FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION
August 1980
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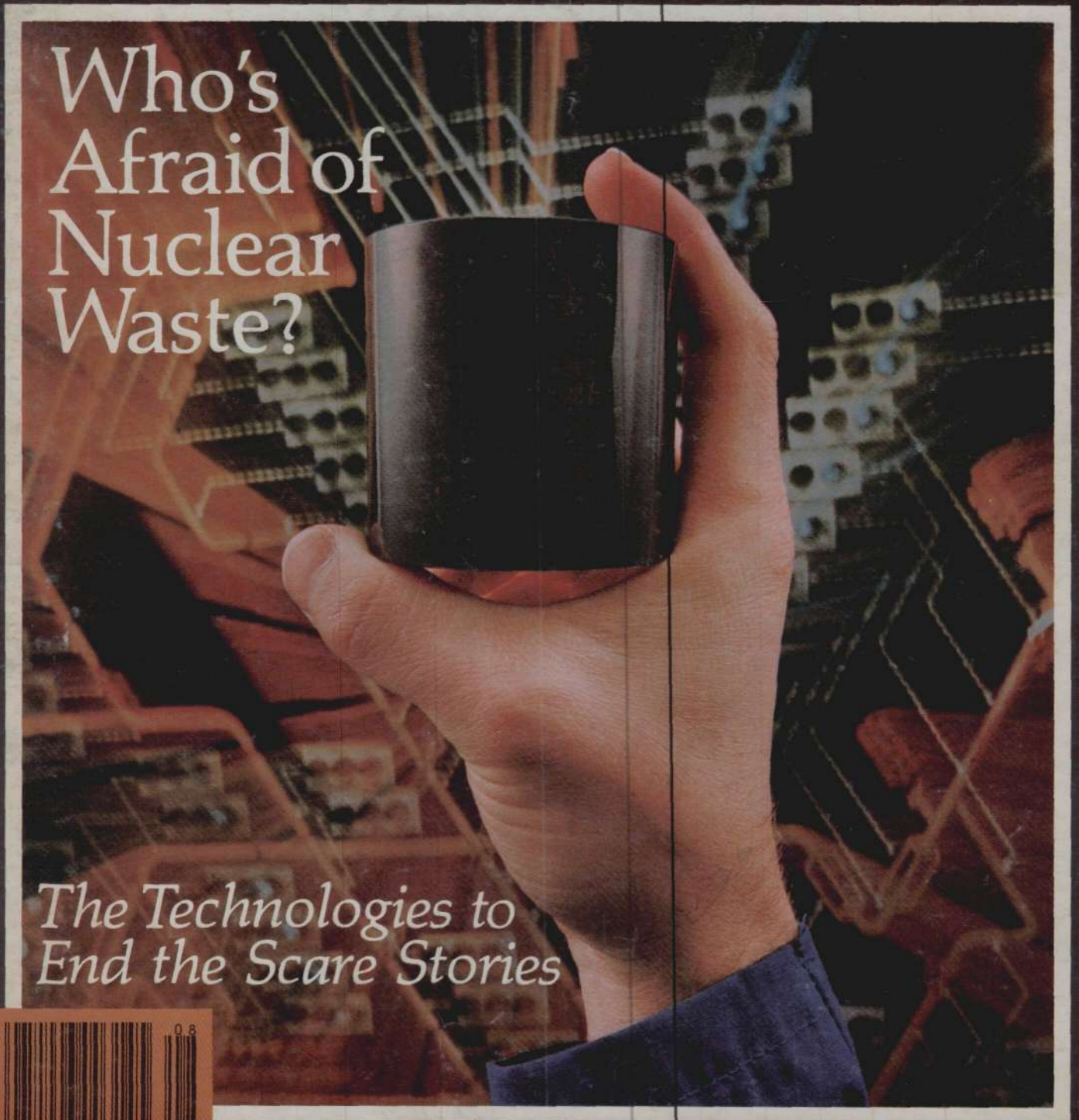
Special Feature: How France Took the Nuclear Lead



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The Technologies to End the Scare Stories

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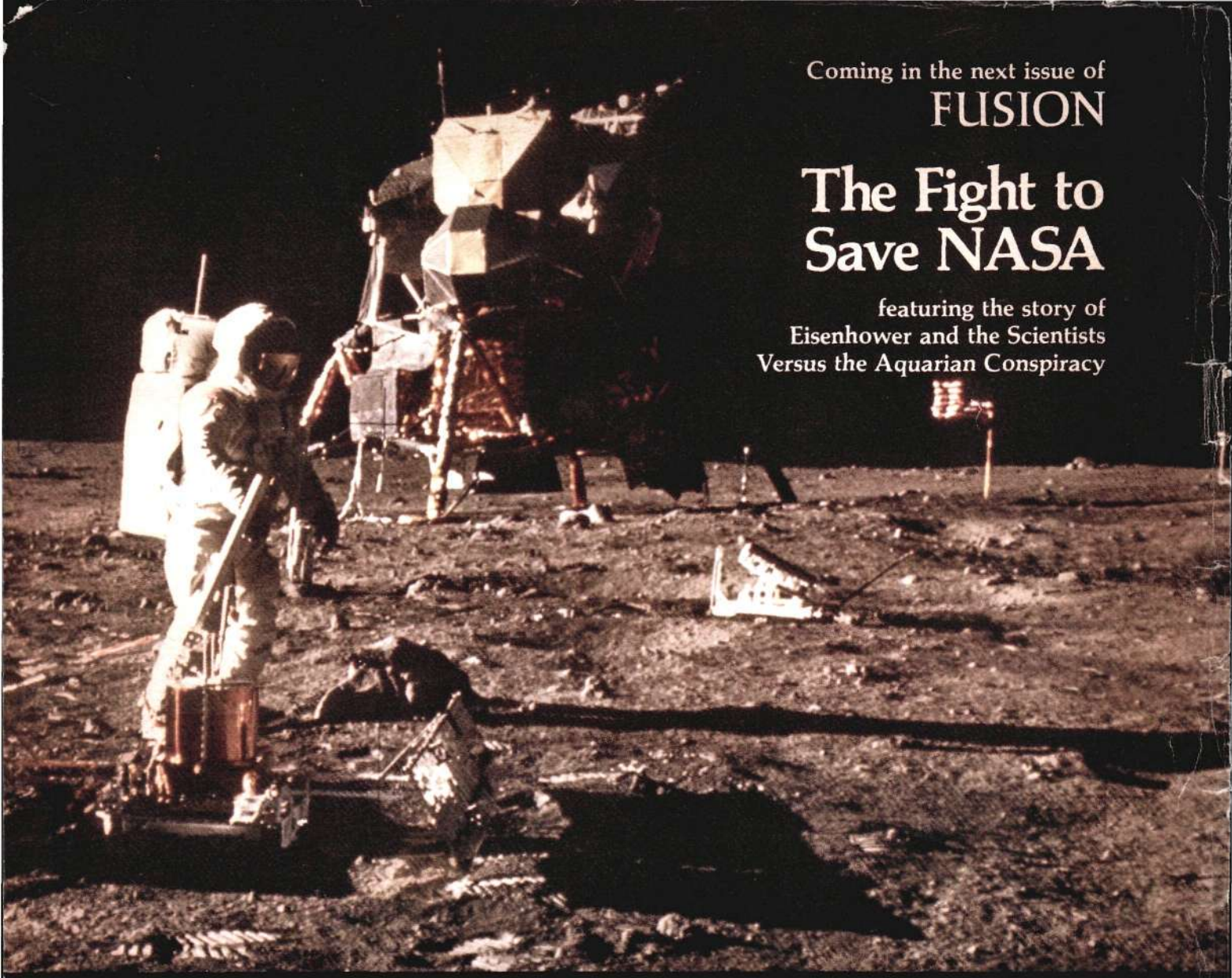

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FUSION

The Fight to Save NASA

featuring the story of
Eisenhower and the Scientists
Versus the Aquarian Conspiracy

FUSION's circulation has increased eight-fold since last March—from 6,700 to more than 55,000 subscribers and from 15,000 to 140,000 total copies sold per month. The magazine has won an award for its articles on the Three-Mile Island hoax and has been instrumental in making the Fusion Energy Foundation the recipient of several grants to continue groundbreaking work in areas from theoretical physics to energy studies. And **FUSION**'s energetic exposes of the "greenies"— who funds them and who publicizes them—have encouraged members of the protechnology majority to put America back on the road to progress. We were talking about "Fusion by the 1990s" long before it became fashionable to do so... In fact, if it hadn't been for **FUSION**, it might not yet be fashionable.

"You are one of the few organized groups I know of that has the courage to stand up and advocate high technology as a solution for some of the problems of the world, and for that I think we owe you a debt of gratitude."

—Dr. John Clarke, deputy director, DOE Office of Fusion (September 1978)

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FUSION

MAGAZINE OF THE FUSION ENERGY FOUNDATION

Vol. 3, No. 10 ISSN 0148-0537
August 1980 USPS 437-370

FUSION is published monthly by the Fusion Energy Foundation, Suite 2404, 888 Seventh Ave., New York, N.Y. 10019, Tel. (212) 265-3749. Dedicated to providing accurate and comprehensive information on advanced energy technologies and policies, FUSION is committed to restoring American scientific and technological leadership. FUSION coverage of the frontiers of science focuses on the self-developing qualities of the physical universe in such areas as plasma physics—the basis for fusion power—as well as biology and microphysics, and includes groundbreaking studies of the historical development of science and technology.

The views of the FEF are stated in the editorials. Opinions expressed in articles are not necessarily those of the FEF directors or advisory board.

Subscriptions by mail are $20 for 12 issues or $38 for 24 issues in the USA; $25 for 12 issues in Canada. Airmail subscriptions to other countries are $40 for 12 issues.

Address all correspondence to FUSION, Fusion Energy Foundation, Suite 2404, 888 Seventh Ave., New York, N.Y. 10019.

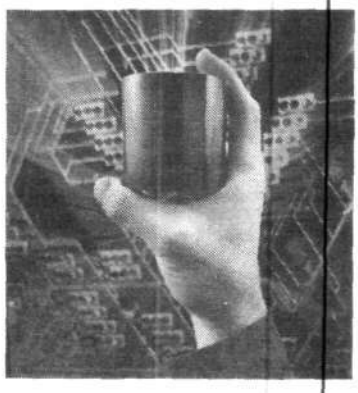
Second class postage is paid at New York, N.Y. and at additional mailing offices.

Advertising Representatives

FUSION's national advertising representatives are Richard Katz and Patricia Van Thof, *Fusion*, 888 Seventh Ave., Suite 2404, N.Y.C. 10019, (212) 265-3749; East Coast advertising representative is Warren Smith and Associates, 38 Hull Rd., Box 754, Bernardsville, N.J. 07924, (201) 221-0184; European advertising representative is Karl-Heinz Holz, Pf. 3329, 62 Wiesbaden, West Germany, Telephone (06121) 440277.

Features

News



Cover: The front cover photograph shows a cylinder of glass illustrating the amount of radioactive waste generated from one person if his lifetime electricity needs were supplied by nuclear energy. Cover design by Christopher Sloan; photograph by Kenneth M. Gatherum, courtesy of Battelle Pacific Northwest Laboratories.

Departments

Editorial

A Real Congressional Scandal

During early May two different congressional subcommittees recommended budget cuts in critical U.S. science programs. If these cuts are not reversed they could well be the proverbial nail in the coffin of U.S. science. The House Appropriations Subcommittee on Energy and Water Use May 7 voted to eliminate $60 million from the $433 million magnetic fusion 1981 budget recommended by the House Science and Technology Committee. Then, on May 9, the House Appropriations Committee voted to reduce the 1980 NASA budget by $320 million, thereby eliminating U.S. participation in the joint European-U.S. Solar Polar Mission.

These votes are potentially catastrophic, not only because of their immediate effect on vitally needed scientific programs, but also as the culmination of a 15-year program to render U.S. science impotent.

The outrageous fusion budget voted by the House Appropriations subcommittee will mean deep cuts in many important experiments as well as delay in launching of the planning and construction for an Engineering Test Facility. The demonstration ETF is the project at the center of HR 6308, the so-called McCormack bill for an "Apollo"-style fusion program.

Whether the amazingly short-sighted congressmen responsible for these budget cuts know it or not, they are also acting out the last phases of a script written in the late 1960s to gut American science. As will be documented in a forthcoming pamphlet, "Stop the Aquarian Conspiracy," and in next month's *Fusion*, it was the space program's very success in mobilizing the best scientific and technological impulses of the American population that made it the target of the group that has emerged as the chief spokesman for the zero-growth and environmentalist movement. That organization, the Club of Rome, set the "limits to growth" for future U.S. science.

The tragedy of the 1970s was that this group and its accomplices were only too successful in undermining the pacing role of the space program and setting back nuclear energy, U.S. strategic military capabilities, and scientific

The Lightning Rod

My dear friends,

You may take my solemn testimony as scripture, that there is nothing quite so enervating to a vigorous spirit as an attack of that obscene malady known to me as *gout*. The considerable pain is greatly augmented by the knowledge that others find the affliction quite comical; and the victim must endure the gentle gibes tormented by the knowledge that his predicament, being the result of folly and indulgence, is his own fault.

Yesterday, preoccupied with such thoughts, I was sunk deep into my chair of morbidity as a long gouty afternoon stretched in front of me, when there came a knock at the door. Hobbling to my feet with what I imagine was a somewhat inhospitable expression, I opened it to find a young friend who sometimes visits me after his day's schooling is ended.

"Why, Jonathan," I said with some surprise, "you are early today; have they cut your classes short?"

"I am playing hooky," he replied dolefully. I have always found Jonathan to be an open and forthright lad.

Judging by the look on his face that his misery far outweighed my own, I invited him in to share a bowl of soup. When we had got ourselves arranged around the kitchen table, I inquired if his absence from school had anything to do with the source of his distress.

"School is horrible!" he replied vehemently.

As Jonathan had never expressed such feelings to me before, I found myself again taken aback, and entered a mild demurrer, stressing the value of education in achieving Jonathan's oft-expressed goal of "building the biggest bridge in the world."

"Oh, Ben," he cried. "I'll never do it. I've gotten stupider since I said that. I'm too stupid to learn science."

At last I felt myself on firm ground.

"That's not true, Jonathan," I declared. "I've seen many a young fellow come and go, and you are brighter than most. Why don't we go over your courses; you tell me what you don't understand, and together we can figure it out. What are you learning in science now?"

"The Big Bang," said Jonathan.

I tried earnestly not to betray my ignorance.

"And what are you learning about that?" I asked.

"That's how the world began," said Jonathan. "There was a Big Bang, and things have been getting quieter ever since."

"I see," I said, although assuredly I saw nothing. "Is there a reason for that?"

"Our teacher says that the main law of the universe is entropy. That's why we're always running out of energy—and everything else."

"And how is that demonstrated?" I inquired skeptically.

"The teacher brought in a glass with sand in it. . . ."

"An hourglass," I interrupted, with some relief.

"Uh-huh. And she turned it over, and all the sand ran down into the bottom of the glass. She made us time it. It took two minutes," he said.

"And what conclusion can you draw from that?" I asked. Believe me, it was not a rhetorical question.

"The teacher says it means we have to hang on to everything we've got and not use it up, because we won't have it long anyway."

"I wonder if she thinks that applies to brains, too," I found myself muttering. I was beginning to understand Jonathan's problem.

"Tell me," said I, sensing it was time to change the subject, "do you have a course in biology?"

"Oh, yes. But the teacher hardly talks to us. Mostly he talks to the plants."

"The plants," I confirmed.

Continued on page 4

education in general. The chickens have now come home to roost. The report released in April by University of Chicago Professor of Mathematics Izaak Wirszup documents beyond dispute that every student in the Soviet Union is receiving the most advanced scientific education in the world, while the average American student is barely exposed to the major areas of science and mathematics. Perhaps the budget-cutting congressmen are simply telling us that U.S. science programs can be cut because the nation could not supply the manpower necessary for the most advanced scientific projects anyway.

The point, however, is not to wring our hands and simply declaim about these latest outrages. The enemies of science have exposed to us not one but two Achilles heels. First, it must now be clear to every thinking American presented with the evidence, that the collapse of our military, space, energy, and science education capabilities all flow from a common cause. Second, the price we have paid is the loss of U.S. superiority in all these areas to other nations, especially the Soviet Union. Therefore, anyone tampering with the U.S. fusion or space programs can be rightly accused of complicity in the undermining of U.S. national security. That is a point that readers of *Fusion* may wish to join us in driving home to the congressional culprits.

A Scientific Renaissance

Our longer-term strategy centers on the revival, and indeed the renaissance, of American science. The latest advances in this direction in terms of ongoing Fusion Energy Foundation collaboration in the Riemann-LaRouche economic model and its implications for physical science and economics are reviewed in this issue (page 57) by Carol White, author of a forthcoming definitive history of the antiscience movement in the 20th century. The FEF is also conducting a series of seminars across the country on the groundbreaking work of the Riemann-LaRouche model; interested readers should contact the FEF for details. In addition, the October issue of *Fusion* will feature a review of U.S. science education and what's necessary to revive it.

Lightning Rod

Continued from page 3

"Right. He says they talk back too, but I never hear them," Jonathan said mournfully.

"Does he say anything else—when he talks to students, I mean?"

"Well," Jonathan thought for a moment, "last week he said that the trouble with people was they walked around like they owned the world and everything in it, but they didn't. 'Man is only the steward of nature,' he said."

Clearly science as taught at Jonathan's school presented some real difficulties. I decided to try the lad on another subject of which I have some grasp.

"Tell me about your history class," I commanded.

"We don't have history any more, Ben. But we have social studies."

"Very well. What are you studying there?"

"My mother told me not to talk about it."

"What?" I was frankly astonished far beyond my powers of imagination. "In God's name, my boy, what happened?"

"Well, I guess it's all right to tell you," Jonathan conceded after some hesitation.

"Now we're studying 'alternative lifestyles,' " he began. "And yesterday the teacher showed us some pictures of men in dresses. 'Gays,' he called them. They didn't look very happy to me; one of them was sticking his tongue out at the camera and the other was going like this with his middle finger. I thought they were ugly, but the teacher said they were just expressing freedom of choice.

"Anyway, when I went home I asked my mother if she thought it was okay for men to dress up in women's clothes. First she started yelling at me and then she started crying, and then she made me promise never to talk about it with anybody."

I felt my gorge rising; in fact I was positively shaking with anger. Oddly enough, in that moment I realized that my gout no longer troubled me.

"Jonathan," said I when I had got control of myself, "again I say to you: you are not stupid. And the proof of it is, that I have learned a great deal from what you have told me today. I intend to visit your school tomorrow and have a talk with your teachers to straighten things out; in fact I may visit quite a few schools. I believe I can explain things to your mother as well."

"Really, Ben?" Jonathan said somewhat wistfully.

"Nothing can stop me," I averred. "And now, since I seem to have recovered my energy, perhaps this day is not entirely lost for learning. Why don't we step outdoors, and I'll teach you how to fly a kite."

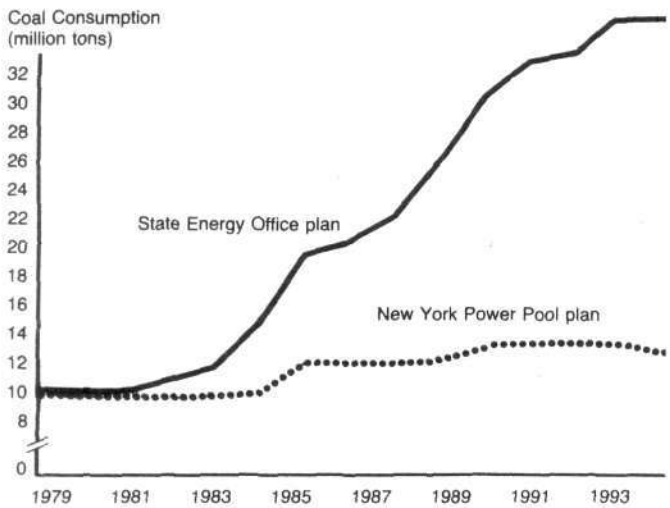
Yr. obt. servant,

Letters

Understanding Darwinism

To the Editor:

. . . I wish to compliment you, especially, on a particularly courageous aspect of *Fusion* magazine: Where most "scientific" publications have rallied around Darwinism, a so-called *scientific model which is at such over*whelming odds with the facts, your magazine has presented Darwinism for what it is. I have not read the article, "Evolution: A Riemannian Ap-



CORRECTION ON NEW YORK STATE'S PLANNED SHRINKAGE

The New York State Energy Office Master Plan specifies the elimination of any new nuclear plants, an across-the-board conversion of oil-fired plants to coal in the immediate term, and the use of solar, wood, biomass, and "cottage-level" hydroelectric projects as the primary sources of energy for households and industry. The chart on page 22 in July *Fusion* reversed the labels on projected coal consumption for electricity generation in New York, which are shown here correctly. The Master Plan projection is shown in contrast to the pronuclear New York Power Pool Plan.

As *Fusion* documented in July, the conversion of oil-fired plants to coal is so expensive that the coal industry calls it unfeasible. The State Energy Office, appointed by the governor, in 1979, has geared its plan to make New York energy "self-sufficient" on the basis of the most costly and inefficient technologies available.

proach to Biology" yet, although a cursory look at it seems to show a leaning towards evolutionism, macroevolutionism, rather. Here, we disagree. . . .

Thank you, though, for showing enough courage to reject Darwinism, in the face of a conformistic tide which remains strong and forceful.

Thomas C. Karter, Jr.
Portland, Oregon

To the Editor:

My first subscription copy of *Fusion* (Feb. 1980) contained a blue ribbon article, which is Mary Gilbertson's first installment, "The National Science Foundation: Taking the Science Out of Education." I thank you for that article, not as an educator in science, but as an older-generation practicing (previously brainwashed) geologist-observer of the passing parade.

It is not shocking to me that NSF is undermining science and math studies in public schools. Some 20 years of antiestablishment geological study has led me to believe that the weed of destruction of 20th century American scientific excellence (NSF) has its roots in certain "common sense" extrapolations (the poisoned ground) of 19th century geologists and biologists. Thanks to the influences of the likes of Charles Darwin (self-taught biologist) and Charles Lyell (self-taught geologist), the world body has been led to accept two myths as truth. These myths are: historical geology, where geological periods follow one another, and evolution, where unicellular ancestors "jest growed" into *Homo sapiens* during these geological periods. . . .

Any geologist who would honestly and objectively research 20th century geological (stratigraphic) data could conclude that Darwin and Lyell were bedtime story-tellers. . . .

William Waisgerber
Sepulveda, Calif.

The Editor replies:

Darwin, No; Evolution, Yes!

Although Mary Gilbertson's article on the National Science Foundation and science education did not directly go into the question of the teaching of Darwinian evolution in the public schools, the writers are quite right to make the connection. Unfortunately, they have apparently opted for a "Big Bang" version of Creation and the origin of humankind instead. There are three reasons that this is unfortunate: the practical, the factual, and the fundamental issue involved.

First, conservative and fundamentalist Christian religious groups especially have been targeted by the neo-Malthusian movement. For example, radical environmentalist Jeremy Rifkin is approaching fundamentalist groups to solicit their agreement with abandoning the call in the Book of Genesis for man to exert dominion over nature. Ironically, this is exactly the situation—reducing man to a talking beast—to which antievolutionists claim to be opposed.

Second, Carol Cleary's article on evolution (*Fusion,* March 1980) provides a broad overview of the scientific evidence of the actual, non-Darwinian processes of evolution that have occurred in the biosphere. To deny that evidence of qualitative evolution is to throw the baby out with the Darwinian dishwater.

The fundamental point, however, concerns the difference between cultist versions of Christianity and the harmony of Neoplatonic Christianity and science.

The next issue of *Fusion* will take up this point at greater length. Here, in brief, are excerpts on the subject from a recent article by Lyndon H. LaRouche, one of the founders of the Fusion Energy Foundation and a frequent contributor to *Fusion* magazine:

"Rigorous Christian theology interprets the word Creation not in the mechanistic sense of Aristotelian method, but in the Platonic sense of creation, as typified by Plato's use of the term composer. The process of continuing creation is a process of continuing evolution of the universe to ever-higher states. This is not 'evolution' in the sense of a Spencer, Wallace, Darwin, or Huxley. It is an ordered process, in the sense that the great 19th-century physicist Bernhard Riemann defines the universe as an

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Letters

Continued from page 5

elaboration of a self-developing nest of efficiently interacting, distinct manifolds. Over the ages, conscious man has associated this notion of distinct, interacting manifolds with the distinctions and connections among the orderings of 'inorganic physics,' the 'living biosphere' per se, and the higher state of life represented by human creative intelligence. The Platonic interprets the account of the 'days' of Genesis as the distinct phase of unfolding of a multiply connected manifold toward ever-higher states of creation (composition).

"In this order, which we call the order of true 'natural law,' man, through the perfection of mankind's potential of creative intelligence, has the duty to serve as the efficient instrument of God in the work of continuing the creative development of the universe. . . ."

—Dr. Morris Levitt

In Defense of Dope...

To the Editor:

. . . I was dismayed to discover that *Fusion* is not a single-issue magazine as its name would imply. . . .

You imply that drugs lead to barbarism and decay. I see evidence to the contrary. Alcohol is a drug, and its prohibition did not decrease the public consumption. . . .

Nuclear power exists quite independently of the drug culture. The "Drug Problem" can have its own magazine; there is no place for it in *Fusion*.

Douglas J. Freyburger
Jet Propulsion Laboratory
Pasadena, Calif.

To the Editor:

What are the articles on marijuana in your September 1979 issue doing in a magazine on nuclear energy? . . .

Gordon Allen
Minnetonka, Minn.

To the Editor:

I might still be with you if your editorials and articles did not . . . drag morality into what should be a purely factual presentation of our desperate

Photo by Linda Ray/NSIPS

Part of the "Direct Action at Seabrook" contingent at a "legalize marijuana" rally in New York City.

need for energy. . . . Tell me, what does pot smoking have to do with fusion power? . . .

Ted Dragin
San Francisco, Calif.

...And Rock

To the Editor:

I think that it is important that you know that I no longer consider *Fusion* useful in the fight to preserve our nuclear energy resources.

In the March 1980 issue, Mr. Andrew Hanlen wisely advised you to relax on the dope issue. I wholeheartedly agree with him. I was shocked by your reply. Rock music does not suit my taste, but to imply that someone who does enjoy it is part of a lost decadent counterculture is absurd.

My 20-year-old son, who enjoys rock music, is a very strong advocate of nuclear power and the "Idea of Progress" as you put it. This guilt by association approach has no place in a reputable journal.

Martin H. Stein
President, RSA Corp.
Dover, N.J.

To the Editor:

You jeopardize the validity of arguments advocating nuclear energy by your persistent statements that rock-and-roll music is degenerating the free citizens of this country.

But how does this relate to nuclear energy? There is not much relation except that it takes electric power to play rock. To throw around loose accusations which don't bear scrutiny undermines the credibility of everything you print. You could do a thorough analysis of, or a polemic on rock. But, you're better off just promoting good old high technology. . . .

Herbert S. Philbrick
Chesterton, Ind.

The Editor Replies:

MORALITY AND SCIENCE

The Aquarian Conspiracy reviewed in the Books section of the July issue and the series of articles exposing the Aquarian conspirators that *Fusion* will be publishing make the following indisputable point: The drug culture and its rock music were deliberately introduced into American society to destroy the minds of youth and prevent the nation from continuing to lead the world in science and technology.

What does this have to do with fusion? We ask the letter writers, who will be around 25 years from now to run the fusion economy the nation and the world need? Certainly not the antinuclear potheads shown in the accompanying photograph demonstrating the unity of the drug and antinuke issues in a promarijuana rally in New York City.

Calendar

July

1-10
8th Int'l Conf. on Plasma Physics and Controlled Nuclear Fusion Research
IAEA
Brussels, Belgium

15-18
1980 Annual Conf. on Nuclear and Space Radiation Effects
Ithaca, N.Y.
IEEE

August

12-16
52nd National Technical Asso. Annual Convention
Chicago
National Technical Asso.

18-22
15th Intersociety Energy Conversion Engineering Conf.
"Energy to the 21st Century"
Seattle
IEEE, AIAA

News Briefs

NSIPS
Chancellor Schmidt

WEST GERMAN STELLARATOR SUCCESSFUL WITH LOW CURRENT

The Wendelstein VII, a low-beta stellarator at the Institute for Plasma Physics in Garching, West Germany, reached record temperatures and density with very low current May 6. According to researchers, the Wendelstein VII results provide experimental evidence for the possibility of developing a steady-state fusion reactor. The Wendelstein previously had operated in a "tokamaklike" mode; that is, with a high plasma current. In the latest experiment, the initial plasma current of 18,000 amp. was reduced below 200 amp. In this regime, the stellarator achieved a stable discharge for 20 milliseconds at a temperature of 4 million degrees and a density of 10^{14} particles per cubic centimeter. Heating was provided by two neutral beam injectors of 300 kilowatts each. Until now, the necessity to increase the plasma current in tokamak experiments has been considered the main limit to continuous operation of a toroidal fusion reactor.

WEST GERMAN-SOVIET ECONOMIC ACCORD APPROVED

The West German-Soviet economic commission meeting May 29 in Bonn approved a long-term joint industrial accord that has "energy cooperation" as its backbone. The agreement will be signed by Soviet President Leonid Brezhnev and Chancellor Helmut Schmidt when Schmidt visits Moscow June 30.

Industrial representatives from both countries will negotiate the specifics of joint projects in exploration and offshore drilling for oil and natural gas; metallurgy and metal processing; construction and modernization of industrial facilities; electronics and electrical technologies; coal processing; exploration for other raw materials; and chemical production and technology. The accord will shape the Soviet Union's 1981-85 Five Year Plan.

FEF TESTIFIES AT BUCHSBAUM HEARING

Dr. Morris Levitt, executive director of the Fusion Energy Foundation, testified May 24 at the public hearing held by the Buchsbaum Committee, the Department of Energy review group for the magnetic fusion program.

Levitt's presentation added a critical dimension to the support for the next-step fusion Engineering Test Facility that came from the broad cross-section of fusion scientists who spoke at the hearings. He stressed that the ETF project in conjunction with the export of nuclear technology is essential to restoring the purpose and leadership of the United States. "The recently released Wirszup report comparing U.S. and Soviet education makes clear that we need a project like the ETF that we publicize from all the rooftops of America to restore a commitment to science in our population and especially our young people," Levitt said.

Photo courtesy of University of Florida
Howard Odum

CLUB OF ROME MEMBER: U.S. MUST LEAD WORLD 'DOWN'

"It is necessary that the United States cut its population by two-thirds within the next 50 years," according to Howard Odum, marine biologist at the University of Florida at Gainesville and prominent Club of Rome member. Odum has completed a study arguing that solar energy and biomass are the sole long-range options for U.S. energy supply. Since they are far less efficient than coal, oil, or nuclear power, Odum said, the nation will be unable to support the present population of 225 million. Once the population is cut to 75 million, Odum elaborated in a recent interview, it "could be stably employed in subsistence agriculture. And unemployment would be virtually nil, as many jobs which are now done by machine would have to be done by human labor."

On the subject of nuclear fusion, Odum commented: "Fusion is a fallacy because its energy and temperature yields are too high. Anyway, if fusion was possible we would really be in trouble because the energy would be unlimited and you couldn't stop growth. . . . The United States has a new and exciting leadership role in the world. We will lead the world down. We will help the world down to a lower plateau on energy use."

FEF DIRECTOR SPEAKS AT WEST POINT

Fusion Energy Foundation executive director Dr. Morris Levitt gave a seminar May 13 on fusion power and its military applications at the U.S. Military Academy at West Point, N.Y. Speaking at the invitation of the physics department, Levitt reviewed the physics of beam-driven fusion and beam weapons.

Noting that the beam issue was first raised three years ago after reports of a Soviet breakthrough in electron-beam applications, Levitt said: "The debate over the feasibility of various beam weapon antiballistic missile systems and the state of Soviet achievements is symptomatic of a more profound situation about which there can be no controversy: The U.S. is being rapidly outdistanced by the Soviet Union in science and technology education and research.

"The situation at West Point I learned of first hand from officers in the science faculty is perhaps the most shocking aspect of the ongoing collapse of U.S. scientific training and capabilities. A team of 'reformers' used the 1976 cheating scandal at the Academy to upgrade the liberal arts curriculum and abolish the requirements for at least three semesters of physics and a course in electrical engineering," Levitt said. "Now a cadet can graduate with just a sniff or two of science, and many cadets are doing just that. Therefore, it is now possible for a West Point graduate to get some sensitive organ shot off by a laser beam without even knowing what the offending gizmo was called, let alone how it works!"

Photo by Ulanowsky/NSIPS

Levitt at West Point

LOVE CANAL: ANOTHER EPA HOAX

The medical studies that provided the basis for President Carter's May 22 declaration of a federal emergency and evacuation of residents from the Love Canal area in Niagara Falls, N.Y. were conducted improperly and did not provide conclusive evidence of any chromosomal or genetic defects among residents attributable to external factors.

A preliminary *Fusion* inquiry has determined that: (1) the study did not include the proper controls. The bad science here was so glaring that it prompted a statement by Dr. Robert Gordon, special assistant to the director of the National Institutes of Health, deploring this fact.

(2) The criteria involved in the study were such that an increased number of defects was a likely and predictable result, which Dr. Gordon also noted.

(3) The subjects chosen were more likely to have an increased incidence of "damaged" chromosomes (present in a small percentage of healthy individuals as well as in ill persons) because the sample involved already sick people, including one cancer victim. Indeed, after examining the data, the head of the Medical Genetics Department at the University of Buffalo Medical School declared that he was surprised that there were not more individuals with abnormal findings.

(4) The study was not subject to the usual peer review. If this process had taken place, it is likely that the study would not have come before the press and public until its distortions were corrected.

LOUSEWORT LAURELS TO WORLDWATCH INSTITUTE

This month's award goes to the environmentalist think tank Worldwatch Institute for a recent report in which the institute goes beyond its usual Malthusian pronouncements to assert that not only are resources running out, but also scientific advances. "Scientific advances in the near future will not be made as frequently or as cheaply as in the past. The known conceptual ground has been worked over pretty thoroughly, and subsequent explorers will find rich research veins less exposed and harder to exploit," says Worldwatch. The report, titled "Inflation: The Rising Cost of Living on a Small Planet," tells Americans that their model for fighting inflation should be the Arctic Eskimo: "The Eskimo's scrupulous use of every scrap of a seal or walrus in the face of absolute scarcity might serve as a symbol for all in the years ahead. Conspicuous and excessive consumption of energy and food should be discouraged by law and by social pressure, thus reducing demand."

News Briefs

Continued from page 9

OPEC OIL PRICES ON THE RISE AGAIN

Algeria, Libya, and Indonesia enacted price hikes of $1 to $2 a barrel in late May, triggering a new round of price increases by the oil cartel, OPEC. As a result, the price ceiling for OPEC crude oil is nearing $40 a barrel.

This move came within days of a Saudi Arabian announcement that the kingdom would raise the price of its crude—the least expensive in OPEC—from $26 to $28 a barrel. The Saudis were calculating that such a move might persuade the pricing militants to agree to stabilize OPEC's chaotic pricing situation. Earlier in the month Saudi Arabia had called a meeting of the OPEC Long Range Planning Committee to propose quarterly price adjustments pegged to the rate of world inflation. The pricing hardliners—Iran, Libya, and Algeria—had tentatively agreed to accept the formula, according to Kuwaiti sources, but then suddenly decided to raise prices instead.

NRC OPPOSES NUCLEAR FUEL FOR INDIA

The five members of the U.S. Nuclear Regulatory Commission voted May 16 against licensing shipments of 38 tons of enriched uranium to India for its Tarapur nuclear power facility. Under the Nuclear Nonproliferation Act of 1978, President Carter can overrule their decision on grounds of "common defense or security." The president had earlier approved a State Department recommendation in favor of the fuel exports. However, an executive order reversing the NRC vote can in turn be blocked if Congress acts within 60 days to approve a joint resolution against it.

India has complied with all provisions of the 1963 agreement under which the United States has supplied Tarapur for 10 years. The NRC, nonetheless, cited Indian government's refusal to rule out the possibility that it will test nuclear weapons and refusal to open its nuclear facilities to international inspection.

The State Department has commented that Carter's policy is in trouble either way. If the exports are approved, the nonproliferation mandate weakens. If the 1963 accord is violated, however, India would be free to reprocess 10 years' worth of spent U.S.-supplied fuel at its Trombay reprocessing plant, and could also probably obtain enriched uranium from the Soviet Union or France. Breaching the accord would also be diplomatically damaging, one Washington source commented; "India is one of the few major countries that we still want to be friends with."

MASSACHUSETTS COURT UPHOLDS 'RIGHT TO DIE'

The Massachusetts Supreme Judicial Court ruled May 13 that 78-year-old Earle Spring, whose case made national headlines, should have been allowed to "die peacefully" instead of continuing the kidney dialysis treatments that had prolonged his life.

Spring, who died from natural causes in April, was taken off dialysis treatments Jan. 18. The former pharmacist had told several interviewers and nurses at the Holyoke Geriatric Center that he did not wish to die, but a court order stipulated that he was incompetent and should die peacefully. Opponents of euthanasia then temporarily stayed the probate court order and Spring's dialysis treatments resumed Jan. 23.

In its key decision, the Supreme Court said that Probate Justice Sanford Keedy had properly ruled that Mr. Spring "would, if competent, choose not to receive the life-prolonging treatment," and should be forcibly removed from dialysis. The court further stated that the question of prolonging treatment for "mentally incompetent" individuals should be left to the attending physician, who should consider circumstances including "extent of mental treatment, the novelty of treatment, the family's opinion, and risks involved."

Viewpoint

The Antinukes and Drugs

by Jeffrey Steinberg

Most Americans who want to see scientific progress and prosperity for their children have a vague notion that somehow the drug counterculture is related to the antinuclear environmentalist movement. They have seen on television that the shirtless, unwashed rabble who turned out for the "Sun Day" demonstration against nuclear energy last fall consumed several tons of marijuana, while the news media portrayed the gathering as expressing the will of "the American people." They know that the rock musicians' organization against nuclear energy, called MUSE, is an all-star lineup of the heroes of the drug counterculture. Yet to many of these

Americans, any links between drugs and the environmentalists are just interesting coincidences.

It's time to set the record straight and make clear the connections between the "greenies" and the "potheads."

There is no difference between the antinuclear movement and the organized drug subculture. Politically, they are controlled and financed by the same forces; epistemologically, they are expressions of a single coherent, antihuman view of the world.

It is no coincidence, for example, that the French environmentalist lobby Les Amis de la Terre cosponsored a meeting over the weekend of May 10 in Paris for the promotion of marijuana decriminalization. Les Amis de la Terre is the official affiliate of the U.S.-based Friends of the Earth environmentalist group.

No Coincidence

Nor is it coincidence that the anarchist Yippies, who organized a marijuana "smoke in" in New York last week, have joined the Coalition for Direct Action at Seabrook, run by the antinuclear prototerrorist Clamshell Alliance. The coalition includes the French antinuclear front, Action Directe, and the German affiliate, Action Reconciliation. Funding and coordination for the coalition is provided by the Movement for a New Society in the United States, a radical grouping linked to the American Friends Service Committee that promotes homosexuality and pederasty.

At the same time that the Yippies have merged with the antinuclear mob, their Atlanta branch, known as the Committee Against Marijuana Prohibition (CAMP), coordinates activities with the national marijuana lobby, NORML, and the prodrug magazine *High Times*. It was revealed in congressional testimony last year that half of NORML's operating revenues come from *High Times*, which in turn gets its money from the large volume of advertising from drug paraphernalia firms. Who endorses the efforts of NORML to decriminalize marijuana, thereby supporting the merchants who sell the coke spoons, water pipes, and heroin-testing kits? Politicians such as Senator Edward Kennedy, who also demands a phase-out of the nation's nuclear plants.

Then there is the case of the environmentalists in California who are campaigning for laws to ban the use of pesticides by West Coast farmers. It would be much safer ecologically, these environmentalists argue, for California farmers to grow marijuana instead. Who supports this legislation? NORML.

A Question of Mind

Aside from the evidence of joint work between the antinuclear networks, drug consumers, and pushers, the most telling confirmation of this connection stems from knowledge of how the human mind works. It is incoherent for someone to favor nuclear energy and at the same time advocate leniency toward drugs. A citizen who understands the necessity of scientific and cultural progress, cherishes the development of the human mind as that quality that separates man from animals. For man to have increasing mastery over the "outside" workings of the universe, the healthy citizen senses, he must increasingly perfect knowledge "inside" his mind, reason. The universe is coherent. There can be no progress in the "outside" world while inebriation and destruction—unreason—reign "inside" the mind.

The enemies of industrial society know this. Witness the case of Dr. Albert Hofmann, the chemist from Sandoz laboratories in Switzerland who invented LSD back in the 1930s. In excerpts from his recent book, published in *High Times*, Hofmann shows that the drugged mind is one that will rebel against the material progress of science—and, indeed, he reveals that this rebellion was the objective behind his invention of LSD.

There are two ways of looking at the world, Hofmann writes. On the one hand, "one approaches the problem of reality rationally, with the logical methods of philosophy." The other approach, he says, occurs when "one obtrudes upon this problem emotionally, through an existential experience." LSD is the most effective way of inducing this perception of a "different reality," Hofmann concludes. In other words, the universe is not coherent; there are several sets of truths; there is no "right" and "wrong."

A person in this condition is ripe for becoming an environmentalist. Hofmann explains: the "rational" view of the world "has produced modern natural science and technology—creations of the Western mind that have changed the world." This process has unleashed "a catastrophic destruction of the environment," he says.

Hofmann shows how reason is viewed by the antinuclear druggie: "Even to the heart of matter, to the nucleus of the atom and its splitting, this objective intellect [reason] has progressed, and has unleashed energies that threaten all life on our planet."

Hofmann's alternative, induced by psychotropic drugs, is "a consciousness of reality in which man is not separated from the environment but rather exists as part of living nature. . . ." Man is not above the lower animals: "In field and forest, and in the animal world sheltered therein, indeed in every garden, a reality is perceptible that is infinitely much realer, older, deeper and more wondrous than everything made by man's hand."

It's no wonder potheads are antinuclear.

Jeffrey Steinberg, coauthor of the bestselling exposé Dope, Inc. *(New York: Franklin House, 1979), is the editor-in-chief of* War on Drugs, *the new monthly magazine of the National Anti-Drug Coalition.*

Special Report

FEMA: Your Emergency Government In the Wings?

UPI

From the Miami riots, to the Love Canal emergency evacuation, to the natural disaster at Mount St. Helens, FEMA has taken command of civilian government functions. Here two scenes from the mid-May Miami riots.

Editor's Note: Zero-growth societies require both an ideology and the institutions to enforce that ideology. Last month, the Books section reviewed The Aquarian Conspiracy *and its plot to remove reason from the minds of American citizens and industry from the economy, substituting "feeling," "consciousness," and more "natural" forms of social organization. This issue's Special Report reviews the operational arm of the zero growthers—the Federal Emergency Management Agency. Next month,* Fusion *will feature the highest-level Aquarian Conspirators—the role NATO has played in engineering the austerity and antiscience ideology that is destroying the economy and the education system.*

A single civilian agency is preparing to administer a military government in the United States in the event of a Mideast war or comparable domestic or international crisis. The body in question is FEMA, the Federal Emergency Management Agency. It has the standby authority to:

- relocate millions of workers, reorganize national industry and banking, and distribute all economic resources and transportation access;
- operate every level of government, through personnel currently in place throughout Washington and the rest of the country;
- institute total energy rationing;
- order mass evacuations of residents in the perimeter of nuclear power plants.

News media with eyes trained on Washington have rarely covered the secretive but highly active FEMA since its inception. This special report reviews FEMA's mandate and presents the agency's preparations for emergency government in the words of FEMA officials.

The TMI Story

Fusion first reported on FEMA during the Three Mile Island incident. We learned that on March 27, 1979, the agency had become operational, centralizing all "crisis management" functions with accountability solely to the National Security Council. FEMA had jumped the gun on its officially designated April 1 activation, and just a day after it became operational, the Three Mile Island crisis began.

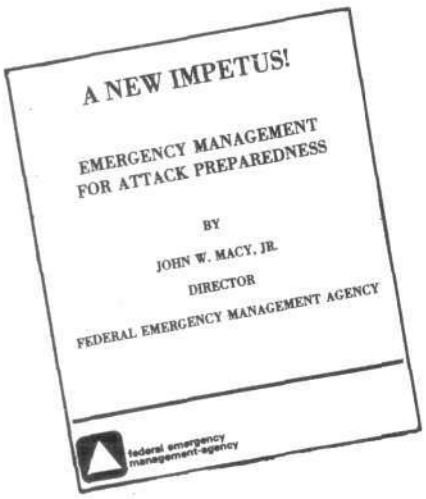
As described in "The Harrisburg Hoax," a series of articles that won *Fusion* the Freedoms Foundation at Valley Forge 1979 George Washington Honor Medal, FEMA personnel actively fostered an atmosphere of panic, and lobbied for mass evacuations that would have given FEMA authority over all other federal, state, and local governmental bodies, with the exception of the governor's office.

During the first test of FEMA's emergency powers, FEMA's field personnel were headed by Barry Evenchick of the Federal Disaster Assistance Administration, which was then being phased into FEMA. In liaison with the National Security Council, this command structure, according to eyewitnesses and Associated Press and *Baltimore Sun* accounts, controlled the flow of information—and glaring misinformation—about the Harrisburg events.

The evidence from TMI, plus the material presented here, suggests that FEMA is, in fact, gearing up to help *create* the crises that will justify its mandate for dictatorial power over every operating level of government, industry, and banking.

Other Crises

FEMA's other crisis management interventions to date include planning the New York City transit strike of April 1980 one year in advance and coordinating the Mayor's emergency measures with the explicit purpose not of standby facilitation of urban



John W. Macy, Jr., director of FEMA—a cool contrast to the crises and disasters the secret agency is planning to manage.

activities, but of "acclimatizing" New Yorkers to cutbacks in city services and associated chronic crises. FEMA is also running the current boatlift operation of Cuban refugees as a test for population relocation. FEMA took command of U.S. Air Force planes and personnel during the May airlift of refugees from Key West to Florida and Arkansas relocation camps—an important precedent. At the beginning of June, FEMA was also hard at work managing the Mt. St. Helens volcano crisis and the Love Canal uproar in New York.

The overall capability toward which these exercises are aimed is summarized in the accompanying interviews with senior FEMA officials.

FEMA's Mandate

FEMA was established June 19, 1978, by a Presidential Executive Order that, for lack of congressional challenge, automatically took effect in April 1979. The Executive Order gave FEMA direct control of nine federal agencies previously dealing with natural disasters and "preparedness"—and over any other federal agency potentially involved in crisis management, from the Treasury to the DOE and Labor Departments.

The FEMA mandate excludes the Pentagon and Joint Chiefs of Staff from top-level discretion over national emergency measures. It creates an Emergency Management Committee within the National Security Council, chaired by FEMA's director and including the national security advisor, the assistant to the president for domestic affairs, the director of the Office of Management and Budget, and the National Security Council assistant for policy and intergovernmental relations.

The 1979 Executive Order was based on Presidential Review Memorandum 32, drafted in April 1978 by Samuel Huntington. The guiding assumption of PRM-32 was that constitutionally mandated institutions would not be able to deal with the scope of crises foreseen for the late 1970s and the 1980s.

Three years earlier, Huntington had elaborated this assumption in his position paper for the Trilateral Commission, titled *The Crisis of Democracy*. Fuel crises, social upheavals, and other emergencies, Huntington said, would require a level of austerity and social control impossible to achieve through democratic institutions: hence the need for new "crisis management" forms of government, nationally and supranationally.

This "crisis management" theme is also intimately connected to National Security Advisor and former Trilateral Commission member Zbigniew Brzezinski. Brzezinski had projected in his 1972 book *The Technetronic Era* a "technocratic dictatorship" as the consummation of the need for "crisis management."

He wrote:

"The next phase may be one of sullen withdrawal from social and political involvement, a flight from social and political responsibility through inner emigration. . . . At the same time, the capacity to assert . . . political control over the individual will vastly increase. . . . Moreover, the rapid pace of change will put a premium on anticipating events and planning for them. Power will gravitate into the hands of those who control the information and can correlate it most rapidly. Our existing postcrisis management institutions will probably be increasingly supplanted by precrisis management institutions, the task of which will be to identify in advance likely social crises and to develop programs to cope with them. This could encourage tendencies during the next several decades toward a technocratic dictatorship, leaving less and less room for political procedures as we now know them."

This perspective is congenial to Brzezinski's choice as head of FEMA, John W. Macy, Jr. In the late 1940s, Macy acted as operations director for an Atomic Energy Commission dominated by opposition to peaceful uses of nuclear energy. In the 1960s, he screened candidates for presidential appointment as a special assistant to the president. Later he ran the pro-counterculture, antigrowth Public Broadcasting System, from 1969 to 1972. On commission from David Lilienthal, his old AEC mentor, and the Lazard Frères investment bank, Macy then moved to Iran for the duration of the chaos leading to the installation of the Khomeini regime.

Dictatorship?

For most Americans, the Boy Scout motto "Be Prepared" still holds as sound advice. But clearly this is not what Huntington, Brzezinski, and the FEMA officials interviewed here are talking about. The main question to be asked is whether FEMA is engaging in "precrisis management" to set up the crises that will allow the agency, under its mandate, to run the U.S. government.

—Susan Johnson

FEMA Describes Its Master Plans

Reorganization, Evacuation, Rationing

This interview with General Frank Camm, associate director of the Office of Plans and Preparedness in the Federal Emergency Management Agency, was conducted in April 1980. Both interviews were made available to Fusion *by the* Executive Intelligence Review.

* * *

Question: I understand you did a "resources exercise" recently with NATO?

Yes, it was of course highly classified but I can tell you this. There was a simulated nuclear exchange between the United States and the Soviet Union. We simulated a crisis in which a large group of people from 34 different government agencies and departments moved to another location to deal as government with the new situation. This included DOE, DOI, DOD, DOJ, every department of the government. We coordinated here at FEMA the entire relocation and restructuring because that is our job—coordination at all levels, federal, state, and local.

This occurred during just two weeks. We are still evaluating the results.

Then we had to look at what was left of the country. For example, if Cincinnati was hit, wiped out, we had to be able to calculate from the level of blast and radiation envelope how much of the economy was lost—how many machine tools we had left, how much energy resources, how much transport infrastructure, how much of our national microwave communications grid had been wiped out in that area.

Certain areas became off limits altogether because of radiation levels. We then had to reorganize the entire national transport and communications grid.

We were also liaisoning and reorganizing entire state and local areas through FEMA's 10 regional directors offices in the 10 federal regions of the nation. Most federal agencies and departments, like Agriculture, Commerce, etc. have their organizations around the country, by the standard Federal Regions of which there are 10. In fact, you can get all the departments' regional offices in the U.S. Government Manual. . . . It lays out the entire infrastructure. FEMA set the national pattern up that way because it is our job to coordinate these things. . . . We naturally take over all liaison with local governments in such a situation.

Regarding the economic rehabilitation of industry, we took off the shelf the plans we have to establish in such a situation a new cabinet-level officer of defense resources to organize all resources throughout the economy—that's what we mean by a resource exercise. We reorganized and allocated on a priority basis all financial resources, manpower resources, natural resources, strategic resources, industrial resources, transportation resources, communications resources.

The nucleus for this would be the present Office of Resources of Planning and Preparedness. The new department would serve as a super-version of the old World War II War Production Board. We exercised this plan, constituting ourselves as the Department of Defense Resources, and started allocating everything. . . .

Question: What are your next priorities, especially peacetime priorities?

Right now our most urgent task is a real crash effort on the Radiological Emergency Preparedness Task Force mandated to us by the Kemeny Commission [on Three Mile Island] regarding planning for evacuation of perimeters of operating nuclear power plants.

We have set up a new Radiological Emergency Preparedness Division within the Planning and Preparedness Office of Resources, which was formed by bringing 12 officers from the Nuclear Regulatory Commission into FEMA to set up here. They are headed up by Robert Ryan, the new division director. This task force, or division, will evaluate the efficacy of all the urban evacuation plans of every major city in the United States where a nuclear plant is operating to see if the population can be effectively evacuated in case of peacetime

FEMA's 10 regions. Each regional director reports to John Macy.

emergency. The division must report to Carter by June 30 on how good the plans are and formulate better ones.

We have all the expertise for this and we are going to apply it, to see that the situation you had at TMI doesn't repeat itself, where people and agencies were milling around with no coordination. We intend to use our planning expertise from the military sphere to coordinate all this.

For example, if we must vent a radioactive gas cloud from the core, the DOE will have to deploy mobilely to keep track of the cloud, to warn and evacuate people in the areas all across its path, to tell the Red Cross when to set up evacuation of hospitals, mobilize ambulances. We're already doing exercises on this, to set up in advance who does what to whom. . . .

We have a full program to evaluate the evacuation plans of every city where there is an operating nuclear plant, both the city's plans and our plans, and then upgrade. We have come up with a list of criteria, and we have 150 FEMA people around the country with long-standing expertise on nuclear war and we're diverting them to these localities to help the local governments develop these plans on a local level.

Question: What about the energy crisis resulting from a Mideast war?

Yes, our next priority is planning for an energy shortage. We don't care if the Persian Gulf shuts down or if every oil field in the United States shuts down. We're going to show the DOE how to run a rationing program. They don't have the staff, as I said before, on the field level to coordinate such a thing with local officials. We have the expertise.

We have already worked out the plans for an oil blockade in case of general war. The fundamental decision has been made that rationing will depend on state and local agencies and the DOE can't coordinate this. Rationing will totally depend on our coordination of local programs, and it will be total rationing, disaster rationing. We would convey the federal plans to the state and local level.

Mobilization Plan: 'Ready to Take Over'

This interview with FEMA's John Nosita, general director of Program Analysis and Evaluations, details the Federal Master Mobilization Plan.

* * *

Question: What will be the peacetime application of FEMA's recent nuclear war simulation?

Oh, that simulation was only a part of the Federal Master Mobilization Plan—we are continuing a series of such simulations so that we have full emergency legislation on the shelf and ready to go for use in any emergency. The Federal Master Mobilization Plan is being developed over time by a joint task force of the National Security Council and FEMA called the "Mobilization Planning and Programming Study" which was set up personally by Zbigniew Brzezinski. When the Master Mobilization Plan is finalized, it goes straight to Brzezinski—that will mean FEMA is fully ready to take over in the event of emergency.

Question: Does that mean that the plan is applicable to any emergency?

Certainly. The plan is totally comprehensive; it contains provisions for mobilization of all resources, industrial resources, financial resources, energy resources. It could be applied to a nuclear disaster. It could be applied to an oil embargo. It has the broadest applications.

Question: What is the structure of this Task Force?

The Study Task Force is headed up by Colonel Joseph Stebbens of the National Security Council and General Frank Camm, FEMA associate director for Planning and Preparedness.

Question: And how does FEMA coordinate its work exactly with the other agencies of the government?

Well, John Macy [FEMA director] does it from the top, you know. He sees the cabinet secretaries personally. He goes around and sees them every day. . . . And you know that they're talking about emergency management; that's their business.

Question: How does FEMA coordinate on the working level with the agencies and departments? Don't you have FEMA liaisons within the staffs at each agency, too?

There is a central emergency coordinator for each department of the federal government with a full staff which liaisons directly with FEMA; that is, the Treasury emergency coordinator, for example, has an entire staff under him in Treasury responsible for carrying out plans developed with FEMA. He would coordinate with General Camm as head of Plans and Preparedness. There is, similarly, an emergency coordinator within each of the agencies of government, all located within the cabinet secretary's office. Bob Merchant, the Treasury emergency coordinator, is in Secretary G.W. Miller's office. Similarly, there are FEMA emergency coordinators in the offices of the secretaries of Energy, Commerce, Defense, the Federal Reserve, Transportation, Labor, HEW, HUD, Agriculture, the FCC, and so on.

Of course, once we're at war or any emergency hits, it is those agencies—through their emergency coordinators—who carry out the president's emergency orders. Once we're at war with Iran—and we'd better be prepared, hadn't we, because we're all going to be doing a hell of a lot of walking—the president will act directly, telling the Treasury to seize Iran's assets and any other financial action which may be necessary, domestic or international financial action.

But we write all the plans beforehand. We tell Treasury what to do ahead of time, and during the process we advise the emergency coordinator.

Special Report

Something's Rotten in U.S. Education

by Mary Gilbertson

Editor's note: In this issue Fusion *begins to look at what's wrong with U.S. education and what has to be done for the nation to produce the young scientists and engineers that the fusion economy will require. The next issue (September) features an exposé of the Aquarian Conspiracy and the network that set out to drown U.S. education, especially science education, in the counterculture and environmentalism. In addition, the question of evolution and science is discussed in full. And in October,* Fusion *will feature a series of articles on the vital question of education.*

* * *

Just when some of the nation's top educators have begun to mobilize around the vast education gap between the United States and the Soviet Union, U.S. education think tanks are spewing out new curricula to widen that gap. The new curricula share one basic characteristic: Traditional American beliefs in science, progress, and man's ability to develop creative solutions to new problems are replaced with the idea that the universe is inevitably running down and that all man can do is learn to live with the consequences of entropy.

These new curricula are not just some oddball creation of an environmentalist group. They are part of a deliberate, top-level effort identifying itself as the Aquarian Conspiracy, which intends to transform Americans into a nation that can accept lower living standards and zero growth. (See accompanying box on Changing the American Image.)

Unless the educational situation is turned around, future generations of Americans will not have the mental powers to think and create; instead,

they will be Aquarians doing whatever makes them feel good.

The specifics of the new curricula are shocking enough in themselves, as I shall show. But they are even more shocking in the context of the much-publicized Wirszup report comparing precollege science education in the United States and the Soviet Union (see box).

As University of Chicago Professor Izaak Wirszup states at the outset of his report: "My investigations show conclusively that in the last decade the Soviets have made simultaneous quantitative and qualitative gains without equal in the history of their education, affecting the entire young population. . . . For the 98 percent of the school-age population that now completes secondary school or its equivalent, the Soviets have introduced science and mathematics curricula whose content and scope place them far ahead of every other nation, including the United States. . . .

"These changes . . . are tantamount to an educational mobilization of the entire population . . . [achieving] radical curricular reforms brought about by an unexpected turn toward the individual and the development of his ability to do independent, creative work."

And in the United States? What little science is taught to the precollege population is about to be subjected to a final solution—the "Steady State" curriculum and the "Creation Model."

The Steady State Curriculum

First, let's look at the most blatant zero-growth curriculum, the Steady State. Its explicit purpose is to get students and teachers alike to think only in terms of a dying society. "If we choose to consider future generations then we must agree that it will soon be necessary to reverse patterns by ending growth, and to start teaching our children about the futility of growth, planned or unplanned."

So reads the introductory statement of the Phi Delta Kappa Foundation's curriculum for primary school children, titled "Alternatives to Growth: Education for a Steady State." Phi Delta Kappa is hardly a fly-by-night outfit. Founded in Bloomington, Ind. in 1966, it is an outgrowth of Phi Delta Kappa International, which dates back to 1911. It boasts a membership of 120,000 graduate students in education in the United States, England, Canada, West Germany, and the Philippines, with 513 chapters attached to major universities.

How respected is it? "We have a cosy relationship with Phi Lambda Theta," the prestigious honorary educational foundation, said foundation spokesman Dr. Burlesan.

The Steady State curriculum, authored by Robert M. Bjork and Stew-

art E. Fraser, both of George Peabody College for Teachers in Georgia, is one of 144 documents on education—called fastbacks—Phi Delta Kappa has published over the years. The authors list the following as the thinkers and institutions behind their steady state ideas:

The *First Report of The Club of Rome*; Herman Daly, Nicholas Georgescu-Roegen, Mihaglo Mesarovic, all members of the Club of Rome; Dennis Meadows, member of The Club of Rome, chairman of the Dartmouth School of Engineering, and coauthor of *The Limits to Growth*; Kenneth Boulding, former president of the American Association for the Advancement of Science and an acknowledged Aquarian Conspirator; Rachel Carson; Thomas Malthus; and Aquarian science fiction writer Isaac Asimov.

The best way to get a grasp of what Phi Delta Kappa wants American children to learn is simply to quote verbatim from the curriculum.

On why the American concept of the developing industrial nation-state must be replaced:

Positive national feeling will not be fostered by eulogizing the bigness or the past growth of the country. . . . In a future society with a no-growth population and economy . . . more and taller buildings . . . more and wider highways will be treated in steady-state schools as outmoded, superstitious misconceptions, rather like we now consider belief in witches. Technological improvements will not be thought central to progress.

On why reason must be rejected because it has led to progress:

Reason is compatible only with optimism and a denial of limits. Such a view is based on 19th-century history and ideas of "progress."

On why most Americans are "outlaws" in zero-growth eyes:

To aspire to be a captain of industry or businessman expanding an industrial empire will be thoroughly discouraged as we now condemn aspirations to become an outlaw. Whatever is left of the business entrepreneur as an examplar in American ideology will quickly disappear.

The most specific curriculum ideas presented are on energy, population, death, and zero-growth economics. These excerpts come directly from the curriculum.

Education About Energy: Solar energy comes to us in a steady flow from outside our earthly system. Steady-State teachers should impart a sense of reverence toward the sun. . . . They will come to a new appreciation of old Egyptian hymns to the sun. [The Egyptian 'Hymn to Alton' follows.] Students can easily understand that all energy constantly tends to go to an unusable form . . . deterioration of the surrounding environment is always greater than the order achieved. Even if fusion energy someday becomes possible, the Second Law of Thermodynamics, which says that energy always tends to go over into an unusable form, still points to limits in the length of time fusion can provide energy. We teach this poorly now because it runs against our technological religion.

The Wirszup Report: 'A Formidable Challenge'

Isaac Wirszup, professor of mathematics at the University of Chicago, summarized his research into the present status of Soviet mathematics and science training in a letter to two officials of the National Science Foundation Dec. 14, 1979 that has since been widely publicized.

Fusion will present a full analysis of the report in the October issue on education. In brief, the extent of the education gap between the United States and the Soviet Union can be seen from Wirszup's comparison of the math and science programs.

"In only 10 years, the Soviet compulsory program for all students covers the equivalent of at least 13 years of American schooling in arithmetic, algebra, and calculus, and does so much more thoroughly and effectively. The American one-year geometry course offers but a very small fraction of the Soviet ten-year curriculum," Wirszup said.

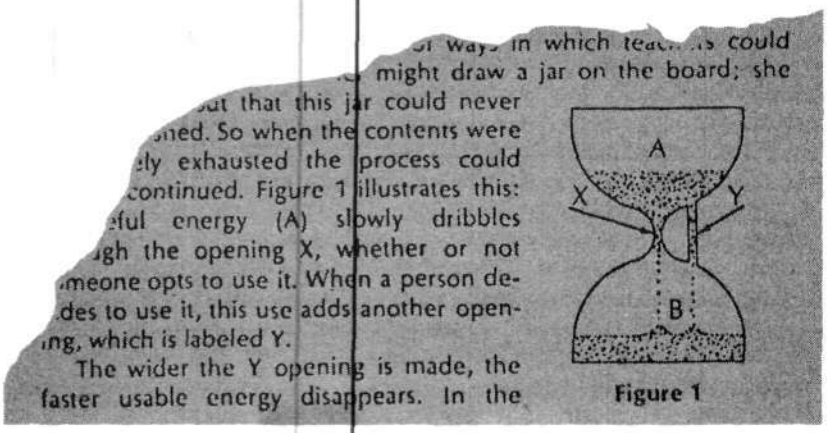
In this 10 years, the Soviet student has 3 years of arithmetic (grades 1-3), 2 years of arithmetic combined with algebra (grades 4-5), 5 years of algebra (grades 6-10), 10 years of geometry (5 of intuitive geometry in grades 1-5; 3 of semirigorous place geometry in grades 6-8; 2 of semirigorous solid geometry in grades 9-10), and 2 years of calculus (grades 9-10). In addition, the *compulsory* curriculum of the Soviet general education school includes 5 years of physics, 4 years of chemistry, 1 year of astronomy, 5.5 years of biology, 5 years of geography, 3 years of mechanical drawing, and 10 years of workshop training.

Wirszup concludes: "The disparity between the level of training in science and mathematics of an average Soviet skilled worker or military recruit and that of a non-college-bound American high school graduate, an average worker in one of our major industries, or an average member of our All-Volunteer Army is so great that comparisons are meaningless. . . .

"The Soviet Union's tremendous investment in human resources, unprecedented achievements in the education of the general population, and immense manpower pool in science and technology will have an immeasurable impact on that country's scientific, industrial and military strength. It is my considered opinion that the recent Soviet educational mobilization, although not as spectacular as the launching of the first Sputnik, poses a formidable challenge to the national security of the United States, one that is far more threatening than any in the past and one that will be much more difficult to meet."

Teaching About Population: Since famine, disease, and war are bad checks on population growth, the student will come to see the following "preventative checks" as reasonable. (1) abstinence, temporary or total, from sexual intercourse; (2) aborting, induced or natural. . . . Technological aspects of abortion will be taught in sex education; (3) contraception, mechanical and chemical; (4) sterilization (both natural and induced); (5) infanticide.

Teaching About Death: The longer the life we want for our species, the sooner we must effect a cessation of growth. . . . A surplus of deaths over births for a rather long time would lengthen our life span. Acceptance of a rational attitude about death and extinction will be a prominent feature of steady-state schools. The steady-state student will understand that each person begins to die at the instant of birth. Further, the student will clearly comprehend that homo sapiens will, at some point, become extinct.



A page from the steady state curriculum: The teacher suggests to the child that our finite supply of energy is always running out—like sand in an hourglass—but if you use it, it runs out much faster!

The Creation Model

The Steady State curriculum is new and not yet widespread. A less obvious but equally zero-growth curriculum already in use in 10 states (with several more pending) is the Creation Model. Under the guise of opposing the evil Darwin who insisted that man evolved from beasts, the model teaches that there is no evidence that development has taken place in the universe, and that the universe, man, and God are all dying.

The Creation Model attempts to prove scientifically that chaos and entropy define the universe. As Luther Sunderland, New York's expert on the Creation Model, put it in an interview: "The Second Law of Thermodynamics is the only way of looking at creation. . . . The universe is moving from order to disorder. . . . Nothing has ever developed from disorder to order. We don't teach that *openly* to primary and secondary school children, of course; it would upset them. We keep that in the background."

Dr. Henry R. Morris, a leader of the Creationists and formerly head of engineering at Virginia Polytechnic, was even more explicit: "The descent from order to disorder eliminates the possibility of a basic law of increasing organization which develops existing systems into higher systems."

Despite the attempt to cast the model in scientific terms, however, what the Creationists cite as science is wishful thinking on their part, or just plain lies. For example, the developers of the Creation Model use as their scientific "evidence" for this entropic view of man and the universe the work of one Dr. Peterson at the British Museum. Says Peterson: "There's no fossil evidence that the world ever developed. . . . There's no fossil evidence of transitions that show development." (This, of course, is a turnaround of the Darwin operation the British Museum launched in the Scopes trial.)

And in the Creation Model curriculum one finds this item: "The earth never developed. . . . It's clear from the decay of the earth's magnetic field that the earth was formed about 10,000 years ago." The model, in fact, states that the universe was "created in an instant by an outside force" and is now dissipating. In this view, God is either impotent, having to stand by and watch his creation disintegrate, or God is dying.

Perhaps the most egregious "scientific" supporter of the Creation Model is Karl Popper, Aristotle Society Member and epistemological grandfather of the environmentalists like Amory Lovins. Popper's theory is that "evolution is purely a metaphysical phenomenon." In other words, if you see evidence of development, it is a figment of your imagination. From the London School of Economics, Popper has spent decades attacking the Platonic notion that the process of development, negentropy, is the underlying characteristic of man and the universe.

The Fundamentalist Snare

The readymade audience for the zero-growth Creation Model has been the fundamentalists who are eager to replace the traditional Darwinian view of evolution (which is, self-admittedly, a bestial view of man). Most of the fundamentalists, however, neither understand nor support the zero-growth intentions behind the Creation Model. But the think tanks pushing austerity and an anti-developmental view of the world understand it very well.

Dr. Oralee McGraw, for example, the Heritage Foundation's director of education, told me that "the Creation Model business is the hot button issue for science." Choosing to ignore the controversial issue of zero growth and its implications, McGraw stated the fight solely in terms of "academic freedom":

"The real issue is one of academic freedom. Where are the scientists on this issue now? They don't care. You know how the scientific community is; they run in packs. They've developed means of protecting themselves from new ideas. . . . We want to debate the biologists because it gives a scientific atmosphere to the whole question. . . ."

As for the relationship between Phi Delta Kappa's Steady State curriculum

and the Creation Model, Heritage Foundation staffer McGraw called the Steady State views "too blatant." As she noted, though, Phi Delta Kappa has published a fastback on the Creation Model by J. Bergman, and Phi Delta Kappa has hosted major speeches on the Creation Model.

What it comes down to is that the Creation Model is the "soft sell" part of a major effort to make zero growth the basis of U.S. science education.

How widespread is the teaching of the Creation Model? It's already being taught in Arizona, Georgia, Idaho, Indiana, Ohio, Oklahoma, Oregon, Tennessee, Texas, and West Virginia. Creation Model bills have been introduced in Iowa, Minnesota, and Florida.

As Luther Sunderland, New York's Creationist expert, told me, "If we can get the curriculum into New York State, it's a cinch for the rest of the country."

The New York deputy commissioner for legal affairs has paved the way by ruling January 1979 that it is not illegal to teach the Creation Model in New York schools, and the state Board of Education has held up its 10-year reevaluation of the science curriculum to make way for the Creation Model.

'Big Bang' Support

Credence for the theologically and scientifically absurd Creation Model is also lent by the more respectable—but epistemologically comparable—"Big Bang" model of astrophysics. As an example of the type of connection being made, the fundamentalist magazine *Upreach* recently reprinted an article by NASA astrophysicist Robert Jastrow, a self-proclaimed agnostic, on how the alleged origin of the universe reveals the limits of science and reason.

Perhaps the biggest boost to Creation Model advocates came from the *New York Times*, which publicized the model on its front page April 7, 1980, lending credence both to the lie that the model is "scientific" and to the Heritage Foundation line that it should be taught simply on the basis of promoting "academic freedom."

Mary Gilbertson, a Fusion Energy Foundation staff member, is the author of "The National Science Foundation: Taking The Science Out of Education," which appeared in Fusion's February 1980 issue.

Changing the American Image

In 1974, the Stanford Research Institute conducted a study on how to achieve a zero-growth civilization. Called "Changing Images of Man," the study was carried out under Stanford's social-policy director Willis Harman. Margaret Mead, B.F. Skinner, Ervin Laszlo of the United Nations, Sir Geoffrey Vickers of British intelligence and others participated.

"Images and fundamental conceptions of human nature and potentialities can have enormous power in shaping the values and actions of a society," asserts the study's statement of premises:

"We have attempted in this study to identify needed characteristics of future images . . . and identify high-leverage activities that could facilitate the emergence of new images. . . ."

The "image of industrial and technological man" is obsolete, the SRI report says, and a way must be found to "discard" it:

"Many of our present images appear to have become dangerously obsolescent. . . . Our analysis of the nature of contemporary societal problems leads to the conclusion that . . . the images of man that dominated the last two centuries will be inadequate for the postindustrial era."

In a review of the "dominant images of humankind throughout history"—from 250,000 B.C. to the present, the study then surveys 19 distinct images of man from the standpoint of their current utility in extirpating the present "industrial-technological image."

Among the Stanford findings are: Totemism and identification with animals in the Upper Paleolithic is useful; the "farmer son of Goddess earth" of the Neolithic era is useful; the Sumerian image of submission to ruling elites is very useful and should be retained in the post-industrial society. The Old Testament image of human "dominion over nature," on the other hand, is dangerous and must be discarded.

The more recent images follow suit: Indian yogi images are potential contributors to the "self-realization ethic"; Chinese Confucianism's image will bolster the "ecological ethic"; the Greek dionysian/mystical image is invaluable in deemphasizing material consumption; the Christian image of the New Testament must be reworked. The image that emerged from the Italian Renaissance, the economic, individualist, rationalist seeker after real, scientific knowledge—this is inappropriate and must be extirpated, the study says.

How shall these new images be implanted in the American character?

The Stanford planners list their prospects:

"Youth involvement in political processes; Women's liberation movement, black consciousness, etc.; Youth rebellion against societal wrongs; Emerging interest in social responsibility of business; The generation gap implying a changing paradigm; The anti-technological bias of many young people; Experimentation with new family structures and interpersonal relationships; The emergence of communes as alternative lifestyles; The emergence of the conservation/ecology movement; A surge in interest in Eastern religious and philosophical perspectives; A renewed interest in 'fundamentalist' Christianity; Labor union concerns with quality of work environment; An increasing interest in meditation and other spiritual disciplines; The increasing importance of 'self-realization' processes."

In February 1980, six years after this study was completed, project director Willis Harman persuaded Marilyn Ferguson to publish a book titled *The Aquarian Conspiracy* (Los Angeles: J.P. Tarcher), which boasts that the counterculture was from the beginning the work of a deliberate social engineering gameplan.

Austerity-Minded Congressmen Clobber 1981 Fusion Budget

A subcommittee of the House Appropriations Committee has cut the 1981 fusion budget by $30 million, claiming austerity and an unfinished DOE review of the magnetic confinement program. The head of DOE review committee, Dr. Sol Buchsbaum, however, reported on an interim basis to the DOE Energy Research Advisory Board that he was very "impressed with the management and scientific progress" of the fusion program, and an optimistic evaluation is expected. Congressman McCormack, meanwhile, has retained the Hirsch advisory panel on fusion to keep open the option of placing his Apollo-style fusion bill before the House and Senate. McCormack has also made public a letter from President Carter in which he said the "administration is committed to the fusion option."

Also for alleged reasons of austerity, the Appropriations Committee killed NASA's Solar Polar Mission, a move that will have the same self-defeating consequences for U.S. science and national security as the fusion cuts.

Speak up for U.S. science and technology by writing President Carter and the congressmen targeted in this month's Congressional Line-up, page 23.

The Energy and Water Subcommittee of the House Appropriations Committee voted May 7 to cut $60 million out of the magnetic confinement fusion budget for fiscal year 1981 and the subcommittee marked up the budget at $373 million. The House Science and Technology Committee had sent the fusion budget to Appropriations with an authority of $433 million, an increase of $30 million over the $403 million request submitted by the Department of Energy.

The fusion budget now goes before the full Appropriations Committee and then the full House for a vote. The mark-up procedure in the Senate is not at this stage yet. If there are differences in the House and Senate versions, the fusion budget will have to go to a conference committee for resolution.

The Appropriations subcommittee cuts were not made because members are antifusion, but because of administration pressure to "balance the budget," according to a committee spokesman. The effects of the cutbacks, however, will hurt every ongoing fusion experiment and will make serious work on the next-step fusion Engineering Test Facility nearly impossible.

A preliminary breakdown of how the cuts would affect the administration budget for fusion includes $8 million from the Applied Plasma Physics division, which funds basic scientific research; $6 million from the development and technology division; $3 million from the equipment budget; $2 million from the confinement systems division, which includes the mainline tokamak experiments; and cuts in administration, planning, and projects.

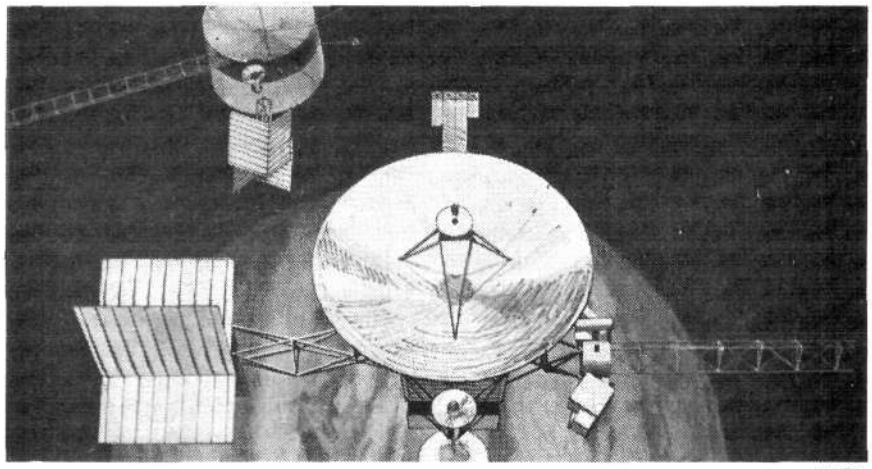
The Appropriations Committee also decided to cut $17 million from the

inertial confinement fusion operating budget, which will most likely affect the advanced laser and heavy ion fusion programs. At the same time, the committee added $25 million to the Nova laser fusion program at Lawrence Livermore Laboratory, a program the administration budget request had cut to zero.

That the cuts are based on nothing but a blind austerity mentality is clear from the remarks of subcommittee chairman Tom Bevill (D-Ala.). The DOE's Buchsbaum committee is now reviewing the whole magnetic fusion program, Bevill said, so why put more money in when the program might be changed?

As Bevill should know, other DOE reviews of specific fusion projects and all the recommendations from the Advisory Panel on Fusion set up by Congressman Mike McCormack (D-Wash.) have advocated that the fusion program be accelerated—which will require adding to the budget. In effect, the caution expressed by the Appropriations subcommittee is simply setting back a fusion timetable that the scientific community agrees should be accelerated.

If the Buchsbaum review recommends to the DOE Energy Research Advisory Board that the fusion program should be accelerated, the DOE can submit a supplemental budget request for fiscal year 1981. In the meanwhile, however, the fusion program will not have the funds it needs, and at least six months will be lost on the Engineering Test Facility, as well as other projects in progress.



NASA

An artist's depiction of Solar Polar spacecraft cruising past Jupiter en route to the Sun's poles. Jupiter's gravity provides a boost toward the Sun for Solar Polar and is also a subject for study for many of the instruments on board.

Appropriations Ctte. Terminates NASA Solar Polar Mission

The House Appropriations Committee voted May 9 to terminate the Solar Polar Mission, one of the most important scientific projects remaining under the National Aeronautics and Space Administration (NASA). NASA had already postponed the launch date of the two-satellite project from 1983 to 1985, in an attempt to meet the committee's requirement that the agency "balance its budget."

The committee cut all the mission's funding in the 1980 supplemental budget, which, in effect, immediately ends the program.

Committee member Edward Boland (D-Mass.) said that the committee took its action because "NASA didn't cancel anything in the budget squeeze, it just deferred a few things." Earlier in the week, another congressional appropriations subcommittee cut $60 million from the committee's fiscal year 1981 authorization for magnetic fusion research, giving similar reasons.

The Solar Polar Mission involves simultaneously launching two satellites in opposite directions that will go over the poles of the earth and then orbit the sun from opposite directions, providing unique measurements of the sun's magnetic fields and other phenomena.

A $320 million project, the Solar Polar Mission is a joint undertaking with the European Space Agency (ESA), which is paying for one-half the mission's total cost. In a strongly worded letter of protest to NASA Administrator Robert Frosch, ESA executive director Roy Gibson explained that the Europeans had already spent $30 million to design one of the two spacecraft and instruments required for the experiment.

According to NASA spokesmen, protest letters have also been received from West Germany, Great Britain, France, Belgium, and Italy, all of which were to participate in the mission. The Europeans now consider NASA an "unreliable partner" in cooperative programs. At stake, NASA officials fear, is not only the specific project the subcommittee has canceled and the loss of important data, but further "downstream" NASA-ESA collaboration.

In his letter to Frosch, ESA head Gibson indicated that the program's cancellation would eliminate 25 percent of Europe's space efforts for the next three years; ESA would suffer not only an immediate loss of $30 million, but also an ultimate loss of $80 million, Gibson said. This is the first time an international space program has been canceled by the default of one of the partners.

Reportedly both the State Department and President Carter's science advisor Dr. Frank Press are concerned about the diplomatic repercussions of the congressional action. One NASA official commented that it appeared some people were trying to make the United States "pull in its tentacles and become a Dark Age society." He recommended that Americans write protest letters directly to President Carter and to House Appropriations subcommittee chairman Boland (see box, page 23).

McCormack Readies Fight For Fusion Bill

Congressman Mike McCormack (D-Wash.) has decided to retain the fusion advisory panel to the Subcommittee on Energy Research and Production of the House Science and Technology Committee, which he commissioned last year as subcommittee chairman. The panel, chaired by the former head of the U.S. magnetic confinement program, Dr. Robert Hirsch, is expected to keep open the possibility of placing before both the House and the Senate the fusion bill McCormack introduced in January, HR 6308.

The bill, cosponsored by more than 150 congressmen, would give the fusion program a national mandate along the lines of the Apollo program to achieve a working fusion reactor before the year 2000.

The Hirsch panel will hear presentations by the DOE fusion office and other fusion experts May 19 on the critical question of the fusion Engineering Test Facility. The ETF is a key part of the $20 billion Apollo-style fusion development bill.

Carter's Fusion Commitment

Just a week before the House Appropriations Committee slashed the FY81 fusion budget, Congressman McCormack wrote a letter to all the members of the House that included copies of McCormack's letter on fusion to President Carter and Carter's April 22 reply. "In view of the great urgency of this matter—fusion energy is clearly the most important energy source for mankind for as far as we can see or imagine into the future—I am reporting the president's statement to you at this time," McCormack wrote.

In his reply, President Carter said: "I strongly support the development of a technology that offers such hope for meeting future energy needs. . . . The administration is committed to the fusion option. . . ." However, Carter

Continued on page 78

Congressional Line-up

Rep. Whitten

Rep. Bevill

Rep. Boland

Sen. Jackson

What Readers Can Do

This issue's Washington section reports on critical cuts in the fusion and NASA budgets.

Your letters count. Write to President Carter, your congressman, and your senator to protest the cuts in the fusion and NASA budgets. Here are some specific congressional targets. All addresses are Washington, D.C. 20515, unless otherwise noted.

Fusion Budget

Rep. Jamie Whitten (D-Miss.), chairman, House Appropriations Committee, 2314 Rayburn.

Rep. Tom Bevill (D-Ala.), chairman, Subcommittee on Energy and Water, House Appropriations Committee, 2305 Rayburn.

Sen. Henry Jackson (D-Wash.), chairman, Senate Energy Committee, 137 Russell, Senate Office Building, Washington, D.C. 20510.

NASA's Solar Polar Mission

Rep. Jamie Whitten (see above).

Rep. Edward Boland (D-Mass.), chairman, Subcommittee on Independent Agencies, House Appropriations Committee, 2426 Rayburn.

Support the Nuclear Waste Legislation

We recommend support for the nuclear waste legislation proposed by *Rep. Barry Goldwater, Jr.* (R-Calif.). Write him at 2240 Rayburn. For details on the nuclear waste bill, see page 51.

Three Mile Island: The Fight Continues

"I agree with the Union of Concerned Scientists' feeling that 'stress' should be a consideration in this decision. . . ." —Pennsylvania Governor Dick Thornburgh in a letter to the editor of the New York Times *May 27, 1980. Above: Gov. Thornburgh and an artist's depiction of one of the TMI venting devices suggested by the Union of Concerned Scientists.*

Pennsylvania Governor Dick Thornburgh had no choice but to give approval to the venting of krypton gas from the Three Mile Island Unit 2 containment building May 18, when the antinuclear Union of Concerned Scientists reported the truth—that the venting would cause no danger. Thornburgh had sought the opinion of the environmentalist group in April before making his decision, although three previous evaluations—including one by the governor's own Blue Ribbon Commission on TMI—had recommended venting the gas as quickly as possible.

"I am now persuaded that the plan is now a safe one," the governor said.

In the first stage of the venting, two engineers from Metropolitan Edison, which operates the nuclear plant, began to enter the containment building May 20, but were foiled by the inner door from the airlock to the building, which had corroded shut.

UCS a Laughingstock

The Union of Concerned Scientists, which assumes leadership for the professional wing of the environmentalist movement, made itself a laughingstock by reporting to the governor that although the venting posed no physical danger, it would be unbearable to the 20 percent of local residents who allegedly had been psychologically damaged by the 1979 TMI incident. To ease this psychological

Continued on page 67

Put TMI Back on Line

The following comments are from a Fusion *interview with David Walls, executive vice president of the Lebanon, Pa. Chamber of Commerce.*

"We want to get TMI Unit 1 back on line. There is an ever-increasing burden on the business community—that's the way we've described it to anyone who will listen. It costs $280,000 per month for Metropolitan Edison to purchase the power that substitutes for Unit 1.

"We brought in Harold Denton of the Nuclear Regulatory Commission to make our case to him. We held one town meeting on the issue. We've met with the City Council. . . . We've spoken with NRC officials and the NRC representative for TMI. We expressed our concern only one week after the accident."

"On the krypton venting, as I say, we're not experts. The way we've stated the matter is that the experts have stated it is safe; therefore, it should be done. They've made that decision. So it should be done. In our view, too many lay people are meddling in this, and none of them are bothering to get the facts.

"Here's what we plan to do. The problem we face is that local officials say it's an NRC problem, and the NRC says it's a Pennsylvania problem. We have been discussing that one thing that might get TMI Unit 1 back on line is to put all the Chambers of Commerce in the Metropolitan Edison service region together in a meeting for the specific purpose of developing some plan of action. . . .

"We are also going to make our case to the national Chamber of Commerce. We're not scientists. But we want to make sure they know the business facts—the impact of putting this plant out of business—which are devastating. If the NRC sends us to the state, and the state sends us back to Washington, at least the national organization has more influence on both.

"We are aware that the electrical workers, at least locally, have taken a very similar position on Unit 1. I am aware that the unions in Philadelphia have taken a very similar position. The building trades take the same point of view."

Four men who did not subscribe to

EIR

Executive Intelligence Review

Lee Iacocca, *Chairman of the near-bankrupt Chrysler Corporation*

Robert Abboud, *ousted Chairman of the First National Bank of Chicago*

Frank Fitzsimmons, *beleaguered President of the Teamsters union*

Robert Dole, *unsuccessful Republican candidate for President*

and missed out on what EIR readers knew—

- **Volcker's October credit policy** would lift inflation to 20% and push major banks toward the brink of bankruptcy.
- **Volcker's policy** would also strangle the industrial sector, starting with auto and steel.
- **the deregulation of trucking** would be rammed through the Senate— its passage will cost the U.S. economy more than the Vietnam war, not to mention thousands of Teamster jobs.
- **the Trilateral Commission** would rig the Presidential primary process to eliminate any candidates it couldn't control.

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F1

The Tandem Mirror Fusion Machine

Getting Closer to Commercial Fusion

by Charles B. Stevens

A REVIEW BY LEADING U.S. fusion scientists for the Department of Energy recently confirmed the most significant general advances in the worldwide effort to harness the unlimited potential of thermonuclear fusion reactions since the development of the mainline experimental magnetic fusion system, the tokamak.[1] This is the tandem mirror approach, chiefly developed at the Lawrence Livermore Laboratory in Livermore, California.

The Mirror Senior Review Panel, composed of leading figures from every area of the U.S. fusion research effort, reported that the Livermore Tandem Mirror Experiment (TMX) has produced results three times better than expected in terms of density, temperature, and confinement time, the three main parameters in measuring fusion progress. Most important, the panel concluded that the principles of the tandem mirror approach work. The experimental results and the panel's conclusion confirm the most optimistic prognosis of the scientific and technological prospects for the Livermore system.[2]

What is most significant about the panel's conclusions is its assertion that theoretical work across the spectrum in plasma physics has sufficiently advanced in the last five years to indicate that additional modifications in the tandem mirror configuration could dramatically ease the process of developing a practical fusion reactor technology.

This does not mean that the tandem mirror is about to replace the tokamak as the "front runner" in the effort to develop fusion electric power plants by the 1990s. But the tandem mirror breakthrough guarantees that economically and technologically practical fusion energy systems can be developed before the turn of this century. The tandem mirror also epitomizes the rapid progress that would be possible if the fusion research program were accelerated.

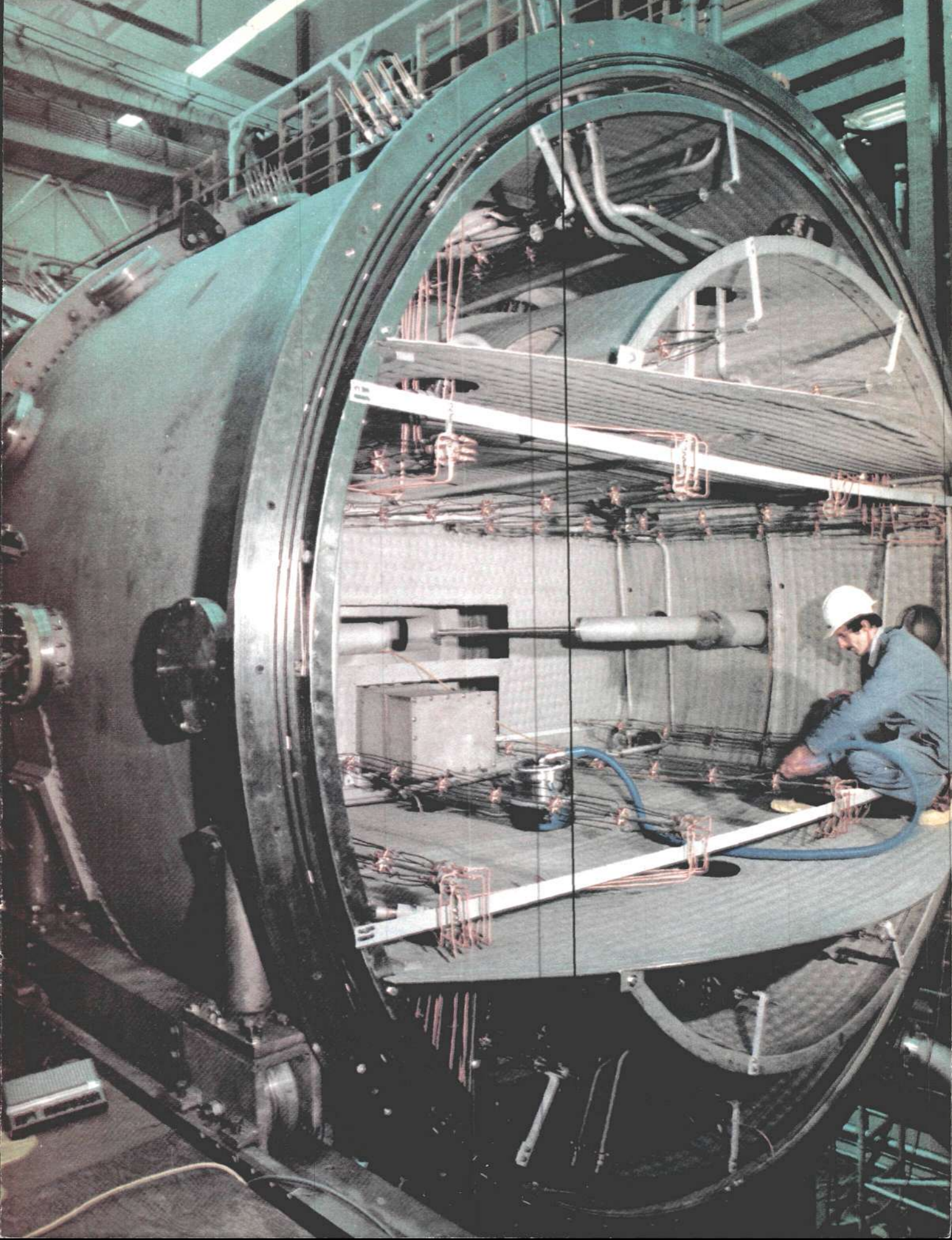
As the Mirror Senior Review panel noted, the fact that the tandem program is at this point limited to only one major experiment, Livermore's TMX (whereas scores of major experiments are currently being carried out throughout the world on the donut-shaped tokamak), is the principal roadblock to rapid progress in the tandem area. One reason for this is the undramatic manner in which the tandem's development has been achieved.

Although the tandem advance is equivalent in merit to the Princeton PLT tokamak breakthrough in the summer of 1978—reaching the 80-million degree Celsius temperatures needed for ignition of fusion reactions using neutral-beam heaters—the tandem advance is not similarly reflected in any single experimental result or theoretical insight. The maturation of the mirror concept is the result of almost three decades of determined research and hard work by scientists at Livermore.

Despite the fact that there is only a single major experiment, the panel has established that reactor-grade plasmas could be achieved in a tandem mirror within the next several years, if the panel's recommendations for broadening the mirror effort and completing key facilities now under construction at Livermore are implemented.

Technician John Evans at Lawrence Livermore Laboratory vacuums dust inside the tandem mirror machine during final cleanup before operation.

Photo by David Proffitt, courtesy of LLL



The panel unanimously proposed that the mirror effort be rapidly expanded and the green light be given for Lawrence Livermore's proposed $125 million Mirror Fusion Test Facility-B. The MFTF-B, which could be completed by 1983, promises to quickly generate the physical conditions needed for reactor-grade plasmas in a tandem configuration. Furthermore, the technology involved in the MFTF-B is not far removed from that required for actual future power plants.

How the Mirror Works

The simple magnetic mirror is based on the same type of magnetic confinement of plasma encountered in the earth's magnetosphere and in astrophysics. Given a magnetic field with two points of increased intensity, a plasma would tend to be trapped between the two points (Figure 1).

The individual plasma electrons and ions are trapped into spiral orbits along the magnetic field lines. When they approach the region of increased magnetic field intensity, they are "reflected" back in the opposite direction.

Some plasma particles, if they have their velocities directed nearly along the magnetic field lines, are lost in this process, primarily the lighter electrons. These are called end losses. The simple mirror configuration has so many end losses, in fact, that it is doubtful that it could ever go much beyond simple fusion energy breakeven (producing as much energy as it takes to get the reaction started).

For this reason, various modifications of the simple mirror system have been proposed to permit the significant energy gains necessary to make mirror system power plants economical and technologically practical (Figure 2). The tandem mirror system is the most promising modification to date.

The tandem mirror was developed independently by U.S. researchers at Lawrence Livermore and by Soviet scientists in Novosibirsk, Siberia. As can be seen in Figure 2, the tandem system uses two magnetic mirrors to trap a cylindrical plasma in a straight magnetic field with one mirror system placed at each end of the cylindrical plasma.

In a simple or standard mirror, the electrons escape out the ends at a greater rate than ions do. This causes a positive electrical charge to develop. The tandem system makes use of this positive potential to confine (end plug) the cylindrical plasma.

In a reactor, the large cylindrical plasmas would generate all of the fusion energy, while the mirror end plugs would operate with mostly nonreacting hydrogen. In this way, only the cheap and easily constructed cylindrical solenoid would be exposed to the fusion environment.

Among the further modifications in the tandem mirror now recommended by the Senior Review Panel are the introduction of an ignited fusion plasma and operation with the advanced fusion (all-deuterium) fuel cycle. Experimental results have made both appear quite possible.

An ignited system means that the primary energy for maintaining the fusion plasma at multi-hundred-million degree temperatures needed for fusion reactions comes from the fusion reactions themselves, rather than from costly external heating systems like neutral beams and microwave generators. The possibility of using the more advanced all-deuterium reaction rests on the fact that the tandem could efficiently attain the extremely high ignition temperatures needed for this reaction: multi-hundred-million degrees, as opposed to the hundred-million degree temperatures needed for the deuterium-tritium re-

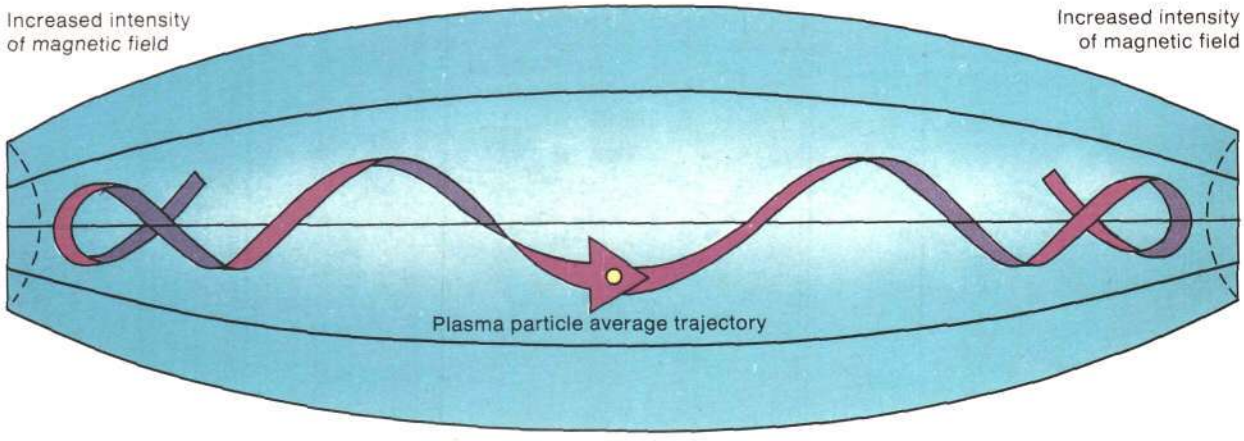


Figure 1
SIMPLE MAGNETIC MIRROR CONFINEMENT

A hot plasma is generated within a straight, open-ended magnetic field configuration. In this simple magnetic mirror, the magnetic field intensity is increased at two points. The electrically charged particles interact with the magnetic field in such a way that some of them are trapped between the points of increased magnetic intensity. The trajectory of a trapped particle is that of a spiral, as shown. If the ratio of the plasma particle's circular motion to its horizontal motion is sufficiently great, it will be "reflected" back into the regions of intense magnetic field.

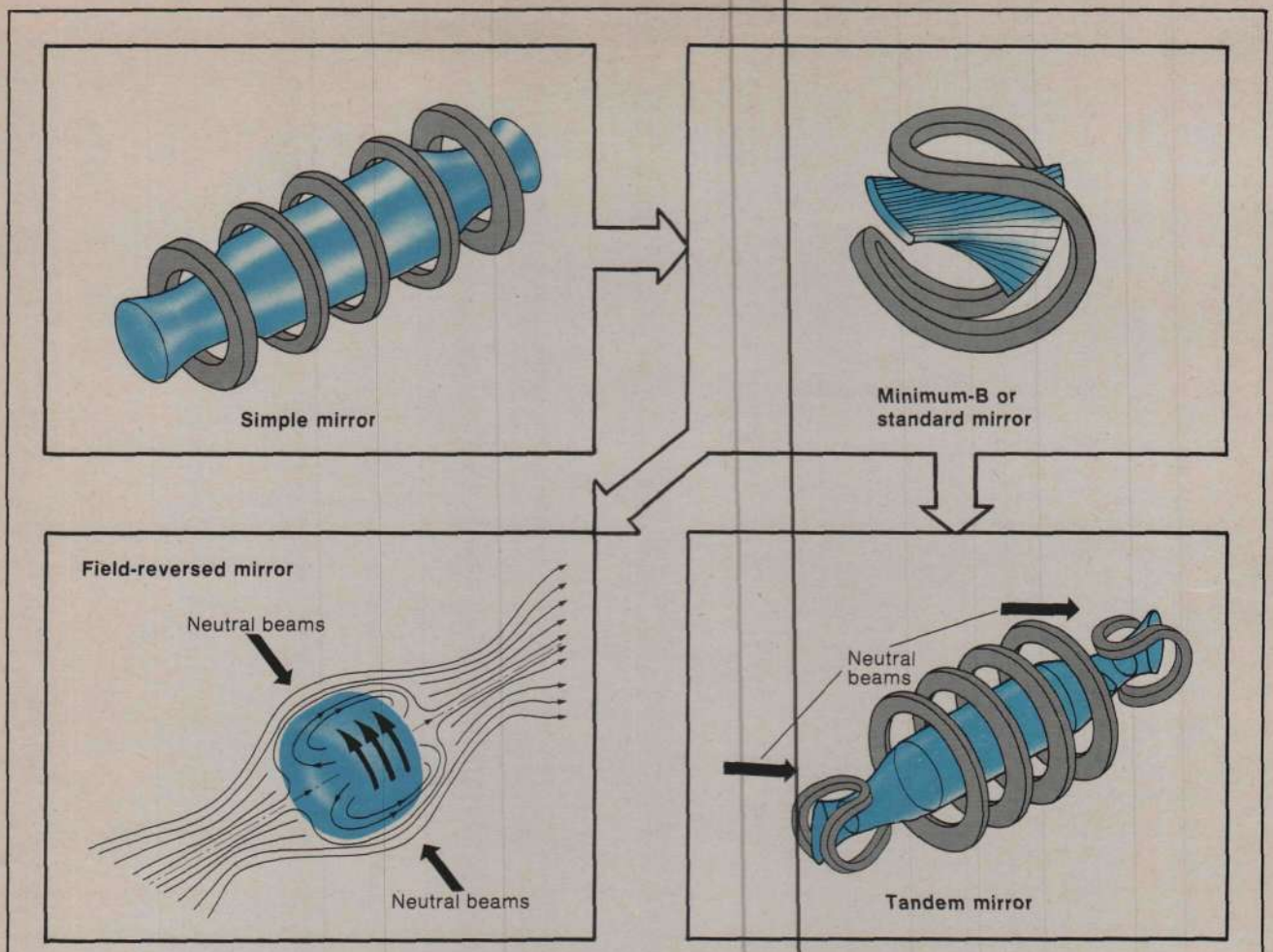


Figure 2
DEVELOPMENT OF MIRROR FUSION CONCEPTS

The early simple mirror magnetic field geometry was subject to macroscopic magnetohydrodynamic instability and was replaced by the minimum-B mirror, now called the standard mirror. (This configuration is also known as the baseball mirror, because the magnetic field coil shape for this configuration is like the seam of a baseball.) In the standard mirror machine, the magnetic field strength increases in all directions from the machine's geometric center, where the plasma is stably trapped. However, some plasma still escapes out the open ends of this standard mirror. And because of this the ratio of fusion power generated to the power of the neutral beams used to maintain the plasma at fusion temperatures, a ratio known as Q, is quite low for standard mirrors. With the theoretically maximum confinements a Q slightly greater than 1 is the best that can be expected. Furthermore the standard mirror could never achieve an ignited thermonuclear plasma—a situation in which internally generated fusion energy is trapped within the burning fuel to an extent that is sufficient to maintain the fuel at fusion temperatures.

For these reasons Lawrence Livermore researchers are working on two new mirror configurations that have the potential for better confinement of thermonuclear plasmas (and, therefore, higher Q). The more speculative design is the field-reversed mirror in which an induced plasma electric current causes the magnetic field lines of the mirror to close so that a donut-shaped plasma is formed. The more promising approach is the tandem mirror, discussed at more length in the text. The tandem concept was developed independently at Novosibirsk in the Soviet Union in 1975 and at Lawrence Livermore. The tandem, as shown, is similar to the initial simple mirror design and has many of the same benefits of technological simplicity. In the tandem, a standard minimum-B mirror cell is placed at each end of a long cylindrical solenoidal cell. The solenoidal plasma is thus "end-plugged" by two standard mirrors. In the minimum-B mirrors, when plasma electrons escape out the ends before the plasma ions do, a large positive electric charge is generated. This electric potential of the two end-cell plasmas then electrostatically confines the plasma in the solenoid.

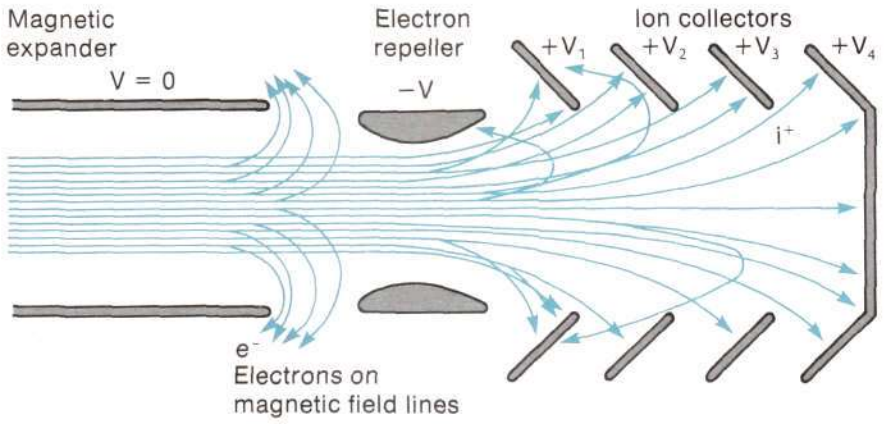


Figure 3
SCHEMATIC OF DIRECT CONVERTER FOR MIRROR FUSION OUTPUT

In this Lawrence Livermore design, the trajectories of escaping fusion plasma ions (i) and electrons (e-) from a tandem mirror are shown as arrowed lines. A mirror fusion plasma (at far left, not shown) is the source for these high-speed electrical particles. A magnetic field directs the plasma particles to the direct converter and simultaneously expands their flow. A kink in the directing magnetic field siphons off most of the electrons, but only slightly perturbs the ion trajectories. Negative electrodes (−V) turn back the remaining electrons. Space charge generated by the absence of electrons rapidly blows up the ion beam, which then collides with the positively charged (+V) electrodes that are collecting ions. Voltages on the collecting electrodes are adjusted for optimum power output, depending on the ion energy distribution.

The direct converter will provide about one-half of the gross electrical output of a deuterium-tritium mirror reactor, and even more for an advanced all-deuterium reactor.

action. More of the fusion energy would be in the form of high-energy ions at this temperature and, therefore, amenable to direct conversion to electricity—the inherent advantage of the tandem mirror design (described below). To neutralize the flow of ions out the mirror end cells, electric plates at the proper voltage are used to collect the high-energy ions.

The reason for the tandem's high-temperature capacity is that it appears capable of so-called classical confinement of fusion plasmas. This type of confinement is distinguished by the fact that the efficiency of confinement (and, therefore, the maintenance of fusion conditions) *increases* with increasing temperature, the opposite of what has generally been encountered in magnetic fusion experiments.

To dramatically improve the tandem's projected scientific and technological prospects, researchers have proposed the use of microwave and neutral-beam injection to tailor the end-cell plasma temperature and density profiles and the addition of a second set of mirror end cells. As the panel noted, this proposal can be experimentally checked by modifying the present Livermore TMX.

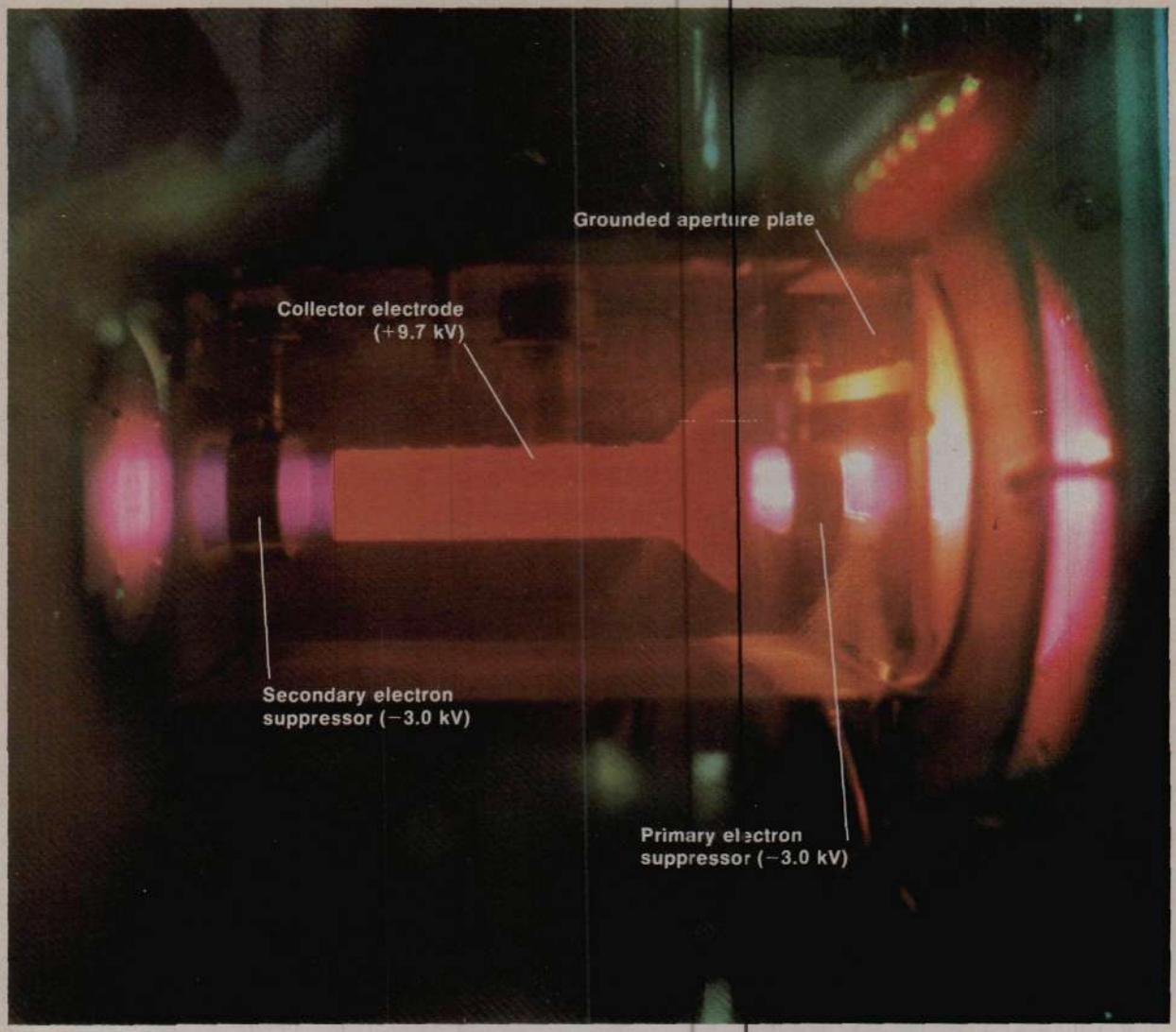
Direct Conversion

Imagine a fusion energy plant whose primary electric power output is derived directly from a thermonuclear plasma without the need of turbines, generators, or a switchyard. Electrical power is obtained by *direct conversion* (at 80 percent efficiencies) from the charged particles making up the reacting plasma. This direct conversion will be possible in a tandem mirror fusion reactor because more than 50 percent of the energy output generated by the high-temperature all-deuterium fusion reaction cycle is in the form of charged particles—ions.

The other 50 percent of the energy output of this fusion plant would occur in the form of electrically neutral, high-energy neutrons that could be used simultaneously to generate fuel for conventional nuclear fission reactors. This would be enough fuel to run all the nuclear fission reactors currently operating in the United States—more than fifty 1,000-megawatt power plants.

The scale of this imaginary fusion-fission power plant is not much larger than that of the conventional fission reactor, about 4,000 megawatts total thermal energy output. But its electrical output would be much greater, because of the improved efficiency of combining direct conversion with ordinary thermal-turbine cycles: about 1,500 megawatts-electric—enough to run a city of 1.5 million.

All of the energy released in fusion reactions is carried by high-speed particles: neutrons, helium ions, and escaping fuel ions. The neutrons simply leave the reacting plasma; most of their energy is recoverable only as heat in a surrounding blanket. The ions, on the other hand,



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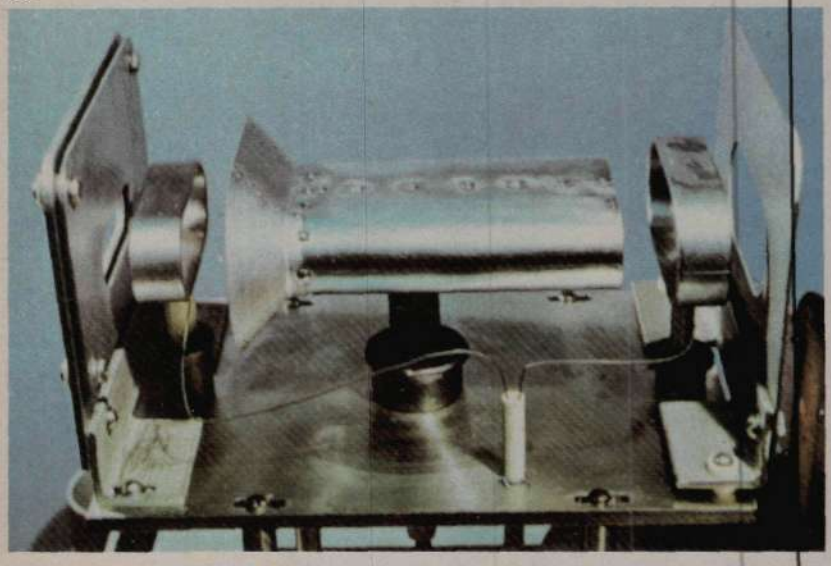


Figure 4
EXPERIMENTAL DIRECT CONVERTER FOR NEUTRAL BEAM HEATERS

These are two views of an experimental direct converter that scavenges ions from a neutral beam heater in order to improve its efficiency. Above, the converter is in operation; below, it is shown dismantled and turned upside down for inspection.

The converter first strips away electrons, making the ions diverge out of the beam by their own mutual repulsion, forcing them to expand most of their kinetic energy against a positive potential gradient.

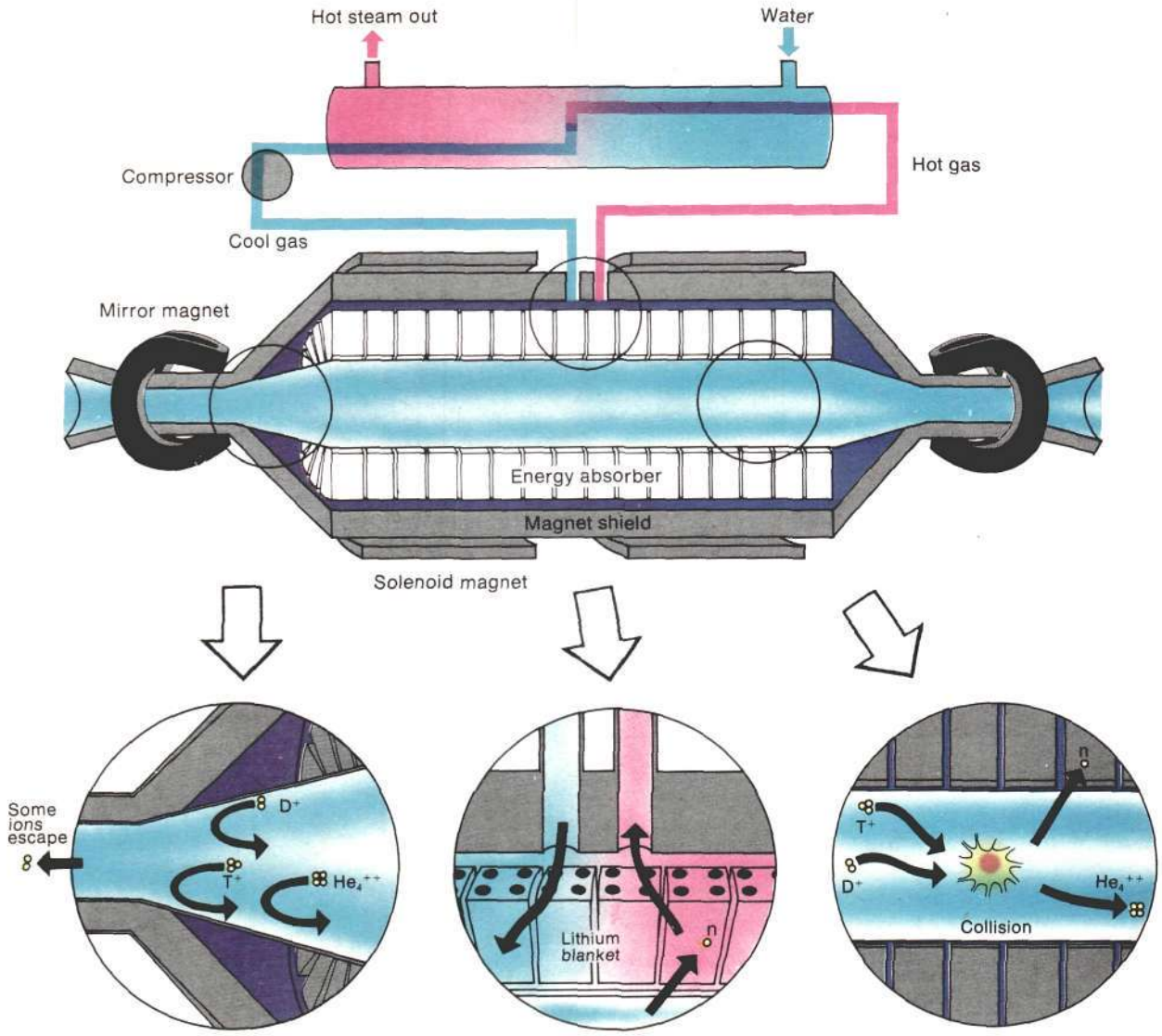


Figure 5
TANDEM MIRROR REACTOR: A DETAILED VIEW

Shown here is a schematic of a tandem mirror reactor design with three detailed views of the fusion process. Deuterium (D) and tritium (T) fuel ions are confined in the center of the reactor, enhanced by the electrostatic stoppering of the end plasmas. The fusion process produces neutrons (n) and alpha particles, helium (H_4). The neutrons enter the lithium blanket and react to produce more tritium, which is recycled as fusion fuel, while the thermal energy of the blanket produces steam that is used, in turn, to produce electricity. The energy of the charged particles that leaks out the ends is recovered by direct energy converters.

In the lower left detailed view, most fusion plasma ions are confined but some escape out the ends of the standard mirror end cell to the expander-direct converter tank (see Figure 6 for an overall view of the reactor).

The detail in the center shows the gas-cooled wall of the fusion reactor chamber of the solenoid. Fusion neutrons penetrate the wall and are stopped in a blanket containing lithium. Nuclear reactions between the neutrons and the lithium lead to the generation of tritium fusion fuel. The heat generated in this process is removed by flowing gas. In a fission-fusion hybrid, blankets of uranium-238 or thorium would be added to the reactor chamber wall.

To generate fission fuel, the lower right detail shows how the reacting deuterium, D, and tritium, T, and their product helium-4, He_4, are confined along the straight magnetic field lines in the solenoid center cell, while neutrons, n, escape.

can be manipulated because they have electrical charge. Direct converters can convert the kinetic energy of those ions that escape from the reaction into useful electrical power. In addition, the efficiency of neutral-beam heaters can be nearly doubled with direct converters to recover energy from unneutralized ions.

Figure 3 shows how a direct converter works. High-speed charged particles escaping from a fusion plasma (at the left of the diagram) are directed along a magnetic field that spreads out the flow of these particles. A kink in this directing magnetic field, together with a negative electrode, siphons off the electrons, while producing only slight perturbation in the motion of the much heavier ions. The removal of the charge-balancing electrons generates a large electric field and the ion beam rapidly expands. The ions then collide with appropriately placed electrodes, which then generate an electric current. These electrodes are maintained at positive voltages close to that of the fusion plasma ions intersecting them. In this way the generation of waste heat is avoided and the ion energy is efficiently converted into electricity. (An experimental direct converter for neutral beams is shown in Figure 4.)

Direct converter technology has been experimentally demonstrated up to nearly reactor-grade levels at Lawrence Livermore. Ion beams at tens of thousands of volts and power levels of several kilowatts have been directly converted to electric current at 70 percent overall efficiencies. Livermore researchers report that there are no significant barriers to achieving full-scale reactor levels at more than 80 percent conversion efficiencies, given the resources to do it.

Moreover, the economics of direct converters are quite good. Adding direct converters to a reactor for an additional kilowatt of electric power output would cost on the order of several hundred dollars. This is only a fraction of the capital cost for a thermal-cycle generated electric kilowatt.

Schematics of a tandem mirror fusion reactor with direct conversion to electricity are shown in Figures 5 and 6.

The Tandem Mirror Hybrid

In addition to the advantages of direct conversion, the tandem fusion reactor will work well as a breeder of fission fuel. The Lawrence Livermore team is working out the design and economics of such a fusion-fission hybrid, which I shall briefly summarize here.[3]

The fusion-fission hybrid is a combination of the fusion and fission processes having complementary features. The idea is to surround a fusion reaction region (in this case, the cylindrical part of the tandem mirror) with fertile materials (uranium or thorium) to allow the fusion-produced neutrons to convert fertile Th-232 or U-238 to fissile U-233 or Pu-239 by transmutation. This fissile material, after appropriate processing, can be fed into a fission reactor, releasing more energy than that generated by fusion (Figure 7).

The fusion process releases 17.6 MeV (MeV equals 1 million electron volts) and one neutron per fusion event. Thus, a fusion reactor produces a large number of neutrons per unit of energy, and with modest neutron multiplication in the blanket surrounding the fusion reaction can produce large quantities of fuel via its extra neutrons.

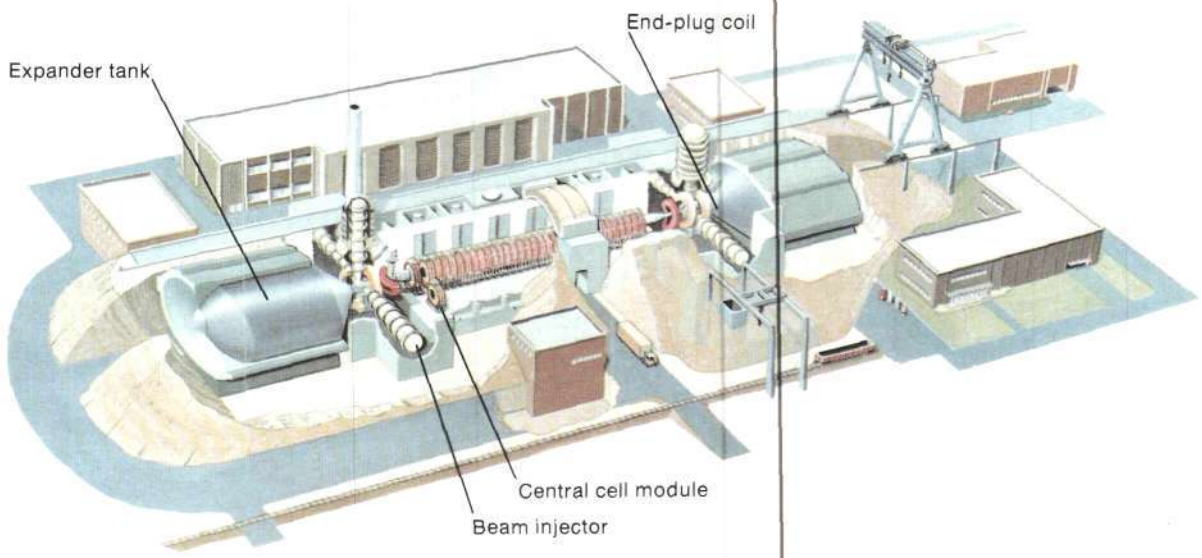


Figure 6
TANDEM MIRROR REACTOR: CUTAWAY VIEW

In this cutaway view of a tandem mirror reactor, the central cell is 100 meters long. Continuous neutral beam injection maintains the end-plug plasmas. Plasma leakage from the end plugs is guided magnetically into expander tanks containing direct converters. Among the advantages of this construction are the modular design of the first wall of the reactor, the blanket, and the solenoid magnet, which makes maintenance and replacement more efficient.

These features complement the fission reactor's characteristics of producing a large amount of energy per fission event (200 MeV) but relatively few neutrons, so that fuel breeding is difficult to achieve. As the Livermore work-in-progress report notes, "It has been said that fission is 'energy-rich but neutron poor,' while fusion is 'neutron-rich but energy-poor.' These characteristics are complementary and appear to fit together nicely in one hybrid concept."

Although commercial fusion reactors are still some distance away, the hybrid can be developed with fusion technology that is almost here, because the requirements for the fusion part of the hybrid are less demanding than for a pure fusion power producer.[4] As the Lawrence Livermore report put it: "The prospect for a fusion reactor to be developed to the required hybrid performance is quite good. . . . The introduction of new capacity is much easier than it is for the fission breeder because the hybrid requires no initial fissile inventory."

The hybrid plant (shown in part in Figure 8) is composed of two distinct functional parts: the cylindrical section, where fuel breeding is the main function, and the end plug region, where fusion plasma confinement, heating, refueling, and dumping take place. The fusion reaction occurs along the magnetically confined plasma column, 1 meter in diameter, that emits neutrons essentially as a line source. The breeding blanket surrounds this line source of neutrons.

The power level has been set at 4,000 megawatts of nuclear power. Because some blanket types release more energy in the breeding reactions than others, the fusion power varies from a low of 500 megawatts to 2,500 megawatts, and the length of the central section of the plant will vary to accommodate the power levels. The layout of the plant, according to the Lawrence Livermore report, is expected to change considerably, depending on the coolant selection and the detailed blanket design. Blanket designs under consideration are characterized by their geometric shape (pancakes or tubes), their fuel form (solid or liquid), and the coolant used (helium, water, steam, liquid metal, and molten salt).

In the next year, the Livermore team intends to integrate the individual components and systems into an overall plant design. For example, beams, magnets, shields, and heat removal and auxiliary systems must be fitted together. The blanket/fuel system and the coolant piping and auxiliary systems will dictate the building size laterally. The blanket, end plug, and direct converter will size the building longitudinally.

Given the Department of Energy's current timetables, a commercial demonstration hybrid reactor could be in operation in the mid-1990s. With an aggressive program, however, this time scale could be significantly accelerated so that a demonstration reactor might be on line by about 1990. A year ago, in fact, before the latest results on the tandem mirror were known, Edward Teller forecast that his brute force tandem mirror hybrid could be ready for commercial introduction in 15 years.

Charles B. Stevens is the fusion technology editor for Fusion *magazine and directs the fusion engineering research program of the Fusion Energy Foundation.*

Notes

1. The Mirror Senior Review Panel report has not yet been made public.
2. For a more detailed report on mirror progress, see the author's "The Magnetic Mirror Approach to Fusion Energy," *Fusion*, May 1979, pp. 32-39.
3. The full report by Lawrence Livermore Laboratory, "Interim Report on the Tandem Mirror Hybrid Design Study," edited by R.W. Moir, was published Aug. 1, 1979.
4. For a comprehensive view of the hybrid, see John Schoonover, "The Fusion-Fission Hybrid—Fuel Factory for Nuclear Power," *Fusion*, Jan. 1979, pp. 18-26.

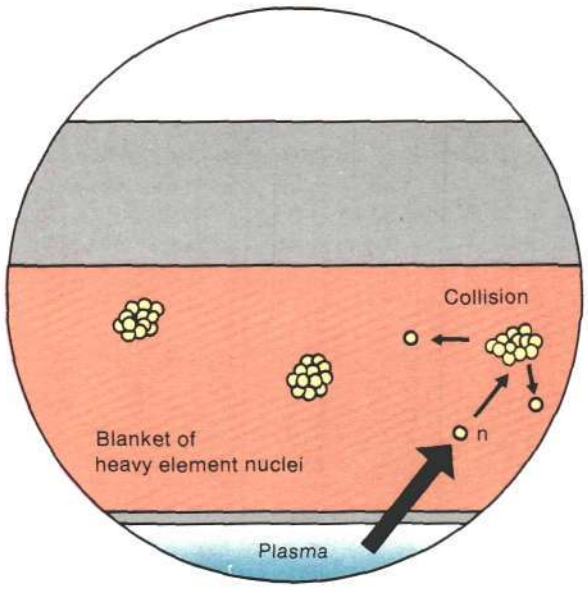


Figure 7
SIMPLE FUSION-FISSION HYBRID SCHEMATIC
This simplified cross-section of a fusion-fission hybrid reactor shows the neutron product of the fusion reaction. This electrically neutral, high energy neutron readily escapes from the fusion plasma, penetrating the walls of the surrounding chamber. Appropriate heavy elements, such as uranium-238 or thorium-232, are placed in this surrounding wall, called a blanket. The fusion-generated neutron collides with the nuclei of these heavy elements and either generates fission reactions or is absorbed by the heavy nuclei. This leads to the generation of fissionable nuclei, that is, fission fuel. One tandem hybrid of less than 1,000 megawatts electric output could supply sufficient fission fuel to keep 10 to 15 1,000-megawatt electric conventional fission power plants fueled on an annual basis. An all-deuterium tandem hybrid could support up to 50 fission reactors annually.

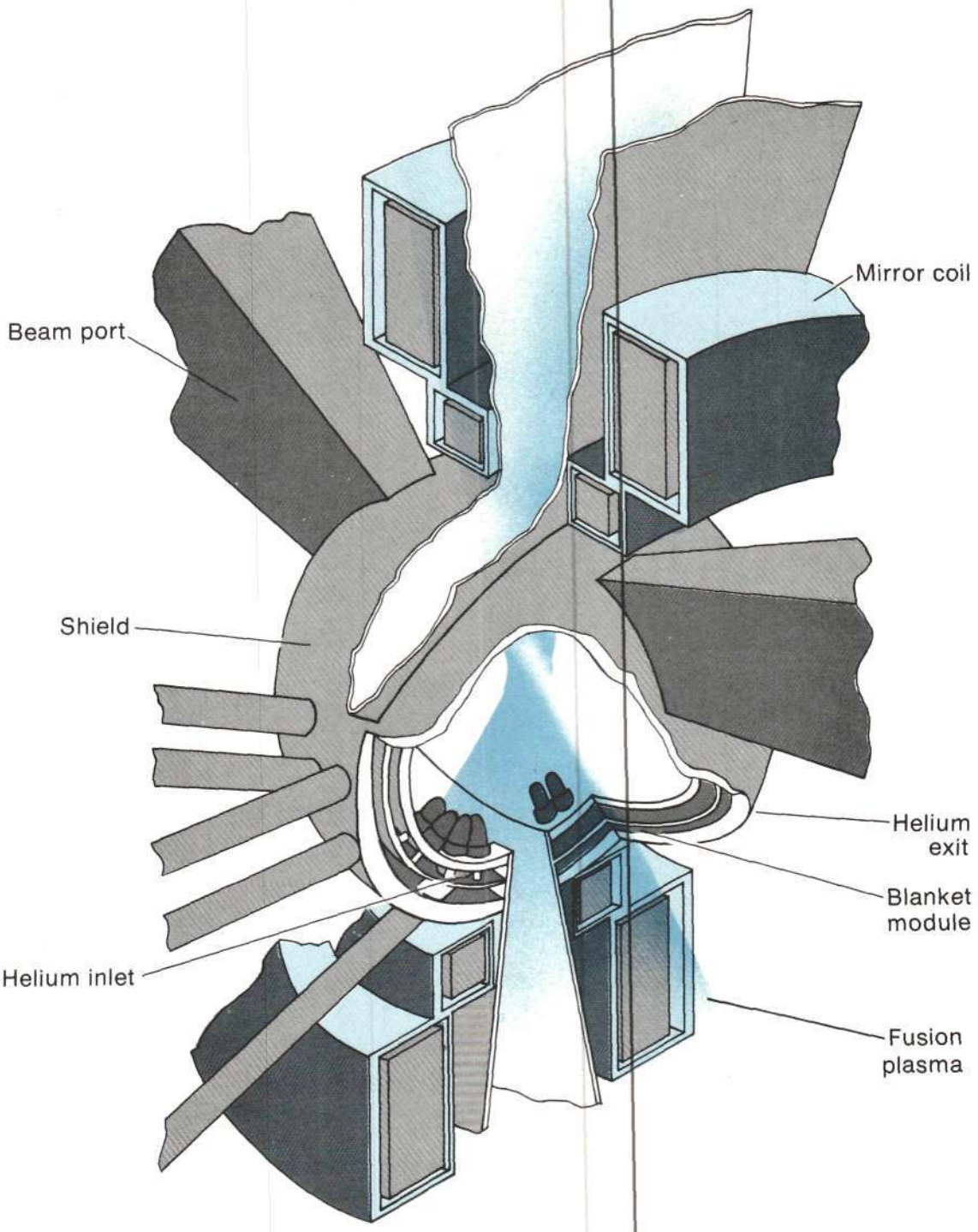


Figure 8
CUTAWAY VIEW OF HYBRID REACTOR BLANKET AND SHIELD

The blanket for this standard mirror fusion-fission hybrid reactor is suspended from the inside wall of the prestressed concrete reactor vessel about 50 centimeters in diameter. It consists of 600 cyclindrical modules. To avoid any major disruption in operations, a refueling machine would replace the models in one-fourth of the blanket every quarter of blanket life. This machine consists of a post inserted down the center of the reactor with a pivoting arm to operate on the modules.

How France Took the

IMAGINE A COUNTRY the size of Texas, with one-fifth the population of the United States, that began its modern industrial development relatively late. Imagine that this same country is now taking the world lead, ahead of the United States, in developing a crash nuclear program, with a complete nuclear fuel cycle. And that this program will supply 80 percent of the next generation's electricity consumption.

How did France do it—and why is the United States lagging behind? The answer to both questions can be seen from the current scope of the French program and its political history.

Since 1974, when France's program was launched under then prime minister Pierre Messmer, construction has been started on thirty 900-megawatt plants and eleven 1,300-megawatt plants. There are more than 20 nuclear plants in operation today, with another 27 under various phases of construction, including 6 that will come on line this year (Figure 1 and table).

Unlike President Carter's empty phrases about taking on the energy problem as "the moral equivalent of war," the French have pursued their nuclear energy objectives with a determination on the state level that can be compared only to France's first efforts to achieve independent national security. Indeed, it is not only to ensure energy independence from the oil-producing countries and the United States that France has relentlessly pursued its nuclear program over the years. As President Giscard d'Estaing has often emphasized with his partners in the developing-sector countries, the nuclear program is critical because there can be no national security without economic development.

And again, unlike the U.S. program, not only has there been no downward revision of the original 1974 plan, but under the Giscard government the program has been revised to bring France to the turn of the century and beyond. When the Messmer plan was first launched, less than 10 percent of electricity consumed in France came from nuclear power plants. This year nuclear production reached the threshold stage for takeoff, since most of the plants commissioned in the 1974 program will be on line in 1980. The amount of nuclear-produced electricity will climb to 24 percent by the end of the year and then shoot up to nearly 60 percent within the next five years (Figure 2).

Perhaps most telling, while the Three Mile Island scare story was on the front page of every major newspaper in the world, French Minister of Industry André Giraud announced April 4, 1979, that the French nuclear program was accelerating, with construction to begin in 1980 and 1981 for nine or ten new reactors with a combined capacity of 10,500 megawatts.

Furthermore, the French have aggressively pursued a policy of exporting nuclear technology—in joint projects with other European nations as well as in bilateral deals with developing nations.

A Dirigist Policy

The French nuclear program is implemented from the top down. Starting with the president and the government setting the targets, there is an array of state-controlled institutions or companies that benefit from a de facto special status and take charge of carrying out the different phases of the program.

On several occasions President Giscard has talked at length to the French people—57 percent of whom fully support the program, according to recent polls—about the government's decisions. In a detailed interview over Europe No. 1 radio station Jan. 18, 1980, Giscard answered his own rhetorical question "Why nuclear electricity?" in the following terms:

> At the present time there is no other readily available technology. There won't be for another 20 or 30 years. Moreover, it is an investment that pays off highly since the higher oil price means that one kilowatt-hour produced in a nuclear plant will cost about 13 or 14 centimes [3.0 to 3.7 cents] whereas the kilwatt-hour produced from oil will cost on the order of 24 to 25 centimes [5.8 to 6.0 cents]. . . . Nuclear electricity enables France to be more independent from the energy standpoint; that is, so nobody can tell us what to do. . . .
>
> The program provides a test for a country's foresight

Nuclear Lead

by Dana Sloan

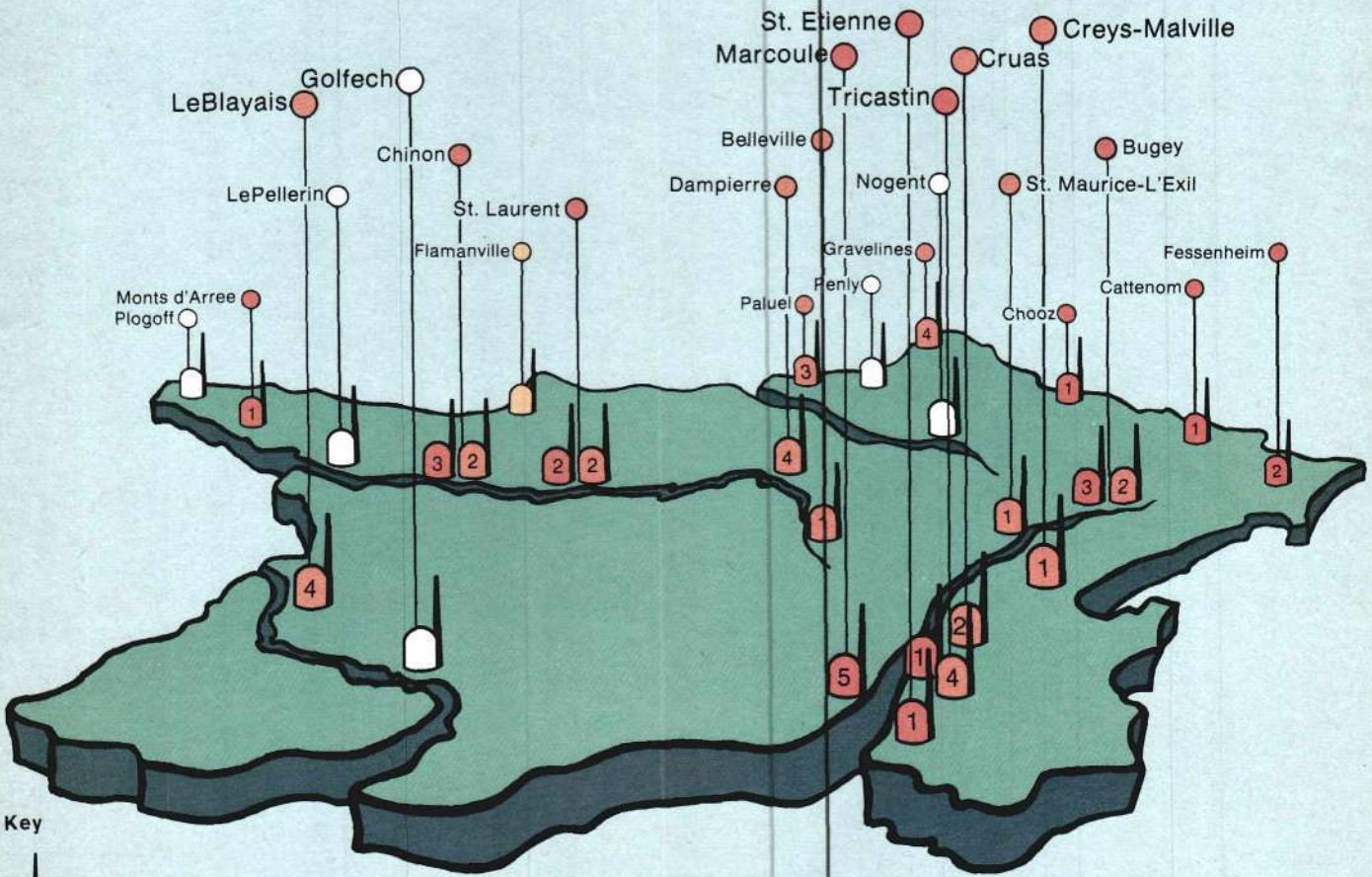


Figure 1
NUCLEAR POWER STATIONS IN FRANCE, APRIL 1979
France has more than 20 nuclear plants in operation, with another 27 under construction, 6 of which will come on line in 1980. The type of reactor and capacity are listed in the table on page 39.

and clearsightedness. The decision to go ahead with the building of nuclear power plants . . . has resulted in their being ready for service five years later. There comes a point, therefore, when a decision is made that is sometimes politically quite difficult. Let me remind you that five years ago most French people were not in favor of nuclear energy. They have progressed since then so that today the majority are in favor of it. . . .

And Dirigist Institutions

Three institutions play an important role in the dirigist or state-initiated and very centralized development and implementation of the French nuclear program: the Commissariat à l'Energie Atomique (CEA, or Atomic Energy Commission), Electricité de France (EDF, the state electricity monopoly), and the Empain-Schneider industrial group, whose company Framatome builds the nuclear reactors.

The CEA, set up immediately after World War II, has had its role increased over the years, contrary to the trend in the United States. The agency is still responsible for the three areas originally assigned to it: prospecting, extraction, and enrichment of uranium ore, overall planning of the national nuclear industry, and research and development. In the late 1950s, the CEA was also assigned responsibilities in the military field, which now include the task of developing the nuclear warheads for French atomic weapons as well as the reactors for atomic submarines.

How closely the CEA works with the government is indicated by the fact that its administrator, beginning in 1971, was André Giraud, who is now minister of industry. And within the Industry Ministry, President Giscard created a new function, general director for energy and raw materials, a position now held by François de Wissocq, who is also president of the CEA's Commission on the Production of Electricity from Nuclear Origins (PEON).

The CEA's role is also enhanced through the activities of its full or partial subsidiaries. Cogema, a 100-percent subsidiary, has exclusive rights over uranium enrichment and reprocessing. Novatome, which is responsible for the construction of the fast breeders, is owned partly by the CEA (34 percent) and partly by a company in the completely private Empain-Schneider group (36 percent). Framatome, which since 1975 has had a monopoly on nuclear plant construction and exports, is also an Empain-Schneider subsidiary in which the CEA participates.

The Empain-Schneider group became prominent in France's program in 1969 under President Georges Pompidou. In that year, the government decided to abandon the natural uranium heavy-water model it had been developing since 1956 in favor of a licensing agreement in which Framatome would construct the pressurized water reactor (PWR) model developed by Westinghouse.

Framatome currently employs 4,000 workers and its ultramodern plant in Chalon-sur-Saône can produce six to eight reactor cores a year. Other companies in this group include Spie-Batignolles, which does most of the public works; Merlin-Guerin, which supplies most of the electrical equipment; and Jeumont-Schneider, which provides the electromechanical equipment.

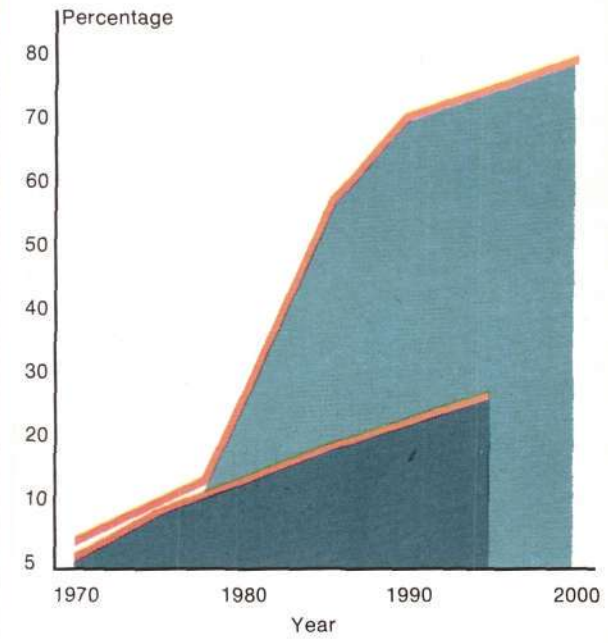


Figure 2
NUCLEAR AS A PERCENTAGE OF TOTAL ELECTRICITY CONSUMPTION: FRANCE COMPARED TO THE UNITED STATES

By the year 2000, France expects that 80 percent of its electricity will come from nuclear power. By contrast, the United States Department of Energy is revising its projections downward and at the moment has no figure for 2000.

Source: Memento sur l'Energie, French Atomic Energy Commission, DPG, 1979; U.S. Department of Energy.

For months now there has been talk of Framatome permanently ending its license with Westinghouse when it expires in 1982, and, according to *Nucleonics Week*, talks are now going on in that direction. Framatome's export strategy makes this imperative. In the 1973-1979 period, the company won about 25 percent of world orders for pressurized water reactors. However, as a Westinghouse licensee, Framatome needs U.S. State Department approval to sell this technology abroad—and current State Department policy would seriously curtail its export potential. The license accord will probably be replaced by a form of looser partnership.

Electricité de France, nationalized by the Gaullist government immediately after World War II, has a monopoly on electricity production and distribution in the country. EDF will be investing 28.8 billion francs (approximately $6.9 billion) this year for its nuclear program alone. To-

gether with the CEA and the privately held Empain-Schneider group, France has a completely centralized system for all phases of the nuclear program.

A Complete Nuclear Fuel Cycle

France's nuclear program serves as a model for the completion of the nuclear fuel cycle—from fuel enrichment, reprocessing and breeding, to storage of waste. France has pioneered the development of technologies that will maximize France's nuclear self-sufficiency as well as its potential for exports.

The breeder. The breeder reactor is key to the French nuclear program, because it vastly reduces the nation's reliance on naturally occurring fissionable uranium (U-235). France's first experimental fast breeder reactor, called Rhapsodie, went into operation in 1967. The successful coupling of France's first demonstration breeder, the Phenix (250-megawatt capacity), with the EDF grid in 1973 was widely recognized as a breakthrough in breeder technology worldwide. Now, with President Carter's indefinite postponement of the Clinch River Breeder Reactor in the United States, France is on the way to becoming the world's leading power in industrial use of the breeder.

The 1,200-megawatt Super-Phenix, currently under construction at Creys-Malville, is scheduled to begin operation within two years. Interestingly, although the construction of the Super-Phenix is being carried out by Novatome, its financial backing is in the hands of a consortium called Nersa, which is made up of EDF (51 percent), the Italian national company ENEL (33 percent), and the German-dominated company SBK (16 percent).

The importance of the fast breeder for France's nuclear program was put succinctly by President Giscard in the January radio interview mentioned above: "Try to imagine it like this: if the uranium mined in France were one day to be used in breeder reactors, France's energy potential, its energy reserve, would be comparable to that of Saudi Arabia."

The breeder uses uranium with 50 to 60 times the efficiency of conventional nuclear reactors. One kilogram of natural uranium will produce 30,000 kilowatt-hours of energy in a graphite gas reactor, or 45,000 kilowatt-hours in a light water reactor; but the same amount can produce between 1.5 million and 3 million kilowatt-hours in a fast breeder.

Uranium resources. Since the creation of the CEA one of its main tasks was to ensure a plentiful supply of uranium for the soon-to-be-developed national nuclear industry. The CEA now has three active uranium mines, with reasonably assured deposits of 95,000 tons of uranium. In addition, active prospecting in the French-speaking African countries of Niger and Gabon has led to the discovery of about 160,000 and 20,000 tons respectively. Between now and 1985, annual uranium needs will be in the order of 6,000 to 8,000 tons.

It is easy to see from these figures why France would seek to maximize efficient use of the uranium it has at its disposal. It is essential not only that the supply be adequate in quantity, but also that it be free of political strings, if France is to have the means to continue the fully independent foreign, military, and monetary policies initiated by General de Gaulle. Now only 50 percent of French uranium requirements are met by mines within French national territory.

The CEA and its subsidiary Cogema, as well as a few large private companies (notably Pechiney Ugine Kuhlmann), have an extremely active uranium prospecting policy that has led to the discovery of a few more uranium deposits in France in the recent period. French oil companies are also being increasingly diversified into this field. In addition to Niger and Gabon, Cogema has interests in uranium prospecting and mining companies in Canada, the Central African Republic, Australia, the United States, and Brazil.

Enrichment. Before the uranium can be used as fuel for most currently operating nuclear reactors, it must be enriched, a process for which France was totally dependent on the United States and the Soviet Union until 1979. When the Carter administration cut off supplies of enriched uranium to Western Europe, the Soviet Union became France's main supplier.

In 1973, France took the initiative to begin building Western Europe's first civilian uranium enrichment plant in Tricastin, setting up a consortium called Eurodif. The consortium regrouped Cogema (the largest shareholder with 27.7 percent), with national companies from Italy, Spain, and Belgium, and a joint Franco-Iranian company

FRENCH NUCLEAR ELECTRICITY RESOURCES
(end 1979)

	No. reactors	Capacity (Mw)
Operating	20	13,050
Traditional reactors (natural uranium)	9	2,600
Breeder reactors	1	250
Pressurized water reactors	10	10,200
Under construction	27	25,800
Pressurized water reactors 900 megawatts	23	20,700
Pressurized water reactors 1,300 megawatts	3	3,900
Breeder reactors	1	1,200

Source: French Embassy, Press and Information Division, New York, N.Y.

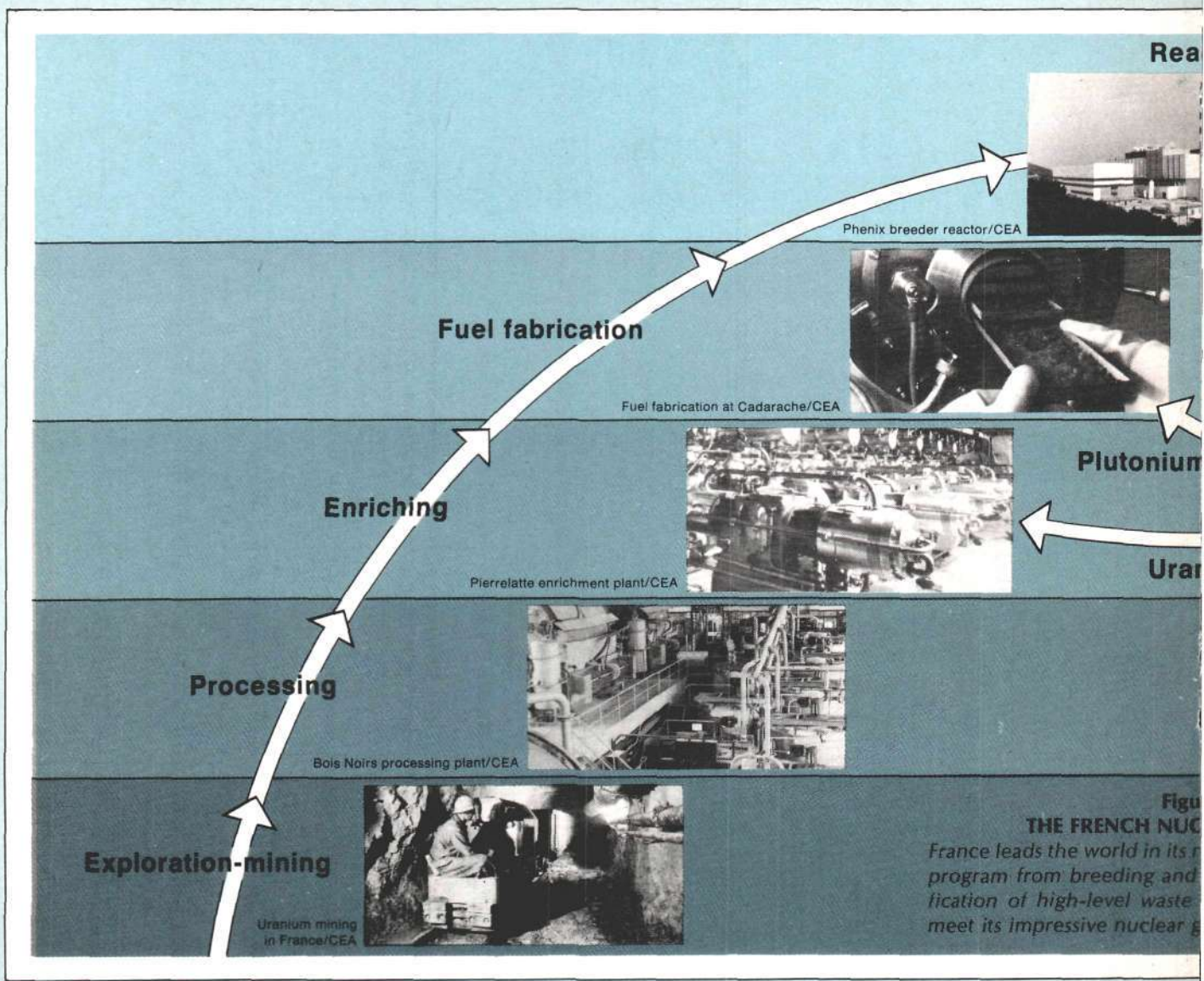
called Sofidif (60 percent CEA, 40 percent Iran) in which the Shah's Iran invested more than $200 million. The Khomeini regime is now demanding a complete refund on that investment.

The Eurodif plant, built at a cost of more than $3 billion, drew its technology from France's military uranium enrichment plant at Pierrelatte. It produced its first usable quantities of U-235 in March 1979, and is now producing at an annual capacity of 2.6 million separation work units. When completed in 1982, the Eurodif plant will be producing 10.8 million separation work units, or about 25 to 30 percent of the world's capacity. The firm has contracts for the entirety of its production capacity until at least 1990, and a second project, called Coredif, is already in the works to fill world enrichment needs. (These are expected to surpass capacity before 1990.)

Reprocessing. The reprocessing of spent fuel closes the nuclear fuel cycle, reducing the amount of waste produced by a plant by 97 percent. For example, for 100 pounds of spent fuel, reprocessing can separate out 96 pounds of low enriched uranium that can be reused as fuel, and 1 pound of plutonium that can be used in the breeder reactor—leaving only 3 pounds of radioactive waste to be stored.

The French have two reprocessing facilities, one at Marcoule for military uses only (called UP1), and a large civilian reprocessing plant at La Hague (UP2). This plant will be expanded to double its capacity by the end of 1984 to service the increasing needs of EDF's reactors. And by mid-1986 another unit (UP3) will be opened at La Hague that will service 30 European and Japanese utility companies for the next 10 years, until their own national projects are completed.

Aside from the Windscale reprocessing facility in Britain, which has been half shut down, the French will have the only reprocessing capacity in the Western world, until various projects now under construction may be completed. Japan will not have a functioning reprocessing plant until the 1990s; West Germany's projects have been stalled by the environmentalists; and the British will be



Figu
THE FRENCH NUC
France leads the world in its n
program from breeding and
fication of high-level waste
meet its impressive nuclear g

expanding their Windscale facility, but it will not be operational until at least 1987.[1]

Waste disposal. France's lead in nuclear technology can be seen in its pioneering work in the last link in the closed nuclear fuel cycle: waste disposal. After spent fuel is reprocessed, which brings down to 3 percent the amount of high-level radioactive waste to be disposed of, it can be vitrified. In this process, high-level waste is placed into an acid bath and taken through various chemical and cooling processes, after which it is solidified by mixing it with glass. The vitrified waste is then stored in metallic drums until permanent storage in deep granite or salt pits.

After reprocessing and vitrification, the CEA estimates that the entire *accumulated* waste produced from the beginning of the French nuclear program until the year 2000 will be reduced to a volume of 3,000 to 4,000 cubic meters, or about the size of two Olympic swimming pools.

France currently has two vitrification installations, both at Marcoule, and a third planned for La Hague. The first experimental vitrification unit began operating at Marcoule in 1969, and the second, the world's first industrial vitrification unit, began operation in summer 1978. It is estimated that this unit will be able to reabsorb all previously produced waste by 1988.

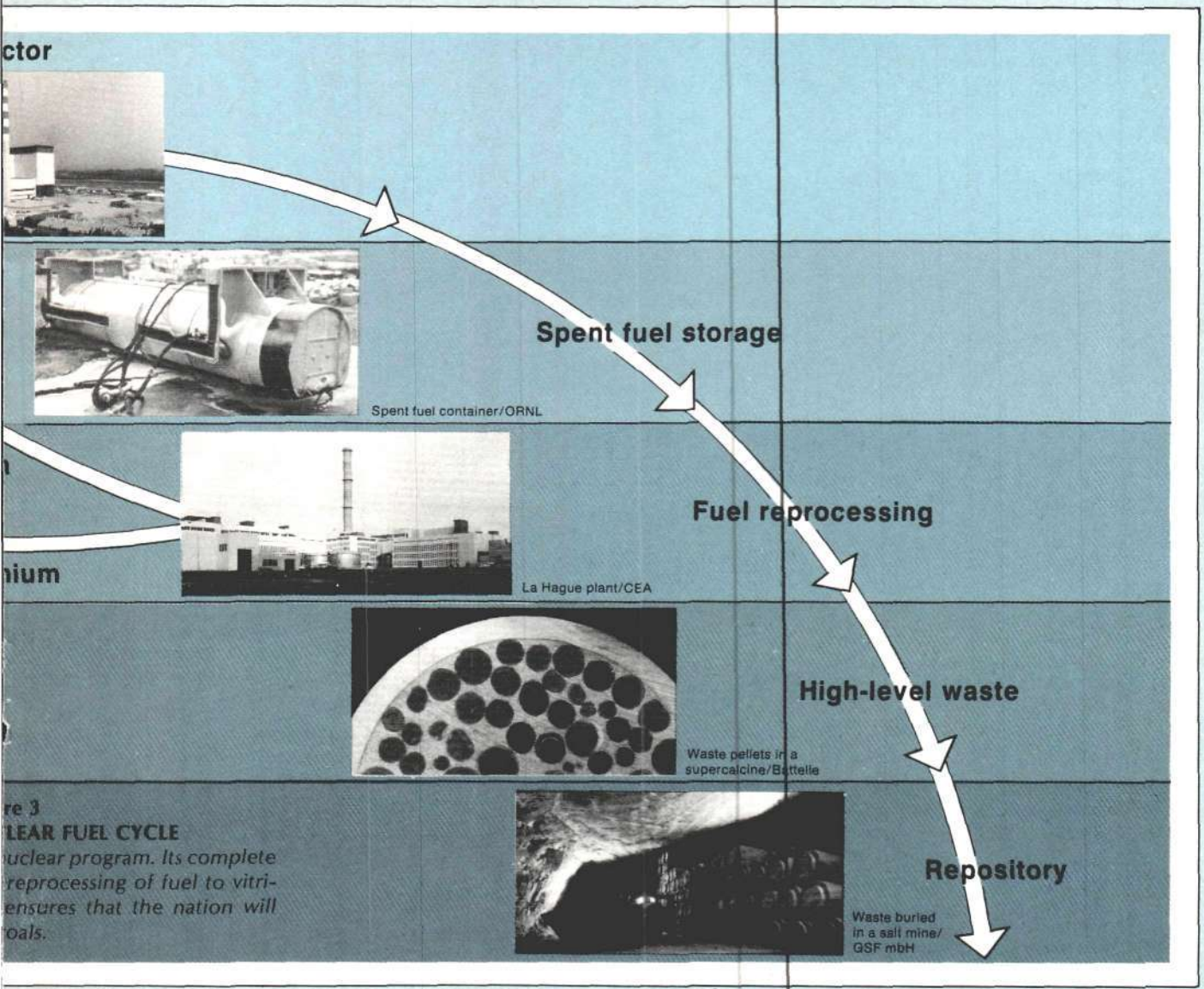
A Dirigist Science Policy: The Historical Roots

The French nuclear program, as its historical roots make clear, is a matter of the nation's will to survive—a commitment shared by France's leaders and citizens alike.

It is not surprising that environmentalist crusader Ralph Nader announced last summer that he was planning a trip to Western Europe in order to create an "environmentalist international" that specifically targeted France. In an Aug. 6, 1979 interview in *Le Point* magazine, Nader complained, "I do not think that there exists anywhere in the world a pronuclear technocracy as arrogant as that in France."

France's nuclear engineers and scientists could hardly be paid a better compliment!

This so-called arrogance is firmly rooted in the close relationship established during the 17th century between



re 3
LEAR FUEL CYCLE
uclear program. Its complete
reprocessing of fuel to vitri-
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the nation-state and scientific-technological research. In fact, the reason the United States became the world's leading industrial and scientific power was because the founders of the American System, Benjamin Franklin and Alexander Hamilton, derived their outlook directly from the policies developed in 17th-century France (policies later spread throughout Europe, especially Germany).

The originator of this explicit relationship between the nation-state and science was Jean-Baptiste Colbert, finance minister for Louis XIV and the founder in 1666 of the Royal Academy of Sciences. The academy was established specifically to make skilled manpower the primary resource, the most valued "raw material," of the country, as well as the base upon which the development of manufacture would depend. The country's highest authority appointed the academy's members and gave full support to their undertakings, which were closely associated with the technical foundations of early French manufacturing.

Even during the French Revolution, more than a century later, when the organizers of Jacobin terrorism proclaimed that "the people have no need for science" and tried to smash the advancement of manufacturing by abolishing the academy, it suffered only a temporary setback. And by 1794, the academy spawned the institution that became the center of European scientific thought—the Ecole Polytechnique.

Founded by the great mathematician and physicist Gaspar Monge, who laid the basis for modern descriptive geometry, the Ecole Polytechnique transformed higher education in France. For the first time in modern history, the research laboratory was made the focus point of education, and the labs of the Polytechnique were the best equipped in the world. With its emphasis on the application of science to industry, graduates of the school changed the face of the globe with such technological feats as the construction of the Suez Canal. The great German scientist Alexander von Humboldt, who spread the method of the Polytechnique into Germany, described the atmosphere in Paris at the time as "the true metropolis of science to which scientists flocked from all over Europe."

The Ecole Polytechnique was also unsurpassed in the field of military engineering, in which Lazare Carnot, the engineer, political leader, and educator, played the critical role. As we shall see, this military tradition has been instrumental in the postwar history of the French nuclear program.

After defeat in the Franco-Prussian war, France began to lose its lead in the 1870s, as emphasis shifted toward a more "practical" orientation—the beginning of the false division between basic and applied science. This tendency prompted the great biologist Louis Pasteur, for one, to launch a campaign in which he issued the following warning: "Take interest, I beseech you, in those sacred institutions which are designated under the expressive name of laboratories. Demand that they be multiplied and adorned; they are the temples of wealth and of the future. There it is that humanity grows, becomes stronger and better."

Louis Pasteur's call would be heeded many years later by the Curie family and its newest member, Frédéric Joliot, husband of the Curies' daughter Irène.

The Joliot-Curies

The story here begins not with Pierre and Marie Curie's discovery of radioactivity, but rather with the work of their posterity—Irène Curie and her husband, Frédéric Joliot, who had joined Marie Curie's lab at the Ecole de Physique et de Chimie in Paris, under the direction of Paul Langevin. It was their work that gave France the unquestioned lead in the field of atomic energy before World War II broke out.

The achievements of the Joliot-Curies began in 1932 with their discovery of what was later given the name neutron, rapidly followed by their discovery of man's ability to create artificially radioactive elements, for which they won the Nobel Prize in 1934. In his acceptance speech, Frédéric Joliot predicted the next phase of their discoveries, the fission of uranium nuclei, which took place in 1938-39, and the enormous potential it would unleash for humanity:

> If we look back at the past and consider the progress made by science at an ever increasing pace, we may feel entitled to believe that researchers, building up or breaking down elements at will, will be able to bring about nuclear reactions of an explosive nature—veritable chemical chain reactions. If such reactions come to be propagated in matter, one can imagine the enormous release of useful energy which will take place.

It was around this time that the Joliot-Curies and their circle of collaborators won a major victory in their effort to promote science: the creation of the Centre National de la Recherche Scientifique or CNRS (National Center for Scientific Research), a government body whose responsibility was to develop, direct, and coordinate all French scientific work. The first mission of the CNRS was to mobilize science for the war effort, but it came too late. France capitulated.

Of Joliot's original team, only he and his wife remained in France during the war and the Nazi occupation, guarding their lab and hiding what remained of their precious quantities of heavy water. As the liberation approached, Joliot, who had joined the French Communist Party resistance movement, transformed his laboratory into an assembly line for making bombs used in harassing operations against the Nazis.

The rest of the Joliot team, Hans Halban, Low Kowarski, and Bertrand Goldschmidt, left for London to join de Gaulle's Free French and were immediately engaged in the allied atomic effort in England, the United States, and Canada. There, with other scientists from all over Europe, the French emigrés took part in the successful efforts to unleash the potential of the atom. And they quickly got a taste of the opposition from the United States and Britain in store for them and their mentor Joliot.

During 1944, Hans Halban suggested to the British au-

"Science is indispensable to this country. A power can only justify its independence by the original contribution it makes to other nations...."
—Frédéric Joliot Curie

Joliot (left) in conversation with biochemist A. Oparin, member of the Soviet Academy of Science and vice president of the World Federation of Scientific Workers (1953).

From *Frédéric Joliot-Curie: The Man and His Theories*, by Pierre Biquard; by permission of Paul S. Eriksson, Publisher.

thorities that it would be useful for the furtherance of their work to establish contact with Joliot, who was still in France. The idea was promptly nixed by Churchill, Roosevelt's advisors, and FDR himself. When Churchill was warned by his advisors that if England did not even make some pretense of collaboration with the French, Joliot might advise General de Gaulle to turn to the Soviet Union for atomic collaboration, Churchill exploded: "If such an occurrence is to be feared, Joliot should be detained by force."

As we shall see, this faction of Anglo-American leadership was determined to limit not only Soviet influence, but also that of France. Already in 1944, the United States, Canada, and Great Britain had created a joint uranium supply trust, the Combined Development Agency, whose purpose was to acquire a complete monopoly over uranium supplies in the West. And an accord was negotiated with Belgium's government in exile that gave the Anglo-Americans the totality of uranium extracted by Belgian interests in the Congo.

Postwar Nuclear Development

Immediately at the war's end, the de Gaulle provisional government made Joliot director of the CNRS, the National Center for Scientific Research. His first job was to convince the government of the need for a 200 percent increase in the CNRS budget, a difficult task because the finance minister, as Joliot put it, "thanks to an absurd policy, which had been pursued for years, did not understand what an excellent investment for the country scientific and technical research constituted."

That unpleasant task successfully accomplished, Joliot was able to turn to things more important: transforming the CNRS into an institution that would answer the nation's scientific needs. First, he drew up new statutes for the CNRS. Its previous structure had differentiated between pure and applied research, and Joliot, like Pasteur before him, wanted to abolish that distinction in order to "testify to the continuity which exists between pure science and all its applications."

Then there was the question of coordinating the research carried out by the different branches of government departments, in order to ensure a free and full exchange of information and to avoid duplication. As Joliot developed his plans, he wrote:

> I thought I had found an original solution, but shortly afterward, I chanced to read several memoirs of Pasteur who had proposed similar solutions 70 years before. There is no doubt that if attention had been paid to Pasteur, the development of French science and technology would have been greatly facilitated.

During his involvement with the CNRS, Joliot corresponded with General de Gaulle on the importance of keeping the lead France had attained in atomic energy. After their second meeting, de Gaulle told him: "I have confidence in very few men. Joliot, I have confidence in you." Soon after, de Gaulle made the decision to set up the French Atomic Energy Commission (CEA) with Joliot as director. It was to be an institution like none other in the world—the world's first postwar *civilian* institution to preside over the development of nuclear technology. And as a further indication of its special importance, the CEA was placed directly under the authority of the prime minister, in order to be free from the scissors-wielding Finance Ministry. To carry out this mandate, Joliot gath-

"I do not think there exists anywhere in the world a pronuclear technocracy as arrogant as that in France."
—Ralph Nader

General de Gaulle visiting the French nuclear complex at Marcoule.
CEA

ered around him virtually all his former scientific collaborators who had returned from the war effort abroad with much experience.

It was not long before the Anglo-American faction that feared an independent France began its efforts to undermine the French nuclear program. At a reception at the United Nations in 1947 Joliot was approached by Bernard Baruch (the same Baruch who would, along with David Lilienthal, propose that no other Western nations but the United States and Britain be allowed to develop atomic weapons). Baruch asked Joliot to come to the United States to work, in exchange for a large salary and well-equipped laboratories the likes of which war-devastated France could provide only with great difficulty. As this incident makes abundantly clear, it was not simply the fact that a communist was pioneering the French effort that disturbed the Anglo-Americans, but the fact that there was a French effort to be pioneered at all. Needless to say, Joliot rejected the offer.

On Dec. 15, 1948, France's first atomic pile, "ZOE," went critical. Immediately the press on the other side of the Channel and the Atlantic launched an anti-French campaign. *Time* magazine set the tone, with its headline "A Communist Pile," and the London *Economist* followed suit, warning: "Atomic research in France with Communist participation is hardly compatible in the long run with French military commitments in the Western and Atlantic Union." The *New York Herald* was even more to the point: "The existence of the French pile is a veritable threat to the measures which the English-speaking nations have seen fit to adopt." By November 1949, President Harry Truman warned, "The U. S. government will seek in the near future to gain control of the production of uranium in all parts of the world outside the Soviet sphere of influence."

In the United States, of course, this was the beginning of the McCarthy era, and the mere mention of Joliot's Communist Party membership was enough to create a climate of fear around the French nuclear program. It is important to understand, however, what party membership meant to Joliot—and to France.

Joliot was profoundly a patriot. And in the years during and after the war, there were only two places a patriot could go to take part in the reconstruction of the country: with General de Gaulle or with the French Communist Party. Both were nationalist forces that have a long history of collaboration—explicitly or implicitly—in the promotion of French national economic-industrial progress up to the present. It is not an accident, for instance, that de Gaulle put French Communist Party general secretary Maurice Thorez in charge of national reconstruction in his postwar provisional government.

Joliot explained why he became a communist to his biographer, Michel Rouze, in 1950:

> *What is it that differentiates man from the animals?* It is the fact that when he wakes up he does not simply think about hunting for food—or rather a day will come when he will be able not to think simply of that. At present, millions of men on earth are forced to live like animals, to concentrate on hunting for food. . . . This is not civilization. It is not true that the work imposed on us by our need to eat is moral work. . . . Should not science and technology enable us to have to do very little work in order to eat? We shall be civilized when man no longer needs to work as he does now in order to ensure his survival. This does not mean he will do nothing. On the contrary, it is only then that his work will become moral, when he does additional, voluntary work with his brain or

his hands, in order to make a contribution to others, to enrich the life of humanity.

The pressure on France became so great, however, that on April 29, 1950, Frédéric Joliot was dismissed from his post at the CEA by prime minister Georges Bidault, in the vain hope that the dismissal might make the Anglo-Americans more forthcoming with political cooperation. (Bidault, it should be noted, a dozen years later became the head of the terrorist "resistance" movement against de Gaulle's policy for Algerian independence.)

Joliot understood clearly that his dismissal was just another prelude to an attempt to destroy French science. At his first regular lecture at the Collège de France after he was fired from the CEA, Joliot told a packed auditorium:

> Science is indispensable to this country. A power can only justify its independence by the original contributions it makes *to other nations.* If it does not do this it will be colonized. It is for the sake of patriotism that the scientist must develop and enlighten his fellow citizens about the role of science.

During the next few years, the CEA's activities stagnated. Its top scientists were personally loyal to Joliot, and it was difficult to find a replacement. Francis Perrin, one of Joliot's early collaborators and the son of the original founder of the CNRS, accepted the post, but he had to threaten to resign when the government tried to stuff the CEA with former high-level Nazi collaborators. At the same time, a faction in the military that wanted France to follow Anglo-American policy was attempting to gain control over the CEA.

How America Lost an Ally

It is useful in understanding the ensuing battle over nuclear policy to look briefly into the French military factions at the time. In retrospect, they are easily divisible into two groups: one that remained loyal to General de Gaulle through the trials of his Algerian policy and his forging an independent political and military policy; the other that was imbued with the old colonial school spirit and would lead or take part in the revolts against de Gaulle that were encouraged by NATO. Both factions supported a military applications orientation for the CEA, but for different reasons.

The first faction was headed by General Charles Ailleret, a Polytechnician who later became de Gaulle's chief of staff and military theoretician for de Gaulle's independent policies. During the 1952-56 period, however, Ailleret was commander of the "Special Armies," a department created to look into atomic, bacteriological, and chemical warfare, and there he began his lobbying efforts. During the same period, Ailleret's brother Pierre was director of studies and research at Electricité de France, the state-owned electricity monopoly.

One of the first political battles this Gaullist military faction had to fight was against the European Defense Community. A small clause in the EDC treaty, which was to create a supranational European military structure, stated that annual production of plutonium must be restricted to 500 grams a year. Authorization for the production of additional amounts would have to be granted by a special EDC committee, and such authorization would only be given if its use for civilian purposes was guaranteed. In short, it would have made a French nuclear weapons system impossible, and even the civilian use of plutonium would have been highly controlled.

The EDC was defeated in 1954 after the Gaullist and Communist parties formed a united front to vote it down in the National Assembly. The fight had to be repeated two years later when Anglophile Jean Monnet's "Committee of Action for the United States of Europe" proposed complete European renunciation of nuclear weapons production—a European version of the Baruch plan. It, too, was defeated. One treaty that was adopted, however, Euratom, provided a foot in the door for such plans. Although its final version did not include controls over military production, the Euratom treaty did create a uranium supply agency with an eye toward manipulation of an eventual uranium shortage.

By this time, of course, the Soviet Union had developed nuclear capacities well beyond the scope of what the French could immediately hope to achieve. Eisenhower's Atoms for Peace proposal as well as other proposals had offered to grant America's Western allies the information and technology necessary for the construction of atomic submarines. But largely as a result of the manipulation of the Congress, the United States refused to communicate to its allies information and weapons that the Soviets had long ago developed.

When de Gaulle returned to power in 1958, the French military atomic program, which had received a small start the year before, went into full swing. An accelerated program was set up to accomplish the first experimental A-bomb explosion during the first months of 1960. After negotiations with the United States on the sharing of information and technology failed, as a result of the determination of the British and the Americans to keep France in the role of junior partner, de Gaulle informed the NATO Council in March 1959 that he had decided to maintain the French Mediterranean naval forces under national command in the event of war. A few months later Congress finally ratified an agreement to sell U-235 to France, but it was too late. France had already decided to go ahead with plans to begin construction of the isotopic separation plant for the production of enriched uranium at Pierrelatte.

Shortly thereafter, de Gaulle made his often cited speech to the Ecole Militaire: "Naturally, French defense would, if the need arose, be coordinated with that of other countries. This is in the nature of things. But it is indispensable that it be ours, that France defend itself, by itself, for itself, and in its own way. [We must develop a] force de frappe [strike force]. . . . The basis of this force will be an atomic armament—whether we build it or whether we buy it—but which must belong to us." The message was clear.

Exactly on schedule, in February 1960 in the deserts of

Algeria, France exploded its first atomic bomb, with three times the megatonnage of the first American and British bombs. The second explosion took place April 1, when Soviet Premier Nikita Khrushchev was in Paris on an official visit, and the Soviet visit ended with the signing of a nuclear cooperation accord, which provided for the exchange of information missions and trainees.

The French tests were conducted under enormous safety conditions to prevent any hazardous effects. Yet, a major international campaign against French atomic testing ensued, including the breaking off of diplomatic relations by Nigeria, then a British colony. The campaign reached a peak in 1963 when the accord banning atmospheric atomic explosions was worked out by the United States, the Soviet Union, and Great Britain. More than 100 countries signed the agreement, and intense pressure was applied on France to follow suit. However, France felt that the accord would affect the future of its military program more than any other country's. By 1963, the United States had carried out 300 explosions, the Soviets 150, and British 25; France, however, had carried out only 4 test explosions and was just at the point when it was testing superpowerful bombs that required aerial tests.

Washington also sought to slow down the French nuclear effort by pressuring Canada, a major supplier, to continue with its policy of not selling "free" uranium to France; that is, uranium free of any conditionalities on its use. And, for the same reason, the United States implemented a boycott on sales of electronic and computer equipment to France, whether or not such equipment was intended for civilian or military use. After the U.S. government embargoed the sale of a multi-million-dollar computer intended for civilian use in France's largest nuclear research center, Saclay, the French government took the first measures to set up a national computer industry. It wasn't long before the United States agreed to start selling France computers for civilian use.

This was, of course, a strange way to treat an ally, and France responded accordingly. However, it would be a mistake to see France's great scientific, technological, and industrial achievement of this period merely as a reaction to such provocations. In line with the "certain idea about France" that he had been expressing for years, de Gaulle saw the need for France to embark on a grand design as a nation. Without such a grand design, de Gaulle warned, France would "decline and die." As de Gaulle told the nation Feb. 5, 1962:

> Throughout her existence, France has passed through periods in which the general process of evolution demanded a regeneration on her part, under penalty of decline and death. . . . This is certainly the case today, for the age in which we are living—marked as it is by the acceleration of scientific and technological progress, the need for social betterment, the emergence of a host of new states, the ideological rivalry between empires—demands a vast regeneration both within ourselves and in our relation with others.

The Gaullists began a concerted effort to make France into a scientific nation-state. This involved not only the atomic field, but also an ambitious space program and R & D in every advanced technological field—all capped by the development of an independent military capability. In this effort, France had a weapon that is relatively unknown to Americans: a five-year plan.

The French Planning Commission, set up after the war, began to play a dirigist role in the area of science and technology during de Gaulle's Fifth Republic. Including members on its board from all sectors of economic activity, its general goal was to achieve cooperation among the different layers of society to achieve specific goals toward economic progress. Unlike the Soviet Union's, the five-year plan was an "indicative," not an "imperative" plan, in which the government could coax labor and industry into compliance through selective use of credit, and so forth.

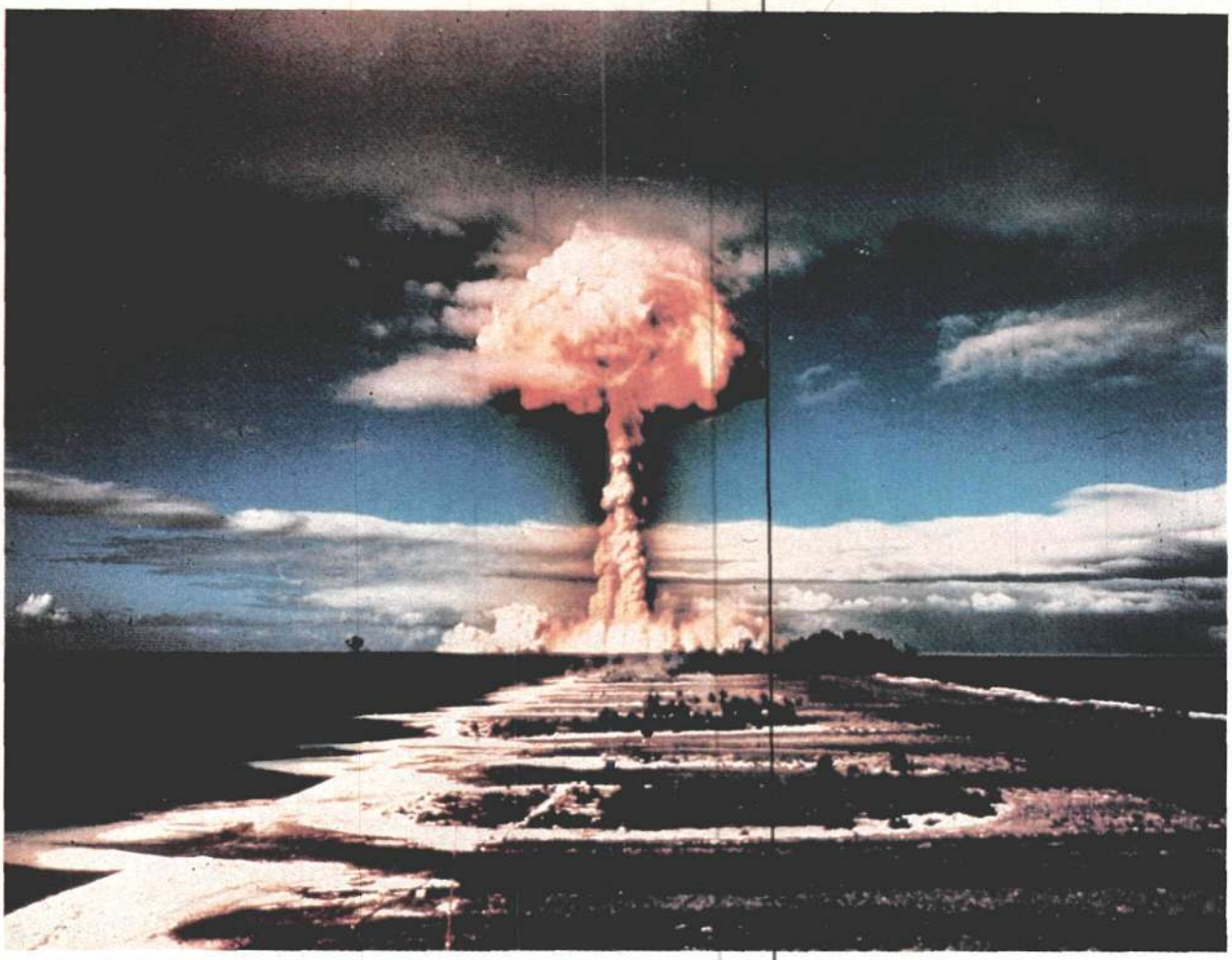
Why the French Environmentalists Have Failed

The most remarkable fact about the French antinuclear movement is that, despite a spate of terrorist sabotage last year, it has been a colossal failure. A good indication of this was an announcement in the daily *Le Monde* in September 1979 that most ecology newspapers in the country, including the Rothschild-linked *Le Sauvage* (The Savage) and the even more ominous-sounding *La Gueule Ouverte* (Open Jaw) were on the verge of bankruptcy.

The efforts of Ralph Nader and his cohorts in organizations like the Friends of the Earth will need more than a little help if they expect to reverse the firm pronuclear sentiment among the French population. The failure of the environmentalists is a direct result of President Giscard d'Estaing's government working with the political base of the organized labor force to promote the necessity for nuclear development. Most interesting about this alliance of a conservative government and labor behind nuclear development is that the key section of organized labor in France is part of the French Communist Party's affiliated labor federation, the CGT.

The alliance developed in 1977, when the U.S.-spawned antinuclear movement was gearing up for a European-wide demonstration and when the antinuclear policies of the Carter administration began to blossom. The environmentalists' target was a June assault against the Super-Phenix fast breeder at Creys-Malville.

The French nuclear industry responded with a tactical about-face, reversing its hands-off stance toward the CGT and advertising in the labor



French atomic bomb test in the Pacific. The first French atomic test took place in February 1960. United Nations/Photo by Sygma

"It is indispensable...that France defend itself, by itself,...and in its own way...."
—Gen. Charles de Gaulle

federation's national paper on why nuclear development was essential. The leadership of the CGT, mostly skilled workers whose economic future is tied to an aggressive expansion of nuclear energy, got the point. As a result, the antinuclear faction, based mainly around François Mitterrand's Socialist Party and its trade union, the CFDT, was unsuccessful in wooing CGT support for the antinuclear assault. The Creys-Malville episode flopped.

An Imported Movement

The environmentalist effort in France is orchestrated by organizers sent over from the groups running the antinuclear movement in the United States, specifically the Natural Resources Defense Council (created by the Ford Foundation) and Amory Lovins's Friends of the Earth.

Other input has come from European Malthusians. The leaders of a new zero-growth group, ECOROPA, tried to persuade President Giscard to suspend the nuclear program in September 1979, but they met with no success. The leaders left Giscard's office announcing they were "disappointed" with his response. ECOROPA, based in Geneva, was set up by the Club of Rome and includes Aga Khan, London-based futurologist Arthur Koestler, ethnologist Konrad Lorenz, Club of Rome head Aurelio Peccei, Nobel biologist N. Tinbergen of Oxford, and a gaggle of other zero growthers from throughout Europe.

The breeding ground for ecology operations in France is worth noting, however, for it is the same center out of which the so-called New Left student upheaval developed and eventually destabilized the de Gaulle government in 1968. This center for antitechnology destabilizations is the Ecole Pratiques des Hautes Etudes, 6th Section, or EPHE 6, as it is known. EPHE 6 was set up after the war with money from the Ford Foundation and the Council on Cultural Freedom, a NATO-funded operation.

—William Engdahl

The Fifth Plan, covering the period from 1966 to 1970, was significantly influenced by Pierre Cognard, an official from the government's General Delegation for Scientific and Technological Research (DGRST) who had de Gaulle's ear. Cognard wrote about the direction the plan had to take in a document published in September 1964 in *Le Progrès Scientifique*, a government review: "It would be most grievous if national independence, which is assured on the military plane, should be insidiously destroyed in the scientific domain. . . . Let us feel assured that the objective of the plan is that the nation, with the support of all, will be able to guard its scientific and technical independence, the keystone to the development and independence of a modern nation."

The version of the Fifth Plan that was adopted called for doubling national expenditures in both research and development in the civilian sector and an increase in the number of research scientists from 33,000 to 70,000.

When General de Gaulle began his state visit to Moscow in 1966, three months after announcing France's break with the NATO command, the question of science was uppermost in his mind. He became the first Western head of state to visit "science city," Akademgorodok, near Novosibirsk in Siberia, and the rocket-launching base at Baikonur. In his speech at the University of Moscow, de Gaulle stressed the importance of Franco-Soviet scientific cooperation in rebuilding "the Europe of the Europeans." The accords signed set up a permanent high commission on the ministerial level to meet twice a year and five working subcommissions, ranging from atomic and space cooperation to more general scientific and technological cooperation and color TV.

It was in this context, spurred by the 1973 Middle East war and the contrived oil shortage, that Gaullist prime minister Pierre Messmer was able to mobilize French national resources, as they had been built up over these years, and begin a crash program for the commercial development of nuclear energy. The effects of the foresighted Messmer policy are being felt today, and the Giscard government is continuing the broad vision of the Messmer policy. Messmer's March 6, 1974 speech, which launched the "Messmer Plan," provides some food for thought for those who are promoting conservation, instead of energy production, as a solution:

> The energy question has been posed for a while. It has been posed in fact since last October, since the war which broke out in the Middle East. At the time, there were two reactions. There was the reaction of those who thought that it was a crisis, expressed by the current embargo, which should be responded to with circumstantial measures, like prohibiting driving on Sundays. . . . And there were those of us who thought it was a profoundly new situation in the world . . . which required deliberate, thought-out, and long-term measures. . . . Our great hope is in electrical energy of nuclear origin, because we have had good experience in all this since the end of the Second World War. And we have developed all aspects of nuclear activities, civilian and military over the past dozen years. And we now also have the will to do so because we believe this is the solution to our needs.
>
> On this very day, we have taken an extremely important decision . . . to launch during 1974 and 1975 the construction of 13 nuclear power plants of 1,000 megawatts each. . . . This is an extremely important decision. . . . We are now going to launch plants which will represent the equivalent of the totality of our energy production in 1962.

Six years later, France has met these goals and has become one of the world's greatest exporters of nuclear technology, supplying and building reactors on all continents. France, along with West Germany, has also led the battle for the European Monetary Fund, which would institutionalize de Gaulle's "grand design" for industrializing the Third World and rejuvenating the developed sector. For these policies, France has come under fire from the zero-growth faction in the United States. Perhaps the case of South Korea best exemplifies the self-defeatism of the present U.S. position:

In April 1980, France signed a groundbreaking protocol agreement with South Korea, which specifies that France will build two out of the next four plants South Korea is planning. Until now, South Korea had given the United States a monopoly on nuclear plant construction. Ironically, France, whose nuclear energy development the United States has continuously discouraged, will now reap the benefits of a nuclear export policy the United States has rejected, moving into first place as the United States closes its nuclear shop.

Dana Sloan, a frequent contributor to Fusion *magazine on France, is on the French desk of the* Executive Intelligence Review.

Note

1. Despite the obvious advantages of the reprocessing step, the Carter administration has eliminated it from the U.S. program, shutting down existing reprocessing plants and banning further work on projects under construction. The spurious argument used is that reprocessing aids the proliferation of nuclear weapons. However, as competent observers have pointed out, any country that intends to could build a nuclear bomb using a very small research reactor.

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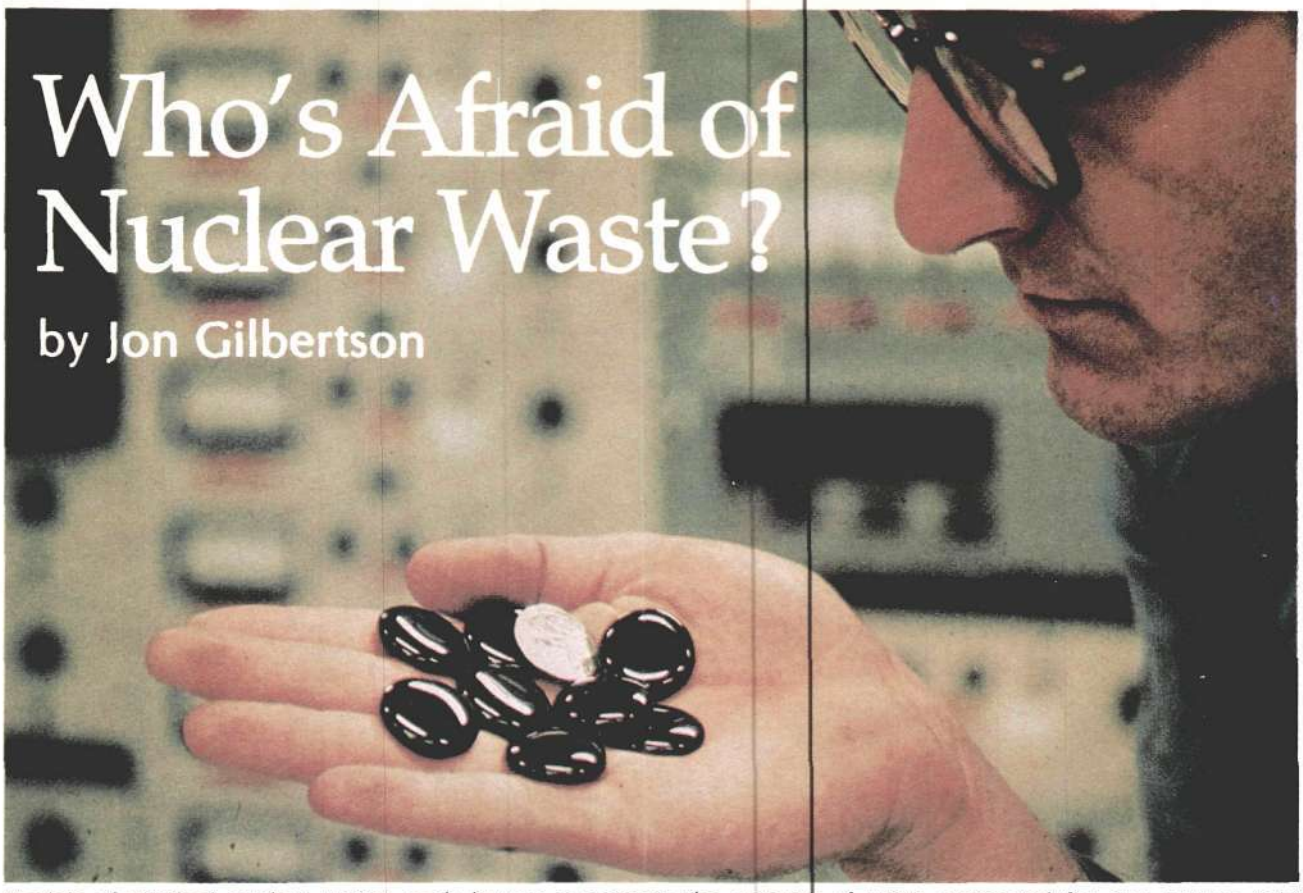
Who's Afraid of Nuclear Waste?

by Jon Gilbertson



Models of vitrified nuclear waste; each button represents the amount of waste generated for one person if his electricity needs for one year were supplied by nuclear energy. DOE

The Technologies to End the Scare Stories

THE ONLY REAL PROBLEMS associated with the disposal of nuclear wastes are political, not technical. To solve the nuclear waste problem today requires implementing a program that will put in operation by no later than 1988 the first underground depository to receive solidified high-level wastes from commercial reactor fuel. The technology to do this is at hand now and, in fact, has been available for well over a decade. What is lacking is the national resolve to get the job done.

The biggest obstacle to implementing the kind of program that is in effect in the other industrial countries has been the U.S. administration, especially President Carter, who has stalled a decision on the U.S. program for more than three years. In April 1977, Carter indefinitely deferred the U.S. program for commercial reprocessing of nuclear fuel, which is an essential part of a viable waste disposal program. At the same time, Carter ignored the assessment of the group he had appointed specifically to study the waste question, the Interagency Review Group on Nuclear Wastes. In October 1978, the Interagency group had recommended that the United States put a waste depository into operation by 1988.

More recently, in February 1980, President Carter officially delayed making the decision to build a waste depository until 1985, a delay that means the United States will not have a waste depository on line until 1995 at the earliest. Two months later, on April 15, the administration released a statement (DOE/NE-0007) that says the decision must now be delayed until 1987. Thus a waste depository will not be in operation until 1997, at the earliest—and possibly not until the year 2006, a delay of from two to eleven years.

This stalling on the waste question is one of the chief issues preventing the United States from having a viable nuclear power program. The refusal of the administration to support the nation's scientific solution for waste has given a carte blanche to antinuclear hysteria about waste. For example, the lack of a national waste disposal program has been primarily responsible for the passage of nuclear moratorium legislation in eight states in the past two years. California, Connecticut, Iowa, Maine, New York, Oregon, and Wisconsin passed moratoria either by state legislation or by administrative decision as a result of pressure from antinuclear groups; Montana was the only state to pass a moratorium as a result of an initiative on the ballot.

At least three additional states—Arizona, Arkansas, and

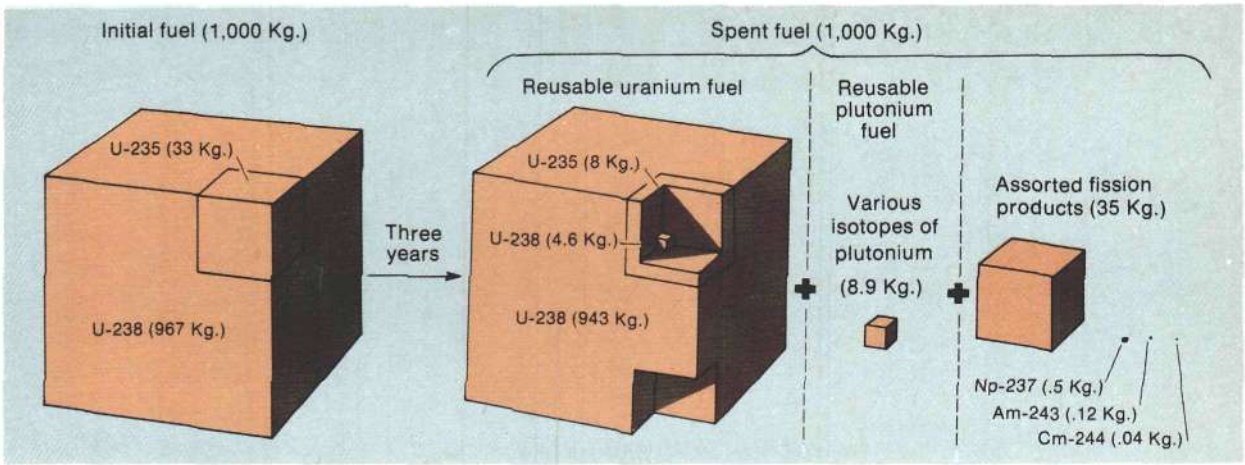


Figure 1
COMPARISON OF MATERIAL COMPOSITION OF NEW AND SPENT REACTOR FUEL

The change in composition of light water reactor fuel as it remains in the reactor over its three-year operating life is depicted here. The fuel starts out enriched in the fissionable isotope uranium-235 to 3.3 percent, with the remainder consisting of nonfissionable uranium-238, both in the form of uranium oxide.

After three years, the spent fuel contains only 0.8 percent U-235, the other 2.5 percent having undergone fission. However, an additional 0.89 percent of mostly fissionable plutonium has been produced. Therefore, more than 1.5 percent of the approximately 3.3 percent enrichment needed for new fuel is still available for recycling along with most of the required U-238. The remaining material, 3.5 percent fission products and 0.6 percent transuranic elements, is also produced as the uranium is consumed. This constitutes the actual high-level waste material in a reactor. The quantities shown are based on an arbitrary 1,000 kilograms of fuel.

Missouri—are expected to have moratorium initiatives on the ballot this year, using the waste issue as the focus. Also, Oregon is expected to have an initiative reaffirming its legislative moratorium, while Maine's upcoming referendum would permanently shut down nuclear power, based on what the environmentalists claim are the insoluble problems of nuclear power, waste disposal included.

The facts of the matter—as opposed to the hysteria generated by the antinuclear groups—support the construction and operation of a U.S. commercial waste depository by no later than 1988. Within three to six months after the adoption of a national nuclear waste disposal program, the initial site could be selected and construction begun. Other sites could be selected and additional depositories built simultaneously, spread out over a several-year period. Once such a national program is put into effect, by administrative order or by federal legislation, most state moratoria would be eliminated.

Every informed person or group supports this position and has publicly said so, and the nuclear programs of other nations affirm this position or something very similar. (See pages 55-56.) The opposition is a very small number of zero-growth activists, plus the uninformed persons they have scared with their lies about nuclear power and the dangers of waste. This minority, however, has managed to control the U.S. administration's nuclear policy, largely with the help they receive from the national media.

There are two ways to bypass this environmentalist bottleneck: through the courts and through Congress. Legal maneuvers, such as the recent decision of the U.S. Federal District Court in California that declared invalid all of California's state legislation against nuclear power, are important and useful. The California decision stated that it was the federal government's responsibility and not that of the state to make decisions concerning nuclear power. The working out of this decision, however, is expected to take several years, as it is sure to be appealed to the U.S. Supreme Court. (California's Governor Jerry Brown has already stated his intent to appeal, as have other groups.)

The nation cannot wait that long to make a decision on nuclear waste. A faster route to a sane waste policy is to bypass the president's stalling policy by pushing some good legislation through Congress. This seems to be a real possibility at present. In the past year two different legislative options have been introduced by California Republican Barry Goldwater, Jr., either one of which could very quickly resolve the waste issue. Both options specify that the United States must commit itself to a national waste disposal program similar to the one presented here.

The first bill is HR 4019, introduced in the House May 9, 1979. HR 4019 would create a waste disposal program to solidify wastes and have the first deep underground waste depository in operation by 1988. To get the question resolved even more quickly, Representative Goldwater is

working with others on the Energy Research and Production Subcommittee of the House Science and Technology Committee to pass an amendment on waste management to the House Appropriations Committee, which is currently marking up its budget recommendations for existing programs. This amendment would authorize $177 million to immediately begin the waste disposal plan.

The proposed amendment passed in a vote of the full House committee, and congressional sources feel that it is likely to pass both the House and the Senate—if the necessary constituency support is generated (see box).

A Viable Nuclear Waste Program

In general, nuclear waste programs here and internationally are converging on the same solution—a solution proposed 20 years ago during the nuclear industry's infancy. The United States, in fact, was committed to this program until President Carter's decision in April 1977 to halt commercial reprocessing of nuclear fuel and to stop the construction of the Barnwell, S.C. reprocessing plant, then 75 percent complete.

There are three basic parts to a nuclear waste management program: separating the radioactive fission product wastes from the spent fuel, recycling the unused uranium and plutonium fuel included in the spent fuel back into nuclear power reactors, and routing the wastes through a waste storage process. As described in more detail below, the process consists of storing the waste in concentrated liquid form in holding tanks for a period of approximately 10 years, solidifying this waste into a very stable glassified form, and sealing it into a metal container to be transported to an underground depository for permanent long-term storage. To cover all possibilities, the depository should be designed so that during the first 100 years of storage, the wastes could be retrieved, in case it were decided later to make productive use of the valuable waste products or to dispose of them by new, more advanced technologies.

The point is that we are not dealing with developing a new technology, such as nuclear fusion reactors, magnetohydrodynamic energy conversion systems, or advanced fission reactors. We are talking about permanently burying something for a long time, using technologies that exist now and are known to work. The tasks at hand are to plan and design this waste disposal program; to engineer it; to build and operate the facilities; and, finally, to monitor and collect data after the start of operations so that any necessary improvements can be made in this facility and in future waste disposal facilities as new things are learned.

In short, all that remains to solving the nation's nuclear waste problem is to engineer and construct the appropriate storage systems.

What Are Nuclear Wastes?

Before the president's April 1977 directive, nuclear wastes in the United States were generally classified as high-level wastes (HLW), transuranic wastes (TRU), low-level wastes (LLW), uranium mine and mill tailings, and gaseous effluents from operating reactors or reprocessing plants. Although all types of waste are important, the most important, and the one causing the major controversy now, is high-level waste; that is, waste that has high radioactivity levels. High-level wastes include all the fission products built up in spent fuel over an approximate three-year period of operation, as well as small amounts of some transuranic elements that are left over after the reusable uranium and plutonium have been removed for recycling. Figure 1 depicts this breakdown of materials, beginning with the new fuel and ending with spent fuel and left-over products.

Fission products are almost always unstable (that is, radioactive) isotopes of these elements and must decay for varying time periods, depending on the element, in order to become stable (that is, nonradioactive). The decay time period can vary from a few minutes to several thousand years or more. These longer-lived fission products make up the bulk of the high-level wastes that have to be disposed of permanently or for long time periods.

The other source of nuclear waste within the fuel includes the radioactive elements created by a nonfission capture of a neutron in uranium or some other heavy element in the fuel. These are generally called the transuranic elements and include neptunium, americium, and curium, plus small amounts of plutonium and uranium that do not get separated out during the reprocessing operation. Although very small in quantity compared to the fission product waste, these transuranic elements are

The Goldwater Amendment

The House Science and Technology Committee unanimously agreed to start construction on four deep-underground repositories to dispose of radioactive wastes in a vote May 8. "This is probably the most significant legislation passed by the Congress to provide safety for the public from our accumulating radioactive wastes," stated Congressmen Barry Goldwater, Jr. (R-Calif.), Don Fuqua (D-Fla.), and Mike McCormack (D-Wash.), who wrote the legislation.

The legislation, known as the Goldwater amendment, instructs the Department of Energy in its fiscal year 1981 authorization to locate the first two repositories before the beginning of 1981. The first is to be in operation in 1986 and the second in 1987.

Addressing the fact that the Carter administration plans to delay the choice of a repository location until 1987 and completion of the repository until the year 2006, Goldwater emphasized: "We have the technology. We have the need. The Congress is showing the administration the methods and schedule for solving nuclear waste disposal."

Goldwater has urged supporters of the bill to write their congressmen and senators.

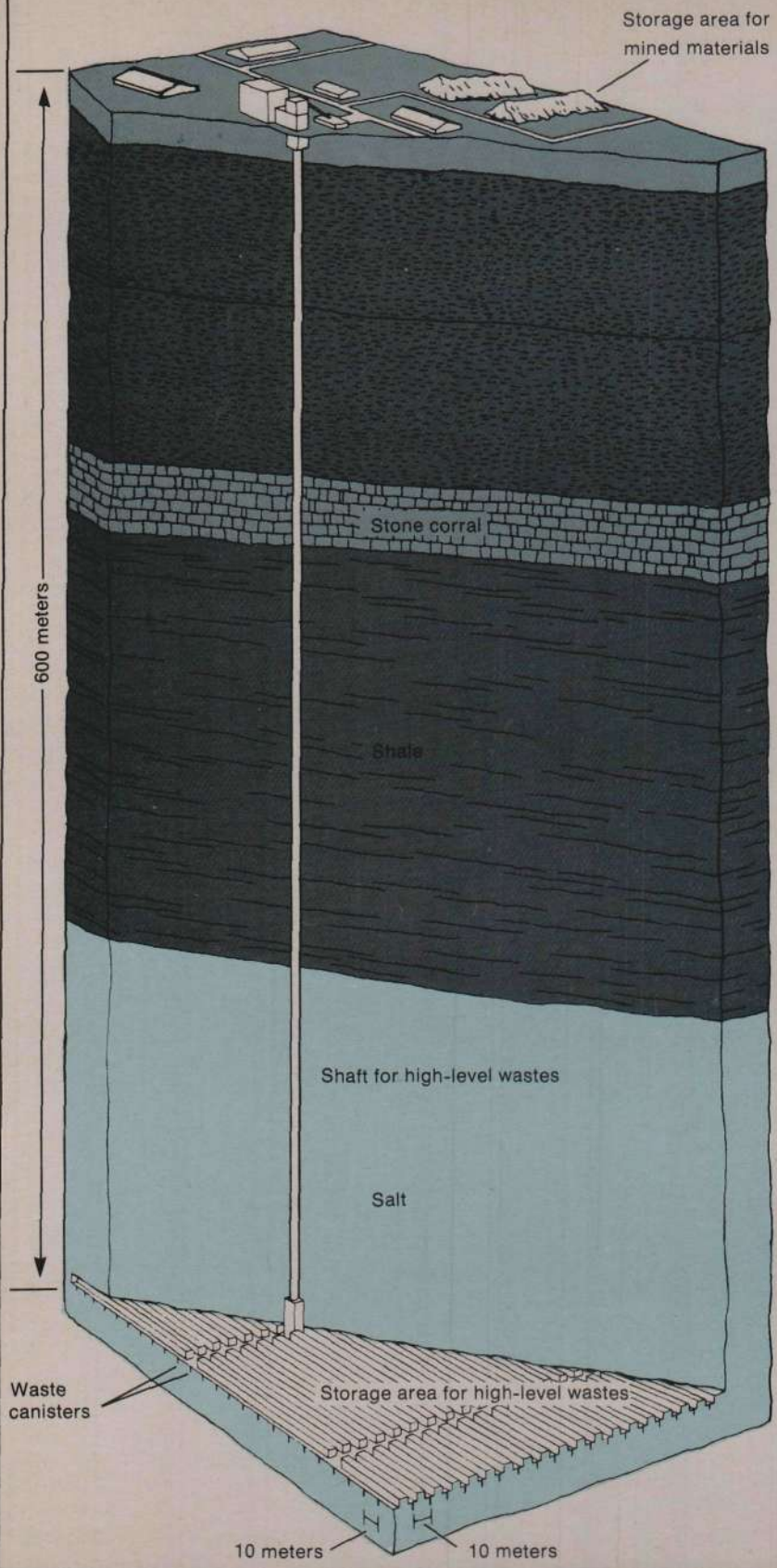


Figure 2
DEEP UNDERGROUND NUCLEAR WASTE DEPOSITORY

Burial of high-level wastes in stable rock salt formations is the method preferred by most U.S. experts. The solid waste canisters would be lowered down a shaft to a storage area approximately 600 meters underground and then stored in holes drilled in the rock salt. The spacing of these holes would be approximately 10 meters to allow for dissipation of the heat without exceeding the design temperature limits in the canisters and salt formation. Assuming that each canister requires 100 square meters of salt around it for cooling, less than half a square kilometer would be needed to store the high-level wastes produced annually if the United States had an all nuclear electric economy of 400 1,000 megawatt-electric plants. In fact, the United States has only about 10 percent of that quantity in nuclear electricity now, or about 45,000 megawatts-electric. This will require only a small fraction (.05) of a square kilometer for storage annually.

In addition to experimental evidence from safety studies at the Hanford, Washington site, geologists recently uncovered evidence in Gabon, Africa of a natural fission reactor that operated underground billions of years ago for a period of about 500,000 years—considerably longer than the 40-year lifetime of today's nuclear reactors. The natural fission chain reaction that occurred was maintained as a result of the uranium isotopic content and the natural ground water flow. Although fission product activity has long since decayed, traces of the plutonium and its radioactive decay products are still evident. The stable fission products and the plutonium decay products both appear to have remained localized, which gives us very good evidence of the safety of storing nuclear wastes underground. Of course, nuclear wastes today will be solidified, containerized, and sealed in a vault, in addition to being located deep underground.

Battelle Photo

Heater test area of the Rockwell Near Surface Test Facility at Hanford, Wash. that will demonstrate what happens to rock formations under the simulated thermal output of nuclear waste.

important because they have very long decay times and, therefore, require long-term storage.

It is only this small portion of the spent fuel, less than 4 percent, that is considered high-level waste and must be disposed of.

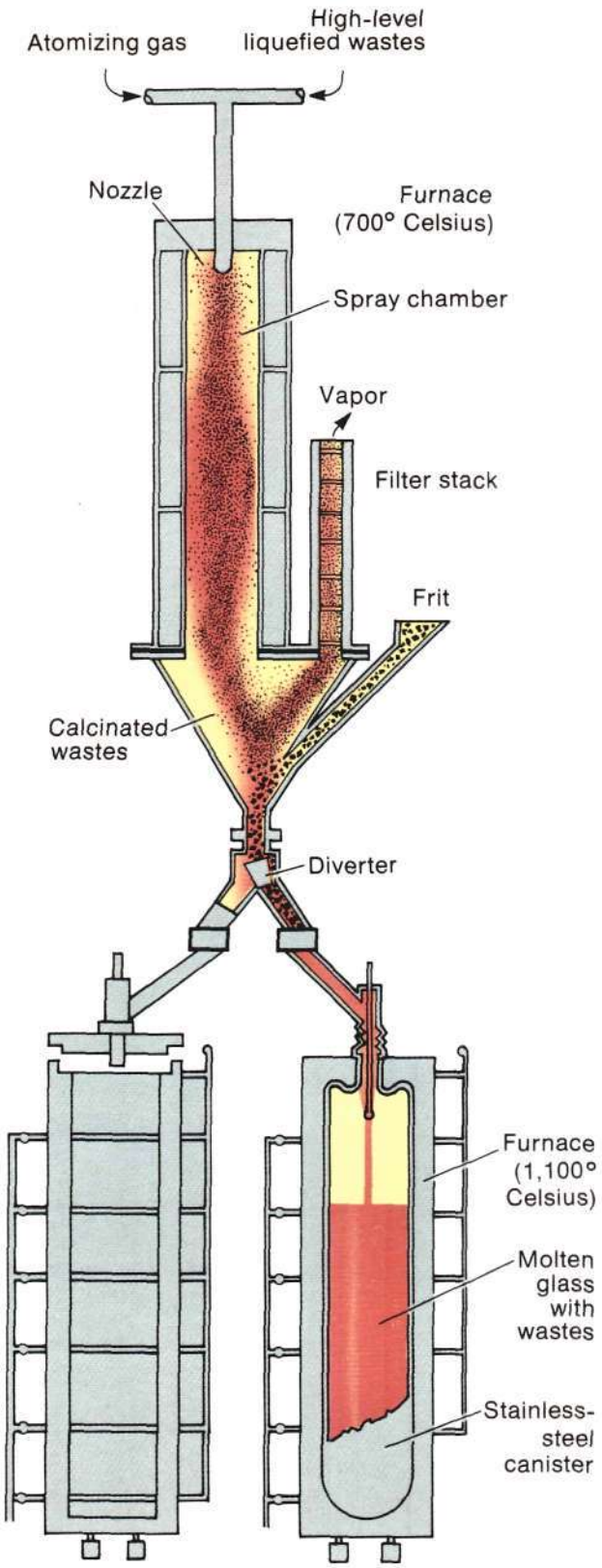
Since President Carter's decision to stop fuel reprocessing, the United States has been left with the situation where all spent fuel is considered to be nuclear waste material. This has increased the amount of waste products, radioactivity, and heat production levels to be handled, since all spent fuel (100%) must be treated as high-level waste (see Figure 1). In addition, the prohibition of reprocessing essentially throws away 40 percent of the required fuel for new fuel elements that could be recycled back into the reactor—a combination of uranium-235, plutonium-239, and plutonium-241. Over a 40-year lifetime of a single 1,000 megawatt-electric nuclear power plant, this would amount to the equivalent of throwing away more than 130 million barrels of oil or 37 million tons of coal!

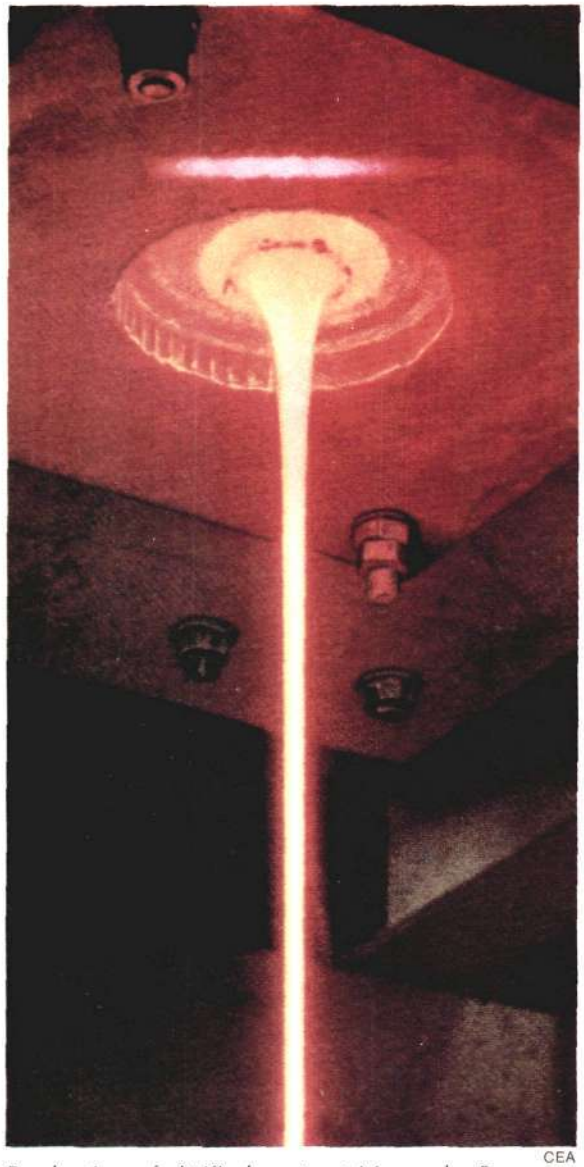
Furthermore, if the primary concern is to get rid of plutonium as quickly as possible, the best way by far is to get it back into a light water reactor or the fast breeder reactor to burn it up as fuel, instead of wastefully burying it.

The only competent way of dealing with nuclear waste is to integrate the waste products into a fully closed nuclear fuel cycle; that is, a fuel cycle with fuel reprocessing. In a closed fuel cycle, nuclear waste becomes a by-product to be disposed of in a straightforward manner—a solution backed by the Fusion Energy Foundation, the nuclear industry, the advanced sector nations, and, most recently, by the developing nations.

To implement a program of safely and economically disposing of nuclear wastes in the United States, it is essential that the nation reinstitute a fuel reprocessing policy. Until that time, a temporary measure for waste disposal must be the finding or constructing of adequate storage areas, away from present reactor sites, simply to store the current and future spent fuel coming out of operating nuclear plants. It should be emphasized that this is only a stop-gap measure; the actual solution to the problem must involve reprocessing. Once fuel reprocessing is reestablished, it will be a simple matter of shipping these stored fuel bundles to the reprocessing plant. Currently, there are no plans to bury any of these valuable fuel elements until sometime in the mid to late 1990s, which is long after the nuclear fight will have been won.

As of early 1979, the amounts of the nuclear waste being stored were as follows: the United States has approximately 4,400 metric tons of commercially spent fuel stored either in reactors or in the few available away-from-reactor





CEA

Production of vitrified waste at Marcoule, France.

Figure 3
VITRIFYING HIGH-LEVEL NUCLEAR WASTES

A process similar to the one shown in the figure is now in commercial operation in Marcoule, France. The U.S. process, called vitrification, converts the liquid wastes into solid glass cylinders about 300 centimeters long and 30 centimeters in diameter. In the single-step solidification process depicted here, the liquid high-level waste is converted into a fine powder inside a calcining chamber, mixed with glass-making frit, and melted into a block of glass within the thick stainless-steel canister in which it will eventually be stored. The process is continuous: When the canister is full, the flow is switched by a diverter valve into a new canister.

storage areas. Only about 4 percent of this fuel, 176 metric tons, is HLW that would be separated out during reprocessing. By the year 2000, more than 98,000 metric tons of spent fuel is expected, with about 3,920 metric tons of this as HLW.

In addition, the amount of reprocessed HLW currently in the United States consists of approximately 70 million gallons from the Department of Defense and only 0.6 million gallons from the one commercial U.S. reprocessing plant, the now-closed facility at West Valley, New York. Reprocessing fuel and separating out the waste will reduce by more than 25 times the quantity of waste material that must be disposed of. This, combined with the reduced radioactivity and heat generation, is an additional important advantage of a fuel reprocessing system.

Storage Technology

There are two technical problems in handling and storing radioactive nuclear fission waste material. The first is the radioactivity from the decay of unstable elements by either alpha or beta particles and gamma rays. This radiation is dangerous to human beings from external or internal sources; therefore, it must be kept isolated from the biosphere for as long as the activity remains high.

The second problem is that radioactive decay produces energy in the form of heat, and this heat must be dissipated for as long a time period required in order to keep material temperatures below certain design limits. Both the shielding and the heat removal must be resolved simultaneously.

The most technically developed process for high-level waste disposal is to store the waste in concentrated liquid form at ground level for a cooling period of 5 to 10 years. At that point it can be solidified into small canisters and buried in a deep underground location in thick, stable rock-salt strata. Liquid storage of the waste and eventual solidification all will take place on the reprocessing plant site (for example, the Barnwell facility) in a completely controlled and monitored environment. For years storage of liquid wastes has been a state-of-the-art technology. In fact, the Department of Defense has used storage in this form since the early 1940s and has highly developed the technique (Figure 2).

This proposed solidification process uses an automated system that converts the liquid waste by evaporation to a fine powder, mixes it with a fine glassy frit material, and converts it to a solid glassy cylinder by heating the mixture to melting and then solidifying it (Figure 3). This is already a developed technology and is now used commercially in France, as shown in the photograph. The solid waste

What the Experts Say About Radioactive Nuclear Waste

American Institute of Chemical Engineers, Nuclear Engineering Division policy statement, 1977:

"... Satisfactory techniques exist today for safe radioactive materials handling, the reprocessing of spent fuel, and solidification of high-level wastes.... Several candidate options for ultimate disposal are ready for demonstration. These techniques are being improved rapidly as the technology continues to advance. Other countries have recognized this, and have overtaken the United States in the rate of introduction of efficient nuclear power plants and waste treatment techniques.... The Institute believes that actual demonstration of radioactive waste disposal is sufficiently urgent that it is far better to proceed with an acceptable solution than to delay by looking for unnecessary minor benefits which might possibly emerge from alternatives...."

Institute representative **Dr. Ernest F. Gloyna** *in testimony to the House* Science and Technology Committee, March 6, 1980:

"... The design and construction of a facility and the operation of a subsurface repository can be accomplished with existing engineering knowledge. There is a proven technology for the separation of radioactive waste from nuclear fuel—we have been doing that for years. Wastes can be stored safely on the surface of the earth in interim storage, or placed into suitable geologic repositories—either permanently or for later reburial. What we lack is not technology, but policy...."

American Nuclear Society, 1979:

"... Based upon various large-scale tests and engineering development in a 25-year research and development program, many prestigious studies in the past few years have concluded the safe disposal of nuclear wastes in a mined repository is an acceptable approach.... The American Nuclear Society believes that expeditious, forthright action is required on the part of the federal government to construct and place in operation at a repository for permanent high-level wastes disposal at the earliest possible time, as a part of a national nuclear waste disposal program...."

American Physical Society, study on Nuclear Fuel Cycles and Waste Management, published in *Reviews of Modern Physics*, 1978:

"... The technology exists for recoverable storage of the spent fuel with minimal deterioration to preserve the associated resources, but full-scale demonstration is required before use....

"Effective long-term isolation for spent fuel, high-level or transuranic waste can be achieved by geologic emplacement. A waste repository can be developed in accord with appropriate site selection criteria that would ensure low probability that erosion, volcanism, meteorite impact and other natural events could breach the repository...."

Association for Cooperation in Engineering, Coordinating Committee on Energy (This association represents 24 major engineering professional societies in the United States, with a combined membership of more than 700,000 engineers.), 1980:

Continued on page 56

cylinder is sealed in a stainless steel canister and shipped to an underground burial site in specially designed shipping casks.

The only part of this waste disposal process that does not yet exist is the deep underground burial site, which can be developed and constructed with state-of-the-art technology. The actual storage area would be located 600 meters underground, in the middle of a thick salt layer. The stainless steel canisters would then be placed inside other containers made out of high-conducting iron oxide concrete that was specially designed to protect against possible salt corrosion. This concrete canister would then be inserted in cylindrical holes drilled into the salt. Heat is transferred and dissipated by conduction from the waste products, through the containers, and into the surrounding salt medium. The canisters could remain there forever or could be removed during the early decades of operation. This capability for removal might be desirable if it were later decided to use the waste products, their radioactivity, or heat energy in a productive way, or if some modification of canister design were needed. Therefore, it is recommended that at least the first few storage facilities be designed with a retrievability option for the first 75 to 100 years.

Because we know more about rock salt formations and their interaction with nuclear wastes, the first one or two depositories should be located in such formations. Most U.S. experts agree that this is what we should do, and even the recent assessment completed by the Interagency Review Group on Nuclear Wastes, a multidepartmental task force set up by President Carter in April 1977, recommends this as a first approach that could be in operation by 1988.

Burial in other types of geological formations such as granite, basalt, and slate, has also been suggested. As the Interagency Review Group recommended, research should continue on an expanded basis into these areas as well as rock salt formations. It is possible that such formations might be found to have some advantages over salt. Additionally, if for some unforeseen reason the rock salt depository does not appear to be operating according to design expectations during the first few decades of service, the canisters could be removed and transferred to this new rock formation-based depository. And having such a back-up capability should satisfy even the most critical opponents of nuclear power.

Jon Gilbertson, director of nuclear engineering for the Fusion Energy Foundation, is a leading authority on nuclear safety.

What the Experts Say

Continued from page 55

". . . Much development of solid waste forms has been done and technology is well in hand, some of it already demonstrated on a large scale. . . . Neither the specifications of solid form nor the location of the repository have yet been decided. It is the lack of these decisions rather than the lack of technology that stands in the way of the disposal of radioactive waste. . . ."

Electric Power Research Institute, testimony of Dr. Floyd L. Culler, Jr., president, to the House Science and Technology Committee, 1979:

". . . The body of technology developed over this period [of 25 years] has essentially confirmed both the early projections of the adequacy of technical approaches employing vitrified wastes in salt repositories, and the technical adequacy of at least a half a dozen other waste forms and geologic media for the long-term isolation of wastes from the biosphere. . . ."

National Academy of Sciences, Committee on Nuclear and Alternative Energy Systems, in "Energy in Transition, 1985-2010," Jan. 14, 1980:

". . . No insurmountable technical obstacles are foreseen to preclude safe disposal of nuclear wastes in geological formations. All necessary process steps for immobilizing high- and low-level wastes have been developed, and there are no technical barriers to their implementation. . . ."

What Other Nations Say About Waste

Australia, J.M. Costello of the Atomic Energy Commission, in a 1977 report:

". . . The technology for safe management of radioactive waste is already available. It now remains to gain public confidence by demonstrating ultimate disposal methods and their safety. . . ."

Canada, The Minister of Energy, Mines and Resources of Canada, in a study, "The Management of Canada's Nuclear Wastes," Aug. 31, 1977:

". . . From all our considerations, we now believe deep geological burial is a potentially very safe method of disposal. This accords with recommendations being made in several other countries. . . ."

Sweden, government study conducted by Kärn-Bränsle-Säkerhet, 1978:

". . . Even in the case where a number of unfavorable assumptions have been made, the calculated changes in the radiation environment are considerably less than normally occurring natural variations. These natural variations do not have any effects on either man or ecological systems which can be demonstrated today. The calculated maximum radiation doses due to leakage from a final repository are below the limit values for nuclear power plants which have been issued by the radiation protection authorities in Sweden. The proposed method for the final storage of high-level waste glass is therefore deemed to be absolutely safe. . . ."

International Atomic Energy Agency, summary report on nuclear waste disposal, 1979:

". . . The technology for handling [high-level wastes] is developed; the difficulty is in deciding which of several methods should be used on a commercial basis. . . ."

The Riemann-LaRouche Model

Breakthrough in Thermodynamics

by Carol White

THE LATEST DEVELOPMENTS of the Riemann-LaRouche economic model imply a fundamental breakthrough for thermodynamics, the rigorous analysis of the economy as a physical system. Specifically, the advance in the model treats capital as a thermodynamic category, allowing the economy as a whole to be modeled as a thermodynamic system in simple but precise terms.[1] This has led to the surprising discovery that the two components of entropy within the economic system are, first, the overhead costs of the economy and second, fixed capital that is not depreciated in a given time period.

As the model's results have shown, this means that it is to the advantage of the economy to depreciate fixed capital as rapidly as possible, introducing more advanced technologies at an ever-increasing rate. If the current fiscal-economic policies are not quickly reversed, the model forecasts that the U.S. economy will die (Figure 1).

The Riemann-LaRouche model was developed by a task force headed by Uwe Parpart, director of research for the Fusion Energy Foundation, and commissioned by Lyndon H. LaRouche, Jr. LaRouche based the model design on the applications to the economy of Bernhard Riemann's theoretical work on shock waves.

The work in developing the model has gone through several phases. LaRouche first elaborated all of the major conceptions of Riemannian economics in the 1950s, including a global noncomputer modeling approach using bar diagrams and flow charts. But it was not until the 1970s that he was able to assemble a project research and development group capable of implementing his programmatic ideas in detail. Only this past year has the work been done to allow the development of a computer simulation model of the economy.

The model is a complete departure from every other econometric model in use. Typical models evaluate trend lines. The Riemann-LaRouche model directly reflects the interplay between political decision making (on questions such as tax and credit policy, which, in turn, affect investment decision making) and the generation of surplus wealth that can be reinvested in the economy's development. The vitality of an economy, like that of a living organism, depends upon its ability to sustain an adequate rate of growth.

The Basic Parameters of the Economy

The basic parameters of the economy used in developing the model are as follows:

E represents the total output of a society for a given period. It can be considered as the total energy of the economic system.

S is the surplus part of that output over and above the cost of repeating the cycle of production.

V is the cost of maintaining the workforce directly involved in producing tangible goods.

C represents the depreciation of fixed capital and the replacement cost for raw materials.

d is a catch-all category combining useful nonproductive labor such as teachers and administrators with all other overhead costs in the economy.

The key categories of the model are a series of ratios that together, by first approximation, characterize its growth potential.

First, there is the rate at which the portion of the workforce which is employed in tangible goods production is able to produce a surplus above the needs of the productive workforce and its dependents to maintain themselves. Measured in constant dollars, this is characterized by S/V.

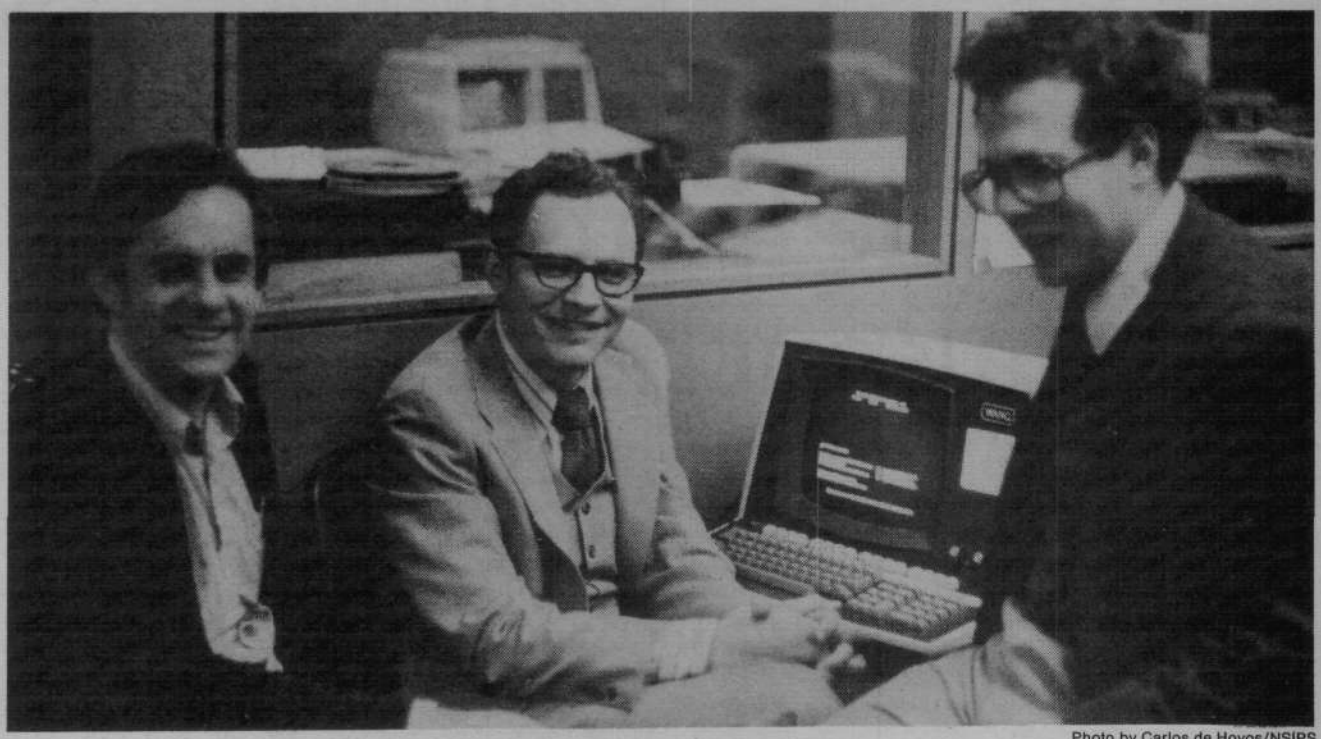


Photo by Carlos de Hoyos/NSIPS

Team leaders for the Riemann-LaRouche economic model project: (from left): Uwe Parpart, director of research for the Fusion Energy Foundation; Dr. Steven Bardwell, associate editor of Fusion *magazine; and David Goldman, economics editor of the* Executive Intelligence Review.

The portion of reinvestible surplus that is allocated to maintain an increase in that workforce is characterized by $\Delta V/(C+V)$.

S must be reduced by *d*, that share of surplus used to support the portion of the population not employed in direct production of tangible goods and the material cost of maintaining that portion of the population at work. (S − d is known as *S'* or net profit.) From this standpoint, military production falls into the category of *d* although it may have useful technical by-products and it may be politically necessary.

Measuring Productivity

The productivity of the workforce then can be considered as the ratio S/V, but the total productive potential of the society also depends upon decisions about how that workforce is deployed. Immediately, the combined ratios S/V [$\Delta V/(C+V)$] give the rate at which new surplus will be generated as a ratio of total output by the industrial workforce.

If we assume for the moment that the category *d* remains constant, the ratio S/(C+V) is a measure of the productivity of the society. The ratio S/(C+V) less the rate of d/(C+V), or S'/(C+V), is a measure of the viability of that society. The rate of increase of S'/(C+V) over the course of time represents what LaRouche calls negentropy. *V* may increase because the workforce has increased in size, but it will also increase with increases in the standard of living or an increase in the price of consumer goods.

There is a direct, demonstrable correlation between the standard of living of a population and its productivity. Nonetheless, at any given technological level, the allocation of $\Delta V/(C+V)$, in other words, the composition of the reinvestible surplus, is determined. Every employed worker demands a certain determinate investment of plant and equipment and raw materials in order to function at optimal productivity. In the short term, S/(C+V) can be made to increase by cannibalizing capital reinvestment (asset-stripping), but this will have disastrous medium- and long-term consequences. (This is exemplified by the present condition of the U.S. steel industry. In a period of recovery from recession, S/(C+V) can increase by utilizing unused capacity or back inventory, but productivity can *really* increase only if S/V is increasing.)

Other economic models use output per manhour rather than S/V to indicate productivity. The Riemann-LaRouche model uses the ratio of output per manhour compared to the output necessary to sustain the industrial workforce. It further refines this ratio by looking at that surplus portion of output above the level necessary to merely sustain production. Output per manhour is a useful indicator, but it is not a parameter for productivity. It is a measure in terms of gross output, gross national product.

One of the key features of the Riemann-LaRouche model is that it further distinguishes the "Helmholtz free energy" of the economy, *S'*, from gross profit. *S'* is net profit, that portion of production that is reinvestible surplus. To do this, LaRouche has established the category of waste and overhead, *d*. A population of farmers that has

been forced to produce cocaine or marijuana instead of food is no longer productive and adds nothing to *S*, no matter what its volume of output. In fact, the full cost of this type of economic activity falls into the category of *d*.

Similarly, the productivity of the workforce may seem to increase, because the pattern of production has shifted to emphasize the less energy-intensive or capital-intensive branches of industry, as is happening today, or because of a global transfer of the workforce into service industry jobs, which produce no tangible goods. For instance, the U.S. economy has shifted from a two-thirds deployment of its workforce in tangible goods production, the ratio at the beginning of the 1950s, to a one-third ratio today. As *d* increases, the economy can no longer generate surplus at the same rate, unless such a shift is accompanied by a rise in productivity.

An example is the shift in employment in the 1970s to production of antipollution devices, a *nonproductive* activity whose output has absorbed almost the whole of new capital investment in the United States. If the automobile workforce now unemployed (one-third of the total) was put back to work producing antipollution devices, the economy as a whole would measurably suffer, but this could not be demonstrated by simply computing their output per manhour.

Energy Efficiency Vs. Energy Throughput

The ratio S/V can be increased in the short run by increasing the efficiency of employment or by demanding more output from workers. But fundamentally it will increase only as a function of the introduction of a higher level of technology into the society. It is directly correlated with the increase in the density of energy throughput per worker. Compare the 20th-century American high-technology farmer to his 18th-century forebear and the point is obvious. Therefore, the ratio of capital investment in the society is a major determinant of productivity. The parameter that measures this is capital intensivity, the ratio C/V.

However, S/V is not simply a function of energy throughput. It is also necessary to consider energy efficiency. Failure to maintain investment appropriately has meant that the U.S. steel industry consumes more energy for less output than its German or Japanese counterparts. Failure to invest in appropriate new technologies in fact guarantees that a given society will have a greater energy investment for proportionately less output as time goes on.

Thus, the failure in the United States to invest in developing commercial fusion reactors and the deliberate sabotage of nuclear power plant construction mean that the energy necessary to produce fuel will increase in cost as cheap sources of oil and coal are used up. An ox uses 10 times as much energy as a tractor to do the same work. Traditionally this is hidden by the fact that the ox driver is forced to live at approximately the same standard of living as the ox.

In general, a healthy economy will show a rising rate of energy flux density; however, the rate of increase of energy-throughput may be reduced in periods of rapid absorption of new, more energy-efficient technologies, as in the period from 1959 to 1967 in the United States, which corresponds to the highest period of NASA spending. Recent propaganda from Club of Rome and Council on Foreign Relations sources has attempted to prove the opposite: that a healthy economy can be based on the conservation of energy and the substitution of labor for energy. This is an attempt on their part to justify turning the United States into a fascist economy.

The Fallacy of Energy "Conservation"

A 1979 report by Harvard Business School economists Robert Stobaugh and Daniel Yergin, which was published in the Council on Foreign Relations 1979 annual review, attempted to prove the case that government-mandated increases in energy prices would be beneficial to the economy. To prove this Stobaugh and Yergin cited statistics showing that gross manufacturing output per manhour in the economy had increased while the use of energy per manhour had declined. Similarly, Harvard economists Dale Jorgenson and Edward Hudson published a study in October 1978 under the title "Energy Prices and the U.S. Economy 1972-1976." There, they calculated that a 2.54 percent rise in the demand for labor occurred through a shift to less energy-intensive methods of production as energy prices rose. They concluded that a 16 percent decline in the quantity of energy input by the year 2000 will result in only a 3.2 percent drop in the Gross National Product and minor problems with productivity.

The Riemann-LaRouche group has taken these reports as a starting point to demonstrate that the arguments that the economy can "cool down" by reducing the consumption of energy, with only minor belt-tightening for the population as the result, are theoretically fallacious and practically disastrous.

LaRouche's project group has taken the correlations and turned them on their head, so to speak, by locating them in the context of the real economy. The Riemann-LaRouche project group embedded the correlation between energy consumption and output in a multidimensional phase space in order to look at the rate and type of capital formation, productivity measured by S/V, the rate of formation of *S'*, and the efficiency of energy use. They found, as any honest observer would have predicted, that the U.S. economy has been deteriorating since the first oil hoax in 1974. The two-dimensional phase space that merely correlates energy to output is deliberately deceptive precisely because it leaves out how this result was obtained. The model shows that the result was obtained by a reduction in capital formation and that any capital formation that occurred was mainly nonproductive investment in pollution-abatement equipment and in shifts from capital-intensive to labor-intensive employment, both guaranteed to raise energy inefficiency.

Phase Change for the Economy

In a series of computer-generated graphs (Figure 1) the Riemann-LaRouche team was able to show, merely by projecting the past trends of the real economy through 1985, that as early as this current year the economy would

be cannibalizing itself because it was producing a negative reinvestible surplus, *S'*.

Looking at the economy as a thermodynamic system, this means that the economy will go through a phase change. Just as water goes through a phase change to become ice or steam under conditions of changing energy throughput, the American economy will undergo phase change and cease to be an *industrial* capitalist economy, unless these trends are immediately reversed.

The point where *S'* equals zero is a critical point for the economy. It is at this point that the basic nature of the economy changes, and the process of self-cannibalization begins. In fact, the model to which the economic planners at Harvard University, Federal Reserve Chairman Paul Volcker, or Milton Friedman openly adhere in their calculations is the model of Nazi Germany's economy under Hitler's finance minister Hjalmar Schacht. They are willfully reducing the United States to conditions of economic self-cannibalization.

The statistics these economists use to show that their present economic policies will merely result in a little belt-tightening are deliberate lies. Nevertheless, these men are also incompetent to understand the magnitude of the disaster they are preparing. They themselves do not understand the rigorous significance of *S'* as the parameter upon which the life and death of the economy depend.

The United States is not Germany. It is the mainstay of the global economy. If these disinvestment policies are allowed to continue, if we do not have an immediate implementation of policies for stimulating economic growth and investment in advanced research and development, then America will not even be able to generate its own recovery from the depression, much less aid in reversing the global economic disaster a U.S. collapse would precipitate.

If the Carter administration program for building $88 billion worth of synthetic fuel plants during the next five years or the $280-billion synfuels program that other forces

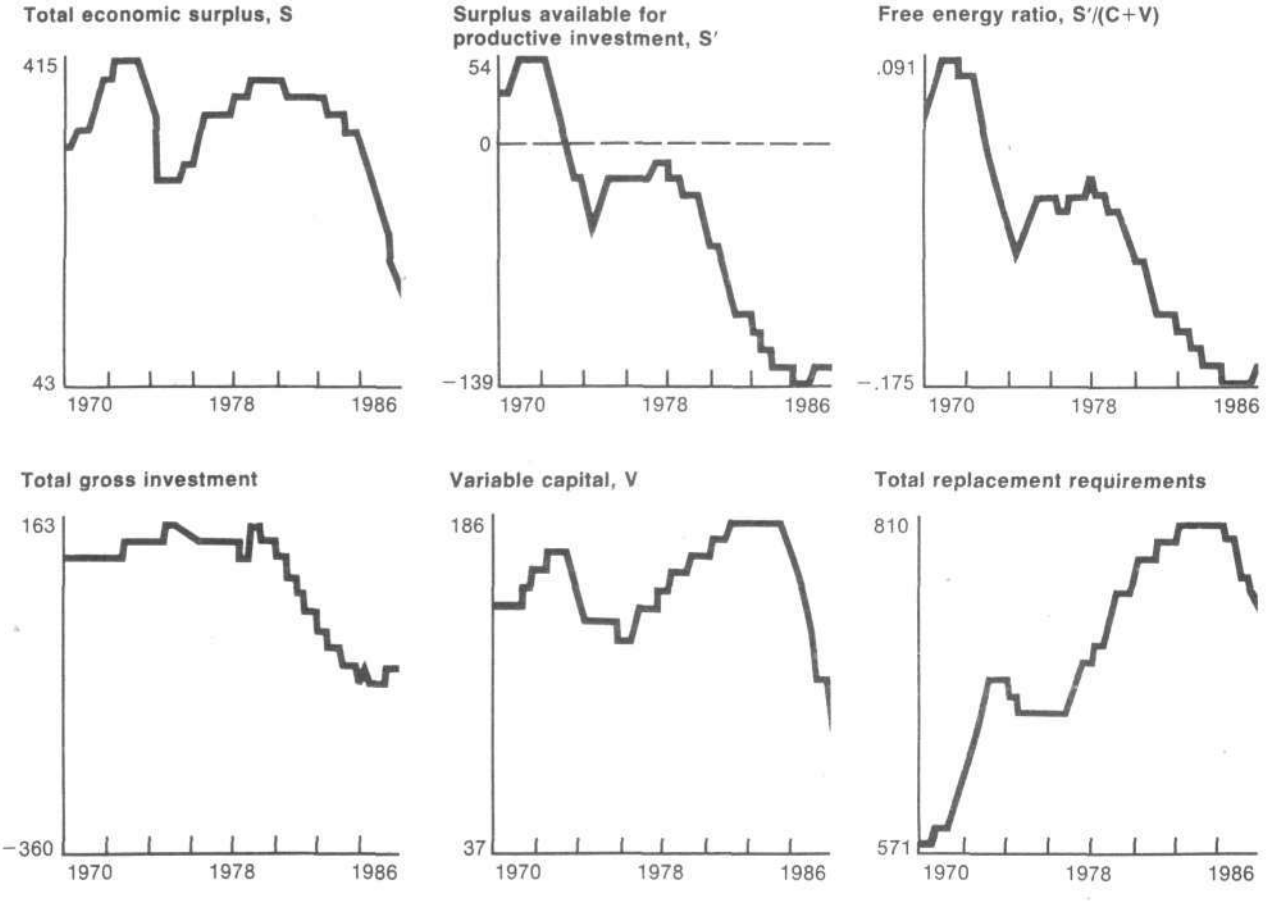


Figure 1
RIEMANN-LAROUCHE PROJECTIONS FOR THE U.S. ECONOMY
Computer projections are based on the assumption that present productivity relations persist through 1985. Vertical axes show billions of 1972 dollars. Total replacement requirements consist of variable capital plus circulating capital plus depreciation; the depreciation component of the replacement requirements reflects the amount of fixed capital that should be retired from production at a given point on the time axis.

in the administration are pushing are taken into consideration, the situation is even worse. This money will produce no return since at best it will have been spent merely to replace existing oil imports. In this case not only will reinvestible surplus be negative, but the model shows that, in the case of the $280 billion program, by 1982 *the entire surplus* in the economy will be negative. This trend is already observable in the failure of state and municipal governments to finance vital services such as schools and hospitals. After 1982, the economy will no longer merely be cannibalizing its plant and equipment—its fixed capital—but it will not be able to meet its raw-materials circulating capital costs.

The Riemann-LaRouche model has shown rigorously that if a minimal 3 percent per annum growth rate is not met in 1980, then the American republic as we know it will die.

What Is Energy?

In the course of conducting this study actual advances were made in the application of the model that demonstrate LaRouche's most fundamental conceptions. Since his original discovery, LaRouche has termed the self-developing quality of universal evolution *negentropy*. A rising rate of $S'/(C+V)$ actively reflects the negentropic characteristic of existence. The emergence of man as a socially evolving species reproducing itself at increasingly higher levels of technology, as well as the ordering of the three domains of existence—material, organic, and human—demonstrate that energy itself is not fixed in the universe. Conventionally, energy is measured according to its scalar equivalence; for example, 1 calorie is equivalent to the amount of heat necessary to raise 1 cubic centimeter of water 1 degree Celsius. But is the calorie content of an apple the same when it is burned as fuel, eaten by a horse, or eaten by a man? In the final analysis one would answer yes only if one thought it was appropriate to make lampshades out of human skin or put men to work as oxen. Human energy is not determinable as the heat from a body subject to combustion.

The development of society's "reducing power," its ability to turn ores into useful metals for example, can be considered in terms of the metric of increasing energy efficiency; but this begs the question. What is energy? The deployable energy released by a thermonuclear fusion process operating at millions of degrees is an energy that will change the course of development of the universe as a whole as it opens the possibility for extended space travel. Therefore, LaRouche has reformulated the concept of a "resource." A society's definition of its resources expresses the limitations imposed upon it by its existing level of technology.

Energy is not finite. It is a *transfinite* that is determinate at any given technological level of society. Energy grows and has grown with the evolution of the universe.

LaRouche has outlined the future development of the Riemann-LaRouche model as a thermohydrodynamic model that will utilize Riemannian shock-wave solutions to provide a rigorous determination of the two directions in which an economy "flows" simultaneously as energy grows. On the one hand, the Helmholtz free energy, S', increases as proper economic policy vectors the economy toward optimizing growth by simultaneously optimizing the rate of energy-flux density, energy efficiency, capital intensity, the quality of the workforce, productivity, and the free energy ratio, $S'/(C+V)$ itself. That is one time frame for progress.

But S' also operates in another time frame: the rate of spread of basic scientific invention through a given society. The rigorous quantification of this implies another whole dimension in the analysis of economic processes. It is the interplay of the rising rate of development of science with the rising rate of $S'/(C+V)$ that provides the shock waves of real economic progress and the transfinite manifolds of evolution. The application of this qualitative approach to the computer model has yet to be accomplished. However, the approach to modeling has accomplished a major theoretical breakthrough.

Fixed Capital Is a Component of Entropy

Heretofore, the unique success of the model in accurately forecasting recent economic developments, a success shared by no other model, was based in part upon prediscounting Gross National Product figures, in order to eliminate the large category of overhead expense, *d*, from what is ordinarily lumped in with useful production. Thus, dollar inflation was adjusted for (as is more or less the case with other models); and waste expenses such as misinvestment in a synthetics fuel program were rigorously accounted for by placing such investment in the category *d* rather than C. But there was no parameter capable of measuring the usefulness of capital investment.

Until the latest development on the model, in fact, it was impossible to take into account technically appropriate capital investment. Now, the Riemann-LaRouche team has provided such a parameter: the rate of depreciation of capital. By doing so, it has also redefined the notion of capital itself, to make it coherent with the actual practice of the American approach to capital investment.

The relevant advance in the model has been to treat capital as a thermodynamic category, just as it is treated in practice by industrial capitalists. This has allowed the economy as a whole to be modeled as a thermodynamic system, in precise terms. And out of this modeling it became clear that fixed capital that is not depreciated in a given time period, and *d*, or overhead, are the two components of entropy within the system.

How does this work? Some months ago a member of a delegation of American bankers was interviewed on his return from a conference of bankers held in London. He was struck by the difference in the two approaches to banking, that in London and the United States. As he said, in America if a customer is in trouble but is a good risk, a banker will make every effort to extend him additional credit in order to keep him afloat. In England, a banker will be happy to call in his collateral at the first sign of trouble. His aim is to turn over a quick profit from his investment. If that leads to asset-stripping, so be it. His

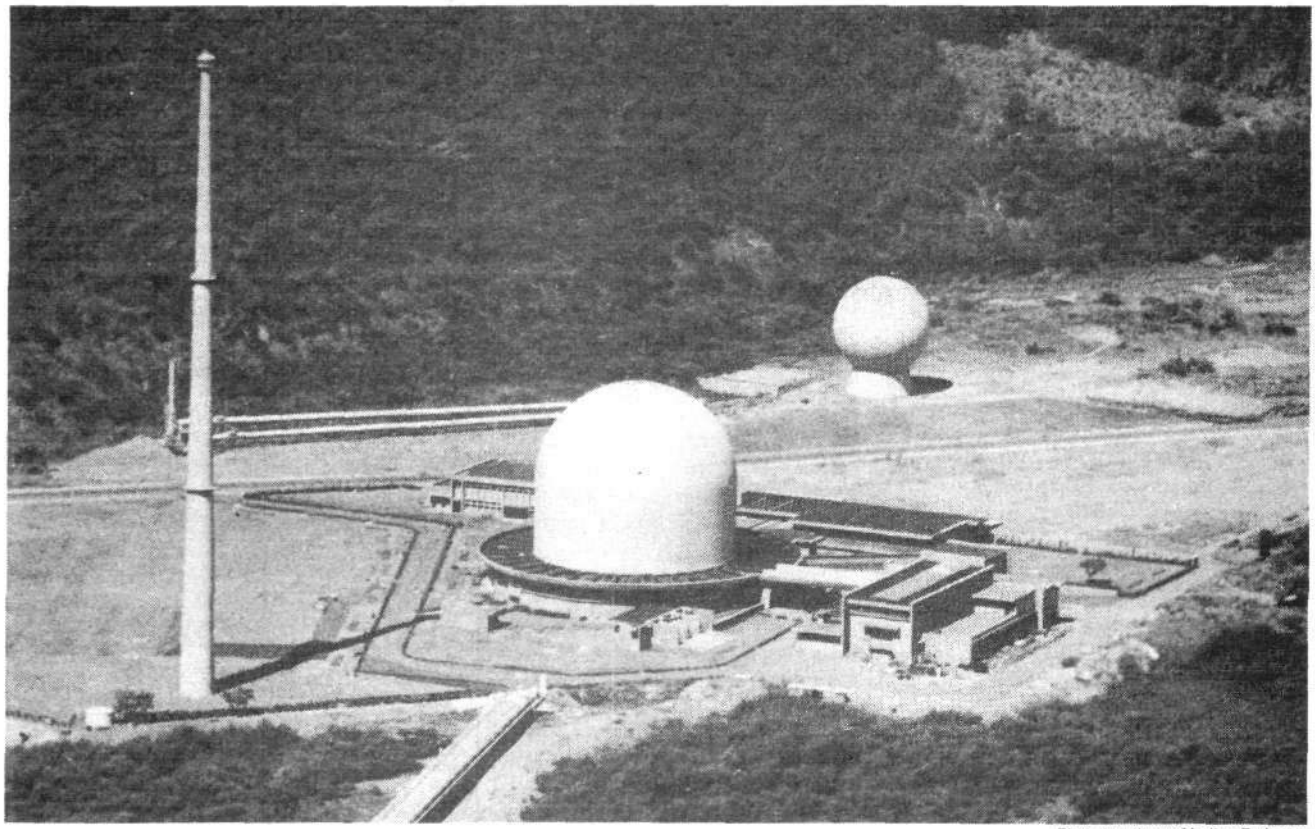


Photo courtesy of Indian Embassy

"job" is not to guarantee industry. This is the essential difference between the American system of industrial capitalism, developed by Alexander Hamilton and represented today by LaRouche, and the British system of finance capitalism, which is modeled on the practices of a feudal landlord concerned only with collecting his rent.

To the American, profits from capital are associated with the risks attached to decision-making involved in capital investment choices. Willingness to risk one's own capital is a sign of commitment to the validity of a judgment and is taken as such by bankers, who, in turn, back up that judgment by extending their own capital—or credit—to the venture. *American capitalism is venture capitalism.* In the British system, the contrary is the case. Capital is looked at as a *possession* in the same way that landed property is. It is a *fixed asset* that gives its owner the right of a return on his investment.

The recent breakthrough in the model thus makes clear that a factor of *constantly increasing entropy* is built into the British system of economics. Not accidentally, Britain has lagged miserably behind France, West Germany, Japan, and the United States in every parameter of industrial development since the latter part of the 19th century.

Debunking Classical Thermodynamics

The total internal energy of any thermodynamic system is the sum of the energy of two parts, the part that has the capacity to accomplish work in a new cycle of production and the part representing the heat flow that accompanies production but becomes dissipated. The first part is the *free energy of the system; the latter partly determines its* entropy.

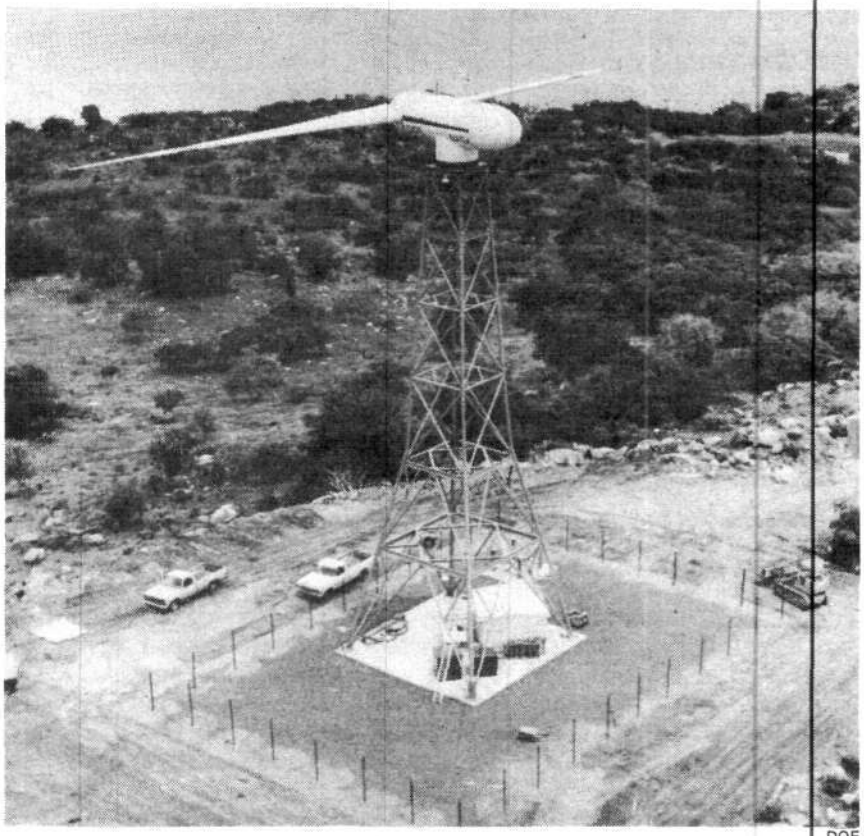
Although it should be obvious that the aim of any system should be to maximize the ratio of free energy to total energy—in economics $S'/(C+V)$—classical thermodynamics only rarely looks at this ratio. Instead, the problem is formulated negatively to emphasize the difference between the total usable energy and the free energy. This difference, the entropy, is the focus of classical thermodynamics.

This is an ideological problem.

The notion of free energy was first developed by Lazare Carnot and his son Sadi, and further elaborated by Helmholtz. "Helmholtz free energy" is a measure of the difference between total and usable energy in a thermodynamic system when its temperature is held constant. (Two other measures of free energy are used that hold either volume or pressure constant respectively.)

The distinction between total and free energy can be seen from an example cast in thermodynamic terms. If we have 4 gallons of water at 0 degrees Celsius and 1 gallon at 100 degrees Celsius in a room at 20 degrees (ambient), useful work can be extracted from the temperature differences between the two bodies. (We could, with an ideal engine, change all the internal energy into electricity, for example.) The total internal energy of the system is the sum of the energy of the two parts.

Now, if we mix the 5 gallons of water together, we will have 5 gallons at 20 degrees Celsius, a mixture with the same total energy as we started with—but with no "free"



DOE

"The key determinant of the efficiency of a thermodynamic system is the temperature at which it is operating. . . . The health of the economy, its thermodynamic efficiency, is determined by the rate at which technological innovation renders [capital] investment obsolete." Building windmills instead of nuclear plants lowers the "temperature" of an economy. Here, the U.S. Department of Energy's pilot wind project on Culebra Island, Puerto Rico and the nuclear reactor at Trombay in Bombay, India.

energy. Since the temperature difference between the water and air is zero, no work can be done with the total (internal) energy in the water. The free energy ratio has changed from 1 to 0.

The deployment of resources into President Carter's synthetic fuels program is equivalent to reducing the free energy of the economy by the amount of labor and resources deployed into that misinvestment. The amount of free energy in the system with synthetic fuels will not have increased despite the additional investment of raw materials and labor. Therefore, the free energy embodied in the labor before its employment in the program is reduced from 1 to 0. Had the energy been employed in building nuclear power plants, additional capacity to do work would have been added to the system.

Classical thermodynamics would say that the labor applied to the nuclear plant could not exceed its original energy value (conservation of energy); however, such a policy of investment could lead to a transfinite leap in energy if it provided a bridge to a fusion-powered economy. Classical thermodynamics insists that entropy is irreversible (to a high level of statistical improbability); yet even waste heat can be used productively, as the example of nuplex construction shows. Similarly nuclear "waste" is waste only to the extent that it is not reprocessed. The fixed capital that is entropic because it is not used in a given cycle of production becomes usable in future cycles.

The purpose of shifting emphasis from free energy to entropy is obvious. Lord Kelvin was the first to restate Newton's incompetent theory that energy is not conserved in the universe (God's clock must be constantly rewound) in terms of Carnot and Helmholtz's discovery of the significance of free energy. Kelvin stated axiomatically that entropy must increase in the universe as proof of the necessity of God's existence. Thus, the necessity is not proven by man's capacity for perfection, but by the incapacity of all creation! For any given determinate energy (that is, any fixed level of technology), entropy will increase, but it is precisely the transfinite, nonscalar nature of energy that actually determines the increase of free energy in the universe.

Since increases in productivity necessarily entail an increase in the ratio of capital investment in a given economy, it would seem to be an anomaly to describe nonutilized fixed capital as entropy. Isn't this an argument that could easily be adopted by an environmentalist? Here again we turn to the ideological distortion by Kelvin for an answer. In real industrial practice we do not seek to reduce entropy by running our steam engines without heat loss, slowly at low temperatures. The entropy of a system is the ratio of heat loss (or more generally loss of available energy) to the temperature at which it is operating (Q being heat and T temperature, it is $\delta Q/T$).[2] The key determinant of the efficiency of a thermodynamic system is the temperature at which it is operating.

The measure of temperature in an economic system is the *rate of depreciation of capital*. The higher the rate of depreciation, the higher the temperature of the economy. Just as a steam engine must be stoked and works most efficiently at high temperatures, so an economic system

EQUIVALENT MEASURES IN THERMODYNAMICS AND ECONOMICS

Thermodynamics	Economics
Pressure (P)	$\alpha\delta$
Volume (V)	Variable capital (V)
Temperature (T)	Depreciation rate (R)
Entropy	$J = \int(\underline{\delta} C, /R)$
Work $\underline{\delta} = p\,\underline{d}\,V^*$	$\underline{\delta} W = \alpha\delta\underline{d}\,V + (1-\alpha)\,\eta\underline{d}\,C^{**}$

*The reader should take note that $\underline{d}$ bears no relationship to the notation *d* in the text, which signifies overhead in the economy. Here $\underline{d}$ is the differential operator.

**$(1-\alpha)\,\eta\underline{d}\,C$ represents the transfer of value to the final product from raw materials, or as it is known, "circulating capital"; η represents the ratio of circulating to fixed capital. For pedagogic purposes, η has been set at zero, although this is not a necessary condition for the model. The analogy to thermodynamics is also rigorous when $\eta=0$.

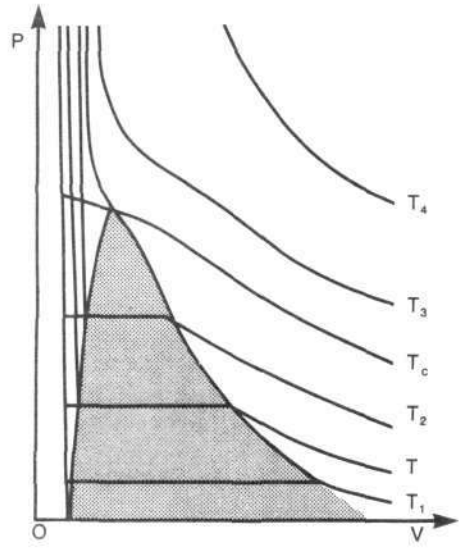


Figure 2
EQUATION OF STATE FOR A REAL GAS

A useful analogy to the equation of state of an economy is provided by the equation of state for a real gas. The pressure of the gas is on the vertical axis, and the volume of a given amount of the gas at that pressure on the horizontal axis. At high temperatures, the pressure and volume are inversely related, generating the family of hyperbolae shown (labeled T_4 and T_3). As the temperature decreases, however, these hyperbolae become distorted, until at a temperature T_c, the curve becomes horizontal for one value of pressure and volume. This is the highest condensation temperature of the gas. The singularity in the slope of the P-V curves indicates the onset of a phase change, liquefaction (in the shaded region).

demands higher and higher rates of investment in fixed capital. But the health of the economy, its thermodynamic efficiency, is determined by the rate at which technological innovation renders that capital obsolete.

The productivity of the economy will vary directly with the rate of depreciation. If the total energy of the economy is viewed as its total tangible output, then its free energy will be that part of the economy consumed each year (either individually or through the productive process). The entropy will be the sum of the category *d* and the ratio of nonutilized fixed capital divided by the rate of depreciation of that capital (see table).

The aptness of the thermodynamic model is startling. In classical thermodynamics, Boyle's law tells us that pressure times volume equals temperature times a constant, $PV = kT$. Thus, at constant volume, temperature varies directly with pressure.

In the economic model, the pressure of the economy is determined by an approximation of the free energy ratio itself, $[\Delta V/(C+V)][S/V]$—its productivity. The volume of the system is in this case the consumption level of the productive labor force. In a classical thermodynamic system a gas is measured by its volume; in the economic model the volume of consumption serves as a measure. The application of Boyle's law then states that the productivity multiplied by the investment in reproducing the workforce should determine the rate of depreciation. The required multiplication results in the value $[\Delta V/(C+V)]S$. If we make the assumption that *d* is held constant, this gives us the parameter for the rate of creation of surplus, which, as the previous analysis showed, does vary with the depreciation rate.

Point of No Return

We can now state that the rate of depreciation is itself a measure of the negentropic potential of an economy. This potential may vary from a temperature below the cost of replacing existing fixed capital, the present situation, to the even worse case predicted—a point where raw materials themselves cannot be replaced (the typical problem for the developing sector now under the duress of International Monetary Fund "conditionalities") to a breakeven point where $S' = 0$, to higher temperatures representing economic growth and increasing rates of growth caused by the introduction of new technologies that render fixed capital obsolete before it is physically depleted. (At $S' = 0$ the economy will not be stable because of the increase in entropy discussed above.)

The model is brought one step further by compiling what is known in thermodynamics as a graph of isotherms (Figure 2), a graph that shows the relation of pressure to volume in an ideal gas at a series of different temperatures (each curve represents the case at a given constant temperature). Such a chart represents those regions in which a phase change can be predicted.

Ordinarily, steam turns to water, or water to ice—that is, undergoes a phase change—when the temperature reaches 100 degrees Celsius or zero degrees respectively. However, a phase change will also occur at a constant

temperature when the gas is compressed (for temperatures at or below the critical temperature [S′=0]). Typical isotherms describe phase changes in gases. At very high temperatures the work done by a steam engine to lift a piston may cool the system without converting the gas to water. The system will then be described as taking a path downward from one temperature level to another, yet the trajectory will not lead into an area of potential instability where a phase change is likely to occur. But at lower temperatures this "danger" arises.

In the case of the economy, the rate of depreciation is an accurate isothermic measure (Figure 3). The depreciation rate reflects tax and credit policy, as well as the judgment by capitalists of whether it is advisable to risk investment. In this sense it is also a measure of the rate of inflation. An escalating rate of inflation encourages speculative investment; firms tend to hoard their liquidity position.

In a thermodynamic system there are two different ways in which a change of volume affects the system. If work is done to a system, for example by forcing a gas to compress, energy will be added to the system, and the temperature will rise. Conversely, work done by the system when a piston is pushed up by an expanding gas will mean that the energy level within the system is lowered.

Conventionally the source of replenishing this energy for a renewed cycle is not considered part of the system. It is described as a conveniently "infinite" reservoir. In the economy, we are not permitted to go "outside" the system for a fuel source; nevertheless we do have a transfinite reservoir of energy. This energy is indeed a function of the temperature of the system—that is, its technological level! Although energy is considered as a primary given under the so-called First Law of Thermodynamics, it is also a derived function that is not known directly.

In the economic model work is done on the system when the productivity of the workforce is increased. $S/V[\Delta V/(C+V]$ will vary directly with depreciation level. If work is done by the system without adequate reinvestment (refueling), the rate of depreciation will be lowered as the fixed capital is allowed to age. If the temperature is held constant in a thermodynamic system, there must be a tradeoff between pressure and volume. But as the system does work, without refueling, its temperature will be lowered. This coheres with the Jorgenson-Hudson results in which conservation of energy resulted in employing more labor at lower skill levels, accompanied by a reduction in gross output. They failed to demonstrate the correlated necessary decrease in the depreciation rate of the economy that followed from the energy-labor tradeoff.

This process is exactly what occurred in Schacht's Germany. As energy autarky was increased and synfuel programs introduced, an actual shortage of labor emerged—but native German labor was reduced to a bare subsistence, to be supplemented by slave labor, which was literally worked to death.

As the obsolescence rate of the economy increases,

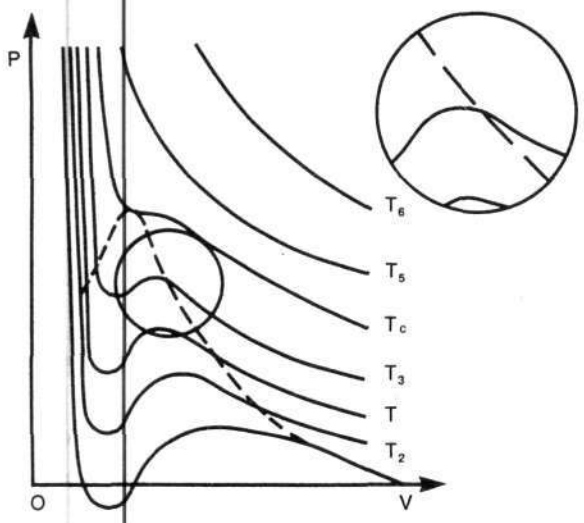
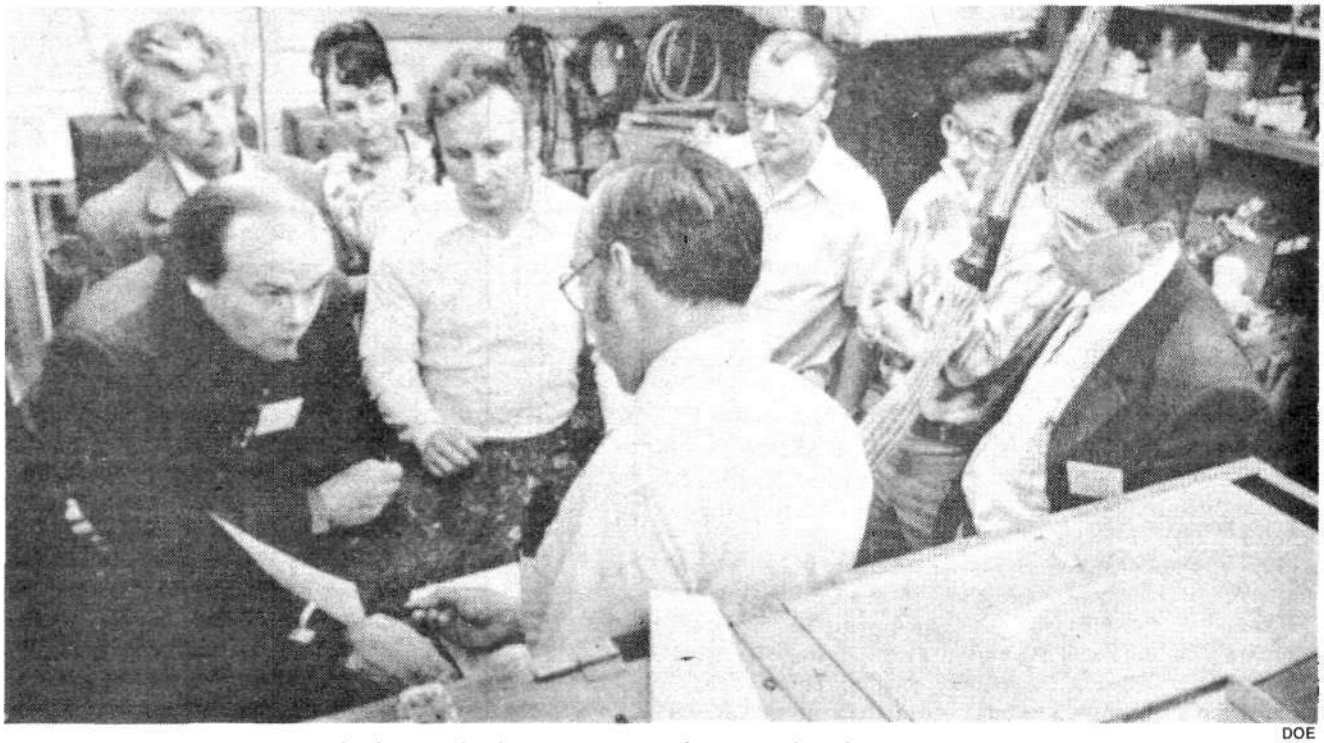


Figure 3
PHASE DIAGRAM FOR AN ECONOMY

By the same arguments that underlie classical thermodynamics, it can be shown that a capital-intensive economy has a phase diagram similar to that for a real gas, where pressure is replaced by $\alpha \cdot \delta$ and volume by V (variable capital). The depreciation rate corresponds to temperature. Thus, the hyperbola shown above for T_6 expresses the fact that for a given depreciation rate (that is, capital investment and composition of investment) the size of labor force and productivity required to maintain that depreciation schedule are inversely related. And, as in the case of a gas, lowering the depreciation rate corresponds to cooling of the economy, a process that can be carried on for only a finite amount of time before a phase change occurs; in the case of the economy, this phase change corresponds to a depression.

The inset shows in greater detail the dynamics of this phase change. It is known that some gases have the property that they can be supercooled below the nominal condensation point predicted by the phase diagram. In this case, the isotherm (the path at constant temperature) changes the sign of the slope. In the case of the economy, this property characterizes the present situation in which a phase change has yet to occur, but during which the dynamics of the economy are opposite to their normal behavior. The usual methods for dealing with inflation, for example, not only do not work, they make the problem worse, precisely because of the inflection in the phase diagram.

The trajectory of the U.S. economy over the last 10 years does not follow an isotherm, but has followed a trajectory taking it from near the curve labeled T_6 to that near T_3 as the productivity-composition product (the vertical axis) has decreased, and the labor force increased.



DOE

"What is the temperature of the human body? It is not 98.6 degrees Fahrenheit but the millions of degrees Fahrenheit that man can control and deploy in a thermonuclear fusion reactor." Here, a delegation of scientists from the U.S.-Soviet Joint Fusion Power Coordination Committee tour the Los Alamos Scientific Laboratory in 1977. In far left front is E.P. Velikhov, head of the Soviet fusion program.

productivity decreases, labor shortages increase, and the workforce cannot be maintained at a level sufficient to guarantee production.

If the volume of a system is increased as a result of inflationary nonproduction while the technology level is fixed, the system will cannibalize itself in order to replace capital and its productivity will be reduced.

Phase Change and Negentropy

It is always abnormal for an economy to remain on a given isotherm. If the volume is decreasing while the pressure rises, it faces the danger of a phase change. If the volume decreases, for example through Volcker's credit controls, and the pressure (output per manhour) increases without a corresponding change in technology, this means that extra productivity is being bought by simply sweating labor. This is indeed the case with the Stobaugh and Yergin results. At the point of a phase change, a gas that is compressed very gently may be reduced below the liquefaction point without liquefying. This highly unstable condition is known as supercooling. In this condition, pressure and volume may decrease as the internal state of the gas changes. In such a state, output per manhour (pressure) may be increasing while volume also decreases. At such a point any effort to "improve" the situation with credit controls or wage cuts will drive down the productivity of the economy and precipitate a crisis—a phase change.

This latest breakthrough in economic modeling makes emphatic LaRouche's original fundamental discovery. The negentropic rate of development of an economy is the point of departure for an appropriate notion of temperature. It is about time that physicists developed a nonscalar notion of temperature to describe the actual nonscalar evolution of the universe.

What is the temperature of the human body? It is not 98.6 degrees Fahrenheit, but the millions of degrees Fahrenheit that man can control and deploy in a thermonuclear fusion reactor.

Carol White, the author of Energy Potential: Toward a New Electromagnetic Field Theory, *has just completed a book on the history of the antiscience movement in the 20th century,* The New Dark Ages Conspiracy. *A former university mathematics instructor, she is a member of the national executive committee of the National Caucus of Labor Committees.*

Notes

1. A detailed description of the Riemann-LaRouche model can be found in "Economics Becomes a Science" by Dr. Steven Bardwell and Uwe Parpart in *Fusion*, July 1979, pp. 32-50. The recent analyses and forecasts of the Riemann-LaRouche model appear in a series of groundbreaking articles, "Can the U.S. Economy Survive the Depression?," "Economics: The Thermohydrodynamic View," "The 1980 Recession: Not Like Any Other," and "Energy Conservation: Building Inflation into the Economy," in the *Executive Intelligence Review* May 6, 1980 and March 18, 1980.
2. The reader should note that Δ as used here bears no relationship to the notation δ, which signifies the ratio S/V. Here Δ is the thermodynamic notation for an incremental increase.

Three Mile Island

Continued from page 24

problem, the UCS proposed that the utility build a 250-foot stack on top of the building through which to vent the gas, or a huge plastic pipe with a balloon on top.

The governor's April decision to call in the Union of Concerned Scientists had angered the residents of central Pennsylvania who want the cleanup to proceed and who want the TMI Unit 1 put back on line now. Many, in fact, thought that the governor had invited in the antinuclear group solely to keep the antinuclear issue hot when interest in the antinuclear demonstrations fizzled after the anniversary of TMI in late March.

To put TMI back on line, a "Friends of TMI" group is in formation, which includes local labor leaders and businessmen, and the area Chambers of Commerce are planning to step up their pronuclear campaign. One Chamber of Commerce spokesman characterized the shutdown as "an ever-increasing burden on the business community" (see accompanying interview).

The battle lines for nuclear power became even clearer after Thornburgh's office released the new state energy plan May 1. According to Lt. Governor William Scranton, Jr., the plan showed that it would not be necessary to ban nuclear power plants in Pennsylvania, because energy studies had demonstrated that "nuclear power is unnecessary" anyway. The state would meet its energy needs with coal and conservation, Scranton reported.

FEF Pronuclear Tour

The same day that the state energy plan was released, and in the midst of the uproar about the governor's commissioning the UCS and stalling the krypton gas venting, Fusion Energy Foundation executive director Dr. Morris Levitt held a press conference in Harrisburg, the state capital, to discuss the environmentalist efforts to shut down nuclear power.

"The Union of Concerned Scientists is not an organization of scientists," Levitt warned, "but former scientists who are now kooks. . . . In addition to delaying the krypton venting for at least several weeks, which may be a hazard, the governor is setting a precedent for involving the antinuclear movement in the day-to-day operations of the nuclear power industry."

Levitt's remarks were documented in charts and other materials presented to the press by Stuart Pettingell, counterintelligence specialist for the *Executive Intelligence Review*. Pettingell briefed the press on the chain of command in the environmentalist movement, from the individuals in the Council on Foreign Relations, think tanks, and foundations who make the zero-growth policy, to the lower-level groups who carry out this policy—including terrorism.

On the evening news broadcasts and in the press, the FEF press conference was featured in sharp contrast to the reports on the state energy plan. The effect of the juxtaposition was startling: The governor's office says no to nuclear; scientist (Levitt) says the antinuclear movement is out to destroy the national economy.

Levitt also addressed a luncheon meeting of the leaders of the state's veterans groups, where he and Pettingell went into more detail on the state's environmentalist groups and on the Aquarian Conspiracy that spawned them. Pettingell traced the evolution of the Movement for a New Society and the Keystone Alliance, two of the groups calling most loudly for the shutdown of TMI.

Both groups are cults, Pettingell said, that use Aquarian "sensitivity training" to produce the antinuclear beliefs of their members. Among the evidence of cult behavior Pettingell presented was the Movement for a New Society's pamphlet on how to become a homosexual and help others to liberate themselves to do the same.

Levitt briefed the veterans' leadership on the Federal Emergency Management Agency and the role it played in the management of the TMI incident, and its current role in "pre-crisis management." In late April, the Pennsylvania branch of FEMA announced that it had completed contingency plans for mass evacuations and other measures in case of another "nuclear emergency" like TMI.

Andrus Creates Scandal to Halt New Oil Drilling

Interior Secretary Cecil Andrus abruptly suspended all oil and gas lease bidding for "noncompetitive" federal lands across the nation Feb. 29—a move that ends oil and gas exploration on 97 percent of federal leased land.

In effect, Andrus has ordered that no new oil and gas wells are allowed to be drilled in the United States. Why? Andrus charges "corruption" in the leasing lottery system. We've checked. The charges are phony.

An official statement put out March 7 by the Interior Department's Bureau of Land Management chief Frank Gregg specifies that "until the Department determines whether the system can be reformed to correct the abuses [it] . . . concludes that it is necessary to convert on-shore leasing to an all-competitive system."

The charges sound appropriately chilling and sinister: "The U.S. Attorney in Denver, Colorado has asked that we make no comment on the ongoing criminal investigation except to say that indictments for wire fraud, mail fraud, fraudulent statements, and conspiracy are expected."

'Competitive Vs. Noncompetitive'

Anticipating a flood of criticism, Andrus stated that the move to suspend all oil and gas leases "only applies to noncompetitive leasing," and that so-called competitive bidding will continue. What he did not say was that only 3 percent of all federal leases are "competitive" and a whopping 97 percent are "noncompetitive." Here's how it works:

The U.S. Geological Survey determines whether federal land is competitive; that is, likely to produce oil or gas. This land is then auctioned to the highest bidder, normally major oil companies or large independents such as ARCO, which can pay large sums for development rights, often only to keep the oil and gas undeveloped and out of a glut market that presently exists.

Noncompetitive land is designated by the Geological Survey to be less likely (that is, more risky) for producing oil and gas. This land is leased for a nominal fee to private producers and a percentage on any earnings paid to the federal government over the term of the lease.

Federal land leasing in the Rocky Mountain and southwest United States is a life or death economic issue. In states such as Wyoming or New Mexico, more than 60 percent of the land is federal.

With choice lands outpriced by the major producers such as Exxon, Mobil, and ARCO, most small to medium-size independent producers have gambled or "wildcatted" on these less desirable federal "noncompetitive" leases. These independents are responsible for more than 80 percent of all drilling in the United States last year. They are the risk-takers in a high-risk industry. On average, only 1 in 9 wells is a strike, the other 8 dry holes. One well's cost can easily run over $1 million, depending on depth. With soaring interest rates, increasing numbers of the more than 10,000 independent producers are finding it impossible to drill for the abundant oil and gas that exists, making the Schlesinger prophesy of an energy shortage self-fulfilling.

Common Practice

What Andrus is charging behind all the "criminal conspiracy" rhetoric is nothing more than a common practice of forcing smaller independents to scramble for these desirable lands by enrolling for leases under the names of several persons, such as members of their family to enhance chances to obtain land otherwise unavailable.

This "crime" is the flimsy pretext for Andrus to impose his remarkable stop order, despite the fact that Andrus proposed regulations last fall to deal with these problems and never enacted them. Senator Malcolm Wallop (R-Wy.) cited this in an attack on the Interior's capricious actions that are "putting the whole nation's energy problem at jeopardy because they haven't been able to deal with a few specifics."

Last June, Andrus introduced legislation, now blocked in Senate subcommittee, to increase competitive leasing on some 100 million acres of federal land from present levels of 3 percent to more than 50 percent. There is strong evidence to suggest that the current tactics of Andrus and the Justice Department are keyed to pressure the Senate to move on his bill.

Pressuring Congress

Peyton Yates, a prominent independent producer from New Mexico has accused Andrus of "using that situation to pressure Congress to come up with legislation he has pending." Indeed, in the March 7 Bureau of Land Management intradepartmental memo, the lease suspension, BLM director Gregg declared: "The Department will also renew its efforts to secure the passage of legislation similar to S-1637 [the Andrus bill]."

Because independent oil producers as a group are locked into actual production and development of oil and gas far more than major oil companies, whose profits can swell merely through withholding supply, the majors have little to lose by Andrus's action. But the nation has a lot to lose if this sector of the energy industry goes under. As the independent producer who put this reporter on to this remarkable story mused, "I am increasingly coming to the conclusion that our own government is a greater threat to our way of life than the Soviet Union."

—William Engdahl

California Pesticide Regulations To Protect Marijuana Growers?

At the insistence of the Environmental Defense Fund, the state of California has attempted to rewrite its pesticide regulation program to double both the time and dollar cost of applying pesticides and herbicides in farm production. New regulations—much more stringent than federal law requires—were railroaded through the state's Department of Food and Agriculture and are now stalled in the State Senate. To counter the extreme regulatory proposals, the state's agribusiness interests have introduced five bills to eliminate pesticide regulation altogether.

The chemical industry and farm representatives agree that the state-proposed measures would cripple agricultural output. The bigger scandal, however, is that the entire effort to regulate farm pesticide use out of existence is being bankrolled by California's marijuana growers and the marijuana industry, who fear that pesticides will ruin the value of their illegal big-money crop.

Under existing California regulations, growers must consult their local pest control advisor, decide on an appropriate pesticide, and apply to the county agriculture commissioner for a permit that will be good for all crops in an entire year. Under the new regulations, however, the grower must prove in writing that all "feasible alternatives" have been exhausted, that use will not conflict with any "sensitive area" prohibitions, and then, if he receives a permit, that additional measures have been applied to "mitigate" the presumed "adverse impact" of the pesticide. Finally, a detailed notice of intent must be filed with the county commissioner—all to exercise a permit good for only one crop in a single planting season.

Hushed Up

The marijuana lobby's efforts are being hushed up. For example, Department of Food and Agriculture chief Huey Johnson threatened to throw *Farm Chemicals* magazine editor Gordon Berg out of his office during an interview on the new pesticide regulations. Berg had asked: "What's more important to California—pot or food?" In the April issue of *Farm Chemicals*, Berg asked in print why Johnson had become so hysterical at the "pot lobby" question.

"They grow very fine marijuana up along the northern coastal area of California," a farmer told one reporter. "They want to stop the use of chemicals in the forested areas because they fear it will contaminate their weed."

—Susan Cohen

World Energy Use Must Increase, Levitt Tells Dems

"World energy use must be increased by a factor of about 3.3 between now and the turn of the century," Dr. Morris Levitt, Fusion Energy Foundation executive director, told the Democratic Party Platform Hearings on Energy Policy, May 8 in Columbus, Ohio.

This is the increase in energy consumption levels required to bring living standards around the world up to the present level of a semiskilled worker in Western Europe, Levitt said. "Unless we do this we will not get the U.S. economy or the world economy moving out of depression conditions."

There is no reasonable alternative to such growth, Levitt reported. "As many world statesmen have warned, we will be creating more Khomeinis, as well as the serious dangers of depopulation, pandemics, and war," he said.

Levitt, who is an energy advisor to Democratic presidential candidate Lyndon H. LaRouche, made the strongest presentation the platform committee heard advocating energy growth. Typical of the other speakers was Institute for Policy Studies spokesman Harvey Wasserman, who called for communes and "back to the earth" programs.

Levitt proposed a "modest 4 percent rate of growth" in advanced nations like the United States. "To do this economically and efficiently," he said, "there must be a small growth in oil and gas use, a modest increase in coal, and the highest rate of increase in nuclear power production." This should allow the United States in a short time to export up to $100 billion per year in nuclear technology.

Levitt also emphasized that "the development of advanced nuclear technology—including fuel reprocessing and waste storage, breeder reactors, high-temperature gas reactors, and fusion power—will solve all our energy needs for the foreseeable future."

International

Mexican Pres. Tours Europe To Buy Nuclear Technology

Photo by Richard Melloul/Sygma

Atoms for peace diplomacy: French President Giscard visiting President Lopez Portillo in Mexico in 1979.

"The 21st century will be the nuclear era. When the problems attributed to nuclear energy are overcome—and I think they have been highly exaggerated by defenders of the environment—there will be no other topic than nuclear." This was the statement made May 16 by Mexican president José Lopez Portillo to the French daily *Le Monde*, on the eve of his European tour.

Lopez Portillo's statement is significant in light of the expected nuclear deals between France and Mexico as well as the rest of the nations the president is visiting. According to press reports, France has already offered Mexico "all the reactors it wants."

Lopez Portillo's French visit, featuring extensive discussions with President Giscard d'Estaing, was aimed at consolidating economic and political ties between the two nations. A major nuclear agreement, through which Mexico would increase its current oil exports of 100,000 barrels per day to France in exchange for nuclear technology, was a top item of discussion between the two heads of state.

Mexican-French cooperation in the nuclear field dates from President Giscard's historic visit to Mexico City in March 1979 and involves a number of key technology and training projects. France is already sharing with Mexico the scientific know-how of the French Phenix breeder reactor, and Giscard has offered enriched uranium and technical assistance in the

exploration and exploitation of Mexico's own vast uranium resources.

Recently the Mexican government commissioned nuclear feasibility studies from companies in several countries including France, Sweden, and Canada. A study released by the French company Sofratome states that Mexico is in a "very good position" to go ahead with the major nuclear program it plans to carry out between 1990 and 2015. Mexico's plan is to bring on line two to three 900-megawatt units a year between 1990 and 2000, three per year after that, and four after the year 2010, Sofratome reported.

Nuclear Shopping Trip

Lopez Portillo's current tour has been characterized as a "shopping tour" for nuclear technology, and he will be visiting every country—France, West Germany, Sweden, and Canada—that has made nuclear offers to Mexico. It is expected that the nuclear issue will be the centerpiece of his talks with heads of state.

The Mexican president noted that the significance of nuclear energy rests not only on the need for a vast and cheap energy source, but, more important, on the fact that it is a highly advanced technology that will open the way for developing "even higher technologies that are still in the laboratory stage."

At a Paris press conference May 18, in answer to a question about a possible French-Mexican nuclear accord, Lopez Portillo said that negotiations were continuing in all areas. In particular, he added, Mexico wants the "superior future technologies" in the nuclear field that France will be developing in the next decade—a reference to fast breeder reactors, fission-fusion hybrids, and fusion energy. More than an energy source, he stressed, nuclear power "gives access to industrial solutions" in other areas, and is the "most important energy source" of the future as a replacement for oil.

—Dolia E. Pettingell

Bottom Line in Hunt Case: Engelhart's Oil Acquisitions

Bunker and Lamar Hunt's nearly $2 billion losses in the silver markets have resulted in a major shift in control of North American oil and gas holdings. Unable to raise a $750 million loan to pay off their silver trading debts, the Hunts have mortgaged their Placid Oil Co. holdings as collateral for a $2 billion credit line from a banking consortium.

They have also granted Engelhart Minerals a 20 percent interest in their Beaufort Sea oil and gas properties in Canada, in lieu of payment on a $665 million silver futures contract the Hunts had signed with Engelhart in January.

Although questions have been raised about the value of the Beaufort Sea assets, Engelhart chairman Milton Rosenthal reported to his stockholders in May that the property "has great potential, perhaps to be one of the greatest oil fields in history," comparable with Saudi reserves.

On the board of Engelhart is Lazard Frères partner Felix Rohatyn, architect of the Energy Corporation of the Northeast (ENCONO), a regional group established to promote oil cutbacks and "alternate energies." Rohatyn's Lazard associate Frank Zarb is a promoter of the Panero Plan for a Pacific Basin energy autarky bloc consisting of the United States, Canada, the People's Republic of China, and Japan.

This transfer of assets from the expansion-minded Hunts to the scarcity-minded Engelhart Minerals is compounded by the Hunts' loss of control, at least temporarily, of Placid Oil, a major hemispheric resource with substantial holdings in Louisiana, Texas, and the Gulf of Mexico. The Hunts were compelled to mortgage Placid properties when Federal Reserve Chairman Paul Volcker intervened to prevent a bank loan to the brothers on less onerous terms.

Environmentalist Roundup

Antinuclear Groups Adopt Iran Model

In the early hours of May 24, 1,000 individuals will leave their base camp in teams and move through the marshes of the New Hampshire seacoast to the Seabrook nuclear construction site. Unlike the six previous environmentalist actions at Seabrook, this is planned as a terrorist commando raid.

The difference reflects a fundamental shift in the outlook of the antinuclear activists taking part. They have merged with the terrorist organizations here and in Europe and intend to create a mass movement modeled on the ultrareactionary medievalism of the Ayatollah Khomeini's followers in Iran. Seabrook will signal the shift to "green terrorism."

The shift is not unexpected. The Western environmentalists and the Islamic fundamentalists explicitly share two things: a hatred of science and technology, and the same intellectual architects.

The terrorist-environmentalist convergence at Seabrook, for example, is typical of the organizing work of Richard Falk, professor of international law at Princeton University and part of the Council on Foreign Relations' *1980s Project*.[1] Falk, working with former attorney general Ramsey Clark, was involved in overthrowing the Shah and bringing Khomeini to power in Iran.

In a recent interview, Falk told a Mexican reporter that the Shah was so repressive only because he wanted nuclear power development. Unless the same kind of popular movement is developed in the United States, he said, the same "repression" due to nuclear development will occur here.

Developing a new "Iran model" for the environmentalist-terrorist move-

ment is now what the Falk-Clark circle is all about. In February, key leaders of the Coalition for Direct Action at Seabrook were taken to Iran by Dr. Norman Forer, who with Falk and Clark, played a principal role in the Shah's overthrow and the taking of U.S. citizens hostage. (Many of the Iranian student militants involved in the Teheran embassy seizure were trained under Forer at the University of Kansas.) Randy Goodman of the Boston Direct Action Coalition and Lucille Gunderson of the New Hampshire Direct Action Coalition went with Forer to meet the student militants. So did Lynn Shivers of the Fellow of Reconciliation, a group created in 1922 by British intelligence's Bertrand Russell. Also with Forer were members of the Revolutionary Communist Party, who carried out the "anti-Klan" side of the racial violence in Greensboro, N.C.

Upon their return from Iran, the environmentalists reported they had learned the necessity of "direct action" from the Embassy militants, and the gun-toting Revolutionary Communist Party members announced that they would be present at Seabrook May 24.

Lynn Shivers is head of the Transnational Collective of the Movement for a New Society, a Philadelphia-based antiscience cult operated under the American Friends Service Committee. In that capacity, she has coordinated an exchange program with European environmentalists that will bring British, West German, and French antinuclear groups to Seabrook May 24.

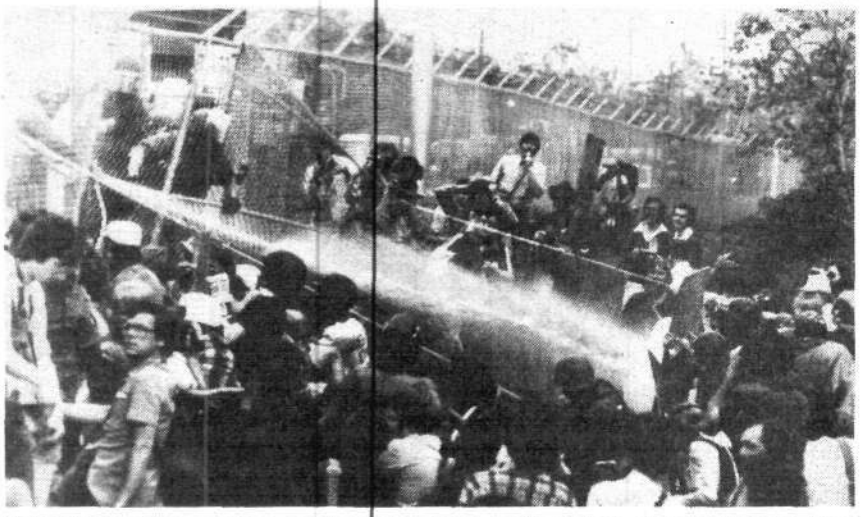
Who are these exchange participants? The British group, the Loch Ness Coalition, is a group of violent anarchists. The French Action Directe is responsible for a series of police-station bombings and sabotage of government-linked computer firms. The German Burgerinitiativen members are veterans of numerous bloody confrontations with police in West Germany, France, and Belgium.

With this type of input, the terrorist capabilities of teams of commandos being assembled for Seabrook are without precedent in the United States. Also unprecedented is the training of these terrorists—psychological conditioning using the Movement for a New Society's "group dynamic and sensitivity" brainwashing methods. More than 250 participants have already received in-depth conditioning at a mountain retreat called "Another Place" to prepare for the May 24 assault. All commandos are now at their base-camp and will not leave until the raid.

The New Hampshire state police had an easy time dispersing the demonstrators who sought to occupy and dismantle the Seabrook construction site Oct. 6, 1979, in part because of the information and warnings issued (by *Fusion* as well as other groups) about the demonstrators' plans. This time, the environmentalist controllers count on pulling together a core of the most hardened commandos after the clash with police. The United States must prepare to deal with a wave of "green terrorism" modeled on Iran's medieval mob, both of which follow a script by such notables as Richard Falk and Ramsey Clark.

This month's column was contributed by Stuart Pettingell, who is on the counterintelligence desk of the Executive Intelligence Review.

Wide World



New Hampshire police successfully keep antinuclear demonstrators from storming and occupying the Seabrook nuclear plant site May 24.

Note

1. *The details of the Council on Foreign Relations' 1980s Project* can be found in Fusion, Oct. 1979, pp. 36-47; Falk's dossier appears in *Fusion*, Feb. 1980, pp. 10-11.

Asdex Tokamak Results Look Promising

Researchers at the Institute for Plasma Physics in Garching, West Germany, report very promising results on the Axial Symmetrical Divertor Experiment, known as Asdex.

The Asdex, Europe's largest fusion facility, has the same goal as the PDX tokamak at the Princeton Plasma Physics Laboratory: to produce the purest possible plasma using poloidal divertor fields. The first experiments with the Asdex divertor at the beginning of May showed a clear decrease in plasma radiation and achieved an exceptionally long plasma discharge confinement time of 3 seconds. The discharge confinement time, an improvement of a factor of 3 over the Princeton Large Torus tokamak, apparently is the result of a lowered level of impurity in the plasma.

The divertor concept is to construct the usually closed magnetic field lines that confine the fusion plasma with a "hole," so that nonhydrogen elements can be diverted out of the plasma. Even minute quantities of these impurities can cause a major energy loss in the plasma. The impurities, partially ionized heavy elements, come from the materials on the wall of the vacuum chamber. They have a much greater nuclear electrical charge than the hydrogen, and the electromagnetic radiation they generate cools down the plasma.

The Asdex is operating solely with ohmic heating now. In order to test the performance of the divertor at high temperatures, neutral beam injection will be installed in 1981. An initial heat level of 2.5 megawatts is planned, with a second-stage heating capacity of 8 megawatts to attain reactor-relevant temperatures.

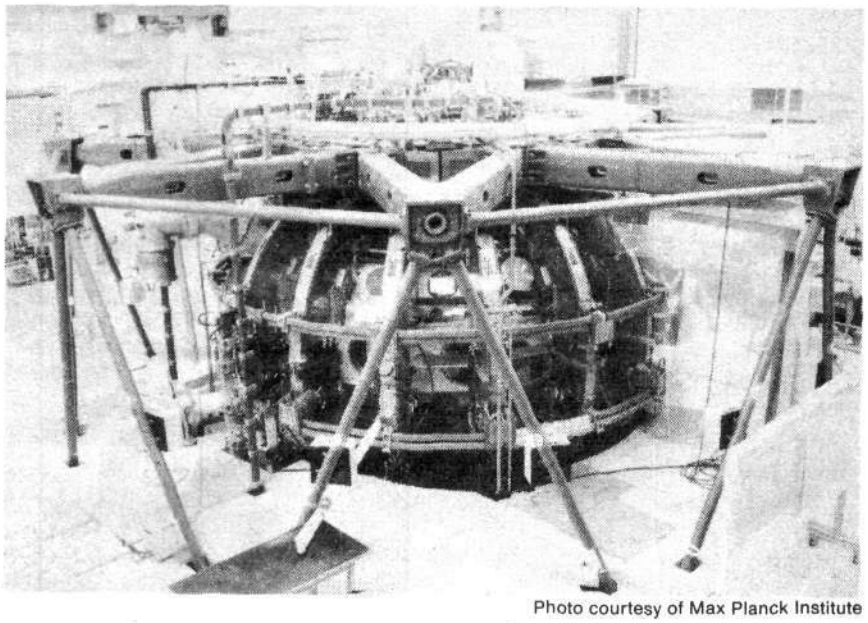


Photo courtesy of Max Planck Institute

The Asdex, Europe's largest tokamak, achieved a discharge confinement time three times greater than that of the PLT.

Dean: Now Is the Time To Push Fusion Engineering

"The scientific basis now exists to start fusion engineering," Dr. Stephen Dean, president of Fusion Power Associates and a past director of the Office of Fusion Energy's magnetic confinement program, told a May 1 session of the American Physical Society's spring meeting in Washington. Dean chaired the panel on "The Pace of Fusion Energy Development."

"Engineers have now been given the scientific information they need to begin work on the development of a fusion power demonstration plant," Dean asserted. The future of the fusion program will no longer depend on "good results," but on the political commitment to get this engineering started.

Although Dean's remarks were not a scheduled part of the proceedings, they were the most important and most provocative part of the meeting. The APS did not schedule any presentations that discussed the magnetic confinement program in tokamaks, mirrors, or other large-scale fusion projects.

Dean challenged the physicists in the audience to consider a concrete, two-phase program to achieve a commercial demonstration fusion reactor by the turn of the century, "as proposed by Congressman Mike McCormack." (McCormack's bill, HR 6308, calls for an "Apollo-style" crash program to meet that goal.)

The first phase, extending over the next eight years in Dean's proposed timetable, would develop the engineering needed to take fusion from the "stage of scientific development to the point where its commerical viability can be assessed. Then, assuming a positive result, the second phase of national commitment would begin in 1988, and lead to the operation of a demonstration plant approximately 10 years later."

Dean made it clear that moving the fusion program ahead into the engineering stage in the tokamak program does not imply downgrading either basic science or alternate concepts like laser or tandem mirror programs. On the contrary, by developing a tokamak engineering test facility, he said, scientists will be gaining knowledge and technology applicable to all approaches in concept and design, thereby enhancing research into basic scientific questions.

LLL Astrophysics Report:

A Coherent View of Supernovas

"The birth, evolution, and explosive death of stars are the fundamental examples in nature of the controlled and explosive release of nuclear energy and the transmutation of the chemical elements. These stellar events are essential in shaping the universe and are the ultimate source of virtually all energy resources we now use."

Thus begins a series of groundbreaking reports on astrophysics studies at the Lawrence Livermore Laboratory in the laboratory's Feb. 1980 *Energy and Technology Review* titled "The Evolution of Massive Stars and the Origin of the Elements," and "Supernova: The Explosive Death of a Star."

The reports begin by noting: "The evolution and final fate of stars with 10 to 100 times the mass of the sun have long been postulated to play a central role in such important astrophysical phenomena as the origin of the chemical elements, supernova explosions, black holes, neutron stars, and cosmic rays. . . . In the past, these phenomena usually have been studied separately and then related to each other and to observations. . . . [This has] been criticized as isolated 'fits'."

The reports go on to state that Livermore scientists, as part of their inertial fusion research, are striving to develop a coherent overview of the evolution and explosive death of stars. Their initial results are presented along with a brief description of the computer model, called KEPLER, that they have developed.

A preliminary review of the reports' highlights follows.

A Dynamic Universe

The ordinary picture of the universe is that of galaxies consisting of rather mundane stars, like the sun, that have been around for billions of years; but the reality is far from this boring picture. From a cosmological time-frame perspective, the universe is almost continuously experiencing stupendous explosions of individual stars, explosions that generate more energy than the entire output of a galaxy of stars.

These supernova explosions are most likely responsible for cosmic rays, which represent more than half of the energy flux observable in the universe; the generation of all chemical elements heavier than iron; the trace elements that are key to the formation of life; and the generation of new stars that are formed as the shock wave generated by the supernova explosion passes through interstellar gas clouds.

In a word, supernovas are key to understanding the dynamics of the cosmos.

The most surprising thing is the short lifetime of stars that lead to supernovas. The Livermore model projects that a star with 25 times the mass of the sun will have a lifetime of about 7 million years. The most crucial part of the star's existence is the final few thousandths of a second prior to its explosion. The Livermore model shows, for the first time, that the entire evolution of the star, through which it proceeds to fuse lighter elements into heavier elements until the star is transformed into a sphere of iron, is important in determining the dynamics of the final collapse and explosion. But it is the macroscopic geometry and hydrodynamics of collapse and the formation of a resulting explosive shock wave, which is called "the bounce," that is essential in determining the final result—how much energy is released, and which and how many chemical elements heavier than iron are generated.

As the Livermore analysis demonstrates, minute changes in the macroscopic dynamic lead to dramatic changes in the final result and the microscopic physics (nuclear reactions, quantum effects; and so on) that take place. Therefore, supernovas are one of the special situations in which microscopic and macroscopic physics are directly and causually connected. Continuing experimental and theoretical studies with laser pellet implosion for inertial fusion will provide new insights and approaches for elaborating the macroscopic, hydrodynamic aspect of the supernova phenomena.

Fusion Materials Review Presented at MIT Conference

The three-day conference on fusion research and development at the Massachusetts Institute of Technology May 8-10 drew an enthusiastic audience of 70 representatives of industry, mostly from top management, and included an excellent summary of the materials question and the status of fusion.

Among the major presentations at the seminar, those of Dr. Gerald L. Kulcinski of the University of Wisconsin and Dr. Lawrence M. Lidsky of MIT were the most informative. Kulcinski reviewed the status of fusion reactor materials and inertial fusion R&D, while Lidsky gave a marathon review of the entire spectrum of fusion physics and engineering disciplines.

Kulcinski began his review of the status of fusion materials R&D by noting that although he would raise many problems in his presentation, he would also provide many solutions.

First, an extremely wide range of materials is involved—from electrical insulators to neutron and gamma radiation shielding materials. Second, these materials are exposed to the most demanding environment man has ever generated.

The ordinary physical forces in a fusion reactor would make the choice of materials a difficult question per se, but it is the direct and coupled effects of radiation damage that are the main concern. The high-energy neutrons generated by the fusion reactions transmute (change the

chemical nature) and physically displace the atoms of the materials that make up the fusion reaction chamber and other nearby components (magnets, insulators, and heat removal systems). As a result, the various physical properties of the fusion reactor materials are degraded, creating unique synergistic effects.

Appropriate Materials

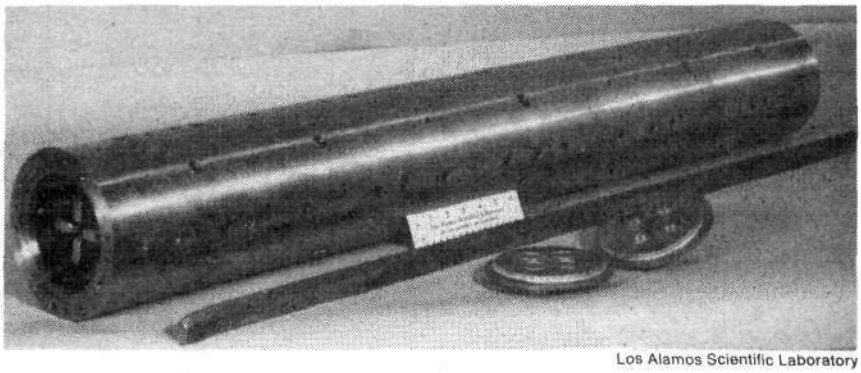
Kulcinski noted that various materials candidates for the fusion reactor chamber have been examined over the past decade. Experimentation has determined the most appropriate materials for various temperature ranges; that is, the temperature at which the energy would be transferred out of the reactor chamber wall.

The best materials choices, taking into account all of the important properties, are as follows: for room temperature to 200 degrees Celsius, aluminum alloys; for 300 to 500 degrees Celsius, austenitic steels and titanium alloys; for 500 to 800 degrees Celsius, vanadium alloys; for 800 to 1,000 degrees Celsius, molybdenum and molybdenum alloys; and for 1,000 to 1,500 degrees Celsius, graphite.

Soviets Reexamine Fusion Materials

Scientists in the Soviet Union, Kulcinski reported, are initiating investigations into innovative fusion reactor designs that use high-temperature graphite and low-activation aluminum alloys. On that basis they are reconsidering various materials broadly rejected by U.S. fusion researchers, evidently proceeding on the premise that acceptance or rejection of various candidate materials is not a question of the materials themselves but a function of overall reactor design.

U.S. design studies examined the graphite and aluminum alloys now under Soviet scrutiny several years ago, and concluded they did not have the physical properties needed to withstand the fusion environment. Apparently, the Soviet Union's researchers believe these materials may, after all, have significant potential in light of the development of fusion reactor designs that could accommodate their shortcomings.



Los Alamos Scientific Laboratory

A side view of the radio frequency quadripole of the Linac assembly, which is designed to prove the principle of the radio frequency quadripole concept. The assembly efficiently combines three functions: initial focusing of the beam; bunching particles before they are injected into the standard drift tube Linac; and preaccelerating the particles.

Los Alamos Demonstrates New Particle Accelerator Method

Scientists at Los Alamos Scientific Laboratory (LASL) in New Mexico report that they have demonstrated a "revolutionary new method" of focusing beams of ionized atomic particles in the way required to induce fusion energy conditions in pellet targets. The new focusing method, developed on the basis of a proposal by Soviet scientists, uses electrical fields instead of magnetic fields to channel the accelerated particles into a narrow beam.

The method was demonstrated on the large Los Alamos particle accelerator called Linac, which some term the "missing link" in accelerator technology. The electric field that focused the particle beam was generated using a radio frequency quadrupole, which has the capacity both to accelerate subatomic particles and to focus them into a coherent beam.

What makes this development important is that it radically improves the efficiency and practicality of accelerating large currents of ionized atoms in linear accelerators. Such accelerated beams are essential to inertial confinement fusion, various fusion materials testing devices, and defense applications.

The old magnetic method of focusing is generally applicable only to the generation of minute currents of particle beams used in high-energy particle physics research. Magnetic focusing is efficient only when the atomic particles have reached a very high speed, because the force that a magnetic field exerts is proportional to the velocity of the charged particle it operates upon. This is not the case with an electric field, whose effective force is proportional to the electric field strength.

Previously it was believed that the only way to generate large currents of ionized particles was by generating intense beams that were immediately accelerated to high velocities. Very expensive, damage-prone pulsed power systems were needed to accomplish this. One result is that a several-billion dollar cost was projected for the 1-million-joule linear ion beam accelerator needed to demonstrate ion beam pellet fusion. The electric-field method of focusing low energy beams, however, obviates the need for this costly power system.

The Los Alamos project was jointly conducted with the Hanford Engineering Development Laboratory (managed under contract by Westinghouse) in Hanford, Washington. The new focusing method will be used in the Hanford Fusion Materials Irradiation Facility. The facility uses a large particle beam accelerator to generate nuclear reactions simulating the fusion environment.

Conferences

India's Industrial Development, Frankfurt, May 7-8

India: A Question of Political Will

A group of leading Indian planners and West German businessmen participated in a conference on "The Industrial Development of India: Its Potential, Its Necessity" May 7-8 in Frankfurt, West Germany to discuss a 40-year plan for bringing India into the front rank of industrial nations. Presented in *Fusion*'s May 1980 cover story, the economic program was developed by experts from the Fusion Energy Foundation and *Executive Intelligence Review*, cosponsors of the Frankfurt conference.

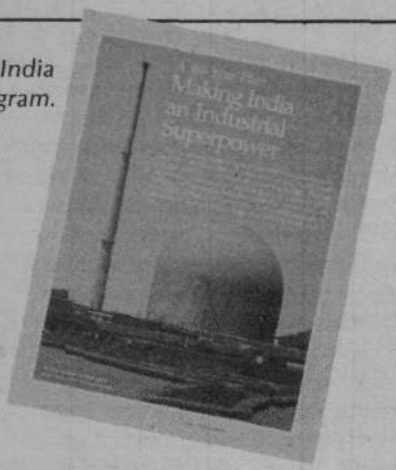
The *Far Eastern Economic Review* recently featured detailed coverage of the 40-year targets as the possible economic planning guide to be selected by the government of India's Prime Minister Indira Gandhi, and Gandhi sent her personal greetings to the conference.

Uwe Parpart, research director of the FEF, and Daniel Sneider, editor-in-chief of the *Executive Intelligence Review*, outlined the program to conference participants. The 40-year plan is centered on a nuclear-based energy development program, aimed at bringing at least fifty 1,000-megawatt-electric nuclear power plants on line by the early 1990s, and a rapid urbanization process based on nuclear-centered agroindustrial complexes, or nuplexes.

Over a 30-year period, $200 billion is to be invested in a national water management system for advanced irrigation and hydroelectric power. In addition, mobilization of 10 million skilled workers and highly qualified scientists and engineers will be accompanied by an in-depth mass literacy and education policy.

The fundamental approach, Parpart explained, is utilization of the most advanced production and energy technologies to create a "shock effect," breaking the cycle of India's underdevelopment. The specific capital and technological inputs required

Fusion's special issue on the India development program.



Nuclear Energy Is The Only Solution

The chief architect of industrial development of India is our great leader Pandit Jawahrlal Nehru. Nehru believed in planning. To him planning did not mean a collection of projects or schemes but a thought-out approach of how to strengthen the pace of progress so that the community advances on all fronts. . . .

Nehru was also conscious of the fact that backwardness in science and technology is the cause of poverty, and utilization of modern technology creates not only wealth but simultaneously employment too. Contrary to the ruralist approach advocated by some political leaders and world organizations, he was quite clear in his mind that nuclear energy used for peaceful purposes would benefit mankind. He had given unqualified encouragement to Dr. Bhabha, our famous nuclear scientist. . . .

It is estimated by some experts that if economic growth is to reach 6 percent, and if there is no change in the present pattern of energy consumption, then our consumption even at a 6 percent economic growth rate by 2000 A.D., would be 470 million tons of coal, 92 million tons of oil, and 550 billion kilowatt hours. Even for achieving this moderate growth the implications are undoubtedly staggering. If an 11 percent rate of growth is contemplated with a multiplier effect, which alone can liberate people below the poverty line, then the requirements of energy would perhaps be beyond the comprehension of present-day planners. Nuclear energy is the only solution. . . .

Though the developing countries talk of self-reliance, self-reliance is not self-sufficiency. International division of labor is inescapable. If this principle is not accepted and implemented, the developed countries of market economy can never be free from economic crisis and convulsions which can sometimes assume the magnitude of nuclear explosions. . . . Financial and technological assistance extended by the developed countries to the developing world cannot be viewed as charity extended by good Christians. It is in reality a necessary investment to ensure the stability of their economies and is a sine qua non of a meaningful partnership which will be mutually beneficial. . . .

—K. Raghunath Reddy, former Indian minister of state for industrial development, May 7

were estimated using the Riemann-LaRouche economic model, which is designed to quantify such nonlinear progressions.

The essential role of nuclear power in overcoming present constraints on Third World development was stressed by other conference speakers, including Professor W. Seifritz of the Eidgenössisches Institut für Reaktorforschung in Würenlingen, Switzerland. Seifritz, a leading European spokesman for nuclear power, presented detailed arguments showing that only a "brute force" development of nuclear energy can provide sufficient resources to feed the expanded global population by 2020.

Another conference participant, K.D. Malaviya, former Indian minister for petroleum and chemicals, affirmed that "Our Atomic Energy Commission is aiming at the installation of 10 gigawatts of nuclear power capacity by the end of the century. My case is that India must produce 50 gigawatts of energy by the end of the century." Malaviya, a close collaborator of Jawaharlal Nehru, is known as the father of India's oil industry.

Other speakers stressed the need for Western European participation in the development of the southern hemisphere. "Our problem today in both developed and developing countries is the monetarists and their agencies like the International Monetary Fund," bluntly asserted K. Raghunath Reddy, India's former minister of state for industrial development.

"Liberation of mankind from poverty and suffering, want and sorrow, is within the reach of man. Both technology and world resources can provide abundance. What is wanting is the political will." (See box for excerpts of Reddy's speech.)

Ganesh Shukla, editor of the Indian weekly *New Wave*, pointed to increasing famine, epidemic disease, and social chaos in the Third World as "flashpoints" for East-West military confrontation.

The Frankfurt conference followed an April 29 seminar in Paris and April 23 seminars in Milan and Washington, D.C. on the subject of Indian development.

—Susan Johnson

AIAA Annual Meeting, Baltimore, May 6-8

The Aerospace Industry: Technology or Geopolitics?

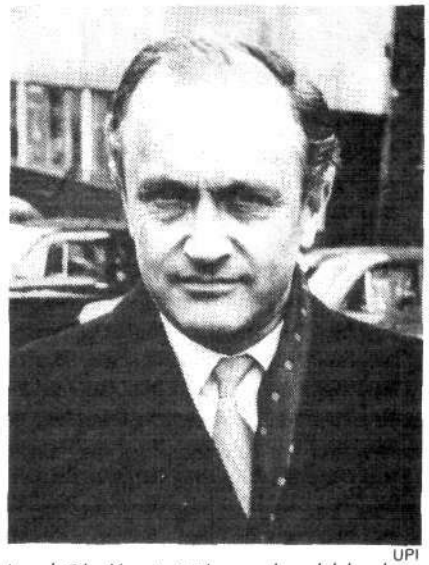
Top executives and engineers in the aerospace industry attending the annual meeting of the American Institute of Aeronautics and Astronautics in Baltimore May 6-8 heard a very mixed set of presentations under the theme "Global Technology 2000." European speakers, in particular, discussed the challenges in space exploration, flight, and military technology the industry will face over the next 20 years. By contrast, others at the conference, led by British spokesmen, termed new technology entirely inappropriate for the coming period's "geopolitics."

Reinhardt Abraham, an executive with Deutsche Lufthansa airlines in West Germany, focused on the future of air transportation. Reviewing the drop in aircraft orders since 1973, Abraham indicated that $60 billion would be needed in capital investment in the industry worldwide in the next decade, vectored for new technology that could extend the lifetime and productivity of air transport vehicles.

"There may be acute fuel shortages and rising prices," he acknowledged, but the industry must "prepare to solve the fuel problem with advanced technology." New developments—"radical concepts"—are needed in engine design and the aerodynamics of plane design, he said.

The second speaker on the program was Dr. Reimer Lust, president of the Max Planck Institute in Germany, who stressed the importance of cooperation between Europe and the United States. The United States, he recalled, had helped form the European space research organization in the mid-1960s. "In general," he said, "scientific discoveries are unpredictable," but nevertheless must be the essential consideration of the industry.

In the next 20 years, "we will do plasma experiments in situ, we will extend our knowledge in astronomy and astrophysics, study the earth's and planets' atmospheres, and study geodesy and geophysics." He proposed that U.S.-European collaboration concentrate on an orbiting telescope, the exploration of outer space, and continued earth-oriented observation from space.



UPI

Lord Chalfont: "There should be less technology."

"Europe has a future highly dependent on technological innovation," Lust stated. "This is very good for international cooperation. . . ."

The change in tone was abrupt, however, for Lord Chalfont's speech, titled "Defense Systems: An Allied Perspective." Every U.S. aerospace company that is involved in commercial aircraft production and the space program is also involved in weapons-related production. However, few present shared Lord Chalfont's "geopolitical" perspective for the industry.

Chalfont began by stating that what he was about to say was his personal view and not necessarily that of the British government; on the other hand, as if to caution them that they had better listen closely, he reminded the audience that he is, after all, a

member of the House of Lords.

Chalfont decried the fact that an "upsurge in European nationalism" renders it seemingly impossible to integrate European military capability either on the continent or with the United States through NATO. Moreover, he stated, even were it possible, integration might not be very meaningful because, from the Soviet Union, "the threat is global." How do you fight this threat? Chalfont suggested that China "provides a great market for U.S. military production."

Chalfont concluded that there is no point in having a small, highly trained military in Europe, and he recommended "guerrilla war" or "people's war" in the event of a confrontation on the continent. "There should be more flexibility and less technology. . . . We would want different kinds of weapons—cheaper, mass-produced weapons that can be handled by a less sophisticated infantry. . . ."

Chalfont's recommendations for "guerrilla war" were particularly astounding to the audience in the light of his remarks that "in the next decade," the Soviet Union would match the West in strategic capability, and that a "window of vulnerability" would exist in the strategic balance.

A return to the topic of technology came in reviews of the current and future military situations by Walter le Berge of the U.S. Defense Department, and spokesmen from Europe. The main problem, they stressed, was the need to improve military and scientific training and education and to push the frontiers of technology outward. In particular, the review of the ballistic missile defense program by its manager, U.S. Army Major General Grayson D. Tate, Jr., showed that the leading area of strategic research, ABM systems, was being held up more by policy decisions than by technological problems.

Other exciting presentations by both U.S. and European scientists focused on aspects of future aerospace and energy and scientific research. Updates were delivered on research and development in liquid hydrogen and nitrogen fuel for transportation; magnetohydrodynamics and fusion power for energy and propulsion; computer applications in the aerospace industry; and materials requirements for the future.

Experiments planned for the Space Shuttle program were described in one seminar session by Neville Barter from the TRW corporation, and imaginative concepts in commercial flight were presented by many aerospace company representatives. The conference also included the largest exposition in the world of aerospace technology, which documented both the history and future of terrestrial and celestial flight.

—Marsha Freeman

Riemannian
Economics Seminars

Model Looks at Thermodynamics Of Economy

The latest simulations and forecasts achieved by the Riemann-LaRouche economic model were the subject of two recent seminars sponsored by the Fusion Energy Foundation and the *Executive Intelligence Review*, featuring the *Review*'s economics editor David Goldman and FEF director of plasma physics, Dr. Steven Bardwell. The conferences, held May 2 in Washington, D.C. and May 15 in Chicago, were part of a series of nationwide seminars to make the groundbreaking work of the model available to government, business, and academic audiences.

Goldman described the model's unique approach that treats the economy as a physical system, dependent on quantity and quality of energy inputs for the productivity gains that permit expansion of reinvestible surplus. Analyzing the Carter administration's programs of high interest rates, limited exports, and energy conservation, the Riemann-LaRouche model has projected that continuation of such policies even for the remainder of 1980 will lead to "thermodynamic death" by late 1981, Goldman stated.

The economy will be physically unable to replace the capital goods and labor power consumed in production at that point, he said. A minimum annual 3 percent growth in productivity in the economy, based on high-technology capital formation, must be achieved—no small task, he added. This entails a commitment to efficient and capital-intensive energy production.

Business and diplomatic representatives at both conferences questioned Goldman and Bardwell closely on the "thermohydrodynamic" approach to economic analysis. As Bardwell explained, this approach is more than an analogy. An economy *is* a thermodynamic system that must achieve higher orders of organization and technology for energy throughput, or else undergo "entropy."

Zero Surplus

The point was illustrated with a three-dimensional phase diagram showing output per manhour, energy consumption in BTUs per manhour, and investible surplus less depreciation. Since 1975, this surplus has been in the region of zero, said Goldman, adding that failure to replenish productive capital is not yet a question of absolute physical constraint but is "just barely" susceptible to policy changes to increase productivity and reduce unproductive overhead costs for the economy as a whole.

By contrast, he emphasized, when one adds to the near-impossibility of capital formation imposed by Federal Reserve Chairman Paul Volcker's credit contraction the cost of "energy conservation"—replacing machines with human labor, which absolutely *lowers* productivity—the economy faces not simply the decline into an industrial depression, but the loss of the capacity for productivity increases and thus the potential to ever achieve recovery.

Seminars on the Riemann-LaRouche model's analysis are planned for New York City, Philadelphia, Los Angeles, Cleveland, Detroit, and Hartford.

—S. Johnson

The Riemann-LaRouche model is described in a feature story in this issue, page 57. Dr. Bardwell will report further on the thermodynamics of the economy in the October issue of Fusion.

Independent Petroleum Association, Denver, May 11

How to Produce More Oil?

The overriding theme of the mid-year meeting of the Independent Petroleum Association of America, the largest association of non-multinational oil producers in the United States, was "how can we produce more energy," despite legislative actions that discourage exploration and pumping of oil. The meeting, held May 11-13 in Denver, drew more than 1,200 small- to medium-sized oil and gas producers.

The prime target of strategy discussion during the sessions, which included addresses by Senators Malcom Wallop (R-Wy.) and David Boren (D-Ok.), was the just-passed crude oil windfall profits tax of 1980. One major independent from New Mexico told *Fusion*, "We can't take $227 billion out of any industry in this country and not have drastic effects." That figure is the minimum estimated revenue the government will receive over the next 10 years from what has been called the largest single tax ever passed by the U.S. Congress.

As independent producers pointed out, the tax is not a profits tax at all, but an excise tax on oil pumped at the wellhead, which, as one producer estimated, would "cut 25-50 percent of my gross revenues" compared with the previous year.

The session focused on legislative strategies to oust a number of liberal senators and congressmen opposed to energy growth and replace them with legislators who will ensure legislative action to encourage oil and gas exploration in America.

Commenting on this effort, Senator Wallop chided the producers. "There are but two choices to make at this juncture. Get out of the business, or stand up and fight to win. The point is that the windfall profits tax is not the last offensive this administration or this Democratic-controlled Congress will mount against the domestic oil industry."

—William Engdahl

McCormack

Continued from page 23

attached no budget figures to this commitment, reminding McCormack that the program was now under review. The president wrote that he hoped the review would "enable us to design an orderly and aggressive approach to the challenge."

In his January 21 letter to the president, McCormack had asked Carter to "declare the development of magnetic fusion energy as a major national priority; and establish as a national goal the construction and successful operation of a magnetic fusion electric generation demonstration plant before the end of the century. . . .

"To accomplish the goals implicit in such a national commitment, it is essential that you announce the administration's support for an increased budget for magnetic fusion for fiscal year 1981—to $500 million; and that you request that a new project be authorized for construction—the Fusion Engineering Test Facility, which is the next major developmental step in the fusion program."

DOE Fusion Ctte.: 'Impressed With Progress'

Dr. Sol Buchsbaum of Bell Laboratories, head of the DOE fusion review committee, reported May 2 to the DOE Energy Research Advisory Board that he is very "impressed with the management and scientific progress" of the fusion program since the last program review two years ago. Although the committee's formal report is not yet drafted, Buchsbaum gave an optimistic appraisal.

"I am amazed by the widespread support, even among nontokamak people, for a tokamak next-step Engineering Test Facility," Buchsbaum said.

The Buchsbaum committee has visited several fusion experiments and met with program scientists over the past two months to help prepare their evaluation of the fusion program.

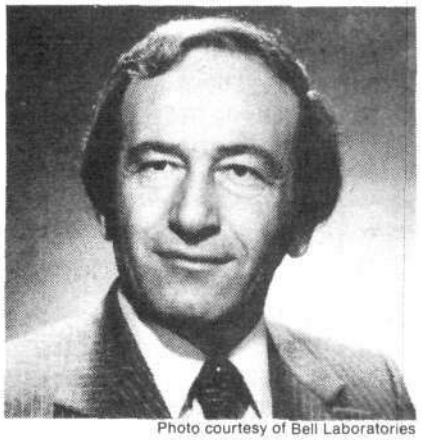


Photo courtesy of Bell Laboratories

Dr. Sol J. Buchsbaum

Buchsbaum indicated to the Energy Research Advisory Board that the fusion scientists were successful in convincing the committee to revise the program to go ahead sooner with the construction of the Engineering Test Facility (ETF) than the DOE current timetable, which would begin work in 1986.

All the details of the goals and parameters of the ETF have not been worked out, Buchsbaum said, and he suggested that the advisory board might provide some help.

Quite predictably, the only dissenting voice on the board came from Tom Cochoran, former counsel for the Natural Resources Defense Fund, who was appointed to the board last year by then-undersecretary John Deutch. Cochoran queried whether the ETF would narrow the fusion program and then stated that he could see reasons for accelerating the program—and reasons for slowing it down.

Had the Buchsbaum committee submitted a draft of its final report at the May meeting of the advisory board, some observers feel it might have helped mitigate the budget-cutting on Capitol Hill and altered the congressional action taken on the fiscal year 1981 fusion budget.

However, it is also felt that Buchsbaum may be gathering political backup to recommend a significant revision in the DOE program. The committee will hold a public meeting May 23 on fusion policy, and among those testifying is Dr. Morris Levitt, executive director of the Fusion Energy Foundation.

Notice

We regret the reference to any representation or interest on the part of Kidder Peabody Co., Mr. Randolph P. Compton, and the Fund for Peace in the activities or conduct of the group known as the Clamshell Alliance or the unlawful conduct of that group in Seabrook, New Hampshire or elsewhere.

After discussions with a representative of Kidder Peabody Co. and Mr. Compton, we tender our apology to Kidder Peabody Co., Mr. Compton, and the Fund for Peace for our observations concerning them in the October issue of *Fusion* magazine.

DOE to Make Nat'l Labs Soft?

The DOE is quietly turning the nation's major scientific research laboratories into "soft path" energy research centers.

Because the national laboratories depend on DOE for virtually all their energy-related research money, they have to do whatever type of research the DOE is willing to fund. Over the past two years, this has meant that more and more lab facilities and manpower went into solar, conservation, and other so-called "alternate" energy programs that the DOE is funding at the $1.5 billion level overall, while hydrogen and advanced nuclear research was squeezed out of research funding.

Brookhaven National Laboratory in New York, for example, is now spending about 10 percent of its operating budget on solar, geothermal, and conservation research. In mid-May Brookhaven announced that it was beginning construction of a solar passive house as a model to demonstrate this technology for the DOE. Although it is not the case that scientists previously doing fusion research are now working on solar, many of the advanced R&D programs are so underfunded that talented people are being forced to move "where the money is."

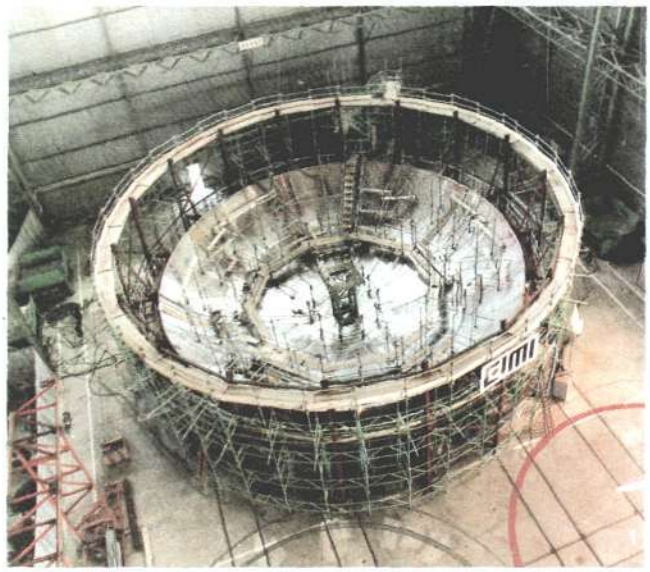
Equally disturbing is NASA's energy-related research—involving the nation's largest pool of scientists and engineers. The space program has virtually no energy development effort of its own, but manages under subcontract some DOE programs. These include advanced technologies such as magnetohydrodynamics, but increasingly the DOE emphasis to NASA subcontractors has been in solar and "alternatives."

Twenty years ago the NASA Lewis Lab in Cleveland used to hold conferences on plasma propulsion systems and fusion. This year the Lewis Research Center hosted a mid-May conference on technology transfer where presentations by NASA contractors included talks on wind-powered farms and solar energy for electric power.

Duncan in Contempt

Energy Secretary Charles Duncan was voted in contempt of Congress after he infuriated members of the Environment and Energy Subcommittee of the House Government Operations Committee by refusing to supply DOE staff documents concerning the president's proposed oil import fee.

Some of the documents, requested by subcommittee chairman Toby Moffett (D-Conn.), allegedly questioned the administration's plan. The contempt charge was purged when the DOE turned over the subpoenaed documents May 12.

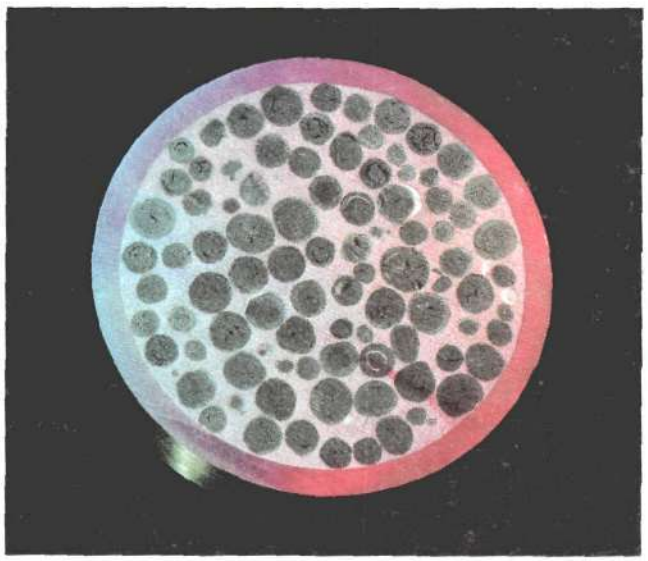


In This Issue

HOW FRANCE TOOK THE NUCLEAR LEAD

France's ambitious nuclear program puts the United States to shame, and France is now beginning to reap the benefits of a nuclear export policy that the United States has deliberately declined. De Gaulle's message to the nation in 1962 is still apt: Without a "grand design" for industrializing the Third World, France – and any other advanced nation – will die.

At left: The Super Phenix fast breeder under construction.
CEA



ENDING THE SCARE STORIES ABOUT NUCLEAR WASTE

Nuclear waste is the biggest bugaboo in the environmentalists' scare storybook. Yet, technologies to safely bury high-level wastes have been known and used for 20 years. Furthermore, with reprocessing, nearly 97 percent of what is now considered waste in the United States can go back into the fuel cycle.

At right: A cross-section of a proposed radioactive waste containment method where wastes are converted to ceramic pellets and placed in a metal matrix.
Battelle Pacific Northwest Laboratories

TANDEM MIRROR FUSION: A NEW LEAP FORWARD

The tandem mirror fusion experiment at Lawrence Livermore Laboratory in California is performing three times better than expected and looks like a contender for first place along with the tokamak-type fusion device. Lawrence Livermore is working on a tandem mirror reactor design that breeds fission fuel and directly converts the fusion-generated charged particles to electricity, increasing the efficiency of the reactor.

At left: An artist's conception of the Mirror Fusion Test Facility at Lawrence Livermore.
Lawrence Livermore Laboratories