Save the Fast Flux Test Facility! The United States Must Go Nuclear

by Marjorie Mazel Hecht

One day in the next three months—unless we stop it—engineers will drill a 1-inch-diameter hole in the reactor vessel of the premier U.S. advanced nuclear research reactor, the Fast Flux Test Facility (FFTF) in Hanford, Washington. The sodium coolant will be drained out through the hole, and the reactor will be permanently disabled.

This deliberate sabotage of the U.S. nuclear research capability exposes President Bush's alleged pro-nuclear policy as a sham. The FFTF is a world-class nuclear research reactor, necessary for testing fuel and components for advanced nuclear breeder and fusion reactors, producing medical isotopes, and expanding our knowledge of neutrons.

The FFTF was conceived in the 1960s and built in the 1970s, to serve what was then assumed to be a nation whose future energy supply would be provided by advanced nuclear technologies. Its signature capability—production of fast neutrons—makes it crucial for understanding nuclear processes and creating more efficient future fission and fusion reactors. Although the FFTF performed flawlessly for ten years, it was put on death row in 1990, when the Department of Energy (DOE) ruled that it should be shut down, because there was no "long-term" mission to justify its operating costs (about $100 million per year).

The FFTF *is* America's energy future. Nuclear is the only alternative to oil-dependence. Without it, we cannot sustain the United States or the world population. Neutrons have always been key to nuclear development. Understanding them will allow us to design more efficient reactors, to breed more nuclear fuel in nuclear and hybrid fusion-fission reactors, and to develop the materials that can withstand the higher temperatures of fusion energy.

The FFTF is a national treasure. Without it, the United States is headed for a new Dark Age. There is not much time left—but the DOE decision still can be reversed. A group of FFTF supporters has been battling for years to save the FFTF, and to counter the fear-mongering of the anti-nukes as well as the cupidity of some local citizens who would prefer to get $2 billion in clean-up contracts from the DOE than to fight to save a key national research facility.

The FFTF Achievements

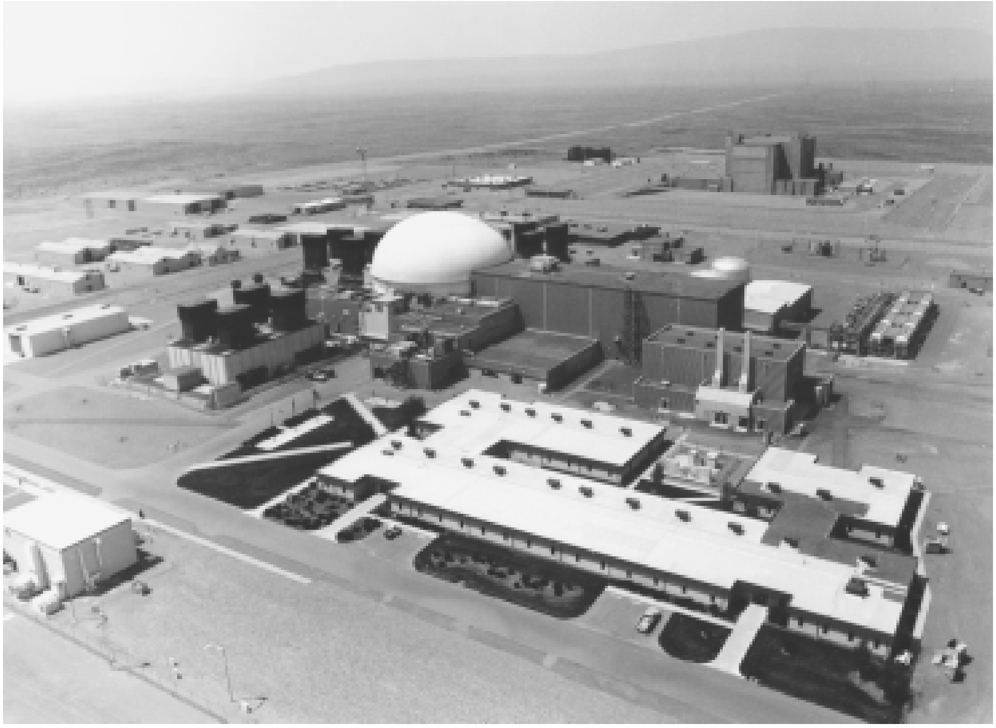
The Fast Flux Test Reactor is a type of reactor known as a breeder, a reactor that generates power from its uranium and plutonium fuel, and produces more nuclear fuel in the process than it consumes. It is the answer to energy shortages for years to come. If hooked up to a steam turbine, the 400-megawatt reactor could power a city of 30,000. The FFTF's purpose, however, is not power production, but the production of neutrons, at all velocities and density of flux.

The FFTF was completed in 1978, and began full-power operation in 1982, under the management of Westinghouse Hanford. For ten years it tested materials and fuel components for fast breeder and fusion reactors under actual operating conditions, so that their performance could be known before being built into new reactors. The FFTF was also used to transmute high-level nuclear waste, to test space nuclear fuel systems, and to produce 60 special isotopes for life-saving medical use and for industry.

This isotope production is essential for supplying both frontier cancer-treatments and routine diagnostic testing (in the United States there are 36,000 diagnostic tests with radioisotopes per day). Right now, the United States has to import 90% of its medical isotopes from Canada and Europe, and many are hard or impossible to get.

The FFTF was working on an advanced fuel design using new alloys, that would have an operating lifetime three to four times longer than previous fuel systems. This would bring the cost of future breeder reactors near to that of conventional reactors. The new fuel system, using new materials that are resistant to radiation damage, would stay in the reactor core three to five years (instead of one year). At the time, Westinghouse estimated that the fuel cost would decrease from about 13.5 mills per kilowatt/hour to less than 7 mills. Also being tested were new safety features, such as passive systems that ensure reactor shutdown and core cooling without operator intervention and without electrical power, if a problem arises.

But, the DOE axe fell in 1990, ordering the FFTF to shut down, and stopping—without advance notice—a Japanese project to test components for its fast breeder reactor that was in progress under a paid contract. Local residents mobilized to save the FFTF, and through legal actions and political pressure have kept the FFTF alive, although it is still on death row. FFTF supporters have searched for private contracts to keep the facility in operation, and came up with a potential buyer, an isotope production company. But despite a Bush Administration that promotes "privatization," and despite the



The Fast Flux Test Facility at Hanford, near Richland, Washington. The white dome is the containment building for the 400-megawatt multipurpose test reactor.

millions of dollars proffered by this company to buy the FFTF as "government surplus," the DOE said "no" to the offer in 2004. The DOE is standing by its decision to kill the FFTF.

At the same time, the anti-nuclear groups targetted the FFTF-shutdown as a "trophy kill," understanding that if the United States were to have an advanced nuclear capability, it would need the FFTF. The anti-nukes understand that the shutdown would greatly damage U.S. nuclear capability, and would disperse a specialized workforce of scientists, engineers, and technicians—which dispersal is desirable from the anti-nuclear point of view. These well-funded Luddite groups assailed the public and elected officials with the usual propaganda and lies, playing on fear of anything nuclear.

This FFTF battle has raged now for 15 years.

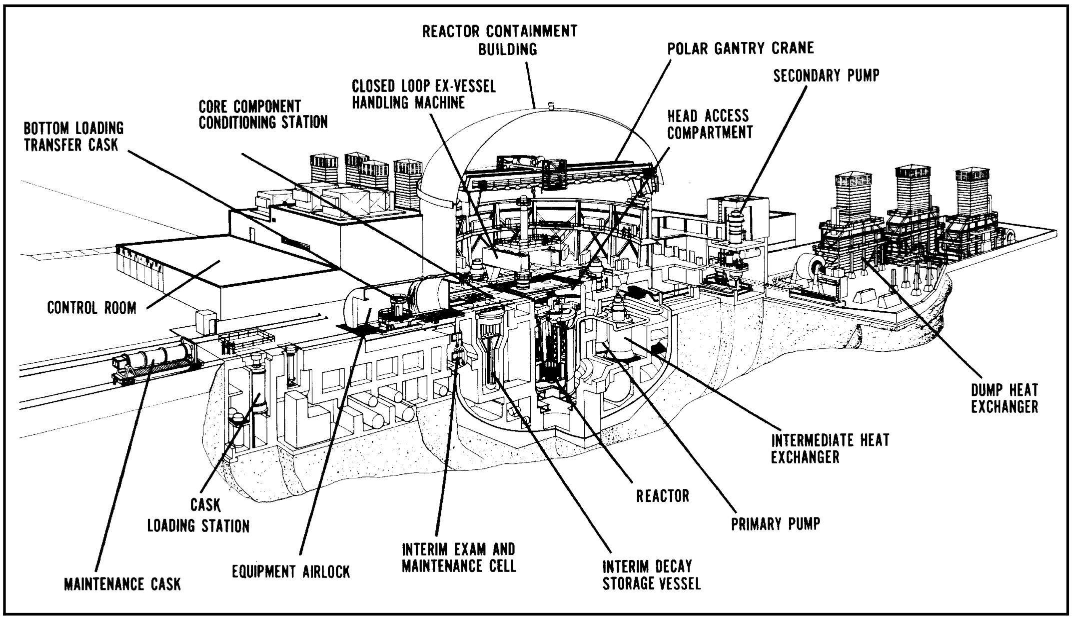
The Revolution of Breeder Reactors

Breeder reactors, also called fast reactors (because of their fast neutrons) produce power at the same time that they create new nuclear fuel. For a country without oil or uranium (like Japan), the breeder offers a way to become self-sufficient in supplying energy for an industrial economy. And as Enrico Fermi said in 1945, "The country that first develops a breeder reactor will have a competitive advantage in atomic energy." In 1951, the United States was the first to demonstrate the technical feasibility of breeding fuel in the experimental breeder reactor, EBR-I, in Arco, Idaho. This reactor was also the first reactor to produce electric power from nuclear fission. Thirty years later, the United States made a decision to drop that competitive edge and ditch the breeder concept.

A nuclear reactor is an efficient way of generating heat to boil water and make steam, which turns turbines that turn generators to produce electricity. In conventional power plants, the heat comes from burning coal, oil, or natural gas, using up these resources and spewing by-products into the atmosphere. One tiny pellet of uranium fuel (1.6 grams) can generate as much electricity as 6.15 tons of coal. The heat of a nuclear plant comes from nuclear fission, the splitting up of the uranium nucleus by slow-moving neutrons. Each time a uranium nucleus splits, it generates heat in the form of fast-moving particles made up of lighter elements. Each fission also produces several additional neutrons. If these can be slowed down, they will cause another fission, and another, and another—a chain reaction.

In a conventional reactor, a moderator, such as water or heavy water, slows down the fast neutrons produced by the fission reaction to a rate that is optimal for maintaining a chain reaction. If the neutrons are too fast, they go right through the fissile material (uranium-235 or plutonium-239), without causing fission. The neutrons have to stay around long enough to hit a fissionable atom, which splits it into two fission products and several neutrons. These neutrons go on to hit other fissionable atoms, or to form plutonium-239.

In a breeder reactor, these neutrons are not moderated, or slowed down, but are caught in a "blanket" of uranium or thorium surrounding the reactor core. There, the neutrons produce new fissile material, such as plutonium-239. At the same time, the heat produced by the fissioning is used to generate electricity.



The FFTF is a liquid-sodium-cooled reactor with a fuel of mixed uranium oxide and plutonium oxide. Fast flux refers to the speed of neutrons produced in the reactor core during the fission process. The reactor vessel is located in the dome-shaped containment building.

The FFTF has the temperature and fuel characteristics of a fast breeder, but it does not breed fission fuel. Its purpose is to test components and fuel for the breeder and fusion reactors, and to give us a better understanding of neutrons.

Life on Standby

In 1993, the FFTF, a billion-dollar facility, was again sentenced to death by the DOE. Since then, the FFTF has been on "standby," not yet irretrievably dismantled, as the DOE has pursued various steps for the shutdown execution and environmental impact statements. From 1994 through 1997, the nuclear fuel was removed from the reactor and stored in above-ground dry storage casks. Some of its systems were shut down, but the DOE then wanted the facility to remain on standby, in case it could be used to produce tritium for the weapons program. (The FFTF had not previously been involved with tritium production.) In 1998, it was decided that this would not be done, and, pending environmental impact studies, that the shutdown should proceed. There were other brief halts, as the DOE was legally challenged or as it considered other possible missions, but the "deactivation" has been proceeding.

In a breeder reactor, liquid sodium is used to carry the heat from the reactor core, where the fission takes place, to where it is wanted. Sodium is used as the coolant because it does not slow down the fast neutrons, and it efficiently moves the heat generated in the fission process.

In the last two years, the liquid metal sodium in the FFTF has been drained from both the primary and secondary cooling systems, but thousands of gallons of sodium still remain in the reactor vessel itself. The last 16,000 gallons of sodium have to be drained by a June 30, 2005 DOE deadline. The most efficient way to keep the last amount of sodium hot until it could be drained, was to keep it at 385°F. in the reactor vessel, where there are immersion heaters. (Sodium melts at 208°F.)

Once the last 16,000 gallons is drained out, the FFTF cannot be restarted. Draining requires drilling a 1-inch-diameter hole in the 3-inch plate of steel at the bottom of the vessel. That hole, and the metal shavings it leaves, will disturb the flow pattern of sodium around the vessel. In addition, the shavings are dangerous to have in the system, and could potentially mess up pumps or clog portions of the flow in fuel assembly, which would cause the fuel to overheat.

At any point before the drilling of that hole, the reactor could be restarted, and the sodium could be put back into the cooling system. But the longer the pipes sit, exposed to the atmosphere, the more chance there is for corrosion.

Bad Faith of the DOE

Local citizens who have been fighting since the 1990 death sentence to keep the FFTF alive, recently discovered through Freedom of Information Act inquiries, a July 15, 2002 memo from Kyle E. McSlarrow, DOE Chief of Staff, which states: "On December 19, 2001, Secretary Abraham directed that actions be taken to proceed immediately with the deactivation, decontamination, and decommissioning of the fast flux test reactor." However, there was no such order by Secretary Spencer Abraham. Instead, as FOIA requests showed, the Secretary ordered only "deactivation." The difference is important: Deactivation is not necessarily permanent; it would not kill the FFTF, but would permit the possibility of its coming back into operation in the future.

A spokesman for the Department of Energy's Press Office assured this writer that McSlarrow would never have written such a thing unless it were true, but when pressed for more

Why the FFTF Is Unique

The FFTF is unique because it produces a lot of neutrons, fast: at peak, 7.5×10^{15} neutrons per square centimeter per second. That's 750 times as much as other research reactors, which have a neutron flux of 1×10^{13} neutrons per square centimeter per second. This means, that if you want to test how a particular material would stand up in a commercial power reactor, you could subject it to neutrons in the FFTF, and in a few days or longer (depending on the material and its use) simulate the long-term effects of neutrons on that material.

The fast flux of neutrons, its large target volume, and the high energy of its neutrons make the FFTF ideal for producing medical and industrial isotopes in quantity. Because of the high flux, there are higher reaction rates, so more of the targetted material can be converted to the desired isotope. The FFTF can also produce multiple neutron capture reactions to produce more exotic isotopes, and it can produce isotopes that are created only with very energetic neutrons. Some isotopes can also be produced in an accelerator or cyclotron, but not all of them, because the the neutron flux is not high enough.

To take one example: One of the most widely used medical isotopes is technetium-99m; there are 7 million diagnoses per year in Europe and 8 million per year in the United States using technetium-99m, which has a half-life of *six hours.* Right now, the United States imports almost all of this isotope—which created a serious problem after 9/11, when the supply was disrupted.

Life-Saving Isotopes

Technetium-99 can be produced in a cyclotron, but to do so requires a starting material that is a rare and costly form of moylbdenum. However, production of technetium-99m in a fission reactor begins with the less expensive enriched uranium (U-235), which then produces molybdenum-99. The technetium-99m is supplied to hospitals and other institutions in an insulated container of this molybdenum-99, which has a half-life of 66 hours, and which decays to technetium-99m. So, delivery of the molybdenum-99 to medical sites can be weekly, with institutions extracting from it the technetium-99m that they need.

The FFTF will lower the cost of supply of molybdenum-99 even further, because production would be through a "capture" process, without requiring enriched uranium targets.—*Marjorie Mazel Hecht*

specifics, has not called back.

FFTF supporters also uncovered the fact that former DOE Secretary Abraham made a trip to France in August 2004 in search of a source in the advanced French breeder reactor for testing advanced fuels and materials—the very services that the doomed FFTF could provide! As a press release Aug. 24, 2004 states: "Secretary of Energy Spencer Abraham today signed an agreement with France's Atomic Energy Commission Chairman Alain Bugat [which] . . . specifically provides DOE access to the Phenix fast spectrum test reactor, which has a capability that no longer exists in the U.S." The release goes on to say, "The cooperation has provided access to French R&D that has saved the U.S. tens of millions of dollars."

But, has it? The real cost of this technology outsourcing is the nation's future as an advanced industrial economy—a fact that eludes this Administration, even as it mouths pro-nuclear statements.

Another outsourcing fiasco in the works is that the DOE is looking for facilities abroad to test new types of nuclear fuel for the one new reactor that is planned for the future. This is a job that the FFTF was designed to handle, and as one of the scientists in charge of testing new fuel components wrote about the difficulties of outsourcing: "It will inevitably prove to be more difficult and constraining than we imagine early on. . . . [W]e are finding that experiment to be more time consuming and cumbersome than originally envisioned, and the benefit will be considerably more limited than a similar test that we would have performed in EBR-II [now shut down] or FFTF. . . ."

Even a cursory look at the DOE's record on the FFTF indicates its bias. One scientist familiar with the project since its inception stated flatly that the staff throughout the middle levels of the DOE is anti-nuclear, and has been since the Carter days. Now, no one at the top wants to admit that the decision to shut down the FFTF was wrong, he said, because then they would be responsible for the lives lost because of the lack of isotopes for medical treatment that could have been provided by the FFTF.

The DOE is riddled with anti-nuclear staffers, and has been since the days after Dixy Lee Ray left the Atomic Energy Commission in 1975. But equally to blame is the monumental stupidity of a government bureaucracy that uses a cost-benefit analysis measured in instant gratification. For example, the DOE Assistant Secretary for Nuclear Energy, William H. Young, stated at Congressional hearings on the FFTF, March 7, 1990: "Production of medical and industrial isotopes at FFTF cannot be economically justified, and even together

The FFTF fuel assembly grid (below) with reactor operating equipment (above). Pelletized fuel of mixed uranium-plutonium oxide is stacked in a 3-foot column inside stainless steel tubes to form fuel pins, which are arranged in 217-pin assemblies for insertion into the core. Samples of nuclear fuel and other breeder reactor materials are placed in the core for testing.

with other options, cannot significantly offset FFTF operating costs. . . . In view of the substantial cost savings resulting from a shutdown of the FFTF, and particularly in view of the intense competition for limited budget resources, the Department cannot justify FFTF's continued operation, and regrettably its shutdown is our only prudent course of action."

Meanwhile, the DOE's own studies, such as the "Expert Panel" convened in March 1999, forecast a coming crisis in isotope availability, and lamented the brake put on medical advancement because of the lack of a reliable isotope supply. The 1999 report produced by the Expert Panel spelled out the tremendous savings in lives and dollars that would come from new technologies using isotopes:

"It has been demonstrated that the use of myocardial perfusion imaging in emergency department chest pain centers can reduce duration of stay (12 hours vs. 1.9 days) and reduce charges ($1,832 per patient) compared to conventional evaluation (*J. Nucl. Med.,* 1997 Vol. 38, p. 131). F-FDG PET has been studied for detecting and staging recurrent ovarian cancer. Potential savings were estimated at $8,500 per patient with PET (*J. Nucl. Med.,* 1998, Vol. 39, p. 249). Non-Small-Cell-Lung Cancer (NSCLS) can be staged with whole body FDG PET 'resulting in fewer invasive procedures and a savings-to-cost ratio of more than 2:1' (*J. Nucl. Med.,* 1998, Vol. 39, p. 80).

"These examples illustrate that a lack of knowledge is very expensive. Nuclear medicine can offer improved patient care at reduced cost over conventional treatments. Though the cost of providing a reliable and diverse supply of isotopes for medical use may seem expensive, it will surely pay for itself in reduced patient care costs, improved treatment, and improved quality of life for the millions of patients that will take advantage of this technology."

The DOE's bias and illogic jump out in everything the Department writes about the FFTF. For example, the *Federal Register* Aug. 13, 2004, giving notice of DOE's intent to prepare an environmental impact statement for the decommissioning of the Fast Flux Test Facility at the Hanford site, states in part: "Other reasonable alternatives that may arise during public scoping and preparation of the draft EIS [Environmental Impact Statement] would also be considered. Because DOE has made a programmatic decision to permanently shut down and deactivate FFTF, and is currently performing deactivation activities consistent with this decision, restart of the FFTF is not considered a reasonable decommissioning alternative. . . ."

Greed and Fear

The DOE's nuclear program in the United States is now centered on billions of dollars of "clean-up" money to clean up the nuclear sites from the Manhattan Project and the Cold War years. These are unscientific programs, emotionally driven, involving an army of staff, operating on the perception that no level of radiation whatsoever can be tolerated. The Hanford Nuclear Reservation is one of the main clean-up sites.

Given this situation, one of the more disgusting aspects of the FFTF issue is the capitulation of some local citizens to greed. Instead of fighting to keep the FFTF alive, they are fighting for a piece of the burial contract. The issue is whether the huge decommissioning and clean-up contract for the FFTF should be awarded to a local or an "outside" firm. About $2 billion is involved, and reportedly political figures in the state have responded to the greed-mongers by agreeing to oppose the FFTF. How deep this opposition is remains to be seen.

Having made this clean-up boondoggle their fight, these locals are now saddled with the enormous baggage of lies about the "clean-up" of the Hanford Nuclear Reservation, on which the FFTF is situated. It means suspending one's reason and entering the fear-land of the nuclear radiation bugaboo, where any radiation is seen as dangerous. Such fear-land inhabitants don't understand that human beings can't live without radiation, that zero-radiation is not possible, and that there are scientific ways to determine whether something is actually dangerous.[1]

A Paradigm Shift

Let's look back at the time when the FFTF was conceived and built. In the 1960s and early 1970s, the spirit of the Atoms for Peace program still prevailed. Nuclear energy and its advanced applications were envisioned as ways to provide a better living standard for growing populations worldwide. We had already put a man on the Moon, and there were plans to explore and colonize space. In the United States, more advanced nuclear reactors were planned, to provide a safe and reliable source of electricity, and many applications of nuclear technology—space propulsion, food irradiation, nuclear medicine, desalination, agriculture, to name a few—were under development. It was assumed that advances in fundamental science—understanding the complex behavior of neutrons and their interactions with nuclei—would lead to all sorts of future advances, including more efficient ways to generate nuclear power.

Fusion energy was seen as the next-generation nuclear technology to be developed by 1990. Children's books were written about rocket science and the world of the atom, because that was the world children wanted to be part of when they grew up.

The FFTF came on line in 1980, and it performed all its tasks well until 1992, including the production of specialty isotopes used in innovative and successful cancer treatments. But since its conception and authorization in the 1960s—in a time of scientific optimism and progress—and its coming on line in 1980, the political situation had drastically changed. Instead of the Atoms for Peace idea, where the United States would complete the nuclear fuel cycle, reprocessing spent fuel and breeding new fuel in breeder reactors, the United States was being pushed into a "post-industrial" mode.

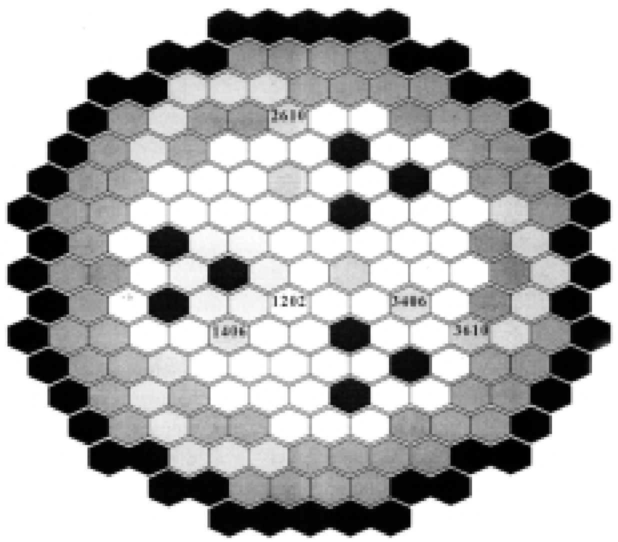
The U.S. breeder program was stopped in midstream, by the overtly anti-nuclear Carter Administration, which launched a fear campaign against nuclear "proliferation." The breeder reactor was labelled by its very nature as "bad." (In fact, when the FFTF, the nation's first industrial-size breeder reactor, achieved criticality—the start-up of the chain reaction—on Feb. 9, 1980, the anti-nuclear DOE didn't even take notice.)

FFTF technicians working on a fuel assembly. Each fuel pin is less than a quarter-inch in diameter and about 8 feet long. The fuel pins are gathered into 217-pin assemblies, like the one shown here, which are housed in hexagonally shaped ducts in the reactor core.

The Reagan Administration continued Carter's anti-breeder policy, by "privatizing" the breeder to death. Without some form of government support, and in an increasingly hostile environment, no individual company was willing to invest in developing a demonstration breeder reactor, especially given the well-funded and growing anti-nuclear environmentalist movement. The Clinch River Breeder Reactor in Tennessee was mothballed in 1983.

The same mentality that shut down the Clinch River Breeder, squeezed nuclear plant construction to death with high interest rates and environmental interventions that had nothing to do with the environment, and stopped the spread of Atoms for Peace to the developing sector, is clearly not going to worry about advancing cures for cancer. If the nation valued its citizens, it would be pursuing the best options for understanding cancer by carrying out fundamental research,

1. For details on the Hanford cleanup, see Michael Fox, Ph.D., "Why Hanford's Nuclear Waste Cleanup Wastes Your Money," *21st Century Science & Technology,* Summer 2004.



This schematic of the FFTF core with multiple missions shows the hexagonally shaped ducts, in which multiple experiments can be conducted. Some ducts contain the fuel rods and control rods. Others are for isotope production, fuel tests, and so on.

and treating it with the best means we have, such as the new cell-targetted therapies. Marlene Oliver, a biologist and member of the Nuclear Medicine Research Council and National Association of Cancer Patients, and one of the FFTF supporters, estimated that thousands of lives are lost in this country yearly because we are not developing the radioisotope technologies now being developed and used in Europe. The savings in lives, and in money now wasted on more costly and less effective technologies, would be in the billions, she has calculated—enough to pay for many FFTFs.

A Nuclear Renaissance

We need a nuclear renaissance now! It can't be done without the FFTF for materials testing, and new, even more advanced facilities, like the FFTF. It can't be done without a training facility for future nuclear scientists and engineers. Dr. Alan E. Waltar, former president of the American Nuclear Society, stated the case eloquently in 1990 at Congressional hearings on the FFTF:

"This reactor has no equal in the United States as an educational facility. Our nation stands at a critical turning point in education. Projections of an engineer shortage of approximately one half-million by the year 2010 and declining enrollements in 'hard' sciences in our colleges and universities are causing justifiable alarm in the halls of technology and academia. At the same time, engineering departments, especially nuclear engineering departments, are being deprived of their training reactors, crucial laboratory facilities, and qualified faculty by hard-pressed administrators faced with increasingly harsh budgetary constraints. Thus begins the vicious cycle. Student numbers reduce even further as programs disappear; the size of the scientific community diminishes; advanced technology with its attendant human benefits and comforts becomes no longer available to a declining economy.

"As the most advanced multipurpose operating reactor in the United States, the FFTF *must* remain available and operating if the men and women who are to design and run the progressive reactors of tomorrow are to be fairly served."

The nuclear renaissance is not just on Earth. To move out into space and return to an aggressive policy for space exploration and colonization will require more plutonium-238 for space nuclear generators and heat sources—something the FFTF can produce and test.

Information technology and outsourced labor are not going to bring about a renaissance. We need to train new generations of nuclear scientists and engineers to build the required nuclear reactors here and around the world. The United States now does not even have the industrial capability for building a large pressure vessel for a reactor, much less an infrastructure for mass producing fourth-generation nuclear plants or fusion plants.

The FFTF is a symbol of what this nation once dreamed about with Atoms for Peace. If we don't make the FFTF a reality now, we are on our way to the nightmare of Third World status and a New Dark Age.