Edwin Kintner: 'Achieving fusion is a problem of politics, not technology'

Edwin Kintner was the director of the Department of Energy's Office of Fusion Energy until January 1982 when he resigned, citing the extreme problems developing in the program as a result of Office of Management and Budget interference. Kintner had, before coming into the program, some 30 years of experience in the development of nuclear technologies, and had been project director, under Capt. Hyman Rickover, of the Nautilus program which developed the first working nuclear power reactor, as an engine for submarines.

Kintner was interviewed for EIR *by Fusion Energy Foundation Director Paul Gallagher, immediately following the International Atomic Energy Agency conference on fusion Sept. 1-8 in Baltimore, at which he spoke on prospects for fusion at a meeting organized by the foundation.*

EIR: You told the FEF session in Baltimore that fusion energy research and development efforts in the United States and elsewhere are continuing to progress in demonstrating technical capacities for fusion power. What are the important new developments, as of this conference?

Kintner: There were a number of very satisfying advances reported at this conference. . the 4.6 percent beta [plasma pressure] from the Doublet III [tokamak at General Atomic in San Diego]. You remember that just a year ago there were theories, and some experimental evidence from the ISX-B at Oak Ridge, that 2.5 to 3 percent was going to be the limit of beta. Many people were quite concerned about that. Now we have information that there is no such limit, and we have not yet seen any reason to believe these machines have reached their limit. This is another one of the major parameters in fusion, as represented by the tokamaks, in which it now appears we can be reasonably confident; we know we can do it in temperature, and we know we can do it in beta, within the ranges that are required for a power reactor. . . .

Another result most gratifying to me is the initial success with the TMX [tandem mirror machine, Lawrence Livermore Lab] Upgrade. I've felt for some time that one of the most important contributions I've made to the program is to get a serious program started on the mirror design side, and the TMX itself did what it was supposed to do: increased the confinement in a tandem mirror by a factor of ten over a simple mirror. The TMX Upgrade was supposed to improve this by another factor of ten; in initial operations they have done this by a factor of three, and there is no reason in their minds why they should not continue to improve.

Another important advance, known before but reported in Baltimore, was the operation of the superconducting magnet for the MFTF-B [Mirror Fusion Test Facility], which is by far the largest and most powerful superconducting magnet in the world. It got up to full power with no difficulties.

Now those were in addition to the ones discussed at the FEF meeting, with the polarization of ions to increase cross-sections [rates of fusion reactions], and the other advantages which take place from that. So I think it's been a period of steady and important fundamental progress. . . .

EIR: You also said, despite this progress, if I quote you correctly, that the United States "may have already blown it," in the effort to commercialize fusion. What did you mean?

Kintner: What I said was that one of the most important questions of fusion was not technical at all. That is, whether or not a program requiring as long a time, and as many resources as fusion, could be organized on a political and social basis, in a *directed* way. I felt we had done that, were on the verge of doing it, with the Buchsbaum recommendations of 1980; and I think that what has happened now, the change that has taken place in the program, is not just a matter of money; it is a matter of loss of forwardness and cohesion along a line. The people who are "saving money," don't realize how hard it will be to get the program back on the track, so it has priority as a program; they simply don't understand it.

EIR: Of the two mandates of the McCormack Act [the Magnetic Fusion Energy Engineering Act of 1980] which the Department of Energy has since renounced—aiming at a specific timetable for commercialization of a fusion reactor; and the immediate development of a Fusion Engineering Device—are these the aspects of current policy which have had the worst effect on the program?

Kintner: Yes, they are. I would, perhaps, put them in different terms. The program has come to the point, from a physics point of view, where it is necessary to accelerate the engineering, to match the physics, so that it is possible to know, in ten years or so, whether fusion is practical, and how much good it can be expected to provide.

Now, that is not going to be possible. Until a systems-integrating device like the FED is built, the understanding on the engineering side won't be there.

The other significant aspect of the Magnetic Fusion Engineering Act which is going to be dead or on the back burner, is that of getting industry involved in a serious way in working on fusion development. . . . I'm talking now, for example, about setting up the Center for Fusion Engineering in an industrially oriented mode, and building it as primarily an industry-oriented activity. Those are going to fall by the wayside, and industry is going to lose interest. These corporations are not going to put their best people or their resources into being small-job shops, for a few million dollars a year, to the national laboratories.

EIR: The President's Science Advisor, Dr. George Keyworth, and other officials of the White House Office of Science and Technology Policy, speaking in public, have alleged the unreadiness of certain scientific aspects of the fusion program for the development of engineering.
Kintner: That may be, but within the community [the outlook is optimistic]—for example, the summary on magnetic confinement progress to the Baltimore IAEA meeting which was delivered by Harold Furth [director of Princeton Plasma Physics Lab], was very forward in tone. I do know that Ron Davidson . . . says that we are making good progress, that there are still questions we haven't answered, but we're moving, and moving well. I don't think the question is that we're not ready. The question is will we support it? I'm prepared to let people have credit for saving money, but I don't think they ought to simultaneously take credit for being experts in what the program needs to get ahead.

EIR: How did the program solve major problems during its past five years, while you were director?
Kintner: There were several things indicative of what now needs to be done on the engineering side. One was started before I got there, and I followed through. That was to organize the tokamak program as a program, with a flagship—the TFTR [at Princeton]—and a number of smaller ships, like Alcator A and B, PDX, ISC, and Doublet—all of which had a role to play to increase the base of technical knowledge and insight which would culminate in the TFTR and the JT-60 [Japan] experiments. That's what I mean by a *program*.

Now underneath that, of course, there were another substrate of experiments for the development of information, and development of the theoretical base, the setup of the Institute for Plasma Physics at the University of Texas, and so forth. What we did in addition to that, and this *was* something I had a great part in, was to create a mirror program, with the MFTF and then MFTF-B as the flagship of the mirror system, and devices like Terra, and the TMX Upgrade, and the Tandem Mirror at TRW, and the program at Wisconsin, so that there were a number of different machines, feeding information into this central, flagship of the MFTF-B. And that's what I mean by a program.

We attempted to have other physics experiments intended to fill in the matrix of physics in the plasma fusion and magnetohydrodynamics field. We couldn't do all those we would have liked to do, but with the machines that we had, and the program we laid out, both toroidal and magnetic, within ten years we would have had a significant body of knowledge contributed to science.

On the engineering side it's a similar thing. You need the flagship—namely, the Fusion Engineering Device, with the objective to make significant fusion energy and extract it—and then under that, there have to be additional development devices which produce the special information of one kind or another, such as the FMIT [Fusion Materials Irradiation Test Facility], and the Large Coil Project, and so forth. You [NASA] could have done all the tests in the world, with rockets, and guidance, and monkeys, and so on; but unless that program had had the objective of sending a man to the Moon and bringing him back, it would have wasted 50 percent or more of its efforts. And that's why you need programs, and you need clear targets.

EIR: From the technology-development standpoint, can the current fusion program be compared to important points in fission development?
Kintner: There is not a Stagg Field [the first atomic "chain reacting" pile] kind of step. There is not an STR-Mark I [submarine power reactor] stage for fusion. The rational approach, if one accepts that fusion development is an important human goal, is that when you get to the point that you can design and build, with confidence, a machine that produces significant thermonuclear energy, the next step is immediately to do that; and you continue the physics development which allows you to make more refined judgments with regard to power reactors.

As soon as you start this process of designing and building a systems-integrating device, then you have to lay out, on the engineering side, the developments which will support the design and construction of that machine. If you then do that, if you carry it out well, you will then end up with two types of insights. One is in physics, with regard to the best way of confining a plasma in a magnetic field, and the knowledge of how efficiently, in how small a machine that can be done. You also have a body of knowledge, then, with regard to the engineering; the magnets, the materials, the safety aspects, handling. Putting those two together, then, you are at a point where you can make an assessment about what the program can do in the future.

I studied the Apollo Program, and the Manhattan District program, the naval reactors and the breeder program, and I've tried to find a parallel. But they aren't there. Fusion development is a special kind of challenge.

EIR: The Nautilus program, in which you were involved, was the first breakthrough to power production with fission.

What kind of problems had to be solved to do that, and how fast was it done?

Kintner: There were tremendous problems, and they were so many, and so difficult, that the people involved were quite often discouraged, and quite often surprised. These problems ranged from just not knowing the physics in power reactors, nor the stability of power reactors under loads, nor the materials with which to make the fuel elements, nor how you would be able to inoculate high-speed, high-power motors, pumps, and gears with water lubrication, nor even the simplest question of how you would be able to shield or weld the primary systems. All those problems were solved; the prototype was running in three years; the ship was at sea, and running at full power and full submergence depth in five years.

Now I'm not saying that you could do that with fusion. I'm only saying that so far, it seems to indicate that the same sort of attitude is rational, and that the principles that were enunciated, which I saw come true in the naval reactors program, are valid in fusion: Nature works best for those who work hardest for themselves.

EIR: The U.S. fusion program has been, until recently, the largest. How do the other major national, and international efforts, in the case of the European program, stand, and what rate of progress are they making?

Kintner: At least for the moment, they're making good progress. Good results came out of ASDEX, in Germany. There are good results coming out of Japan, and I think that the Soviets' work on the T-15 Tokamak is doing well. I think that at least for the moment, the results of the Beckerts Committee indicate that technological development in Europe is going to happen, and the same thing is true in Japan.

But my sense of the matter, with both the Japanese and European systems, is that there may come in those countries a reflex action from the downturn in the U.S. program. Their building up recently, in the JET [Joint European Torus] and JT-60 [Japanese Tokamak] programs, came from the impetus of the United States' acceleration since 1972. They're not going to continue full bore if the United States does not.

EIR: What do you think the impact of the program has been, over the last decade, on the training of physicists in the United States?

Kintner: There has been a significant body of bright young people trained and brought into the program. It is inevitable that they are going to continue to produce good results, whether in the fusion program, or outside, in other physics activity. That is a permanent, lasting contribution of the program, absolutely. There is still, and I think will continue to be, an impulse in people to see, in something like fusion, an intellectual and moral challenge, and it will draw to it worthwhile young people who will train themselves, and eventually make major contributions.

Polarized fuel: the that could move up

Nuclear fusion has been called the ultimate energy source. Using the same energy generation mechanism as the stars, nuclear fusion produces energy more intensely, at higher temperatures, and in more different forms than any other form of energy known. The fuel for fusion is the various light elements, hydrogen and helium being the most important.

The fuel cycles most attractive for fusion energy generation are:

deuterium + tritium→ helium-4 + neutron
deuterium + deuterium→ helium-3 + neutron
deuterium + deuterium→ tritium + hydrogen
deuterium + helium-3→ helium-4 + hydrogen

The common ingredient in all these fuel cycles is deuterium, a doubly heavy form of hydrogen that occurs naturally; approximately 1 out of every 6,000 hydrogen atoms has a deuterium nucleus. This isotope of hydrogen shares all the chemical properties of normal hydrogen but has different nuclear properties. The energy attainable through the deuterium-deuterium cycle from a quart of water is equivalent to

TEMPERATURE REQUIREMENTS FOR FUSION BREAKEVEN*
in degrees Kelvin

Fuel Cycle	Unpolarized	Polarized
D-T	100,000,000	80,000,000
D-D	350,000,000	220,000,000-300,000,000
D-He^3	700,000,000-1,000,000,000	400,000,000-500,000,000

*Assuming standard tokamak conditions for density-confinement time.

Courtesy of Fusion magazine