley Authority (TVA) found, for example, that on average, nuclear operating costs now exceed the operating costs of

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coal-fired plants. A recent Department of Energy (DOE) study found, moreover, that the continuing escalation of nuclear operating costs may require that plants be shut down for economic reasons before their physical operating lives are complete.[13]

Nuclear operating costs are compared with oil in Figure 4. The operating cost advantage enjoyed by nuclear plants from the mid-1970s through the mid-1980s has eroded, as the result of steady increases in nuclear operating costs, and the recent decline in oil costs. Note that these data do not include construction costs, which are currently about four times higher for nuclear plants, according to the Electric Power Research Institute.[15]

There are, of course, many other resource alternatives to oil and nuclear. Conventional fossil-fueled technologies such as coal-fired power plants and gas-fired combined cycle plants can be considered. Demand-side technologies such as efficiency improvements in lighting, appliances, and building shells are even more promising. The comparison with oil is presented here because oil-fired generation is traditionally considered a high operating cost option; yet now nuclear is in the same price range (even when the enormous construction investments in nuclear power plants are ignored).

Moreover, both oil and nuclear operating costs are expected to increase in the future. The recently reported pipe thinning and pipe degradation problems at many plants will likely result in large future maintenance and repair costs. The continued ageing of nuclear units may add similarly to the increase in future operating costs. In addition, the NRC still faces a backlog of roughly three hundred unresolved safety issues.[16] As the NRC deals with these issues, we may expect further orders and regulations requiring changes (and associated cost increases) at existing plants. Thus nuclear operating costs may well remain high compared to alternatives.

While the escalation of costs has undermined the economic viability of nuclear operations, it is important to note that operations have failed in more than just cost terms. In order to offset their high initial construction costs and other high fixed costs, nuclear plants need to realize significant running cost benefits. These benefits can only come from running the plants at high capacity factors.[17] Back in the halcyon days of nuclear optimism, utility analysts often predicted that units would operate at capacity factors of 75% to 80%. In fact, nuclear capacity factors have averaged below 60%. At such low rates of energy production, it is virtually impossible for many modern nuclear plants to compete with alternatives.

Thus, nuclear operations have failed on two fronts. First, the costs of nuclear operations have vastly exceeded utility expectations. These costs continue to escalate at rates that far outstrip the background rate of inflation — a pattern which shows no sign of abating. Second, nuclear units have operated at levels far below the original projections

Figure 1.

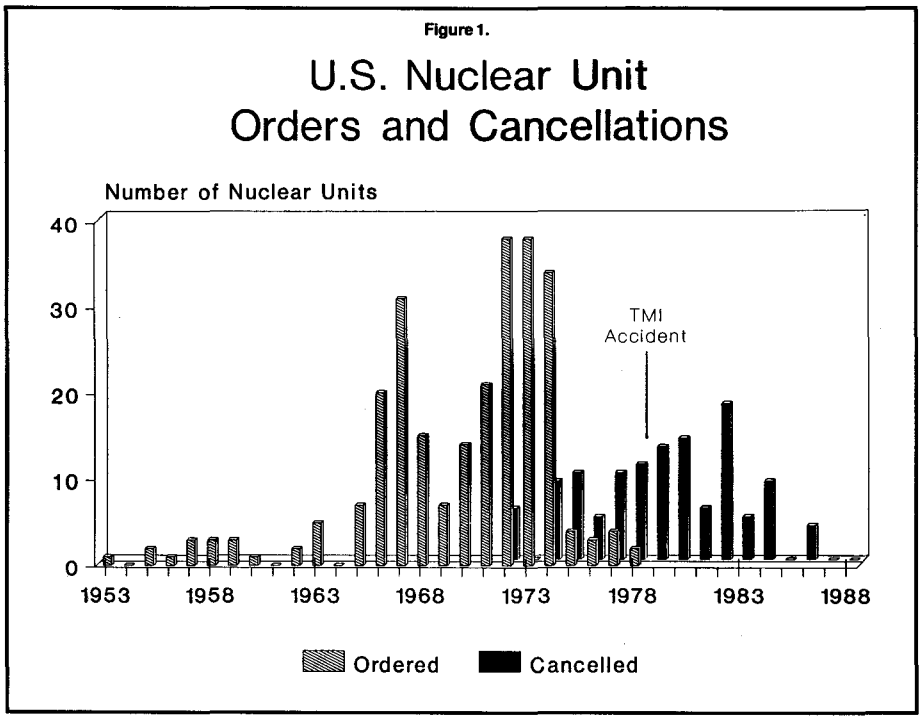
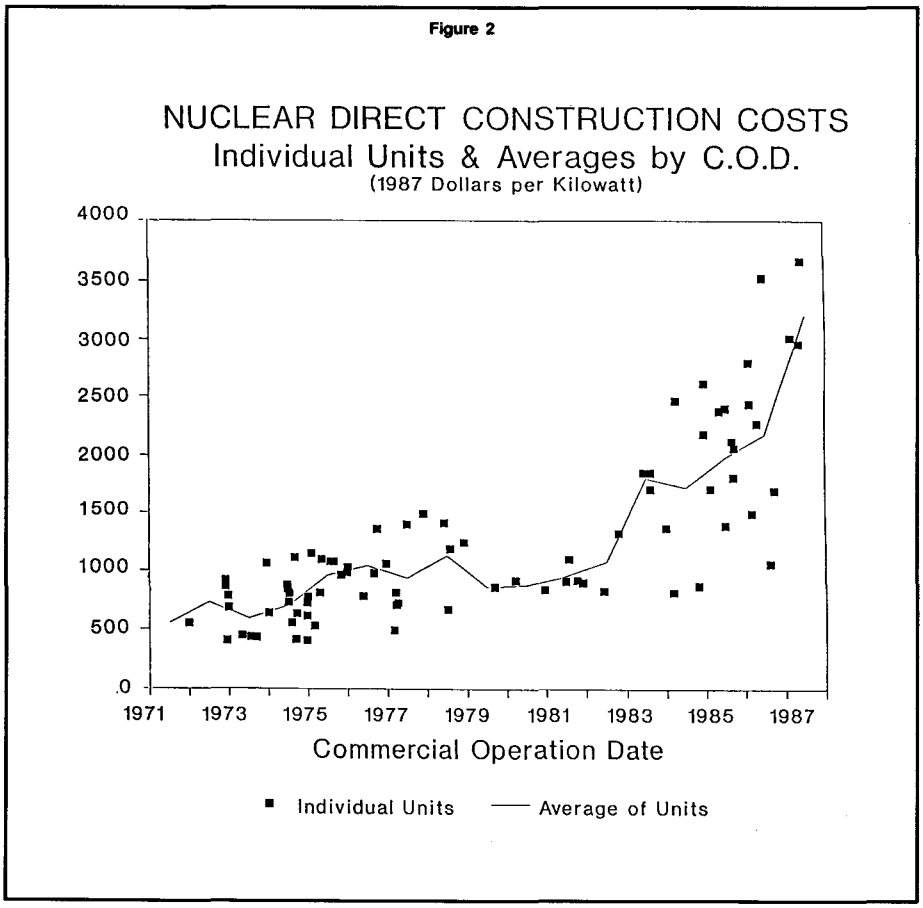


Figure 2



of the industry. The result is that consumers have been stuck paying far more than expected, for much less power than expected. Rather than being "too cheap to meter", the nuclear energy produced at many plants has ended up costing far more than it is worth. In many cases, the multi-billion dollar investments needed to build the plants have not been justified by subsequent operating benefits, and future benefits will likely be small or non-existent. As a result, a reevaluation of existing nuclear units may now be in order.

THE RESPONSE TO HIGH OPERATING COSTS

New regulatory, economic, and political questions have arisen due to the high level of operating costs and the low level of performance of nuclear units. Whereas once the political battleground centered on the issue of whether to build these plants, current concerns now revolve around the question of whether, or under what terms, these plants actually ought to operate. Arguments over the responsibility for high costs and poor performance have become common. Consumers Power Company's (CPCo) troubled Palisades nuclear unit is a useful example, since the proposals for addressing that unit's poor operating performance span the full range of approaches considered thus far.

In May 1986, technical problems forced Palisades to come out of service. Subsequent safety related problems and NRC concerns extended the outage through the rest of the year, and resulted in $20 million in excess costs. Normally, the costs incurred by the utility during a plant outage are eventually recovered from ratepayers. In this case, however, the Michigan commission ruled that costs incurred during that outage would not be recovered from ratepayers, because the utility "was negligent in its maintenance of the Palisades plant equipment."[18] Disallowances of this type provide an incentive to the operator of the plant to avoid long outages.

For some plants, performance standards have been put in place. These standards, or "incentive" mechanisms, result in automatic cost disallowances for poor plant performance. Some systems also provide for extra rate recovery to the utility as a reward for achieving excellent plant performance. An administrative law judge recommended such a standard for Palisades in 1987. Under the proposed mechanism, if Palisades operates at an annual capacity factor of less than 60 percent, then the recovery of replacement power costs during the extra outage time would not be allowed. Plant performance standards of this type can provide electric ratepayers some protection from the cost impacts of low nuclear plant capacity factors, since they shift a portion of these costs to utility shareholders.

Another emerging strategy for addressing the deteriorating economics of nuclear electricity production is the structuring of unconventional ownership arrangements for nuclear plants. The risk of poor performance, and the rewards for good performance, can be shifted to the electric utility company, or to a new corporate entity.

Again, Palisades serves as a useful illustration of this approach. CPCo, Palisades' current owner, recently proposed selling the plant to the Palisades Generating Company (PGCo), a new corporate entity created to own and operate the plant. The shareholders of PGCo will be CPCo (or an affiliate), Bechtel (the nuclear engineering firm that constructed the plant), and other investors. Under the proposed arrangement, CPCo's customers will pay a predetermined fixed price for each kwh produced by the plant. Thus, if the actual capacity factor of the plant is higher than projected, or if the actual operating costs are lower than projected, PGCo will reap the benefits. Conversely, if the capacity factor is low or operating costs are high, PGCo will bear the excess costs.

All of the mechanisms noted above attempt to protect consumers from the impacts of poor nuclear operating economics. Despite the merits of this objective, however, these arrangements can create new problems that more than offset the old ones. For example, in providing incentives to the operators of a plant, it is important not to focus narrowly on only one component of plant economics while ignoring other important elements. A restricted approach may provide inappropriate motivation, such as the incentive to overspend on O&M and capital additions in order to receive rewards for high capacity factors. In such a scenario, ratepayers would bear the costs of those excessive plant investments as well as the cost of the bonus provided as a reward to the utility. Thus, while they may be useful in some cases, performance standards that are based solely upon the capacity factor are only a partial solution, since they fail to address overall nuclear plant economics.

Another important concern with some incentive mechanisms is plant safety. Experience at TMI and other nuclear plants has underscored the importance of judgement and the "human element" to safe power plant operation. If a utility company is provided with large bonuses for keeping a nuclear plant online, its willingness to bring the plant down for unscheduled maintenance may be diminished. As a result, some maintenance requirements may go unsatisfied, thus increasing the possibility for safety problems to arise.

In the case of the recent arrangement for PG&E's Diablo Canyon nuclear plant, for example, ESRG found that the Company would lose more than $3 million for each day of down time.[19] With incentives of this magnitude, we are entering unknown territory. Will plant operators make decisions that compromise public safety? The NRC has expressed concern with incentive plans for nuclear plants:

> ... in the interest of real or perceived short-term economies, utilities might hurry work, take short-cuts, or delay action in order to meet a deadline, a cost limitation, or other incentive plan factor. In other words, the potential exists that such a program could encourage, directly or indirectly, the adoption of actions designed to maximize measured performance at the expense of plant safety (public health and safety).[20]

Another consequence of some of the new plant ownership arrangements is that plant retirement decisions will be outside the control of state regulators. With the deterioration of nuclear plant operating economics, it would be rational to consider shutting down some plants, particularly the lemons of our nuclear fleet. Under conventional arrangements, state regulatory commissions oversee utility planning and operating decisions through the ratesetting process. Some of the novel ownership arrangements will circumvent state power by transferring regulatory authority over the plants from the states to the Federal Energy Regulatory Commission (FERC). As a result, state and local influence on nuclear operations may be greatly diminished.

Developments in nuclear plant operating economics call for innovative responses. Proposals made to date, while imaginative, must be considered inadequate, since they fail to provide a suitable incentive structure for nuclear operations. These proposals do raise important economic, safety, and jurisdictional questions that regulators must address in solving our nuclear operations problems. Regulators, ratepay-

ers, and citizens should all be concerned with the deficiency of the current set of "solutions."

Despite the foregoing, perhaps the most troublesome problems with commercial nuclear power are yet to come. The "back-end" costs of nuclear power production, spent fuel disposal and decommissioning, have not yet been adequately addressed.

No high-level disposal facility exists to receive and store the spent fuel regularly discharged from operating nuclear plants. The DOE's plans to open a high-level repository by the year 1998 have been frustrated by technical and political difficulties; the current schedule is to begin accepting high-level waste for burial in 2003.[21] Meanwhile, an increasing amount of discharged nuclear fuel is in temporary storage pools at reactor sites.

Decommissioning, the process of dismantling, transporting, and burying the plant itself at the end of its operating life, has yet to be attempted for a full-sized nuclear plant. The amount of radioactive waste at a typical modern nuclear plant after 30 years of operation will amount to about 18 thousand cubic yards of contaminated concrete and steel, containing a total of about 5 million curies of radioactivity (primarily concentrated in the reactor vessel and internal components).[22] In contrast, the largest nuclear plant in the U.S. that has been fully dismantled is the Elk River Reactor, which contained only about 10 thousand curies at the time of its shutdown, after operating for only 4 years.

Current cost estimates for nuclear plant decommissioning are extremely optimistic, based upon theoretical engineering studies developed without the benefit of actual experience. These engineering cost estimates for decommissioning have been increasing steadily since 1976 at an annual rate 15 percent faster than inflation.[23] Decommissioning plans that fail to recognize the likely further increases in the engineering cost estimates are unlikely to be adequate for the requirements of an actual plant decommissioning. Thus, while some initial steps have been made toward recognizing the back-end costs of nuclear power, these costs still pose significant problems for the coming decades.

In light of the recent attention given to global warming theories, some energy policy analysts are looking to a new series of nuclear construction projects as the way to serve our country's growing electricity requirements. Industry advocates argue that standardization and modular plant design for these future plants will avoid the huge construction costs incurred by first generation nuclear plants. They also argue that the plants will be "inherently safe" — impervious to the loss-of-coolant accidents that are the gravest threat of our current generation of nuclear plants.

These optimistic projections must be met with skepticism, given the sorry performance of the first generation of

Figure 3

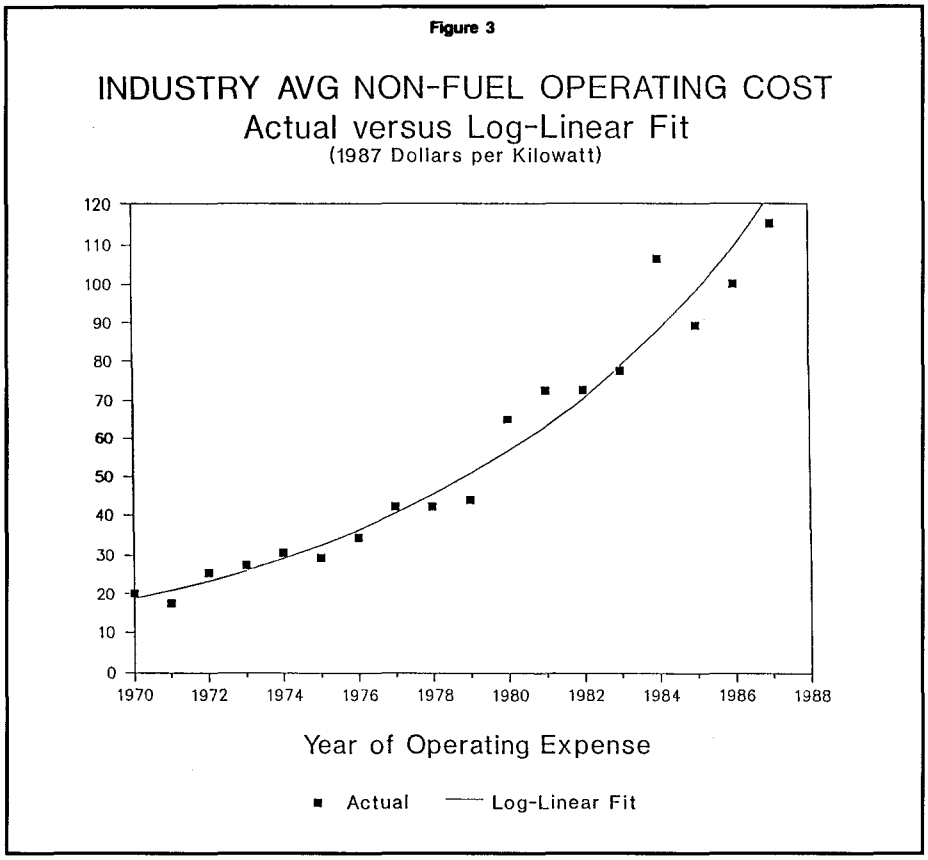
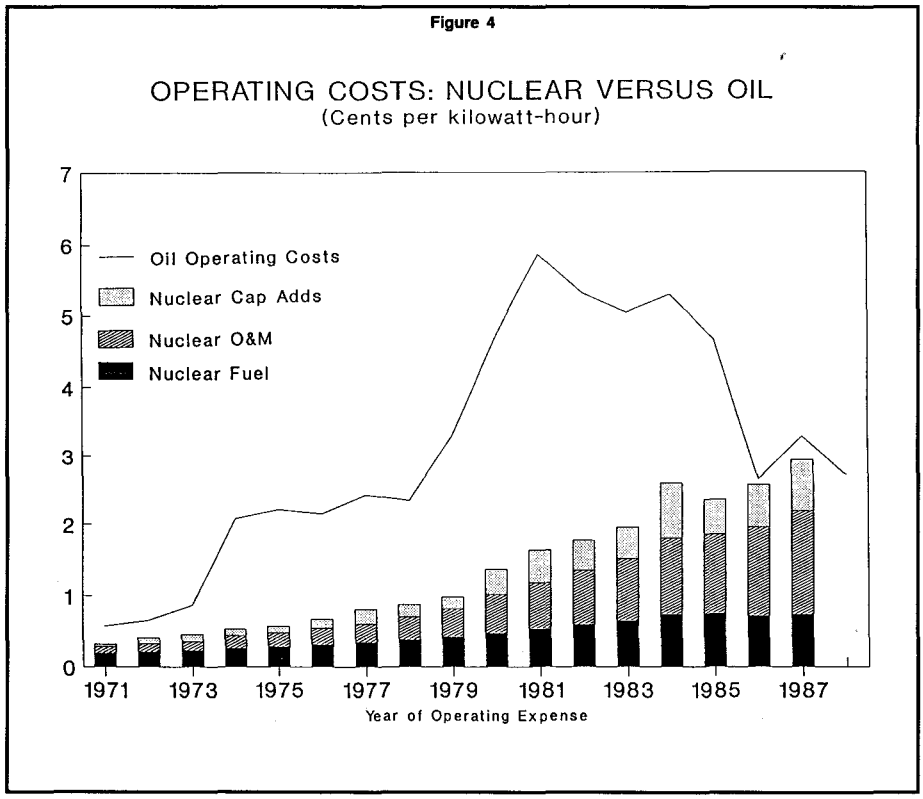


Figure 4



plants. The proposed future generation will clearly face a series of difficult tests. The safety of the plants, for example, must be ensured. Some analysts have suggested that safety and licensing evaluations could be performed as a combination of theoretical analysis (the basis for current safety standards) and actual proof testing.[24] Such a "license-by-test" practice would certainly be a major improvement over current practices, although it does fail to address some significant safety concerns, such as the impact of plant ageing and associated plant deterioration. Environmental concerns must also be addressed. Policy makers have yet to address adequately the range of environmental problems caused by the current stock of nuclear plants. It would seem unwise to start in on a second round of nuclear plants until and unless we solve these current problems, in particular that of nuclear waste.

While the next generation of nuclear plants will (hopefully) be required to satisfy stringent safety and environmental criteria, it is likely that economic concerns will pose the hardest problems. As the reader has probably noticed, we have emphasized economic issues throughout our analysis of the current nuclear generation. This emphasis is intentional, for the failure of the nuclear industry, thus far, lies not in the technology's inherent dangers and environmental problems (which have been, and will remain, a legitimate cause for concern), but, in fact, in its economics (which, of course, have been significantly influenced by public concerns over safety and the environment).

The original lure of nuclear power lay in its promise of limitless, cheap energy. The fact of nuclear power, however, has been one of ridiculously expensive energy. The plants have cost too much to build, have cost too much to operate, and have often operated below the levels needed to make them economic. The future costs of waste disposal and decommissioning, moreover, while as yet unknown, will likely be enormous. Proponents of the next generation of nuclear plants will be hard pressed to demonstrate that their plants will overcome all these economic problems. Advocates argue that standardization and modular design will keep construction and operating costs low. While this may be so, we must wonder how and why it is that the next generation of plants will be able to achieve the level of standardization and cost control to which the first generation aspired, but could never achieve.[25]

Thus as we embark on our second decade following TMI, we must remain leery of the optimism of those who tout nuclear power as the technical fix to our current set of economic and environmental woes. While we applaud and encourage the ever broadening interest in global warming and related environmental crises, we remain skeptical at this time that nuclear power should have any significant role in our policy response, particularly when so many problems of the current generation remain unsolved. Even if a second generation of nuclear plants will *eventually* play a role, it will not do so for at least another decade. Global environmental issues demand a response now. **Thus the prospects for a second generation of nuclear plants cannot and should not interfere with our immediate policy decisions.** Improved energy efficiency, both in terms of end uses as well as in production, remain the key to solving the environmental and economic problems that plague our current energy policy.

NOTES

1. Based on Government documents: *U.S. Commercial Nuclear Power: Historical Perspective, Current Status and Outlook*, DOE/EIA-0315, U.S. Department of Energy, March 1982. NUREG-0020, *Licensed Operating Reactors: Status Summary Report*, U.S. Nuclear Regulatory Commission, monthly (a.k.a., the "NRC Grey Book").

2. In principle, the following units are still in construction: Bellafonte 1 & 2, Comanche Peak 1 & 2, Grand Gulf 2, Limerick 2, Perry 2, Seabrook 1, Shoreham, South Texas Project 2, Vogtle 2, Watts Bar 1 & 2, and WPPSS 1 & 3. In practice, only Comanche Peak 1, Limerick 2, and Vogtle 2 appear certain to operate. As we go to press, Seabrook 1 and Shoreham still have hopes of getting on-line. While the prospects for other units are dimmer, it is possible that one or two will eventually go into service.

3. John L. Campbell discusses the financial plight of the industry in some detail in his book *Collapse of an Industry: nuclear Power and the Contradictions of U.S. Policy*, Cornell University Press, 1988.

4. See, e.g., *An Analysis of Power Plant Construction Costs*, DOE/EIA-0485, Energy Information Administartion, March 1986.

5. Sources: PG&E Response to Data Requests in CPUC Application Nos. 84-06-014 and 85-08-025; and *Executive Summary of the Review of the Costs of PG&E's Diablo Canyon Nuclear Power Plant Project*, CPUC Public Staff Division, May 14, 1987.

6. "Nuclear Follies" by James Cook, in *Forbes*, February 11, 1985.

7. O&M costs essentially represent routine operations and maintenance expenses; capital additions represent actual capital improvements to a plant.

8. Based on ESRG nuclear databases. This database has been developed from FERC Form 1 (and similar reports) that utilities are required to file with the Federal Energy Regulatory Commission (FERC).

9. See Campbell, op cit., for a discussion of past attempts at standardization.

10. With a few exceptions, U.S. nuclear plants come in two varieties: pressurized water reactors (PWRs) and boiling water reactors (BWRs). PWRs contain two coolant systems: a pressurized primary system, in which the coolant water does not boil, and a secondary system in which water boils and thus drives a steam turbine. BWRs, as their name implies, contain only a single loop coolant system, in which the primary coolant itself is used to drive the turbines.

11. Based on a phone conversation with an Indiana and Michigan Electric Company spokesperson.

12. ESRG Database.

13. *Revisions to the Completion Date of Bellefonte Nuclear Plant*, Tennessee Valley Authority, July 1985.

14. *An Analysis of Nuclear Plant Operating Costs*, DOE/EIA-0511, March 16, 1988.

15. *Technical Assessment Guide, Volume 1: Electricity Supply*, EPRI P-4463-SR, December 1986.

16. *A Prioritization of Generic Safety Issues*, NUREG-0933, U.S. Nuclear Regulatory Commission, August 1987.

17. The capacity factor measures actual plant performance as it compares to the maximum possible plant performance. More specifically, the capacity factor is defined as actual electric generation divided by the maximum possible electric generation over some specified time period.

Non-fuel operating costs (O&M and capital additions) should be considered as fixed costs in the short-term (e.g., in day-to-day dispatch). Since fuel costs 9the principle short-term variable cost) are relatively low, a nuclear unit running at a high capacity factor will achieve cost benefits as compared to the same unit running at a lower capacity factor. In the long-term, however, non-fuel operating costs should be considered as variable costs. If these costs are high, it may thus sense to retire a plant early, even if it is capable of running at high capacity factor.

18. *Electric Utility Week*, McGraw Hill, January 23, 1989.

19. Testimony of Dr. Stephen S. Bernow in California Public Utilities Commission Application Nos. 84-06-014 and 85-08-025, ESRG #88-050, September 1988.

20. *Incentive Regulation of Nuclear Power Plants by State Public Utility Commisions*, J.C. Petersen, Office of Nuclear regulation, U.S. NRC, NUREG-1256, December 1987.

21. *Mission Plan Amendment (Draft)*, U.S. Department of Energy, Office of Civilian Radioactive Waste Managment, DOE?RW-0187, June 1988.

22. *Technology, Safety and Costs of Decommissioning a Reference Pressurized Water Reactor Station*, R. I. Smith, G.J. Konzek and W.E. Kennedy, Battelle Pacific Northwest Laboratory, for the U.S. NRC, NUREG/CR-0130, June, 1978.

23. S. Bernow and B. Biewald, "Nuclear Power Plant Decommissioning: Cost Estimation for Planning and Rate Making." *Public Utilities Fortnightly*, October 29, 1987.

24. See, e.g., "Safe Nuclear Power" by Lawrence M. lidsky in *The New Republic*, December 28, 1987.

25. See Campbell, op cit., for a discussion of past attempts at standardization.

KEEPING NUCLEAR POWER HONEST

CITIZENS MONITOR MAINE YANKEE

BY ELIZABETH KING

The morning we heard about the accident at Three Mile Island, over 500 miles away from my home in Woolwich, Maine, my son Andy dug out an old civil defense geiger counter and went outdoors to look for fallout. As I milked the goats, Andy was walking in and out of the barn door with the counter. Inside the barn the count was slow. Outside, in the falling snow, the count was much faster.

That snowstorm was contaminated, though from what source we can only guess. Discussing this incident over the dinner table that evening, we realized that readings from a single instrument could not tell us much, but if there had been a thousand teenagers out there with geiger counters that morning, we might really have learned something.

Soon after the Three Mile Island accident, a group of technically-oriented citizens met to discuss how to provide emergency information to our community in the event of a similar accident at the neighboring Maine Yankee reactor. They reasoned that we don't rely on the fire department to tell us when we have a fire. Couldn't we develop a device just as simple as a smoke detector and designed to be used in a similar way, only to detect unusual levels of radiation?

We went to the local library to see what kinds of radiation we should be looking for, and realized for the first time that a perfectly healthy nuclear power plant routinely releases large amounts of radiation. Most of this is in the form of noble gases into the air and tritium into the bay. We discovered that the limits set by the Nuclear Regulatory Commission (NRC) for these releases are quite high and their adequacy is hotly debated within the scientific community. Moreover, the limits have been officially revised downward several times. Further downward revisions can be expected as we learn more about the health effects of radiation.

Radioactive uranium fuel is supposed to be securely sealed in special alloy tubes, known as "fuel rods." But when the rods are fabricated, minute particles of fuel, known as "tramp uranium," stick to the outside of the tubes. The radioactive daughter products of these impurities are washed into the cooling water surrounding the core. Moreover, with age the fuel rods develop cracks and pin holes. Daughter products also seep out of these breaches into the coolant. After allowing the unwanted radioactive materials to decay a short time in holding tanks, Maine Yankee simply releases them. Gas is vented through the plant's tall green smoke stack and liquid effluents are washed into nearby Montsweag bay.

The dose to the public from these releases is calculated by computer model, however studies have shown that these models may be flawed. One recent government study of the Savannah River plant in South Carolina tracked a radioactive plume all the way to New Jersey where the concentration was 20 times larger than the model predicted for the site boundary. Such atmospheric releases are not normally monitored off site, except with cumulative instruments known as thermoluminescent dosimeters

PHOTO/Ellen Shub

Elizabeth King is an environmental activist living in Maine.

(TLD's). However, these instruments are relatively insensitive to Xenon-133 which makes up most of the radiation in a reactor's plume. TLD's are read monthly or quarterly, and so average out any short-term fluctuations in the radiation levels. They are therefore not at all useful as an early warning system. Furthermore, we know from the public record that the plant's radioactive gas is sometimes released in short intense bursts. Some researchers believe that such bursts may be may be more dangerous to our health than the same amount of radioactivity released over a longer period of time.

Indeed the only device at Maine Yankee that gives instantaneous readings is on the stack itself. But this instrument cannot tell what happens to the gas after it leaves the plant. A recent report conducted by the Three Mile Island Public Health Fund finds that radiation monitoring at all commercial nuclear reactors is ineffective. "After extensive review," the report concludes, "NRC requirements themselves appear inadequate to provide for comprehensive routine and emergency radiation monitoring."[1]

Furthermore, the models used by Maine Yankee are too simpleminded. They take no account of how the complex Maine coastline affects the dispersion of stack emissions. Under certain weather conditions, for instance, the radioactive plume could descend to ground level, in a process known as "fumigation." Rather than dispersing evenly over a large area, as utility models predict, this plume could then be swept up a narrow inlet and cause unsafe exposure levels.

In the fall after Three Mile Island, we had the first solid evidence that there was cause for concern about radiation in our area. We brought a borrowed commercial radiation meter with a strip chart recorder to the Woolwich farm. For six weeks we recorded an unexpected series of sharp peaks of radioactivity 25 to 50 times higher than the normal, or background, level. The pattern of the peaks, rising very rapidly then gradually decaying, is consistent with a burst of radioactive gas passing overhead. We learned later that the plant was shut down for maintenance and for the replacement of nine leaky fuel rods during this time.

By the first anniversary of Three Mile Island, with the help of a group member who was an electronics professional, our first monitors were ready. The "black boxes," as we call them, have a speaker that makes an audible beep with each radioactive disintegration it detects. If the box detects more than a pre-set threshold level, it sounds an alarm. A clock plugged into the box shuts off as well when the alarm sounds. That way the clock marks the time when the alarm occurred even if nobody is at home to observe it. Our members are instructed to note the number of beeps sounding during five successive one minute intervals every month so that we have a record of the background radiation at each location. Our inexpensive boxes are not sophisticated enough to discriminate among different sources of radiation. Cosmic rays from space, radon from our soil, and radioactive gas from Maine Yankee all register identically. We believe, however, that we can distinguish plant releases from other sources of radiation by keeping careful records of background and by comparing readings from nearby monitors.

The Citizens Monitoring Network, as we have come to be known, now has over twenty black boxes surrounding Maine Yankee. Moreover, this year our private network was supplemented by a state administered monitoring program. The program was mandated under a law sponsored by one of our own members, state Representative Maria Holt. It requires Maine's Radiation Control Program to distribute radiation monitors similar to ours to 50 volunteers and to set up a smaller network of 20 sophisticated automated monitors—all at the expense of Maine Yankee. The automated monitors are tuned to detect radiation emitted by Xenon-133. Measurements of this gas give an indication of the quantity of the other radioactive materials present in the plume as well. These monitors will for the first time give minute by minute readings of radiation levels around the plant.

Although our group may have made the first organized attempt to keep tabs on a local nuclear plant, other similar organizations are being formed in the United States and Europe. Greenpeace recently released a survey of 38 European monitoring organizations.[2] Many of these groups were formed to take emergency readings or to guarantee the purity of food after the accident at Chernobyl. But others, such as Umweltinstitut Muenchen in West Germany and Movement Ecologique in Luxembourg, continuously monitor ambient radiation levels around members homes. In the United States, the Citizens Radiation Monitoring Network Pilgrim 1 recently installed 30 monitors around the Massachusetts Pilgrim nuclear plant—one of the least safe atomic plants in the country. The group sends out weekly computer readouts to the NRC and the Massachusetts Public health department and other appropriate The monitors are made by International Medcom of Sebastopol, California. They are affordable enough for network use, though people who want to build their own devices can obtain free instructions by contacting us.[3]

In the nine years since we began monitoring Maine Yankee, our boxes have sounded dozens of alarms. Our efforts to correlate these with plant releases have been assisted by a unique Maine statute: Passed in the wake of Three Mile Island, the law requires the utility to report anticipated daily gaseous and liquid releases on a toll-free recorded telephone message. Since we began our program, there has been only one unexplained instance of an alarm sounding when there was no radiation released reported from the power plant. There have, however, been many instances of reported releases that were not detected by our boxes, because we do not yet have complete geographical coverage of the area. We now know that radiation from some unexplained source is periodically reaching our houses in measurable levels. Since we have ruled out radon and cosmic rays, we have concluded that the source must be the Maine Yankee plant. We do believe, however, that Maine Yankee is now being operated more conservatively because utility administrators and technicians know that we are watching.

NOTES

1. Dr. Jonathan Berger, ed., A Radiation Monitoring System for Nuclear Power Plants, (Philadelphia, Pennsylvania: 1987).
2. Andy Stirling, Survey of Radiation Monitoring Organizations in Western Europe, (London: Greenpeace, 1988).
3. Citizens Monitoring Network, 115 High St., Bath, ME 04530, or contact the manufacturer: International Medcom, 7497 Kennedy Rd., Sebastopol, CA 95472.

THEATER OF WAR, THEATER OF DISPLACEMENT

BY PAUL ROUTLEDGE

In North Orissa on India's Bay of Bengal Coast, a three year conflict between the Central Government and local farmers and fisherfold continues, virtually ignored by the international media.

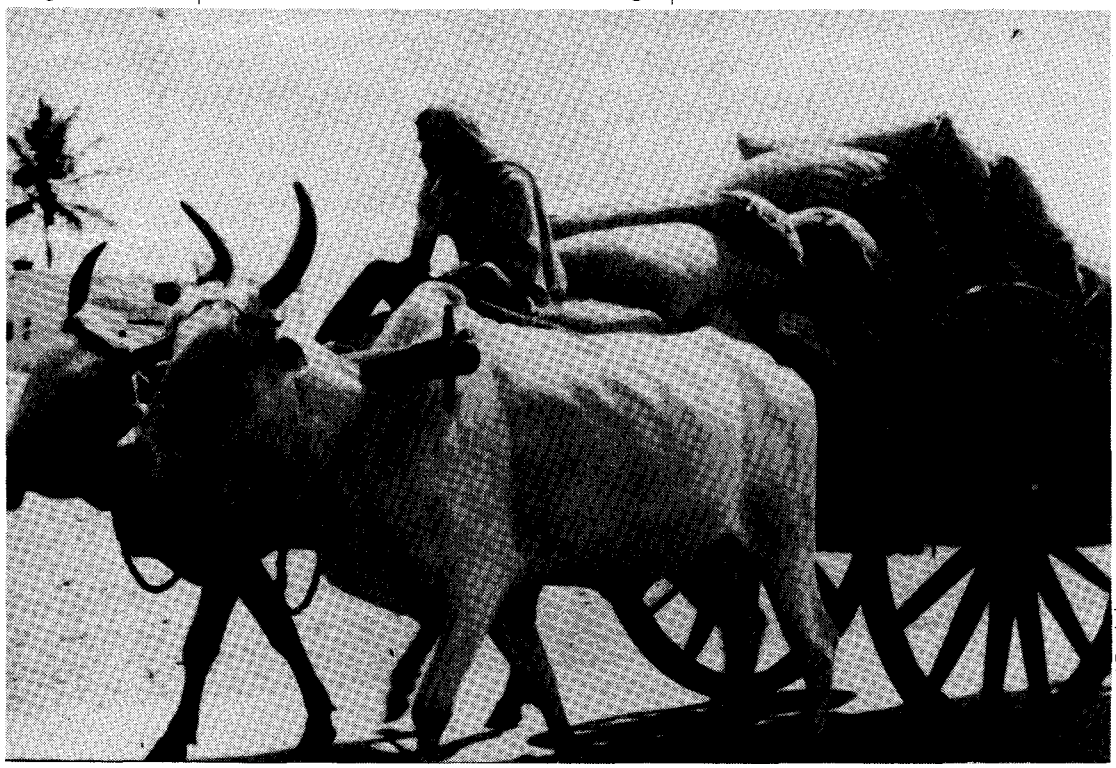
In the village areas of Baliapal and Bhograi — a region known as the granary of Orissa because of its great fertility and high yielding cash crops — approximately 100,000 people face eviction from their homes and lands to make way for the National Testing Range, a military base designed to test and launch satellites, rockets and missiles.

The Testing Range, which will cost an estimated US $840 million forms part of a military network that spans the state of Orissa and includes naval and air force bases, radar observation stations, an ammunitions industry and a MIG fighter assembly plant. According to V.S. Arunachalam, the scientific advisor to the Defense Ministry, the basic function of the test range is flight trials for the design and development of rockets, pilotless aircraft and ballistic missles. It will also be used for practice firing of long range missiles with a range of up to 5000 km, electronic warfare dynamic testing, and the testing of facilities to monitor the path and efficacy of missiles. According to the Prime Minister, Rajiv Gandhi, the proposed range will dovetail with the Government's space program. As he stated in 1986, "Our polar satellite launch vehicle project will be very much more feasible from this site, as will our surface to air and other tactical missile projects."

Defense analysts have pointed out that the PSLV can be modified and developed into an intermediate range ballistic missile. Since 1974, when a nuclear device was exploded in the Pokhran desert, India has been slowly piling up plutonium reserves by enriching spent uranium fuel from its nuclear reactors. Refusing to sign the nuclear non-proliferation treaty or submit to the treaty's full safeguards, India retains the nuclear bomb option but lacks a delivery system. Apprehensions that India may be developing such a system have been heightened by the knowledge that the Bharat Dynamics section of the Department of Defense is involved in a missile manufacturing project in collaboration with the Soviet Union. The missiles — short range, intermediate range and integrated guided missiles including SS20's and SS30's, and in due course intercontinental ballistic missiles, would be tested from the National Testing Range.

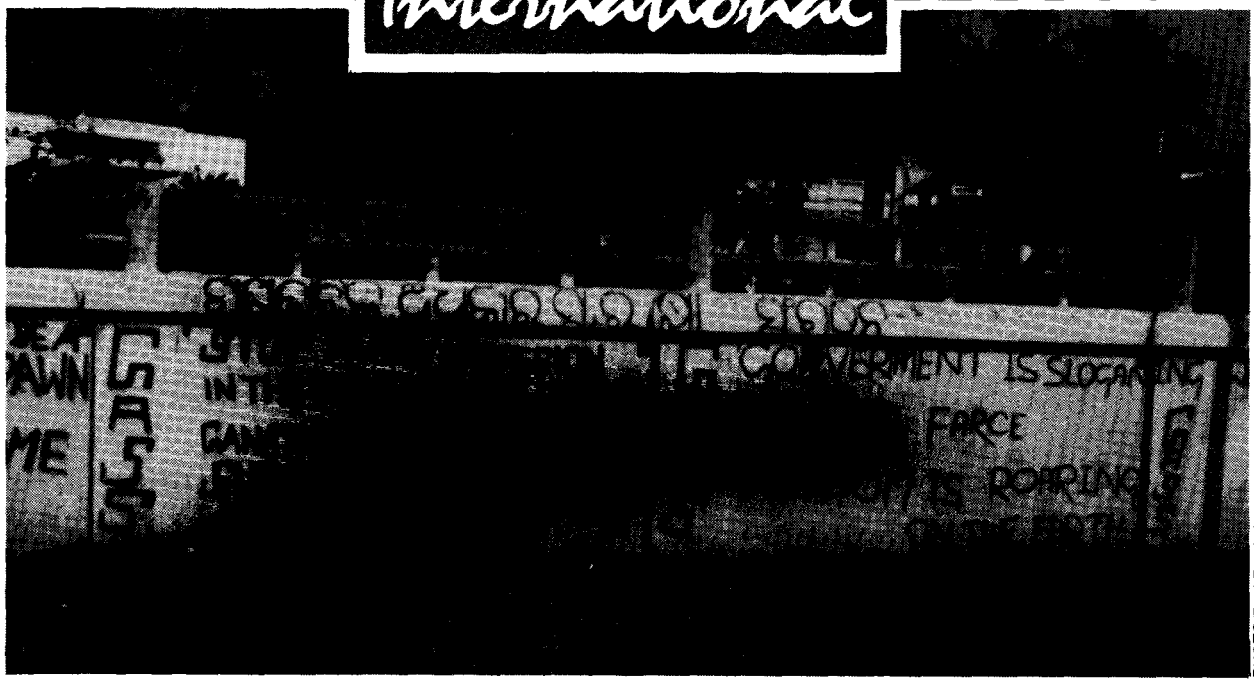
In order to pacify local resistance to the project, the government has proposed an elaborate Rehabilitation and Compensation scheme, to relocate the villagers in model villages and set up industries to provide alternative employment — hence transforming traditional farmers and fisherfolk into unskilled and semi-skilled factory workers, destroying their culture and communities. Skepticism and resistance concerning the Rehabilitation scheme is deepened by the knowledge that of the 30,000 people made homeless by the Rengali Dam project in 1977, 22,000 have yet to be rehabilitated.

Determined to resist eviction and



PHOTO/Paul Routledge

Paul Routledge is a PhD candidate in geography studying social movements in India.



PHOTO/Paul Routledge

prevent the construction of the Testing Range, the villagers have organized a resistance movement adopting nonviolent and non-cooperation tactics. The movement comprises mainly peasants, agricultural laborers and sharecroppers with some middle and wealthy landowners giving support. An "outside front" of trade unions, student groups, writer's forums and political parties in opposition to the Congress (I) ruled state government are also providing support to the movement.

The villagers have set up a "Janata (people's) Curfew" whereby no government official or representative is allowed into the area. To enforce this checkposts have been set up barricading the entry roads into the area with bamboo and trenches have been dug to stop any approaching government vehicles. The checkposts are staffed around the clock and conch shells are blown and thalis (metal plates) beaten to warn the villagers of approaching vehicles, whereby thousands of women, children and men gather at the barricades to form human road blocks. In February 1988, for example, 24 magistrates accompanied by 3,000 armed police attempted to enter the area but were prevented from doing so by a human wall of 20,000 people. A maran sena (suicide squad) comprising 5,000 people has also been created to prevent, at all costs, government vehicles entering the area in the event of an emergency.

The area has been effectively sealed off for the past 33 months, the villagers refusing to pay taxes and holding people's courts to settle area disputes. The movement has also held strikes, printed posters, held public meeetings, conducted demonstrations and painted wall slogans in an effort to popularize their struggle.

In April, demolition squads were set up to destroy the model villages under construction by the Orissa state government, since the government had declared that evictions would only begin once the model villages were completed.

In response to this resistance the government has set up an unofficial economic blockade of the area, preventing commodities such as kerosene and sugar from being made available. In addition, it has imposed deterrent fines on bullock carts and vehicles leaving the area with betel leaves, coconuts and cashews bound for market. By late May 8,000 armed police had been deployed in the area and police repression against local activists had increased. In the past 2 years over 100 activists have been arrested. In an interview with the author Bhograi activists related their experiences of arrest, torture and being held in custody without being brought before a magistrate within the 24 hours stipulated by Indian law. Jagabandhu Ghose, an organizer in the area stated "I have been arrested six times because of my work against the National Testing Range and been beaten up (by the police) on several occasions." Shankar, a fisherman, echoed his friend's experience, "I was arrested without a warrant and held by the police for six days which is against the law."

When asked about the future tactics of the resistance, Ghose replied that despite police provocation the nonviolent resistance would continue. However, when asked about the response to increased violence by the state (leading to fatalities) he replied, "If the government becomes violent, who can control the response of the movement and their actions? The Gorkha National Liberation Front are armed and the government has not been able to tell them what to do..."

At the time of writing (February 1989) the area remains in a state of tense uncertainty as the final phase of the struggle awaits to be acted out. It is possible that the Orissa state government is waiting for the outcome of the state elections (the results not known at the time of writing) to be decided before it makes the decision about the use of armed personnel against the movement. However, as one of the movement spokesmen, Sasadhar Pradhan has stated, "We are ready to give our lives in front of armored vehices and tanks. But if that kind of incident occurs, its protest will not be limited to India alone. The whole world will condemn the Indian government, saying that these messengers of peace have built the missile range on the corpses of innocent Orissa peasants."

THREE MILE ISLAND

CONTINUED FROM PAGE 7

ent sites showed exactly the same value."

The community has fought for improved radiation monitoring of TMI. Last year two studies commissioned by the TMI-Public Health Fund criticized the existing off-site radiation monitoring systems aroung TMI; a third maintained that monitoring systems in place at nuclear power plants throughout the country, including TMI, are "inadequate." However, the Fund consistently refused to purchase any equipment that would enhance or upgrade off-site radiation monitoring.

Although it is difficult to determine the exact radiation doses received by members of the surrounding communities, there is a clear pattern of area residents suffering adverse physical and psychological health effects as a result of the accident and its aftermath. Many people in central Pennsylvania reported symptoms consistent with radiation exposure during late March and early April, 1979. In interviews with area residents, Mitsuru Katagiri and Aileen M. Smith-Katagiri found that hundreds of people experienced symptoms ranging from a hot sensation on the skin, often resulting in sunburn to nausea, vomiting and diarrhea. These experiences parallel those described before by servicemen who have witnessed atomic blasts and by the residents around the nuclear weapons testing grounds in Nevada.

There is some evidence that the psychological stress on residents is leading to adverse physical effects, particularly immunity impairments. Psychologist Marc Schaeffer found in 1985 that urine and blood tests showed neighbors of TMI had increases in stress-related hormones and reductions in various disease fighting cells in their immune system.

There are over 2,000 unresolved health suits filed against the designers, builders and operators of Three Mile Island Unit-2 for health problems caused by the accident. To date, numerous health suits have been settled out of court; the largest award was $1.1 million for a child born with Down's syndrome. In September 1988, GPU asked that the cases be moved to federal court, claiming the Price-Anderson Act established a compensation plan for individuals harmed as a result of a nuclear accident. However, there are twelve test cases scheduled this year for jury trial.

While the debate over TMI health effects rages, the crippled reactor is still being cleaned up. The entire core is scheduled to be shipped to the DOE's Idaho National Engineering Laboratory (INEL) for "research." As of January 1989, 18 rail shipments of TMI waste have made the 2,400 mile odyssey across 10 states. The transportation route passes through several large population centers including Pittsburgh and St. Louis. As the removed core materials are studied in detail at the Department of Energy's (DOE) laboratory in Idaho, the picture of the accident is revised. It is now widely accepted that temperatures rose well above 5,000 degrees Fahrenheit. Seventy percent of the core was damaged, almost half melted, and approximately 20 tons of molten materials plunged to the bottom of the reactor vessel.

Not all of the waste is being shipped off-site. Some 2.3 million gallons of radioactive water containing radioactive isotopes of tritium, cesium and strontium have accumulated on-site. The GPU, with the NRC staff's blessing, wants to evaporate this radioactive water directly into the environment. The Susquehanna Valley Alliance (SVA) and TMI-Alert are intervening before the NRC's Atomic Safety and Licensing Board (AS&LB) to prevent the mass boil-off. On February 3, 1989, the AS&LB approved GPU's evaporation plan. SVA/TMIA will appeal the decision.

This recent example of GPU's callous disregard for public safety might have been predicted by its shameful history which includes withholding critical information from state and federal officials during the accident and, just over a year after the accident, illegally venting 43,000 curies of radioactive krypton-85 and other radioactive gases. GPU was the first and only NRC licensee ever criminally convicted under the Atomic Energy Act.

Continuing this pattern, GPU recently announced that they were prematurely mothballing Unit-2 before the plant was fully decontaminated or decommissioned. As part of the plan, called Post-Defueling Monitored Storage (PDMS), GPU intends to dismantle their most sensitive radiation detection mechanisms while leaving some parts of Unit-2 highly radioactive. Although PDMS has been opposed by an 8-2 vote of the NRC's TMI-Advisory Panel, the people who live around TMI and have already endured a decade of delay, deceit and danger, may find it impossible to trust the efforts of the regulatory system.

Eric Epstein works with TMIA.

BLESSED ASSURANCE

CONTINUED FROM PAGE 13

but not by much. We follow the numbered double rows of woven steel fencing topped by barbed wire. There are spherical sensing devices on the palings at regular intervals, and watchtowers overlooking the sensors.

Again I am struck by those curious oblong earthen mounds. Pointing, I ask: "Are weapons stored there?"

Lifton: "I'd prefer not to say."

So we talk about New York City, which he doesn't much like. In the distance, I see what looks to be a colony of huts. "Is that a housing development?" I ask. "No," says Lifton, "that's a staging area."

Some freight trains are parked in the distance. They look like idling freight trains anywhere, but for their immaculate whiteness.

There must be people around, but all indoors or underground. We pass only one out in the open: a jogger, in the appropriate togs — running shoes, shorts, tee shirt. He smiles and waves at us. His security tag flaps as he goes by.

One of the employees on his break, Lifton explains. And it seems to me now that each of the employees whom I have seen passing through the administration building has been smiling. It is this, I realize, that is most disturbing about Pantex - the discordance between the seemingly fine corporate organization and the singularly destructive nature of the corporate product. The plaques and certificates on the wall, testifying to the plant's good citizenship, the cheerful radio music playing in the reception hall - all sharpen the dissonance.

The Pantexan, the plant's in-house newsletter, projects the image of a corporation that is full of family concern - concern for its own and for the local community. Aside from its many civic involvements, there are blood drives, car pools, and grants for the continuing education of its employees.

At Christmas time, employees are asked to donate the money that they would otherwise spend on greeting cards to a fund for the needy. In 1983, the Pantex Christmas Card Project collected over three thousand dollars to provide food and gifts for needy families and for the isolated elderly. It is all rather warming - and chilling - at the same time. I am reminded of the first time I heard the expression "enhanced radiation weapon." It sounded luminous and beautiful.

Network

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