Fusion Energy Foundation

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A Matter of Necessity

The creation of a crash program for the development of fusion power is not merely a nice idea — it is an absolute necessity if the human race is to survive the next quarter century. The alternative to the development and the implementation of a fusion-based economy on a worldwide basis within the next decade is an ecological and biological holocaust that will decimate the world's population within the next 10 to 20 years.

The hundreds — possibly only tens — of millions of human beings who survive the plagues and pandemics of old and new viral and bacterial strains **which are already making their presence felt** in the historic breeding grounds of plague and such epidemics and pandemics (India, Pakistan, Bangladesh, Brazil, various parts of Africa, etc.) will be technologically — and what is more to the point, psychologically — incapable of maintaining a standard of existence on a level higher than that presently achieved by the most backward forms of society extant on this planet.

Ironically, that would be **a** solution to the world's present energy crisis, for what deindustrialized civilization would have need for even the limited amounts of fossil fuels presently remaining on this rock? Obviously, such a solution is not one that any sane human being would seriously entertain. Yet, that "solution" must logically follow from present energy programs, which call for reduced energy throughput in the environment — as can be evidenced by the recent two-part article by Prof. Rene Dubos, of Rockefeller University, which appeared in the New York Times. Prof. Dubos does not make clear just what level of human culture he wants us to return to, however, he was implicitly speaking about — even praising — a return to the functional cultural level of the neolithic period.

Why do we bring up ecological holocaust in the context of an editorial calling for the crash development of fusion power? There are cogent and interrelated reasons for doing so. First, what we are saying about an imminent ecological holocaust is **fact**, not conjecture as can be attested by the deaths by starvation and disease of upwards of 20 million persons in the last year; outbreaks of cholera, meningitis, typhoid, and other epidemics; and the appearance of new viral and bacterial strains along with the older, more common varieties. Second, the significance of fusion is not as a technology per se, but a necessity for mankind at this time in the history of our species. Third, the development of fusion and a fusion-based economy must draw upon the **totality** of human knowledge, science and technology, since what is required with the advent of fusion power is that Man take responsibility for the cultivation of the entire planet — which will necessitate an extent of self-conscious planning never before even dreamed of. Which is to say that there is no reason for the development of fusion power outside the context of what it offers in terms of progress for the human race — since progress is an essential requisite for the continuing survival of our species.

Why Hasn't Fusion Been Achieved Thus Far?

Within the scientific community and among informed laymen, there is general unanimity that the achievement of fusion power is, ultimately, a necessary task for the human race, which will lead us into an age of intellectual and material advancement far beyond anything yet known. Why, then, haven't we developed it so far?

Is it that the theoretical basis for the achievement of fusion power eludes our grasp? In the broadest sense of "theory," no. That is, there is nothing known to science that contradicts the development of fusion power. In fact, thermonuclear fusion is a known process in the universe — it is the process that powers the Sun and the stars. The problem we face is in developing the methods of harnessing and containing that process in controlled thermonuclear reactors here on Earth. In that endeavor, not all the scientific and theoretical knowledge necessary is presently within our grasp. But, **why** is that so, and what can be done about it?

The basic reason we do not have fusion power today is because of a widespread basic misconception of the way in which necessary technological and scientific breakthroughs are come by— a misconception that expresses itself in chronic underfunding by the AEC, due to an overcautious step-by-step criterion which stultifies creativity by depending upon previously existing models that are worked on at a limited number of laboratories which **compete** with each other for government funding.

If history has taught us anything, it has taught us that ideas are produced not in such a necessarily inhibited atmosphere, but in a context which allows for the free, uninhibited exchange of creative ideas and the ability to pursue new avenues of development, with the certain knowledge that even eventual failures prove fruitful when they are pursued by creative individuals in the proper moral and intellectual context — as was amply demonstrated by the Manhattan Project, which not only produced the atom bomb but, also, gave birth to a great many fruitful lines of scientific and technological development that have already proved beneficial to us.

In essence, the problem is one of environment — the creating of an environment in which the necessary conceptual, scientific breakthroughs can be made.

In reality, the problems facing a Manhattan Project-style crash program for fusion development are far less significant than those facing the scientists on the original Manhattan Project. At least we **know** that fusion is feasible. Those scientists didn't know fission was — in fact, many of those scientists were out **to prove that it couldn't be done.** Yet, they finished the project in less than 3 years. Present estimates — under present conditions — for achievement of actually less problematic controlled fusion are still presumed to be 20 years off.

The human race cannot afford the luxury of waiting 20 years. Unless we have **implemented** fusion power within the next 10 years you can forget the whole project — and humanity along with it.

Which is why the Fusion Energy Foundation came into existence. Faced with the imminent prospect of ecological holocaust, we could not afford to have this fatal misconception perpetuated for one moment

longer than it takes to turn the situation around.

Which is also why the Fusion Energy Foundation will succeed. It will succeed because if it does not succeed, there is no human race. It will succeed because the means of developing the environment in which the required scientific knowledge can be developed is understood. It will succeed because you as a human being will make it succeed by organizing your colleagues, your friends, your acquaintences, your relatives to make it succeed. **It will succeed because it must succeed.**

The question is not one of scientific achievement, the question is one of preventing the rapid demise of the human race. Faced with that challenge, you will not let it fail.

New Era Begins

With the establishment, on Nov. 23, 1974, of the Fusion Energy Foundation, a new era has begun for the human race — an era of scientific renaissance that is presently centered around agitation for and support of an immediate crash program for the development and utilization of fusion power within the next 10 years. The group of scientists and other pro-fusion advocates who met at the Tudor Hotel in New York City and took the historic step of founding the Fusion Energy Foundation represent the germ-form of an organization that will play a pivotal role in solving today's energy problems and, in so doing, will lay the foundations for a new human society. In addition to the FEF founding members, the meeting was also attended by representatives of the United Nations, the International Atomic Energy Agency, the United States Atomic Energy Commission, and the United States Labor Party.

Fusion Pioneers

Three pioneers in the development of fusion power agreed to serve on the Foundation's Scientific Advisory Committee: Louis Gold, Robert Moon, and Winston Bostick.

Dr. Louis Gold, of the Biopolis Corporation of America, was the originator of numerous innovations in low energy laser fusion theory and a pioneer in high density plasma work. He also worked on the Manhattan Project.

Dr. Robert Moon, University of Chicago Professor-at-Large, was a co-worker with Enrico Fermi and Leo Szilard on the Manhattan Project. During the 1930s — before the discovery of the neutron — he was working on concepts for fusion development, including one of the original deuterium-trapping experiments.

Dr. Winston Bostick, Professor of Physics at Stevens Institute of Technology, has worked on the magnetic pinch approach to fusion since the 1950s, and was the first to explain magnetic filament effects in high density plasmas.

A pro-tem Board of Directors was elected at the meeting, which includes: Mr. Larry Bogart, coordinator of over 200 anti-fission groups under the Citizens' Energy Council; Mr. Russell Johnson, a national leader of the American Friends Service Committee; Mr. Charles Stevens, Science Editor of Campaigner Publications; Dr. Morris Levitt, of the U.S. Labor Party; and Dr. Fred Howard, of the Yale University Department of Computer Sciences.

Additional members will be added to the board and the Scientific Advisory Committee as the organization grows in membership.

Not "Just Another Meeting"

The day-long conference-symposium focused on a discussion of the social process by which creative scientific work is possible, examining the qualities of the creative human mind.

Lyn Marcus, who spoke as a representative of the U.S. Labor Party, set the context for this discussion in his opening remarks, when he said: "The problem we are discussing here is not a technical one of fusion per se. The problem is one of human survival." Marcus located the necessity for developing fusion power by the middle of the 1980s by laying out the extent of the ecological catastrophe that would engulf all of humanity if present energy policies are allowed to continue. This ecological catastrophe, evidence of which can already be seen in areas of South America, Africa, and Asia, would circle the globe by 1990, and culminate in widespread plagues caused by old and new strains of bacteria and viruses, reducing the world's human population to hundreds, perhaps only tens, of millions of people.

"We must not concern ourselves with so-called absolute time schedules," Marcus stated, referring to well-publicized projections that fusion power could not be developed until 1990 "at the earliest." "There is no such thing as an absolute time schedule. We must specify what is needed — the application of a fusion power technology by the mid-1980s at the latest — and then organize our research and resources to meet that target date. We are capable of accelerating the rate at which creative scientific development takes place," Marcus stated.

In response, physicists and others present drew upon their experiences, especially with the wartime Manhattan Project that created the Atom Bomb, to specify the only condition in which such a creative flowering can take place: broad financial support and complete freedom of inquiry in an atmosphere of intellectual collaboration among morally self-disciplined, creative scientists.

Prof. Bostick raised the fear of bureaucratization and heavy-handed interference with creative work that lingers as an afterthought in the minds of most scientists who worked on the brute force Manhattan Project, and who suffered through the post-war Dark Ages. Both he and Prof. Moon described the tendency of the leadership of the project and various funding agencies during the post-war era to view the scientists as just so many soldiers, or platoons of workers at their desks, grinding out daily assignments.

Marcus answered their fears directly, stating that a "multifarious" approach was necessary, that creativity could not be mass produced as if it were som assembly line product.

Prof. Moon commented, "Creativity is a social experience that is fostered by the free exchange of ideas among small groups of creative individuals," as he recalled memories of the Manhattan Project. Describing how the Manhattan Project actually worked, de-

spite the wishes of its military and bureaucratic overseers, Moon stated, "There is an interpersonal method of knowing which comes about when people get together and share ideas. New ideas pop up which are beyond anything that anyone thought might happen."

Prior to this exchange, Mr. Charles Stevens had outlined the general parameters of a brute force fusion development program. Stevens demonstrated that only fusion power would be an actual source of new "net" energy. A fusion power plant, would produce two times as much energy in its first year of operation as it consumed in producing it. In fission, fossil fuel, or solar energy production, no such net increase in energy production takes place. Dismissing the arguments of a number of speakers who had proposed solar energy as a less risky alternative to fusion power development, Stevens demonstrated that the most efficient way to use solar energy would be to use fusion power to expand agricultural production and as a by-product enlarge solar energy "capture" through photosynthesis.

The representative of the Atomic Energy Commission, Mr. Rice, spoke about the problems of the "R&D business." He stated that one of the basic problems they face is that of "trust" — whether or not they could trust the applicants for AEC funding not to waste the taxpayers' money on "fruitless endeavors."

In answer to Mr. Rice, Marcus countered, "the creative individual must be intrinsically trusted...there must be complete trust for scientific progress to take place." Marcus continued by dissecting the fear of scientific progress that has been spawned by present-day "Zero Growth" ideology. "We should not fear progress or the problems that are its by-products. These so-called problems merely define the next challenge — challenges which science must solve."

Reaching Outward

The Fusion Energy Foundation will immediately begin reaching out to the large numbers of independent scientists who are now at work in isolated pockets or as individuals in the present-day environment of scientific laboratories and universities. These scientists will once again be given the intellectual environment and support to make the creative advances now required to prevent ecological holocaust and human destruction over the next decade.

The FEF will be developing and disseminating the most comprehensive assessments about current fruitful lines of development of fusion power.

Simultaneously, through publication of articles in this newsletter and through the circulation of its forthcoming journal, Profusion, the FEF will keep scientists and the lay public abreast of the latest developments in fusion technology.

Founders Discuss Crash Program

The following is an edited exchange between Profs. Moon and Bostick and Lyn Marcus, which occurred during the FEF founding meeting. The exchange clearly outlines the essential subjective features of crash scientific program of the type we are proposing for fusion power development. As such, it represents in cameo form the type of creative free "exchange of ideas" the speakers refer to.

LYN MARCUS — Dr. Bostick has hit upon a very significant problem which is an included problem that we have to face, and it's a problem which faces socialists in particular. There's an insufficient recognition of the subjective element in human progress. That we have to focus effectively on giving a great deal of freedom and facilities and resources to individual teams which constitute themselves and deconstitute themselves when their specific purpose is completed.

PROF. MOON — I've just jotted down a few things here that I'd like to bring to your attention. The Manhattan project was born after the discovery of the neutron in '32 and then fission in '38 by Hans Strauss. It put scientists to work all over the world in their little laboratories, verifying the various natures of fission. And then the scientists of their own accord went into secrecy. Well, this was one of the first times it seemed that there might be a possibility to get energy from nuclear reactions.

But what I'd like to say is, the atmosphere that existed at that time, in the first place we had this self-imposed secrecy and went to work on neutron diffusion — that's what we called it. The main thing was a group of scientists were brought together, they were fed work, there was no question about patents or anything of that sort, they were working for the good of the country. There was no — such as we have experienced since then — there was no long term writing of proposals and writing of reports and so on. The question is: how do you really do research, if there is a crisis on, and you have got to spend a great deal of time writing reports and getting referrees to approve them — particularly if its a new idea? You didn't have to do this on the Manhattan Project. You just went ahead. This is exactly what happened. Scientists worked, and they worked together. They worked on any idea that came to their minds. No stone was left unturned.

This was one of the great things about the Manhattan Project. And we had information meetings — once or twice a week the scientists got together and discussed all the things that were going on. And there was no self-pride involved at all. We were all reduced to the same level and fighting for the same thing.

If we are ever going to get ahead on fusion, it seems to me something of the order of the Manhattan Project (is needed) in which scientists can come together and work and which funds are given and questions are not asked.

PROF. BOSTICK — Let's remember this when we're talking about crash programs. They are not necessarily an answer to the problem. They have inherent difficulties, inherent poisons built into them. They have the seeds of their own destruction built into them. Also, with the situation in fusion now, there are big centers that have their own programs that are already fairly big. There are these empires and the power brokers of these empires and they aren't going to take kindly to a kind of dismemberment of their empire and a pooling of their resources. I don't know how a crash program is going to come about. I really don't see how to organize it. Maybe somebody else does but it looks difficult to me.

LYN MARCUS — So we have a problem of social development here which I think ought to be integral to our approach. What we have to do is to be multifarious, but have an overview of what we're doing. We can't say, "well, what is the effective approach; this is our policy; now everybody work within this policy." We've got to get away from that bureaucratic approach to scientific development. It doesn't work, because scientific development always is based upon the individual and small group who activates the creation of a hypothesis and the initial experimental demonstration of the hypothesis which then is ready to be assimilated as a part of general policy. What we need in this case, is we need a crash program — but a crash program, I think, has to be not unilinear. It has to be based on fostering every productive line of experiment. Which means essentially fostering a lot of small hypothesis-chasing individual groups based on general experience and competence.

This kind of thing which, while it's indirect in respect to the fusion question itself, is fundamental to getting the kind of progress we want. We must have a social conception of the necessary conditions of scientific achievement as well as the overall funding and general targets which we work for.

Our job is to create a culture in which there is a large proliferation of scientific skills. These skills then have to be given the means to realize their potential. This has to be done in cognate with the raising the cultural level of the entire population, and I think our method of social control is the one by which we are going to be able to achieve these objectives.

Our ability to win this fight for getting back to the idea of progress, away from the idea of zero growth and stagnation proliferated recently, is based on the constituence of the skilled and semi-skilled American worker and his brother in Europe and other parts of the world and the anguish of the underdeveloped countries which need this. And it's to the extent that we make these policies and needs comprehensible to this political constituency which demands that qualified physicists and engineers will be developed, will be given the facilities to realize their potential as individuals and groups to produce the demonstrations of experimental feasibility of hypothesis. We can then — as a source, as a warehouse of ideas — select those demonstrated feasibilities for actual large scale social practice.

But this relationship, I think, must be much more clearly understood. And it our specific responsiblity, particularly from the standpoint of my organization, to deal with that problem. We have to integrate a working concept of how scientific development occurs in society together with the problem of a mass policy of this type. We know from the entire history of the human mind, we know that the mediation of creativity is the creation of hypotheses by individuals often working as individuals or small groups. This demands laboratory and cognate facilities for these individuals and groups be made available with a great deemphasis on saying what are you going to do as a result of getting these facilities. You must be giving considerations along the line Dr. Bostick indicated. We must consider the kinds of sociological problems that come with the furthering of scientific creative development, and we must incorporate these things into our program. The fact that we as an organization are pushing this does not mean, as some might interpret, that we foresee a single policy which everybody gets in line with. Quite the contrary, we have to go through a mediating process which emphasizes individual mental capacity for generating new hypotheses. And it's your responsibility to feed back to us from your experience the empirical knowledge of this sociology.

PROF. MOON — I just want to say another word I forgot to say when I was up here. And this is in line with what both Prof. Bostick and Lyn Marcus have said, namely, on the Manhattan Project there was this great sharing of ideas. This is extremely important, to share ideas, to bring together scientists, they share ideas and they share them freely. They're not thinking about what's in it for me, but rather, what's in it for the country, for the world, in this sharing of ideas. Out of this came new ideas. You find it at the scientific meetings where the scientists gather in little knots in the hallways and discuss problems. Out of this sharing of ideas come new ideas.

I might say that in order to have this sharing we had a little fight when we became the Manhattan Project. General Groves spoke in terms of what Lyn Marcus was talking about, the platoon arrangement. He wanted every scientist to work in his own little cell, not to tell the scientist next to him what he was working on. He thought this was the way to bring about national security. The scientists refused to work! And strangely enough, the scientists brought a sufficient amount of pressure that General Groves gave in.

And so we had our information meetings. We had the sharing of ideas. We felt that we were the ones that had the knowledge about nuclear energy.

The following is an edited exchange between Mr. Rice, from the Atomic Energy Commission, and Lyn Marcus.

MR. RICE — I've been in the R&D business for quite a few years. And one of the basic, gut questions always is to what extent you give the contractor a free hand? The answer to that is very complicated, but it involves among other things, trust. It involves the matter of has that contractor shown not that they're not trustworthy, but that they're effective — that they spend their dollar in a very effective way.

LYN MARCUS — This is the area of creativity we are concerned with. Some of you know from personal experience that the creative person, when functioning as a creative person, does not fit the Rousseau social contract view of competitive individuality. The creative individual can be intrinsically trusted when being creative. There must be complete trust and that's the only basis for scientific progress.

The creative person has a completely different

motivation than the so-called typical person as conditioned by this society. The creative person is not a person who will cheat society. He is incapable of cheating society as long as he is proceding from a creative identity.

What's the creative person's primary concern every morning? What's the agony of the creative person? The agony from which their identity is located? They know that over a period of time, over the period of their maturation, that they have done things that are original. They have synthesized new gestalts, which have a usefulness for mankind, generally. They know they've demonstrated this capacity. And the greatest fear the creative person has is that one morning he'll wake up and find that that capacity for creativity is gone. The creative person goes through all kinds of agony trying to cultivate and maintain that special quality of creativity for fear that somehow it will be lost.

The creative person knows that anything that involves moral prostitution, particularly in respect to the professional areas in which their identities are associated, will undermine their creative potential. The creative person will often leave a job because they find that their creativity is being stultified by the kind of identity which they are forced to adopt in that environment. Because they can feel, as they would say: "My mind won't last in this environment. I'll become a clod."

So the creative person can be trusted because the creative person's sense of identity in society is intimately associated with real achievement. The history of real achievements, disciplined achievement in scientific work, is the essential immediate superego of the creative person. He doesn't do things irresponsibly. His past achievements and discipline guide him in determining what he regards as a responsible contribution.

I would suggest that, in general, a creative person in a creative environment, with a creative opportunity, can never cheat, will never propose an activity which is irresponsible.

Our problem is to develop disciplined, creative people. If we produce creative people, the creative person can be intrinsically trusted. The minute we begin to say: "Can we trust creative people; do we have to put checks on them?" we're going to lose. We're going to stultify creativity. We must recognize that the creative person has a different sense of identity than the average person in society is permitted to achieve. And that a creative person can be trusted.

The other aspect of this — and all of us who do creative work know this — know what we will permit and what we will not compromise with. We know that what we've achieved for ourselves in finding a creative identity in society rather than a routine identity is something which is the proper property of every human being. We want a society in which all human beings have a right to realize this creative potential, this sense of identity of being intrinsically trustworthy people who will not cheat society, who will always act in such a way that they know that their existence is something useful to the human race. They will never do anything deliberately to soil that.

Now the principle upon which this achievement rests is the principle of trusting creativity. And our problem is to recognize it where it exists and to cultivate it where it does not yet exist. Under those principles the problem will be solved.

Because you put the scientists in a banalizing environment. You say, "well, we're not interested in science anymore; science has gone too far." You get these kind of Frankenstein ethics coming out; the mad scientist who's guilty of hubris and he's insulted the gods, the gods are going to destroy the environment or something hideous like that.

The basic principles of science are being rejected in our culture. We talk about the ecological problem: we produce a new crop, we have a new parasite — so what! So what! Everytime we change, we advance, we create a potential problem. That problem, in turn, defines the need for the next advance.

The problem should not be looked at as a reason not to undertake the advance, but rather the problems incurred by the advance become the basis for making further advances. They become the problems that define what further advances should be made.

Hanna Sponsors Fusion Bill In Congress

The following statement was delivered by Rep. Richard T. Hanna, upon introduction of his fusion bill into Congress on Tuesday, November 26, 1974. It is reprinted here from the Congressional Record.

Mr. Speaker, today I have introduced the Fusion Energy Act of 1974. The bill is a first legislative step toward a national crash program to develop useful power and hydrogen from thermonuclear fusion. Recent technological advances have greatly increased the prospects for useful controlled thermonuclear reactions. The bill would provide for the appointment of a blue-ribbon committee of fusion experts to reappraise the current state of the art for fusion and recommend an expanded and accelerated research and development program and whatever else may be necessary to yield useful power and hydrogen from nuclear fusion.

The intense concentration and focusing of intellectual, physical, and financial resources of a crash program seems justified under present world energy conditions and the current state of fusion technology. The urgency of achieving unlimited electrical energy and hydrogen from the fusion reaction can hardly be overemphasized. A little over 30 years ago Albert Einstein wrote to then President Franklin D. Roosevelt:

> Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. . . . This new phenomenon would also lead to the construction of bombs, and it is conceivable — though much less certain — that extremely powerful bombs of a new type may thus be constructed . . . that it may become

possible to set up nuclear chain reactions in a large mass of uranium, by which vast amounts of power and large quantities of new radium-like elements (now generally known as fission products) would be generated. Now it appears almost certain that this could be achieved in the immediate future.

It took just 3 years of focused, intensive effort of the Manhattan Project to deliver workable nuclear weapons. This "crash" project used multiple approaches as technological insurance. Two kinds of nuclear weapons were developed and put into the Nation's armory. Four processes producing uranium-235 from uranium were tried and two continued into full-scale production. Plutonium was derived from nuclear reactors. I believe there is now the necessity to mount a similar program for the production of useful energy and hydrogen from nuclear fusion. We are at a time of crisis in world energy and we need a solution urgently. Fusion energy would provide the most pervasive solution to man's energy needs of any potential energy source on the horizon.

Most fusion scientists believe it can be successfully harnessed within a few years. No one knows how much a multiple path technology approach would accelerate the advent of a useful fusion process. Every expert agrees that millions spent now to achieve a "commercial" fusion system would save billions in the U.S. economy in the decade following its practical adaptation.

The development of fusion needs a substantial technological insurance through parallel, full-scale construction of experimental and demonstration facilities and equipment. Industry should be brought into this national effort to achieve useful fusion power at an early date.

Today, in 1974, our scientists and engineers are much closer to the goal of controlled fusion than were their predecessors to the goal of controlled fission in the 1940s. We may even have more potential avenues of success in fusion systems than was the case earlier. The United States and the USSR have both achieved so-called fusion burns — with an English team confirming the nature of the first USSR burn. These so-called burns mean that we have demonstrated neutrons that can be produced from the fusion of hydrogen atoms under controlled laboratory conditions. This is a vital demonstration. The next step is to produce more energy in a fusion reaction than is consumed by the experimental apparatus, a milestone on the way to practical thermonuclear power. To reach that milestone will require rapid development of several technologies that are now converging and that promise to produce quantum jumps in progress rather than limited incremental progress. It is just in such convergence of parallel technologies such as plasma physics, laser optics, accelerator science, low temperature physics — super conductivity — ultra high speed electronics, and the materials sciences that achieve unpredicted successes dividends and "spin-offs." Controlled thermonuclear fusion, the experts tell us, can be achieved by one or more of the following approaches:

First, magnetic or electrostatic field containment wherein hot plasmas — ionized gases — are confined and heated to produce temperatures sufficient for the fusion of hydrogen atoms.

Second, laser beam induced fusion — either through their use for plasma heating or impacting on small pellets of hydrogen isotopes.

Third, electron — or ion — beam induced fusion — either through their use for plasma heating or impacting on pellets of hydrogen isotopes.

Various combinations of these techniques may ultimately prove to be the most efficient way of achieving a useful fusion "burn." Such fusion systems will constitute intense neutron sources which can be used in many geometry configurations to achieve tritium production from lithium and fissionable materials from thorium and depleted uranium. Perhaps these fusion-fission hybrids will play an important transition role on the road to achieving a pure fusion power or fusion hydrogen generation system. The useful fissionable nuclear fuels, plutonium and uranium-233 would allow the fuller interim development of fission reactors which is now seriously clouded by the potential shortage of uranium in the world.

Indeed, some scientists and engineers have proposed that neutrons from a fusion source might be used to sustain the chain reaction of a conventional fission reactor and by so doing greatly reduce the present problems of nuclear safety. As I mentioned earlier the fusion neutrons generating systems may also be used to produce more of the fusion fuel tritium — an isotope of hydrogen — as well as natural hydrogen gas. Such hydrogen gas may ultimately be produced from the fusion process directly by heating or from electricity produced. Regardless of which fusion path produces the most economic hydrogen this raw material for methane and other organic fuels could meet our U.S. vehicle fuel needs.

Some idea of the recent growth of the beam impact on pellets approach is gained when we are told that there are some 50 skilled technicians in various U.S. laboratories now making the incredibly small, sometimes complex, pellets which will contain the nuclear fuels. And that the Fusion Division of the American Nuclear Society has grown from 50 to 500 members in the past year is further evidence of the growth of this area.

The designs for the experimental equipment to pursue the various fusion options is even now on the drawing boards. We need a crash program to take these designs to final form, to build and operate the fusion machines needed to get on with the job of creating a practical and useful thermonuclear technology.

Of the several engineering approaches to fusion, perhaps the dark-horse approach is the electron beam approach. It can be shown that the necessary beam energies required to produce fusion are more within our technological grasp than are the powerful lasers required for laser fusion. We hope that increased funding for the electron beam approach can be initiated very soon.

I would like to further stress the exciting prospect of using neutrons from a fusion reaction to break up water molecules into their constituent atoms of oxygen and hydrogen, both of which are immediately useful. Or, through high temperature disassociation, and scientists and engineers anticipate that in the future hydrogen will become widely used as a fuel and as a means to store excess power produced by intermittent power sources energized by solar, wind, or tidal energy. The successful demonstration of a fusion neutron source to manufacture hydrogen could open up the prospects for greatly reduced dependence on imported oil. Hydrogen is the basis of all of our organic fuels and fertilizers. Just think of the implications of a major, virtually limitless source of hydrogen.

There is still another prospect for the fusion beam-

pellet process. This could be used to provide the thrust for space propulsion.

A laser or electron fusion propelled space vehicle could "tour" the solar system within a few weeks in comparison with the years required for conventional chemical propulsion.

More recently, Prof. Hannes Alfven, a winner of the Nobel Prize in 1974, observed that both the Manhattan and the Apollo projects have shown our science and technology to be so powerful that if an intense effort is made, we can do almost anything we want to do in about 10 years.

When we consider these potential applications for controlled fusion reactions — generation of electricity, manufacture of hydrogen and synthetic fuels, and space propulsion — we cannot help but realize this energy source deserves a super national and international effort to demonstrate its practicality at an early date. There is sufficient deuterium, the fuel of the fusion process, in the oceans of the world to constitute a virtually limitless energy supply for the world, its economies, and its peoples. The fusion process produces none of the air pollution of burning fossil fuels, nor the intensely radioactive fission products of the fission reaction. It is inherently far less dangerous than the controlled fission processes and offers prospects of higher thermal efficiencies, meaning less waste heat to be dissipated in the environs of a powerplant.

As a corollary to this bill we urge that the President with the assistance of the new Energy and Resources Council immediately designate specialists in the following areas:

Magnetic containment approaches, 3; laser induced fusion approaches, 3; electron beam induced fusion, 3; hybrid combinations of the preceeding approaches and combination of fission and fusion; and a chairman.

This committee will consist of 13 scientists/engineers eminently qualified to decide on the proper balance of funding, available manpower, and facility requirements. This committee is to come up with its recommendations within 6 months from the date of its formation and report to the Energy Resources Council its findings. The council will then appoint a committee for the continued direction of the expanded fusion program. Further, the council would establish an advisory committee for International Coordination in Fusion Energy Development. Open international cooperation in fusion power should be encouraged by the United States.

There is no question in my mind that the fusion program should be expanded now. The exact magnitude and direction of this expansion I leave up to the commitees of experts, I have herein proposed. They will assess and recommend the how and where of the expansion.

I therefore recommend to your careful consideration and early action on this bill to get on with the development of fusion power. I further rush to supplement the above with the conclusion from an assessment of fusion power made by scientists of Brookhaven National Laboratory — BNL 18430.

Conclusions

The principal conclusions of this study are:

First. Synthetic fuels derived from fusion reactors can supply most of the U.S. energy needs, eliminating all oil and gas imports, coal gasification, and coal strip mining. Fusion reactors can supply these synthetic fuels indefinitely into the future.

Second. Synthetic fuels from fusion reactors will probably be comparable in cost to synthetic fuesl derived from coal. However, the use of fusion reactors would avoid having to strip mine a large fraction of the West. Without fusion reactors 4,000 miles per year would have to be stripped. Further, conservative fusion reactor and H2 production technology has been assumed for this analysis, and it is possible that synthetic fuel production costs with fusion reactors may be substantially less than those from coal.

Third. Production of synthetic fuels is also feasible with fission reactors. However, fusion reactors seem preferable to fission reactors. Synthetic fuel production costs are significantly lower with fusion reactors, but more importantly the problem of large scale generation of radioactive wastes is virtually eliminated.

Fourth. Total CTR power generation in the United States is almost an order of magnitude larger if CTRs are used for synthetic fuel production and all electric needs, rather than being used only for part of the electric needs — the remainder being supplied by base loaded fission reactors and fossil peaking plants.

Fifth. CTR unit reactor size can be much larger if synthetic fuels are produced. Unit rating up to 20,000 MW(e) appear compatible with the total U.S. energy system. If CTRs are used only for electric generation, the unit ratings will have to be approximately an order of magnitude lower. In addition, synthetic fuel CTR plants can all be base loaded, where only some fraction of CTR electric generation plants could be base loaded.

Sixth. Catalyzed DD fuel cycles appear competitive with DT fuel cycles in the range of 10,000 to 20,000 MWe reactor size. A DD cycle should greatly ease blanket development problems and could result in much cheaper blankets. It should also greatly reduce tritium emissions and inventories from the amounts in a DT cycle.

Seventh. The larger reactor ratings possible with synthetic fuel production should significantly ease plasma containment problems. Because of the large plasma diameter, the ratio of required containment time/Bohm time is much smaller than the value necessary for reactors used only for electric generation. Also, weaker magnetic fields can be used for containment.

Eight. For DT fuel cycles, synthetic fuel costs are not greatly affected by reactor size in the range of 5,000 to 20,000 MWe, under the assumptions of the study, which limited the scale-up of most nonnuclear components.

Ninth. The principal environmental concern with siting large CTR reactors for synthetic fuel production appears to be with thermal discharge effects. Coastal or offshore siting would resolve this concern however. The thermal effects at such sites appear to be minimal.

Tenth. In the long run, the supply of fossil fuel will be exhausted. Of the four alternatives, fission, fusion, solar, and geothermal, fusion seems like the only practical source for the production of synthetic fuels on the scale required. Fission will be more expensive and produce a large amount of radioactive wastes, while solar and geothermal are either too diffuse or limited in extent to meet the demands for synthetic fuels. From a conservation standpoint, it may well be

desirable to have CTRs take over fuel production before fossil fuels are exhausted, since the remaining fossil fuels would be of value for other purposes.

Hanna Bill

"Fusion Energy Act Of 1974"

93rd CONGRESS, 2d Session

H.R. 17538

IN THE HOUSE OF REPRESENTATIVES

November 26, 1974

Mr. Hanna introduced the following bill; which was referred to the Joint Committee on Atomic Energy

A BILL

To expand and accelerate the domestic and international development and use of thermonuclear energy through the establishment of certain advisory committees.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "Fusion Energy Act of 1974."

Sec. 2. The Congress finds that —

(1) the general welfare of the United States would be enhanced through the development of various applications of controlled fusion energy (commonly known as thermonuclear energy), including the production of electrical power, helium, hydrogen and space propulsion systems; and

(2) many such applications may soon be possible due to recent progress in laser, electron beam, and other advanced technologies.

Therefore, it is the purpose of this Act to encourage the acceleration of research and development of such applications of fusion energy by establishing the Advisory Committee on Thermonuclear Energy , the Advisory Committee on Fusion Systems Development, and the Advisory Committee for International Coordination of Fusion Energy Development.

Sec. 3 (a) There is hereby established the Advisory Committee on Thermonuclear Energy (hereafter in this section referred to as the "Committee") which shall be composed of thirteen members to be appointed by the Energy Resources Council as follows:

(1) three members selected from among scientists and engineers who are experts in the area of magnetic containment research and development;

(2) three members selected from among scientists and engineers who are experts in the area of laser fusion research and development;

(3) three members selected from among scientists and engineers who are experts in the area of electron beam fusion research and development;

(4) three members selected from among scientists and engineers who have experience in the area of fusion research, hydrogen and helium production, and hybrid systems; and

(5) one member, who shall serve as Chairman of the Committee, selected from among scientists and engineers who are knowledgeable in a broad range of fusion energy developments.

A vacancy in the Committee shall be filled in the manner in which the original appointment was made.

(b) The Committee shall develop proposals to expand and accelerate the research and development of experimental and prototype fusion systems to be used for electrical power production, space propulsion, and resource element production. In developing such proposals —

(1) the Committee shall emphasize laser and charged particle beam techniques utilized in bringing about a fusion reaction; and

(2) the Committee shall consider means of gaining additional participation of industry, university, and private expertise in the area of fusion energy.

The Committee shall submit a report of such proposals to the Energy Resources Council no later than one hundred eighty days after the date of the enactment of this Act.

(c) For the purpose of developing the proposals described in subsection (b), the Committee shall establish subcommittees to study the following areas: laser and charged particle beam techniques; engineering systems; the economies of fusion systems; the potential of fusion energy for space propulsion systems; education in fusion-related sciences, technology, and economics; and the safety and site problems associated with fusion powerplants.

(d) (1) Except as provided in paragraph (2), members of the Committee shall each be entitled to receive the daily equivalent of the annual rate of basic pay in effect for grade GS-18 of the General Schedule for each day (including traveltime) during which they are engaged in the actual performance of duties vested in the Committee.

(2) Members of the Committee who are full-time officers or employees of the United States shall receive no additional pay on account of their service on the Committee. For the purposes of this paragraph, the term "pay" does not include travel expenses or per diem as such terms are used in paragraph (3) of this subsection.

(3) While away from their homes or regular places of business in the performance of services for the Committee, members of the Committee shall be allowed travel expenses, including per diem in lieu of subsistence, in the same manner as persons employed intermittently in the Government service are allowed expenses under section 5703 (b) of title 5 of the United States Code.

(e) Seven members of the Committee shall constitute a quorum.

(f) The Committee shall meet at the call of the Chairman, a majority of its members, or upon request of the Energy Resources Council.

(g) (1) The Committee shall appoint a Director who shall be paid at the rate of basic pay in effect for

grade GS-18 of the General Schedule.

(2) With the approval of the Committee, the Director may appoint and fix the pay of such personnel as he deems desirable.

(3) The staff of the Committee shall be appointed subject to the provisions of title 5, United States Code, governing appointments in the competitive service, and shall be paid in accordance with the provisions of chapter 51 and subchapter III of chapter 53 of such title relating to classification and General Schedule pay rates.

(h) The Committee may procure the services of tion 3109 of title 5, United States Code, but at rates for individuals not to exceed $100 per diem.

(i) Upon request of the Committee, the head of any Federal agency is authorized to detail, on a reimbursable basis, any of the personnel of such agency to the Committee to assist it in carrying out its duties under this Act.

(j) The Committee may secure directly from any department or agency of the United States information necessary to enable it to carry out this Act. Upon request of the Chairman of the Committee, the head of such department or agency shall furnish such information to the Committee.

(k) For the purpose of carrying out this Act, the Committee may hold such hearings, sit and act at such times and places, take such testimony, and receive such evidence, as the Committee may deem advisable.

(l) The Committee shall cease to exist thirty days after submitting its final report pursuant to subsection (b) of this section.

Sec. 4. (a) There is hereby established the Advisory Committee for Fusion Systems Development (hereafter in this section referred to as the "Committee") which shall be composed of thirteen members who shall be appointed by the Energy Resources Council in the manner set forth under paragraphs (1) through (5) of section 3(a) of this Act. A vacancy in the Committee shall be filled in the manner in which the original appointment was made.

(b) The Committee shall advise and consult with the Energy Resources Council with respect to —

(1) the implementation of the proposals set forth in the report of the Advisory Committee on Thermonuclear Energy (submitted to the Council pursuant to section 3(b) of this Act); and

(2) the experimental and demonstration fusion systems under current development.

(c) The provisions of subsections (d) through (k) of section 3 of this Act shall apply with respect to the Committee.

(d) The Committee shall cease to exist two years after the submission of the report of the Advisory Committee on Thermonuclear Energy under section 3 (b) of this Act, or upon the termination of the Energy Resources Council, whichever occurs first.

Sec. 5. (a) There is hereby established the Advisory Committee for International Coordination of Fusion Energy Development (hereinafter in this section referred to as the "Committee") which shall be composed of thirteen members who shall be appointed by the Energy Resources Council, after consultation with the Secretary of State, in the manner set forth under paragraphs (1) through (5) of section 3 (a) of this Act. A vacancy in the Committee shall be filled in the manner in which the original appointment was made.

(b) The Committee shall advise and consult with the Energy Resources Council with respect to the coordination of joint programs with other nations in the area of fusion systems designed to meet the world need for energy, propulsion, and resource materials.

(c) The provisions of subsections (d) through (k) of section 3 of this Act shall apply with respect to the Committee.

(d) The Committee shall cease to exist two years after the date of enactment of this Act, or upon the termination of the Energy Resources Council, whichever occurs first.

Sec. 6. As used in this Act —

(1) the term "Energy Resources Council" means the Council established by section 108 of the Energy Reorganization Act of 1974 (88 Stat. 1242);

(2) the term "hybrid systems" means systems which combine the use of both the fusion and fission process; and

(3) the terms "laser fusion" and "electron fusion" include both the impact on pellets and heating of magnetically contained plasmas.

Sec. 7. There are authorized to be appropriated such sums as may be necessary to carry out the provisions of this Act.

Sec. 8. The provisions of this Act shall become effective on the date of the enactment of this Act, except that section 4 shall become effective upon the expiration of the one hundred and eighty-day period which begins on such date of enactment.

U.S. Labor Party Drafts Fusion Bill

The following Bill was drafted by the U.S. Labor Party, and efforts are presently being taken to introduce it into Congress. The Fusion Energy Foundation firmly endorses this Bill. We urge you to call your Senators and Congressmen in support of it, and organize your friends to do so as well.

A Bill

To establish a national program for research and development of controlled thermonuclear fusion technology and energy production.

Be it enacted by the Senate and the House of Representatives of the United States of America (assembled) in Congress, that this Act may be cited as the "Federal Fusion Energy and Technology Research and Development Act of 1975."

SECTION 1: The Congress hereby finds that:

(a) The immediate development of controlled fusion is of priority concern to the Nation and World.

(b) The major reason for the Nation's past failure to develop controlled fusion has been the lack of an aggressive research and development strategy designed to bring the necessary resources to bear on the problem.

(c) The neglect of potential controlled fusion resources has led to deficiencies in the Nation's array of available material resources.

(d) The Nation's energy and resource requirements

can be met if a national commitment is made now to dedicate the necessary financial resources, to enlist our scientific and technological capabilities, and to accord the proper priority to developing controlled fusion to serve national needs, conserve vital resources, and protect the environment.

(e) The urgency of the Nation's and World's resource problems requires a commitment similar to those undertaken in the crash development Manhattan and Apollo projects; it requires that the Nation undertake a long-range, top-priority, research and development program in cooperation with all interested nations of the world.

(f) In order to guarantee the integrity of such a crash development fusion program, Congress will initiate an immediate public inquiry into the possibility that criminal neglect and sabotage are responsible for the failure of the Nation to have previously developed controlled fusion. This Congressional investigation will run concurrently with the implementation of the crash development fusion program.

GENERAL POLICY

SECTION 2: The Congress hereby declares as policy:

(a) A National Department for Development of Controlled Fusion will be immediately established to carry out a national crash program of basic and applied research and development, including demonstrations of practical applications, with respect to all applications of controlled fusion.

(b) The Department for Development of Controlled Fusion (DDCF) will be directly responsible to Congress as a whole and will provide monthly public reports on progress of the crash program.

(c) The DDCF shall promptly make all records available for public inspection and copying at reasonable rates.

SECTION 3: The Congress authorizes and directs that, to the fullest extent possible, the Department for Development of Controlled Fusion authorized by this ACT shall design and execute its activities according to the following principles:

(a) All patent and proprietory rights which bear upon controlled fusion or its development or applications will be held in abeyance.

(b) The DDCF will cooperate with all other national and international efforts directed toward development of controlled fusion.

SECTION 4: The Congress further authorizes the Department for Development of Controlled Fusion to:

(a) Review the current status of all research efforts into controlled fusion and furnish a full report to the Congress and the Nation within two months after the enactment of this bill.

(b) Form a committee of the Nation's leading scientists and engineers to review current and projected fusion research efforts and develop a detailed crash program beyond that program outlined herein. This review will be reported to Congress within 6 months of the enactment of this bill.

(c) Obtain under the authority of the Congress all classified scientific information and other materials which relate to the development of controlled fusion (particularly laser and electrical beam fusion) and make this information available to the public.

(d) Implement on an expanded crash basis the Atomic Energy Commission's Subpanel 11 Fusion Crash Program.

(e) Initiate a massive educational aid and development program to supply the necessary physicists, engineers, and scientists for fusion research.

(f) Make provisions to build a materials testing linear theta-pinch reactor within the next 6 months.

(g) Take possession of all existing governmental facilities (and in particular those of the Atomic Energy Commission and Department of Defense) which could contribute to fusion research.

(h) Report all of its activities to the Congress and the Nation on a monthly basis.

(i) Set up a national communications and translation network to transmit scientific data and reports as rapidly as possible.

(j) Establish several national centers which would function in the same capacity as the Los Alamos Laboratory acted for the Manhattan Project. These "never centers" of several thousand scientists, engineers and technicians would command and coordinate the rapid development of the necessary industrial base for producing fusion technologies.

THE DEPARTMENT FOR DEVELOPMENT OF CONTROLLED FUSION

SECTION 5: The Congress hereby declares that:

(a) The Department for Development of Controlled Fusion will replace the Atomic Energy Commission (AEC) and function under the same legislative authorization as the AEC until Congress completes its investigation of fusion sabotage. The President will temporarily appoint with the consent of Congress an eleven-man committee to take possession of the AEC and implement this bill. Their term will end within 6 months.

(b) All facilities currently engaged in the United States in research on fast breeder nuclear fission reactor research shall be transferred to fusion research under the control of the DDCF.

APPROPRIATION AUTHORIZATION

SECTION 6: The Congress authorizes the following appropriations for the crash development of controlled nuclear fusion:

(a) In the fiscal year of 1975, $5,000,000,000 will be appropriated to the Department for Development of Controlled Fusion.

(b) In the fiscal year of 1976, $20,000,000,000 will be appropriated to the Department for Development of Controlled Fusion.

Letters to the Editor

The following letter, dated January 14, 1975, was received from the Atomic Energy Commission.

Dear Dr. Levitt:

We share your views on the importance of telling the American public about the benefits of fusion power. The AEC provides a free pamphlet on fusion, and the booklet by Dr. Samuel Glasstone is available for a nominal fee. Also, the Argonne National Laboratory is preparing its second revision of the 28-minute file on the status and prospects for fusion. This will be available for prime time showing on television and for viewing by interested audiences throughout the United States.

We also publish a newsletter, entitled **Fusion Forefront**, which is intended to cover recent developments. Your newspaper should provide a further means of making fusion information available on a widespread basis. If you find that material in **Fusion Forefront** is of interest, you should feel free to use it in your Foundation newspaper.

Information flow is two-way, and we value comments and constructive criticism that we receive from the public. In this regard, we intend to provide documents such as environmental statements to interested groups for review and comment. The first of these will be the report entitled "Environmental Statement — Tokomak Fusion Test Reactor Facilities," WASH-1554, January 1975. This covers proposed facility construction at the Princeton Plasma Physics Laboratory in Princeton, New Jersey. Two copies will be sent to you as soon as the formal budget request for the TFTR is presented to Congress. Comments of the Fusion Energy Foundation on the content of the report will be welcomed. Other reports are presently in preparation and will also be distributed for comment.

We appreciate the enthusiasm of the Fusion Energy Foundation's Directors for the prospects of fusion power. The efforts of the Foundation toward attainment of the near and longer range goals are most certainly appreciated.

Sincerely yours,
William L. R. Rice
Special Assistant to the
Director
Division of Controlled
Thermonuclear Research

The following letter by Dr. Bo Lehnert, one of the world's leading fusion scientists, is indicative of the responsiveness of scientists to our program for crash development of Controlled Thermonuclear Fusion power. Dr. Lehnert currently heads a research group in Sweden at the Royal Institute of Technology. He is on the board of editors of Nuclear Fusion, one of the most prestigious journals of fusion science, published by the International Atomic Energy Agency.

Thank you very much for your letter of November 7 with the material which I have studied with great interest. Please, forward also my thanks to Prof. Morris Levitt and collaborators for the invitation to the informal seminar, which I was not able to attend on account of a conference in Japan.

In this letter I have enclosed a report which expresses in more detail my points of view on the slow development of fusion research. I think that fusion research has ended up in a difficult situation, mainly for the two following reasons:

(i) Far too small resources are devoted to fusion research on the international level as a whole. With the outstanding social and peace-conserving importance of an adequate energy supply of the world in mind, it is difficult to understand why this situation is tolerated, at the same time as almost unlimited amounts of money are being spent on such objects as rearmament and consumption and advertising of a number of superfluous goods.

(ii) In an attempt to accelerate fusion research towards its final goal, under the contemporary constraint of limited resources, a great number of laboratories throughout the world have restricted their efforts to narrow lines and to a few large experimental devices, without taking the time to make a broad approach in terms of basic research. As a consequence, several of the most important projects appear to be on the verge of failure at this stage.

With these points in mind, I fully support your arguments about a "brute force" program in fusion research. Such a crash program has to be conducted on a systematic research basis.

Sincerely yours,
Bo Lehnert

FEF to Participate In AEC Study

As a result of meetings of representatives of the Fusion Energy Foundation with the CTR (Controlled Thermonuclear Reactor) Division of the Atomic Energy Commission, the FEF has been invited to participate in the formulation of the Environmental Impact statements being prepared on fusion by the AEC. Studies are presently being conducted by Battelle Northwest Laboratories in terms of overall environmental aspects of an hypothetical fusion-based economy.

The FEF's role will be to provide a methodology which focuses on the integrated technological development which should be a natural concommitant of fusion power. From such a standpoint, there is no separate category of fusion per se, since effluents and by-products themselves become inputs for other integrated processes.

U.N. Application Pending

Another channel for FEF's scientific and educational work is being developed through the pending application of the FEF for Non-Governmental Observor, Consultative status with the Economic and Social Council of the United Nations.

As part of the ongoing work at the U.N., the FEF

recently held a seminar for invited U.N. officials, featuring videotapes of the founding meeting of the FEF, and of an ecological study summarizing research performed by a team of scientists under the auspices of FEF Associate and National Caucus of Labor Committees member, Eric Lerner. This study, based on present world health conditions and declining industrial and agricultural production — from an historical perspective — demonstrates the clear threat of ecological holocaust within the time scale of approximately 15 years. This videotape, as well as that of the founding meeting, is available for rental from the FEF by interested groups.

FEF To Launch Theoretical Journal

The creation of the intellectual climate in which the entire range of potentially fruitful approaches to fusion can be explored is central to the activities of the Fusion Energy Foundation. The existence of such a creative environment is especially crucial during the present period, in which most funding has come to be concentrated in only a few lines of development.

Profusion, the quarterly journal of the FEF, will be the concrete expression of the necessary unfettered exploration of scientific ideas. Profusion is not intended to duplicate the efforts of the plethora of presently existing theoretical, technical and "popularized" journals. Rather, the intention of Profusion is to examine fusion research from the standpoint of developing alternative research **policy**. Our objective is to encourage and stimulate fusion scientists and others to rethink their own work within a broader perspective.

The first two issues of the journal are now in preparation. The inaugural issue, slated for publication in February, will present scientific and lay readers with a stimulating sampling of the creative concepts that have been only partially developed, even neglected in official fusion programs. Its contents will include: A review and assessment of fusion research by Prof. Bo Lehnert, one of Sweden's top fusion scientists; an article by Dr. D. Wells, on plasma instabilities; an article by Dr. W. Bostick on Pinches and Vortices; New Directions in Laser Fusion, by Dr. L. Gold; From Ampere to Fusion: Magnetic Effects of Nucleon Collisions, by Dr. R. Moon; and several other articles. The articles by Wells and Gold, in particular, indicate fruitful new areas in magnetic and laser research. The article by Prof. Lehnert (see his letter, this issue) indicates the type of international collaboration which the FEF is engendering.

The second issue will develop the conceptual foundations and resource requirements for a crash program, as well as an examination of the economic and ecological implications of such a program.

Profusion will be available by subscription — 4 issues (one year) for $8.00. Requests for subscriptions should be addressed to: Profusion; GPO Box 1901, New York, New York 10001.

Hearst Paper Calls For Fusion Crash Program

Reprinted from the Baltimore News American, Sat., Nov. 2, 1974

BREAKING ENERGY BARRIER

President Ford intends to cut down oil imports from six million barrels a day to one million barrels. The energy industry is ransacking damestic oil fields, natural gas deposits, coal beds and its laboratories to come up with more energy fuel.

The Alaska pipeline is at last under construction. Nuclear plants are becoming more numerous every year. The Clean Air Act has been modified to allow greater use of existing fuels. Congress has voted to spend $20 billion over 10 years for energy research in many categories: nuclear, solar, geothermal, coal gasification, shale oil, and so forth.

We are spending $400 million for present-day nuclear reactors, those operating on the fission principle, Fusion is recognized as the next step: $80 million is budgeted. Fusion reactors create more fuel than they burn. In energy terms, fusion is the equivalent of perpetual motion, with one exception — it is possible to achieve.

Truly, the number of avenues we are running down in search of a solution to soaring oil prices are myriad. And were the costs of all these explorations added up, the sum would be astronomical. But the money may be scattered like stars against the dark universe.

A massive, aimed effort would be more fruitful.

The nuclear fusion reactor is the most practical answer.

Development of solar and geothermal energy sources remains farther away. Gasified coal and oil from shale are no more than stopgap measures.

We would be better off funding a concentrated development of the fusion reactor. The United States did this once before — the "Manhattan Project" — to build the atomic bomb.

We spent $15 billion on the Trident submarine development program.

The question is not whether we can afford to focus our money and efforts to develop the fusion process, but whether we can afford not to do so.

Fusion Research Squelched

by Chuck Stevens

As indicated elsewhere in this issue, the **basic** problem in achieving fusion is one of overall organization and stimulation of scientific creativity. The problem here, however, is not merely one of errors of omission. There is strong evidence of conscious obstruction as well. For example, in this scenario, which appears in the December issues of both Fortune and Science magazines, KMS Fusion, a private research company is cast as the heroic victom of AEC bureaucratic obstructionism.

In Fortune, KMS is reported to have made more significant progress in harnessing laser fusion than all the "big teams of government researches in both the U.S. and the Soviet Union, as well as smaller groups in Great Britain, France, Japan, and West Germany." Fortune continues "in this fast moving field...KMS Fusion appears to be rewriting the theory" despite the AEC's initial suppression and continued obstruction of KMS research."

Science, the weekly publication of the American Association for the Advancement of Science, has taken a more cautious position on the KMS research because their better informed scientific readership could be expected to see through Fortune's wild claims. The Science strategy is to report straightforwardly on the AEC's suppression of KMS research while pooh-poohing KMS' experimental results. Science then quotes Dr. Edward Teller: "Research on laser-induced compression and heating of pellets should not be categorized as energy research at the present time."

As an alternative, Science journalist William D. Metz puts forward a laser isotope separation process for improved nuclear **fission**. Although fission is vastly less efficient for energy production than fusion, and much more hazardous, Metz quotes one scientist at Livermore Labs: "The isotope separation effort got started to some extent on laser fusion money. And I wouldn't be surprised if isotope separation becomes the bigger sister...all the money might go the other way."

In reality, the entire KMS controversy is a red herring. The KMS approach will not lead to fusion power production; it is being put forward only to cover up the suppression of far more promising research proposals by, among others, Dr. Louis Gold, member of the Science Advisory Committee of the FEF.

To explain the magnitude of the crime fully, it is necessary to briefly review certain aspects of the history and science of controlled fusion.

Thermonuclear fusion, which fuels hydrogen bombs and the Sun's inferno, is a process in which nucleii of light atoms are "fused" to form nucleii of heavier atoms. For example, the heavy isotopes of hydrogen, Deuterium (D) and Tritium (T), can be fused to form helium (He). Vast quantities of energy are created during fusion because mass is transformed into energy.

In order to ignite fusion the reacting nucleii must be brought very close to each other. This does not occur under ordinary conditions of temperature since the positively charged nucleii electrostatically repulse each other. This obstacle is called the Couloumb barrier.

To break through the Couloumb barrier and ignite fusion, the nucleii must be accelerated to high velocities, high temperatures. Besides temperature, the rate at which fusion proceeds depends on the density of the reactants since the more nucleii which are present per given volume the more likely it is that fusion will occur. In addition, the reactants must be "contained" for a sufficient period of time to allow for a significant amount of fusion to take place. The product of the confinement time and density to achieve net energy producing fusion reactions is called the Lawson criterion.

Unlike nuclear fission, thermonuclear fusion does not **necessarily** involve radioactive elements in either its reactants or products. In fact most of the heavier elements are the products of chains of fusion reactions initially begun with hydrogen.

The first man-made fusion reaction which produced more energy than used in its ignition took place on Eniwetok Atoll in 1952. The system used was that of inertial confinement, and a nuclear fission bomb was used to ignite the fusion reaction. Deuterium and tritium were placed inside the atom bomb so that the fission bomb explosion compressed (imploded) the fusion fuel and then heated it to fusion temperatures.

The Odyssey of Dr. Louis Gold

In 1949, Dr. Louis Gold, a leading scientist who worked on the Manhattan Project, suggested that controlled fusion could be achieved utilizing the same inertial confinement system as that projected for use in the "Super" — the original H-bomb.

The fission bomb used to spark fusion in the Super would be replaced by an electrical spark. Dr. Gold presented his findings in his paper "On the Production of Extreme Temperature by Electrical Discharges" in 1949. In exploring his proposed method of exploding electrodes to induce fusion, Dr. Gold discovered that lithium-6-deuteride (Li-6-D), could be utilized as a substitute fusion fuel for the hydrogen gasses deuterium and tritium.

The advantage of Li-6-D as a fusion fuel in inertial systems is that it is a solid at room temperatures and does not have to be refrigerated as hydrogen gasses must. Meutrons from the fusion of deuterium "split" the lithium atom into helium and tirtium and thus create the fuel for the D-T reaction in the process of the reaction itself. Edward Teller utilized Gold's concept to produce a viable hydrogen bomb.

Throughout 1950 and 1951 Dr. Gold lobbied for an overall effort to achieve controlled fusion exploring both magnetic containment (the system used in the Tokamak) and inertial confinement. Dr. Gold's clearance for data related to this research was cancelled. Shortly thereafter, Dr. Gold lost his job.

Moreover, work on inertially confined systems to achieve fusion was kept under a cloak of strict secrecy, even though systems such as exploding electrodes could have no weapons applications. The largest conceivable burn of fusion fuel with an electrical

ignition system the size of a three-story building would produce no more explosive effect than that of a few pounds of TNT.

With the invention of the laser in 1961, Dr. Gold saw a clear path to achieving controlled fusion. Previously, the use of electrical discharges necessitated a material link between the fusion fuel and the electrical ignition system. This link substnatially limited both the amount and rate at which energy could be dumped into fusion fuel.

But lasers produce coherent electromagnetic radiation pulses which travel through empty space. Therefore large quantities of energy could be optically focused withing billionths of seconds on extremely small quantities of fusion fuel.

Gold's efforts to get the AEC and other interested government agencies to undertake a major research program to develop lasers applicable to fusion and begin experimentation in laser fusion were completely rebuffed.

Publicly the AEC contended that the scale of lasers needed to produce fusion temperatures would have to have energy outputs 1,000 to 100,000 times greater than any laser built. This estimate was based on naive physics.

Essentially the laser energies required were calculated on the basis of inducing fusion at ordinary densities. On contrast, Dr. Gold approached the AEC and Air Force in early 1972 with an approach which could achieve laser fusion at lower laser energies than previously projected.

As was well known to weapons designers at Los Alamos and Lawrence Livermore Laboratories since the early 1950s, fusion reaction rates could be enhanced through increasing the density of the reactants — as was done in the hydrogen bombs. By the early 1960s, Livermore scientists carried out secret calculations which showed that a laser pulse could be used to first compress a pellet of fusion fuel to high densities and that a second pulse of laser light could then ignite fusion.

These calculations showed that fusion could be achieved with laser outputs 10 to 1,000 times less than that calculated in the naive model which was released for public consumption. Dr. Gold's approach went significantly beyond even those secret calculations.

Vincent LoDato, an unemployed physicist who had worked for the Rand Corporation, tried to publish his own work — along the same lines as Dr. Gold's — at the same time that Gold was independently lobbying in Congress for an experimental program to verify his hypothesis. LoDato's work was confiscated by the AEC as reported in Time Magazine in August 1972.

Simultaneously, during the Montreal VII International Quantum Electronics Conference, Edward Teller publicly released the information on the secret calculations carried out at Livermore 10 years previously. Gold was warned previous to Teller's disclosure — by the AEC and the Air Force — not to publicly reveal his concepts.

Teller's revelations were obviously designed to divert attention from Gold's lobbying efforts and from the outright suppression of LoDato's work. Gold was prevented from publishing his concepts and strung along by the AEC and Congressman Chet Holifield until Gold's chief supporter in Congress, John Dow, was defeated in the November elections. LoDato was given a plush job at Xonics, a private research firm. John Gilvarry, LoDato's chief sponsor at Rand, a top laser expert, and a close friend of Louis Gold's, lost his job at Rand shortly after he endorsed Gold's laser fusion proposals.

As for KMS fusion, it was founded by scientist entrepreneur Kip Siegel, who received his first briefing on laser fusion from Dr. Louis Gold, whom he no longer speaks to. The KMS approach to fusion is based on laser compression of nucleii in tiny balloon pellets.

Analysis shows that the balloon-pellets of KMS aren't capable of leading to fusion energy systems because they require lasers with greater than 50 per cent efficiency. At present, top laser efficiency is 3 to 4 per cent. And in fact the results which KMS has achieved are based on an approach which may not even be producing fusion neutrons at all.

In any case, the flagging of the AEC obscures the actual defects in the research program and creates a meaningless controversy over KMS's results.

The Fusion Energy Foundation is compiling a complete proposal to follow up Dr. Gold's hypothesis. This approach would not involve more than $2 million in research funds, and will be reported upon in the next issue of this newsletter.