From Antarctica to Aneutronic Fusion

History of the Founding of TAE Technologies, Inc.

By
Harry R. Hamlin

(Updated July 9, 2022 after Robert Turner corrected the timeline at the DKE house in Berkeley and again August 27,2022)

August 27, 2022

In the fall of 1974, after graduating from Yale with degrees in Drama and Psychology, I was offered a scholarship to study acting at the American Conservatory Theater in San Francisco. My parents were not happy about my career choice and refused to support me. When I arrived in San Francisco, I had no place to stay and went back to my old fraternity house in Berkeley, Delta Kappa Epsilon, where I was given a bed for free. There, I met Robert Turner whose father worked for the National Science Foundation studying the polar Ice Sheets in Antarctica. Turner came into my room one day with a letter from his father that said his team at NSF had concluded, unequivocally, that the planet was on course to experience historic climate change that would ultimately lead to a new ice age. The conclusion was based on their findings about the melting of the polar ice. He told his son not to tell anyone because the NSF and the Government wanted to keep the finding secret for the time being. But, Turner told me anyway. The news was shocking to me and made a deep impression. That was the very beginning of what I call "my climate journey'.

In 1980, I was living in Rome, Italy with my son's mother, Ursula Andress who was pregnant with our son Dimitri. In February 1980, Ursula and I were invited to the Swiss Consulate in Rome for a cocktail reception. At the party, I realized that I spoke none of the languages I was hearing in the room and was approached by another man who also spoke no Swiss German or Italian. He introduced himself as Dr. Bogdan Maglich an American nuclear physicist born in Serbia with a laboratory in Princeton New Jersey. He said he was deeply involved with a new technology that could revolutionize the way people around the world generate electricity. He called it aneutronic or non-radioactive, clean nuclear fusion. He was extremely passionate as he spoke and his enthusiasm for the project was infectious. I was intrigued by his passion and also by the idea that his project might change the world for the better. I told him that my main residence was in Los Angeles. He asked if he could send some more comprehensive material to me there. I gave him my address and thought that I would never hear from him again. But when I got home there was a big package

with several of his published papers and a letter inviting me to keep in touch. (Attachment)

Then, in 1982, I was asked to play Hamlet at the Tony winning McCarter theatre in Princeton, NJ. I accepted and, fortunately, the production was a success, which landed my picture on the front pages of the local newspapers. Dr. Maglich's lab was in Princeton and when he saw my picture, he went to the theater and invited me to see his lab, which was very impressive. Then, the following year, I was asked to Play Faust at the same theatre. Once again Dr. Maglich found me and we spent many hours together as he detailed the progress of his MIGMA aneutronic fusion project.

Environmental pollution and global warming had entered the national conversation and Maglich championed that fusion would provide the solution to many of the world's environmental ills. He continued to send me updates of his progress throughout the 80s and, in 1990, he wrote that he was moving his entire operation from Princeton to Irvine where another scientist, Dr. Norman Rostoker, head of the Physics dept. at U.C. Irvine was working on a similar approach to aneutronic or non-radioactive Fusion. Dr. Maglich told me he was starting a company called The Advanced Physics Corporation and asked me to join the Board of Directors. I responded that I would consider the offer but only if Dr. Maglich would sit down with me to explain the technology. I added that if Maglich agreed and I was able to understand the science at least marginally, I would join. We spent a full day together at my home in Bel Air with Maglich drawing his idea out on a sketchpad. I still have those early sketches.

At the first Board of Directors meeting for The Advanced Physics Corp. (APC) I was introduced to fellow board members Dr. Murray Gell-Mann (Nobel Laureate for his discovery of Quarks), Dr. Glenn Seaborg (Nobel Laureate for his discovery of Plutonium), Dr. Buzz Aldrin, and Robert Byrd as well as observers journalist Frank Braun and businessman Gerald Simmons. At some point, a year or so after that company opened, George Sealy became an observer and advisor to the board after having met Dr. Seaborg at the Bohemian Grove in northern California. Dr. Maglich set out to raise funds for an experiment at U.C. Irvine and had some success though such an experiment never materialized. In the meantime, I was asked to advocate on behalf of aneutronic fusion on television, in Washington D.C. and among the investment community.

In 1993 I visited Washington several times to lobby various lawmakers such as John Dingell, Christopher Dodd, Dick Gephardt, and Jim Moran. In April of 1993 I testified before the House Energy and Commerce committee on behalf of Aneutronic Fusion (Attachment included) and read Dr. Seaborg and Paul Nitze's Op Ed piece from the NY Times dated November 23, 1991 entitled TOWARD A NEW ERA OF ENERGY into the Congressional Record (Attachment included). I followed that with an appearance on PBS Science Times and later, an appearance on Larry King Live advocating aneutronic fusion.

During subsequent Board meetings for APC, I became more acquainted with Dr. Seaborg and a friendship developed. He asked me to help him lobby California governor Pete Wilson on behalf of a group of Nobel Laureates who had donated their time to craft new standards for science and math in the California K-12 public schools. All during that time, Dr. Seaborg who was then Chairman of the Board of APC, continued to champion aneutronic fusion. By late spring 1994, however, it became apparent that Dr. Maglich was mishandling funds he had raised for his experiment and Dr. Seaborg and myself along with a quorum of the board decided to terminate Dr. Maglich as president of the company he had formed and, after a unanimous vote during an impromptu board meeting, Dr. Maglich was terminated thus effectively dissolving his company, the Advanced Physics Corporation. The following week we all received a letter threatening to sue each of us for $91 million.

The demise of APC left the future of any work on aneuronic fusion at U.C. Irvine in jeopardy and the remaining board members along with UCI and the University of Florida decided to form an Advisory Committee to find a path forward for the research with Dr. Norman Rostoker of UC and Henk Monkhorst of University of Florida as the lead scientists. Prior to the establishment of this new advisory board and around the time of the dissolution of The Advanced Physics Corporation, Dr. Monkhorst had determined that the Maglich approach called "MIGMA" would, more than likely, not produce the desired results and felt that his and Dr. Rostoker's idea of using a Field Reversed Configuration for the Plasma containment would have a better chance for success and it was decided to explore the feasibility of that approach.

The new Committee included myself, George Sealy, Russell Kulsrud, senior scientist at Princeton Plasma Physics Lab, Nobel laureate Glenn Seaborg, Dr. Buzz Aldrin, Astronaut, Dr. Hans Schneider-Muntau, Director of the National High Energy Magnet Lab, Alan Puckett, Former CEO and Chairman of Hughes Aircraft Company, Dr. Roald Sagdeev, Former Director of the Russian Space Institute, Bruno Coppi, Professor of Physics at MIT, Gerald Simmons, Financial Consultant and Frank Braun, Journalist. The board was named "The Advisory Committee for the Joint Colliding Beam Reactor Project" comprised of elements from UCI, University of Florida and the National High Energy Magnet Lab.

Because of my long-standing involvement as an advocate for aneutronic fusion, I was elected Chairman of the advisory Committee. To be clear, this committee was made up of people who were colleagues in some respect but who, mostly, did not know each other personally. The committee held informal meetings by phone and two formal meetings prior to the founding of Colliding Beam Fusion Reactor, Inc. (CBFR, Inc.) in April 1998. The name, CBFR, Inc. was changed to Tri Alpha Energy in 2000 which was subsequently re-named TAE Technologies, Inc.

In November 1997, SCIENCE MAGAZINE published a paper written by Dr. Rostoker, Henk Monkhorst and Michl Binderbauer entitled "Colliding Beam Fusion Reactor". The publication of that paper in such a prestigious Journal gave new

impetus to the advisory Board to find a path forward for Norman's work. David Schetter, head of U.C. Irvine's Technology Transfer Department, requested a formal meeting of the CBFR Advisory Committee to be held at the Airport Hyatt Hotel in Orlando, Florida. The meeting was convened on December 10, 1997 in Orlando Florida for a two-day conference. The agenda put together by Tom Walsh, head of the University of Florida Division of Sponsored Research and David Schetter of UCI was comprised of discussions of the scientific feasibility on day one and presentations from two companies, which wanted to license and fund the project on day two.

As chairman, I ran the meeting. During the meeting, the board asked that I call Dr. Seaborg and ask that he co-chair the Committee with me. I called Glenn and he agreed. Because he was ailing, Dr. Seaborg co-chaired the meeting by phone from his home in Northern California but only for a few hours.

On day one of the conference, we heard briefings from Dr. Rostoker, Dr. Coppi and Dr. Hans Schneider-Muntau among others. David Schetter, head of Technology Transfer at UCI, and Tom Walsh from the University of Florida represented the Universities. The discussion that followed the presentations centered on possible paths to success scientifically and it was determined that there was enough positive evidence that the science might be successful to merit moving ahead with trying to locate appropriate funding.

On day two of the conference we heard presentations from the two prospective funding entities. The first was delivered by Robert Goffe and was generally dismissed mainly because it had been discovered during due diligence of his background that he had been disbarred by the D.C. Court of Appeals for dishonest and unethical conduct. (I have a copy of the original D.C. Court of Appeals documents and Goffe's dossier compiled by Dave Schetter)

The second presentation was delivered by Mr. Ron Militello who had formed a company called Beam Fusion II, Inc. with the intention of gaining a license from the Universities and funding the project to the tune of $40 million. This figure got the attention of the scientists and many of the other board members but, as chairman, I interjected that Mr. Militello was not able to be properly vetted and that his background was shady and that his involvement with the project could jeopardize the long-term prospects if we ever had to go to another bank like Morgan Stanley for further funding which I felt would be inevitable. The argument from the scientists, especially Dr. Rostoker, who had formed a friendship with Mr. Militello, was that "a bird in the hand was worth the standard two in the bush". I was very emphatic that if we took any money from Mr. Militello, we would, essentially, be dooming the project. (I have the original 33 page proposal by Mr. Militello to take possession of the license dated February 8, 1996 which includes my handwritten red-line notes)

Because of my long history of engaging politicians, banks and wealthy individuals on behalf of fusion, I had a deep understanding of the skepticism among the

scientific and political communities and the investment community. I was convinced that the only hope for the long-term life and credibility of the project was to ensure that only the most respectable and venerable institutions and individuals be involved. The debate about my perspective became heated at times because the scientists saw an immediate opportunity coming from Militello. I finally stood and said that they should feel free to accept Militello's proposal but that I would quit the project if they did. I felt that strongly about it. I believed that, as chairman, it was incumbent upon me to make my opinion known in the strongest possible terms. That statement ended the debate and the discussion was tabled until the next meeting which never took place.

We broke for lunch and I was demoralized because it was apparent that there were no suitable funding opportunities. In the cafe, I set to thinking about all the potential options we might consider to move forward. It had become clear to me that there were no options and, quite suddenly, a thought came to me. We had to do it ourselves...we had to form a company and get the license ourselves since we were all passionate about the project and we could be vetted. I turned to the man sitting next to me who happened to be George Sealy and said simply, "We need to do it ourselves. We need to start our own company." George Sealy responded instantly that it was not a good idea and that it wouldn't be possible. I told him I thought it was the only way but he wouldn't hear it. In the elevator on the way back to the final session of the meeting, I brought up the idea with David Schetter, head to Technology transfer at UCI. He seemed to think the idea had some merit and encouraged me to bring it up at the meeting which I did.

When we reconvened to close the meeting after lunch, I broached the idea to the remaining members. A discussion ensued in which the only member who gave the idea any credence was Henk Monkhorst who said that it might not be a bad idea if the company was in Florida and I was president. I said that I had no intention of being president of any company because I had too many obligations at home and that I certainly could not move my family to Florida. The rest of the group remained absolutely opposed to the idea but were open to a short debate.

I explained that I really did not believe that we would find a reputable licensor because of the arcane nature of the technology and that our only suitors would probably be like the ones we had seen earlier in the day...quacks and charlatans. I said that if we waited to find a suitable partner, we would have a zero to less than zero chance of success but that if we started our own company, we would have at least a "greater than zero" chance. Still, there were no takers. The idea of a "start-up' was tabled until the next meeting (Which never happened because we ended up with a startup) The meeting was adjourned and the committee dispersed and headed into the Christmas holiday and I flew to Washington D.C. to attend the National Science and Technology Awards Dinner. (Frank Braun wrote contemporaneous notes of the meeting and David Schetter wrote a "task list" of action items that evolved out of the meeting. These documents, which are the

closest thing we have to "minutes", corroborate this account and they are attached in the Appendix)

On December 15th, 1997, David Schetter sent me a Fax asking that we meet "in private' to discuss the idea of a start-up. (The Fax is attached) I met with Schetter and he told me he thought our getting the IP License was a good idea.

In January 1998 Glenn Seaborg sent a letter that I had written but which was signed by Seaborg to Vice President Gore on behalf of the project. (Attachment included)

I felt that, among the board members, George Sealy was the most levelheaded and, having been an executive, could possibly be the best ally if I could only convince him. We had several phone calls over the holiday and he remained adamant that it would not be a good idea for us to get the license. But David Schetter was warming to the idea of our group having the license to the IP and he called Sealy to encourage him to embrace the idea. Most adamant against forming a company was Dr. Rostoker who felt that we would be "squandering the license" if we had it. Rostoker continued to believe that Millitello and the $40 million or some other going concern was our best path forward. I remained hopeful but was resigned to the immediate fact that there was no support other than Dave Schetter for starting our own venture.

In early December 1997, I met with Senator Barbara Boxer at her offices in Los Angeles to explain the project. On December, 16, 1997, Senator Boxer wrote a letter to Vice President Gore urging him to take a serious look at the technology. (Attachment included) On December 15, 1997, I went the National Science and Technology Awards Dinner in Washington D.C. where I met Ernie Moniz, Undersecretary of Energy, John Gibbons, Presidential Advisor on Science and Technology for President Clinton and Gary Bacula, Science and Technology Director for the Department of Commerce. I felt, at that point, that our only hope to keep the Rostoker/Monkhorst project alive would be through some sort of Government funding. On the 17th of December, I wrote letters to Moniz, Gibbons and Bacula describing the project. I never heard back from any of them personally but did get a response from the Assistant Director for Physical Sciences and Engineering on Dr. Gibbon's behalf saying that the budget for Fusion Science was in "transition" . (Copies of these letters are attached)

Recall that the Kyoto Protocol Agreement was signed on December 11, 1997 and was a headline referring to human generated climate change the world over. I saw this project as a possible solution to the problem of climate change which was, at that moment, top of mind. Kyoto made me that much more passionate about finding a way to continue this important work.

The New Year came and, in mid January, George Sealy called me to say that he had changed his mind and wanted to explore the idea of our starting our own company but he said he had some serious issues and reservations about the idea. He said that he had no experience making licensing deals and asked if I knew anything about such deal making. I said I had no idea but that Andrew Conrad, my neighbor in Malibu, had recently made such a deal with UCLA and that Conrad might be willing to help.

I had met Dr. Conrad in Costa Rica the previous spring and had told him about the colliding beam fusion project. Being a scientist, he was intrigued and, over the Christmas Holiday, we discussed my idea to start a company. Andy was a close friend and, in fact, I had called him the night of the last session of the Florida meeting to ask his opinion about our starting our own company. Around that time, Dr. Conrad asked if he could meet some of the people involved in the project and I introduced him to Dr. Rostoker and George Sealy.

Meanwhile, Sealy reminded me that he was retired and didn't have the motivation to run a company and asked if I would agree to be president. I said that I could not be president for several reasons. One, because I was not a business man, two, that my wife was three months away from giving birth and that, furthermore, not only was the film business about to go out on strike which meant that I needed to make as many films as possible over the next year but that, also, my address in Malibu meant that any commute to Irvine would be five hours round trip.

I reassured Sealy that, at first, there wouldn't be that much to do. We would need to raise enough money to hire a lawyer to begin negotiations with the University and we would need to write a business plan of some kind. I said that we would find someone to run the venture and that the three of us could carry any load up front. I agreed to be Secretary, George agreed to be temporary president and Andrew Conrad agreed to be treasurer.

I then called Glenn Seaborg and told him of our plan to start our own company and asked if he would be our Chairman. He supported the idea of the company and agreed to be Chairman. A few days later he called me back and said that he had misspoken and that his wife, Helen, had reminded him of his status as octogenarian and had scolded him for taking on this new responsibility. Seaborg recommended that we ask Alan Puckett, the Former Chairman of Hughes Aircraft and CBFR advisor, if he would step in as Chairman. Sealy and I called Puckett who agreed, with the condition that Seaborg be named as Chairman Emeritus. I then called the board members from the previous company as well as some of the members of the CBFR advisory committee and tried to form a board for the new company. Buzz Aldrin, Frank Braun, and Gerry Simmons agreed. I located Dr. Murray Gell-Mann at a lab in New Mexico but he declined. The new Board was comprised of myself, George Sealy, Andrew Conrad, Frank Braun and Gerald Simmons with Alan Puckett as Chairman and Glenn Seaborg as Chairman Emeritus. (Possibly the only company in history

that had a "Chairman Emeritus" on it's first day of operation!) Dr. Rostoker remained skeptical throughout the process until George Sealy brought in enough funds to get an experiment started. That experiment is now called the original "Sewer Pipe" project.

We then formed an Advisory Board comprised of:
Bruno Coppi, MIT
Dr. Russell Kulsrud, Princeton
Henk Monkhorst, University of Florida
Dr. Norman Rostoker, U.C. Irvine
Dr. Ronad Sagdeev, Former Director-East/West Space Institute
Dave Schetter, Technology Transfer Director University of Ca., Irvine
Hans Shneider-Muntau, Director, National High Energy Magnet Lab
Dr. Glenn Seaborg, Nobel Laureate, Director, Lawrence Berkeley Lab
Tom Walsh, head of the University of Florida Division of Sponsored Research

Our Attorney was Marshall Lewis of Lewis, Hoxie and Spear

On April 10, 1998, letters of incorporation were filed with the SEC. (Attached)

Our first official Board Meeting was a Special meeting held on April 18, 1998 at The Sofitel Hotel in Beverly Hills where Glenn Seaborg was staying while he was undergoing treatment at Cedars Sinai Hospital. Along with the Board, present at that meeting, as observers were Norman Rostoker, Frank Wessel and Michl Binderbauer. The Special Meeting was the only meeting ever attended in person by Glenn Seaborg who passed away ten months later in February 1999.

Frank Wessel prepared the business plan, which was delivered on May 1, 1998. (I have a copy of the original business plan) Negotiations with the university began shortly thereafter.

As it turned out, George Sealy took the reigns and did most of the heavy lifting in terms of the management for the first two years and Sealy should be credited with the early success of the company.

Jim Valentine joined the Board on November 12, 1999 and on January 7, 2000 took on the role of President while George Sealy remained as CEO.

Also, in November 1999, Valentine introduced Dale Prouty to the Board and they both agreed to make a substantial investment in the company and on December 4, 2001 the Board of Directors elected Prouty Vice President and COO of the company.

The name of the Company was changed from CBFR, Inc, to Tri Alpha Energy, Inc. on January 30, 2000. Michl Binderbauer formally joined the Company on March 12, 2000 as Chief Scientist by unanimous vote by the Board of Directors. His title was soon changed to Chief Technical Officer.

The first significant funding for the project came from Jim Valentine, Andrew Conrad, Dale Prouty and Michael Buchanan of Buchanan Investments in 1999 and 2000. Thereafter, funding from Paul Allen's Vulcan set the stage for further investments from Art Samberg and Jim McNeil of Pequot Capital, Dick Kramlich of NEA and then venture capitalists from around the globe. Without these adventurous investors, TAE would never have survived. (The exact timing of these investments is in question and can be easily discovered)

The idea for this company did not come from a businessman, it came from an artist and environmentalist. I doubt any serious businessman would have started a company that would harvest no substantial revenue for 25 years!

Sincerely,

Harry R. Hamlin

SEE APPENDIX BELOW

APPENDIX

Attachments:

1. Maglich Paper with date of our meeting
2. Hamlin Congressional Testimony
3. Seaborg OP Ed NYT
4. Maglich's 25 Claims debunking DT Fusion: Cover Letter
5. Hamlin Business Card
6. Agenda for 1997 Meeting in Orlando

7. Frank Braun notes of Dec. 1997 Meeting
8. Hamlin handwritten notes of Orlando Meeting
9. Task letter following the Dec. 1997 meeting
10. Program Plan for Path Forward
11. Fax from David Schetter requesting "private meeting" re start-up
12. Letter to Sen. Boxer
13. Boxer Letter to Al Gore
14. Letter to Ernie Moniz
15. Letter to Gibbons & Response from the Assistant
16. Letter to Bacula
17. Handwritten first draft of Seaborg letter to Gore
18. Seaborg letter to Vice President Gore
19. Letters of Incorporation
20. Minutes of meeting hiring Michl Binderbauer
21. Email exchange with Dale Prouty..." You Started it All"
22. Letter from Henk Monkhorst

To Harry Hamilton
with compliments from
the author
Maglich
Rome, 1st March 1980

High-energy fusion: A quest for a simple, small and environmentally acceptable colliding-beam fusion power source

By Bogdan Maglich

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February 19, 1993

Honorable Vic Fazio
House of Representatives
Washington, DC 20515

Dear Vic:

Thank you for your letter of February 11, 1993, requesting that Mr. Harry Hamlin be scheduled to testify before my Subcommittee on Energy and Water Development.

Mr. Hamlin's testimony has been scheduled for 11:55 a.m. on April 1, 1993, for 5 minutes. The hearings will be held in Room 2362, Rayburn House Office Building. Attached for information is a copy of instructions for the preparation of statements and other pertinent data.

Sincerely,

Tom Bevill, Chairman
Subcommittee on Energy
and Water Development

Attachment

TESTIMONY TO THE ENERGY AND WATER DEVELOPMENT
SUBCOMMITTEE ON APPROPRIATIONS

Harry Hamlin, Actor and Environmentalist

I am testifying here today in support of the work of the research consortium S.A.F.E. or System for Aneutronic Fusion Energy, an international consortium of Laboratories, Universities and Corporations including but not limited to U.C. Irvine, General Electric Corporation R&D Center, the Advanced Reactor group at M.I.T., The Advanced Physics Corp. and at least six prominent Russian institutes of physics. S.A.F.E. is dedicated to creating a controlled thermonuclear fusion reactor using Helium(3) and Deuterium as fuel that will produce affordable energy without the residual pollutants associated with current methods of energy production.

I speak to you today as an environmentalist and as an American citizen.

As a citizen, I am dedicated to building a strong America; an economically healthy, globally competitive America. I believe this can be accomplished by promoting the creation of peaceful, cutting edge industries that can compete internationally by providing goods and services that are essential to world markets.

As an environmentalist, I am dedicated to eliminating the pollutants that are the residue of the way our civilization has come to live. Some of the most egregious pollutants are those associated with energy production.

In support of this potential new industry involving the manufacture of clean safe energy through Aneutronic fusion, I would like to read the main body of an article written by Glen Seaborg and Paul Nitze as it appeared in the New York times on Nov. 23, 1991. Glen Seaborg served as chairman of The Atomic Energy Commission under three presidents and was awarded the Nobel prize in 1951 for his discovery of Plutonium. Paul Nitze served as arms control advisor to every president from Harry Truman to Ronald Reagan. The article reads as follows:

"The announcement of a successful nuclear fusion experiment by a European research team, using tritium fuel for the first time, shows that great progress has been made toward an important new source of energy. But there are serious questions about the practicability and environmental costs of that approach, based on the fusion of two heavy forms of hydrogen, deuterium and tritium, the last being radioactive.

Tritium does not exist on earth and must be manufactured. It poses health risks. If accidentally released into the environment, it can easily substitute for hydrogen and be incorporated into water and the human body. Moreover, the speeding neutrons produced by tritium fusion are sure to generate radioactive waste.

These neutrons can also be used to make plutonium for nuclear arms, thus increasing the possibility of the proliferation of weapons. In addition, tritium fusion is expensive. Its reactors would have to be massive and would likely cost billions of dollars.

The original promise of releasing this hidden power of the atom was to provide a safe, clean and environmentally sound source of energy. Tritium fusion does not lead there - but another option now exists that does.

The possibilities of a new approach that would solve today's problems (and tomorrow's) were outlined almost 60 years ago. In 1932, two British scientists, John Cockcroft and Ernest T.S. Walton, demonstrated that nuclear energy could be generated by the collision of artificially accelerated atomic nuclei in which both the initial and resulting nuclei were nonradioactive. Energy was released in the form of electrically charged atoms. This opens the possibility of converting the nuclear energy directly into electrical energy, avoiding the heat conversion that is common to all electric-power generating processes and that warms the planet.

Several types of nonradioactive nuclear reactions were discovered in the 1930's and 40's. One is fusion of deuterium (extracted from sea water) with light helium, which is known as helium-3. The decision to focus on tritium is based on the belief that while helium-3 would be close to the ideal fusion fuel, tritium presents the most feasible option. Helium-3 was believed to be extremely rare. Moreover, using it in a reactor would require 10 times the temperature needed for tritium fusion, which has been hard enough for scientists around the world to achieve.

But a number of developments in the 80's have made helium-3 fusion an option that should be tested now. Ample resources of helium-3 have been discovered in the atmosphere and in the earth's mantle. And in the past decade, physicists have found a way to create the equivalent of ultrahigh temperatures by making atoms collide in particle accelerators.

This has stimulated the invention of colliding beam fusion, by devices much smaller and simpler than those required for neutron-emitting tritium reactions. One promising technique fires beams of helium-3 and deuterium into a chamber where magnets make them turn and collide.

Four such self-colliders have been built* in the U.S. and achieved the equivalent of 10 billion degrees centigrade. Since they are almost neutronfree and because the concept can be tested in small volumes, such tests have cost less than $10 million, a tiny fraction of the cost of tritium experiments.

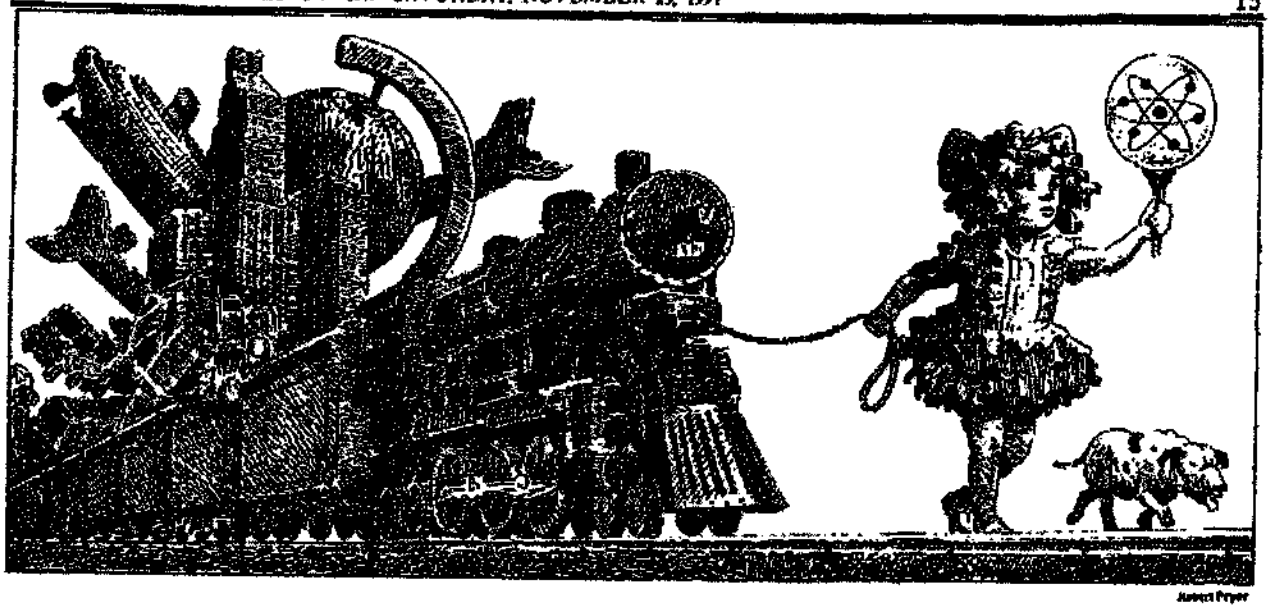
Until now, the difficulty has been to keep the atoms moving in stable orbits and not flying off in all directions before they have had a chance to fuse. It is possible that this may now be achieved with a new technique called field reversal. This approach creates enough particle density to reverse the polarity of the magnetic field in the center of the reactor.

Helium-3 research is now ready for a test that would prove or disprove this idea. The project would not divert much time or resources from our man tritium fusion research and could engage a broad spectrum of new talent at our universities and private industry and the national laboratories. If helium-3 fusion works, it will reduce our dependence on imported oil, polluting coal and conventional reactors. The nation talked in the 70's about the energy crisis, but the real problem now is an environmental one, caused largely by the residue of our current energy sources. This waste crisis contributes greatly to global pollution and should guide public thinking from now on.

No other form of energy would come as close to solving this problem as helium-3 fusion: there is no radioactive fuel, and the reaction creates a small fraction of the radioactivity resulting from tritium fusion or conventional nuclear reactors. We may be at the brink of a new era of energy technology - compact, safe, economical, and producing virtually nothing but the electricity we need.

We should test it now and find out."

I share the sentiments of these men and believe that it would be irresponsible of government to ignore the potential of such technology both from an economic and environmental perspective. I strongly urge this Administration and the Congress to support this technology.



Robert Pryor

Toward a New Era of Energy

By Glenn T. Seaborg and Paul H. Nitze

WASHINGTON

The announcement of a successful nuclear fusion experiment by a European research team, using tritium fuel for the first time, shows that great progress has been made toward an important new source of energy. But there are serious questions about the practicability and environmental costs of that approach, based on the fusion of two heavy forms of hydrogen, deuterium and tritium, the last being radioactive.

Tritium does not exist on earth and must be manufactured. It poses health risks. If accidentally released into the environment, it can easily substitute for hydrogen and be incorporated into water and the human body. Moreover, the speeding neutrons produced by tritium fusion are sure to generate radioactive waste.

These neutrons can also be used to make plutonium for nuclear arms, thus increasing the possibility of the proliferation of weapons. In addition, tritium fusion is expensive. Its reactors would have to be massive and would likely cost billions of dollars.

The original promise of releasing this hidden power of the atom was to provide a safe, clean and environmentally sound source of energy. Tritium fusion does not lead there — but another option now exists that does.

Test helium-3 fusion. It's safe, clean, economical.

Why then tritium? Scientists are familiar with it. The hydrogen bomb is based on deuterium-tritium fusion. More important, of all the known fusion reactions, tritium has the lowest ignition temperature: about 100 million degrees centigrade. Thus, it was reasonable to assume that tritium would be the first fusion fuel within technological reach.

Even so, we are 50 years away from a working tritium-deuterium reactor. It would require extraordinary financing — billions more dollars — and we would still be faced with radioactive waste. For these reasons, the utility industry stopped financing tritium fusion research in 1983.

The possibilities of a new approach that would solve today's problems (and tomorrow's) were outlined almost 60 years ago. In 1932, two British scientists, John Cockcroft and Ernest T. S. Walton, demonstrated that nuclear energy could be generated by the collision of artificially accelerated atomic nuclei in which both the initial and resulting nuclei were nonradioactive. Energy was released in the form of electrically charged atoms. This opens the possibility of converting the nuclear energy directly into electrical energy, avoiding the heat conversion that is common to all electric-power generating processes and that warms the planet.

Several types of nonradioactive nuclear reactions were discovered in the 1930's and 40's. One is fusion of deuterium (extracted from sea water) with light helium, which is known as helium-3. The decision to focus on tritium is based on the belief that while helium-3 would be close to the ideal fusion fuel, tritium presents the most feasible option. Helium-3 was believed to be extremely rare. Moreover, using it in a reactor would require 10 times the temperature needed for tritium fusion, which has been hard enough for scientists around the world to achieve.

But a number of developments in the 80's have made helium-3 fusion an option that should be tested now. Ample resources of helium-3 have been discovered in the atmosphere and in the earth's mantle. And in the past decade, physicists have found a way to create the equivalent of ultrahigh temperatures by making atoms collide in particle accelerators.

This has stimulated the invention of colliding beam fusion, by devices much smaller and simpler than those required for neutron-emitting tritium reactions. One promising technique fires beams of helium-3 and deuterium into a chamber where magnets make them turn and collide.

Four such self-colliders have been built* in the U.S. and achieved the equivalent of 10 billion degrees centigrade. Since they are almost neutron-free and because the concept can be tested in small volumes, such tests have cost less than $10 million, a tiny fraction of the cost of tritium experiments.

Until now, the difficulty has been to keep the atoms moving in stable orbits and not flying off in all directions before they have had a chance to fuse. It is possible that this may now be achieved with a new technique called field reversal. This approach creates enough particle density to reverse the polarity of the magnetic field in the center of the reactor.

Helium-3 research is now ready for a test that would prove or disprove this idea. The project would not divert much time or resources from our main tritium fusion research and could engage a broad spectrum of new talent at our universities and in private industry and the national laboratories. If helium-3 fusion works, it will reduce our dependence on imported oil, polluting coal and conventional reactors. The nation talked in the 70's about the energy crisis, but the real problem now is an environmental one, caused largely by the residue of our current energy sources. This waste crisis contributes greatly to global pollution and should guide public thinking from now on.

No other form of energy would come as close to solving this problem as helium-3 fusion: there is no radioactive fuel, and the reaction creates a small fraction of the radioactivity resulting from tritium fusion or conventional nuclear reactors. We may be at the brink of a new era of energy technology — compact, safe, economical, and producing virtually nothing but the electricity we need.

We should test it now and find out.□

* by Advanced Physics Corporation

Glenn T. Seaborg shared the Nobel Prize in chemistry in 1951 and helped pioneer peaceful nuclear technology. Paul H. Nitze was an arms control adviser to every President from Harry S. Truman to Ronald Reagan.

March 10, 1994

This prepublication is being sent for accuracy check and/or comments that would be included into publisher's copy.

TO: A. Davies, OFE/DOE
S. Dean, Fusion Power Assoc.
H. Forsen, ITER Eng. Team
R. Rowberg, Congress. Res. Serv.
M. Rosenbluth, ITER
N. Rostoker, S.A.F.E
W. Nitze, Alliance for Save Energy
T. Cochran, N.R.D.C.
H. Geller, A.C. Energy Eff. Ec.
H. Hamlin, Environ. Energy Act.
A. Lovins, Snowmass Inst.
K. Brueckner, S.A.F.E.

25 CLAIMS COMPARED TO REALITIES OF THE DOE'S FUSION ENERGY PROGRAM

Bogdan C. Maglich*

FOR A SUCCESSFUL TECHNOLOGY
REALITY MUST TAKE PRECEDENCE OVER PUBLIC RELATIONS
FOR NATURE CANNOT BE FOOLED.

Richard P. Feynman
(Report of the Presidential Commission on the Space Challenger Accident)

CLAIM #1: Tritium-fueled Tokamak TFTR has produced 5.6 million watts of fusion power for about 1 second.

REALITY: For each 1 **megawatt-second** of energy produced in TFTR, 100,000 **megawatt-seconds** of electric energy from the grid were spent on the average. In the best case (best "shot"), 84,500 times *less* energy was produced than invested: TFTR burned 7,392 kilowatt-hours of electric energy from the grid per shot (worth $739) to produce 0.0875 kilowatt-hour of equivalent electric power† (worth less than 0.1 cent). Since the ratio of energy output-to-input in an economic nuclear fission reactor must be at least 10 to 1 [3], the TFTR is a

*Research supported in part by the Tesla Foundation, 424 Emerald Bay, Laguna Beach, California, 92651. Biographical information on the author is found on p. 18.
†This implies a cost of $8,446 per kilowatt-hour *without* the inclusion of operating and capital cost; the US average all-inclusive price is $0.08 per kilowatt-hour.

C.B.F.R.

COLLIDING BEAM FUSION REACTOR

Harry R. Hamlin

Co - CHAIRMAN NATIONAL ADVISORY COMMITTEE

JOINT CBFR PROJECT

U.C. Irvine
Univ. of Florida, Gainsville
National High Energy Magnet Lab
Tallahassee, Florida

TEL: 310/276-1877
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UNIVERSITY OF CALIFORNIA, IRVINE
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Office of University/Industry Research & Technology

380 University Tower
Irvine, CA 92697-2700
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FAX (714) 824-2809

December 8, 1997

Colliding Beam Fusion Reactor (CBFR) National Advisory Committee

Dear Colleagues:

Please find attached the agenda for the December 12, 1997 Advisory Committee meeting scheduled for 10a.m. – 5p.m. at the Hyatt Regency in Orlando, Florida. Also, enclosed is a draft scope of work schedule and budget for the first three years of the project.

If you have an interest, I would be happy to have you sit in on the December 13 negotiations with possible licensees and investors.

If you have any further questions or comments, please give me a call. Looking forward to seeing you in Orlando.

Best regards,

David G. Schetter
Director

Draft Agenda

CBFR National Advisory Committee Meeting
December 12, 1997 10:00 A.M. – 5:00 P.M.
Orlando, Florida

Welcome and Introductions (Walsh)

Review Agenda and Meeting Schedule (Walsh/Schetter)

Progress and Status Reports

- UC Irvine (Rostoker)
- University of Florida (Monkhorst)
- Magnet Lab (Schneider-Muntau)
- Patent Prosecution (Rostoker)
- Funding/Sponsorship (Schetter)
- Governmental Relations (Walsh/Hamlin)

Issues for Discussion

- Role of the Federal Government
- Participation of Foreign Firms and Governments
- Evaluation of Proposals from Strategic Partners
- Nature, Content and Coordination of Publicity

Plans and Actions for 1998

Presentation by Tandem Energy Company

Discussion of Tandem Energy Company Proposal

Plans for Next Advisory Committee Meeting

Buzz Aldrin
Apollo XI Astronaut

Frank Braun
Braun Communications

Bruno Coppi
Professor of Physics
Massachusetts Institute of Technology

Harry Hamlin
Actor/Environmentalist

Dr. Russell Kulsrud
Professor of Astrophysics
Princeton University

Hendrick Monkhorst
Professor of Physics and Chemistry
University of Florida

Alan Puckett
Former CEO
Hughes Aircraft Co.

Dr. Norman Rostoker
Professor Emeritus
UCI- Physics & Astronomy

Dr. Roald Sagdeev
Director
East/West Space Institute

Dave Schetter
Director, UIRT
University of California, Irvine

Hans J. Schneider-Muntau
Deputy Director
National High Magnetic Field Lab

Dr. Glenn Seaborg
Nobel Laureate
Lawrence Berkeley Lab

George Sealy
Industrialist

Gerald Simmons
Financial Consultant

Tom Walsh
Technology Transfer Director
University of Florida

George,

Below are my notes from meeting, as promised. They are in rough draft form and would like to keep them confidential for time being since they also include some of my thoughts and reactions.

Will contact you in next couple days on draft for that letter under signatures of Chancellor's of both Universities.

Am also including copy of couple of stories I did while in Brazil, as promised earlier.

Regards,
Frank

C.R.F.R. Board Meeting 12-12-97

According to Schetter, because of federal funding early -on in Norman's work on this project, Federal govt. has "march-in" rights. (Gives it world-wide rights??)

Manufacture for the U.S. market must be done in the U.S.

$17,000 has now been invested into the U.S. patent. We need to get a World-Wide Patent, ($100,000 to $200,000 for world-wide coverage). $10,000 per country, according to Schetter???

Has to be completed by March 11????

According to Hamlin (per Peter Dekman), we need to get a sign-off from the the U.S. Dept of Commerce.

Hamlin said he met Mary Coode thru Shoman Doda. Coode was former Asst. Sec. of Commerce, former C.E.O. of Allied Signal, and now heads Venture Capital Inc. in Little Rock, Ar. Seeking to establish a Venture Capital Base in Little Rock.

Advantages of our approach, according to Hans Snieder, are ;

- =suppression of anomolous diffusion
- =great stability of the plasma state.
- =the high density you can reach because of the configuration.

Series of rear-end collisions. Hydrogen fast, boron slow.

—(Sealy, at request of the Board) Will write draft of letter under the names of Chancellors of U.C.L., University of Florida, Director of High Magnetic Laboratory, to be signed by one follow-up person

--E-Mail List Server thru Schetter, or Walsh.

—Fraun Braun contacts Fallows for meeting with Monkhorst & Rostoker, and Hans Sneider. (contacts with Seaborg). Contacts Ron Disney??
-Press Kit for CBFR
-Op Ed piece with Seaborg for N.Y. Times or other major paper.

--Norman meets with "Monis" at Dept. of Energy thru Copi & Seaborg as contacts.
glseaborg@lbl.gov.

—Write a letter from Seaborg to Vice-president Gore tying all this in to Global Warming Treaty and our new national policy to cut back on Greenhouse Gases.(Global Warming Treaty). Write and place an Op-Ed piece on the New York Times, Wash. Post, and W.S. Journal.

Last few things Schetter and Hamlin decided on: To form a company through Walsh at University of Florida.

Schetter, then Monhorst, to some degree in favor of Hamlin being President of this company. I don't agree, neither does Rostoker, and Hamlin is not too keen on that idea, either. Rostoker trying to persuade Monkhorst against the advisability of such a thing, though Hamlin can certainly play significant role in the background as fundraiser and communicator, with me. Either Sealy or Puckett should play the role of Co. President.

Question—How would the value of shares be established??
—Who would get shares?
—Who would run the company?
—Status of the Advisory Board???

GOFFE

Goffe said they estimate they would need $90 million to get this on line.

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ORLANDO INT'L AIRPORT ™

To Do - Follow up to meeting in Florida

1. Contact Christopher Flavin
World Watch Institute - co-author w/
Nicholas Lenssen. Power Surge: Guide
to the Coming Energy Revolution

2. Contact Stephen Spielberg

3. Check out Wolfson who is
Head of the World Bank.

4. Check out Tim Coffey at ONR

5. Contact Paul Allen

6. Contact Murray Gell-Mann

7. Meeting w. Pierre Dekom
re U shiny gang

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Women Hawk Arms - Finance Hotel

LUCY JARVIS

BARBARA BOXER – INVESTORS – } Lucy JARVIS

MARY GOOGLE – DISCOVER – }

GOVERNMENT –
PETER DIAMANDIS –
SINGULARITY –

$15,000,000 in money.

SAIC
BECHTEL } managed by Progress

1 – Come up w/ a use or
Managers – get money first.

Q – WHAT DO WE CALL
this Reactor – is it Fusion

KERRI-ANN JONES }
OFFICE Science TECHNOLOGY }

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ORLANDO INT'L AIRPORT ™

(1) TO GET INFO ON MAGNET LAB -

(2) DEPT COMMERCE AGREEMENT

(3) CONTRACT W/ DOE.
4/4m OCD - BUILT A MACHINE - FERMI'S PIND PROJECT.
⇒

WHO ARE REPOSITORY.
HERE ⇒

(4) $ 450,000. ⇒

(5) - SPEAK TO LICENCY EXPERT MET AT SEABORG MEDAL.

WORLD BANK WOLFSON
JEFFREY SACHS
PRESIDENT of WORLD BANK - WOLFSON

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Brochure.

1. Quotes From Spaceburys Letter

2. Contract #'s

3. Al Gore Dedicated The Magnet Lab - Nov - 1995?

(4) Paul Allen

Tim Coffey - O.N.R.

CBFR Tasks from Orlando Advisoroy Committee Meeitng

Intellectual Property

- Patent package to Tom from Dave
- Selection of new Patent Attorney
- Review of patent strategy by Florida attorney
- Election of countries by 1/11
- Complete National Phase election by March 11.

Communications

- Seaborg letter to Gore
- Brochure development for Companies
- Brochure development for Environmentalists
- Set up of listserv
- Revise and update Program Plan (P.I.'s first then NAC) integrating NHMFL and revised scopes of work
- Web page creation

Marketing & Industrial Relations

- Termination letter to Goffe
- Letter from Chancellor, President and Director to prospective sponsors
- Hans contact Electricite de France, Westinghouse, Siemens, Bechtel
- Wait and see with Militello/Beam Fusion II
- Pursue Commerce approval to market internationally
- Consider option of start-up comp;any (control and locus for $$$)

Administrative

- Hamlin to ask Seaborg to serve as co-chair
- Letter to Mary Goode asking to serve on NAC
- Pursue Bridge funding for Wessel at UCI
- Establish Interinstitutional Agreement for NHMFL with FSU - when there is a joint invention
- Hans and Tom to provide mechanism for the NHMFL to cost share in the marketing of the research program as a full partner in the CBFR
- Next NAC meeting in Bay Area in February, 1998

Program Plan and Budget for the Colliding Beam Fusion Reactor (CBFR)

There are three institutional participants in the program. During the first three years (phase I) the tasks of the participants are detailed in Fig. 1. The general objectives are:

- To establish the principles of the CBFR with pulsed experiments mainly at the University of California, Irvine.
- To do numerical analysis and evaluate fuel polarization mainly at the University of Florida at Gainesville.
- To do engineering analysis, design superconductor magnets and prepare for a seamless transition to steady state experiments in phase II at the National High Magnetic Field Laboratory. The other participants will also contribute to phase II planning

The budget for the first three years consists of the following.

University of California, Irvine	9.6M$
University of Florida, Gainesville	2.4M$
NHMFL, Tallahassee	3.1M$
	15.1M$*

The cost of phase II steady state experiments has previously been estimated as 50M$ to produce in three years net power in a steady state reactor prototype. Details of the budget estimates for phase I are provided in the balance of this document. They are organized in accordance with the tasks and schedules of Fig. 1.

* The budget involves an increase compared with the previous program plan of 1.9M$ for increased emphasis on planning for the transition to phase II

University of California, Irvine

1. Current Scientific Personnel

Norman Rostoker: Professor Emerius of Physics. Co-inventor of the Fusion Reactor. University of California, Irvine. 37 years experience in Fusion Research, General Atomic, Cornell University, University of California, San Diego and Irvine.

William Heidbrink, Professor of Physics. 11 years experience in Fusion Research; Princeton University; General Atomic; University of California, Irvine

Frank Wessel, Associate Research Physicist. 15 years experience in Pulsed Power, Particle Accelerators, Inertial Fusion; Hughes-Malibu, Western Research Corp. and Jaycor, San Diego, University of California, Irvine.

Yuanxu Song, Assistant Research Physicist. 8 years experience in particle Accelerators, Nuclear Engineering; Institute of Atomic Energy, Beijing; University of California, Irvine.

Vitaly Bystritskii, Research Physicist. 31 years experience in High Current Electronics, Intense Ion Beams, Pulsed Power; Institute of High Current Electronics, Institute of Nuclear Physics, Tomsk, Russia; University of California, Irvine.

Eusebio Garate, Associate Research Physicist. 11 years experience in Microwave Radiation Sources, Lasers, Ion Beam Sources; Dartmouth College, Ecole Polytechnique, Paris; University of California, Irvine.

Hafiz-ur Rahman, Associate Research Physicist. 13 years experience in Plasma Beam Propagation, Colliding Beam Fusion, Inertial Fusion; University of California, Irvine and Riverside, Jaycor, San Diego.

We would expect to hire three more scientists and four technicians.

2. **Research Tasks**

- **Task 1: Injection, trapping, and confinement experiments**
  Using existing equipment at UCI an experiment will be carried out that involves injection trapping and confinement of a proton beam. This experiment has a limited objective of a trapped beam current of 25 kilo-amperes at 200 keV confine for about 1 millisec. It will be completed during the first year and the milestones will be the observation and documentation of:
  - Intense beam focusing of a 5 k-ampere beam.
  - Trapping and current multiplication to 25 k-amperes.
  - Betatron acceleration of ions.

- Task 2: **Upgrade existing ion beam accelerator**
  The ion accelerator will be upgraded so that the ion energy is increased to 650 keV and the number of particles trapped will be increased by a factor of 10. The vacuum chamber, coils and power supplies will be upgraded to accommodate larger magnetic fields. Results of these experiments will be obtained in the second year. The milestones will be:
  - Creation of High beta plasma close to filed reversal.
  - Long wavelength stability will be studied and controlled with either a toroidal field, quadruple field or possibly no additional external fields.

- **Task 3: Field reversed configuration experiments**
  A fully field reversed configuration can be created by the "transformer" techniques employed at Los Alamos National Laboratory for about 20 Years. An external accelerator is not involved. The ion energy is limited to about .5 keV and the electron temperature to about 100 eV, resulting in a lifetime of about .1 milli-sec. We propose to construct a similar experiment that has a central flux coil to accelerate ions from .5 keV to about 200 keV by an acceleration process well- known in betatrons. We can also inject and trap energetic ions from an external accelerator. The milestones will be:
  - Trapping injected 650 keV ions in a fully field reversed configuration.
  - Acceleration of ions by the betatron method which would simplify start-up of a reactor.
  - There exists operating FRC's in USA and Japan. We plan to rent time on these facilities in order to obtain some results during the first two years.

- **Task 4: Advanced ion accelerator**
  An injector of sufficient capability to reach field reversal requires a current capability of about 100 kilo-amperes at 650 k-volts for 1-2 micro-sec. A development program for this will be initiated in the first year with industrial participation by either Maxwell Laboratories, Physics International Co. or Pulse Sciences inc. It is expected that the accelerator would be available for experiments during the third year.

The total cost of the accelerator is estimated at 1.5M$. The milestone in this case would be:

- Full field reversal with 650 keV protons produced by an external accelerator.

- **Task 5: Theory development**
  This involves analysis of beam propagation, accelerator and ion diodes in direct support of the experiments. It also involves reactor kinetics for phase II.

- **Task 6: Direct converter experiment**
  We will produce an annular ion beam similar to the expected form of the fusion products and inject it into a cyclotron configuration. Direct measurements of slowing down, bunching and conversion efficiency will be made.

The costs for the above tasks have been estimated based on UCI policies on salaries, overhead etc.

1. Personnel (cost 3 years) 1.6M$/year including indirect costs of overhead and benefits of 70%. Staff additions are included.	4.8MS
2. Equipment (excluded from indirect cost assessment)	
Field Reversed Configuration (Task 4)	1.500MS
Advance Ion accelerator (Task 3)	1.500MS
New Equipment and Upgrades (Task 1 & 2)	.350MS
Direct Converter (Task 6)	.150MS
	3.500MS
3. Consultants (included indirect cost of 49% overhead) Dr. John Greenley, Cornell University Dr. Michel Tuszewski, Los Alamos Lab Dr. Richard Siemen, Los Alamos Lab	.135MS
4. Rental for time on existing FRC's	.500MS
5. Materials and Supplies	365MS

6. Travel	.150M$
7. Miscellaneous (computer and shop service, journal and page charges, telephone etc.	.150M$
Total	9.600M$

University of Florida, Gainesville

1. Personnel

H.J. Monkhorst will be employed full time and will function as Project Leader at UF, Gainesville. He will be involved with all the theoretical issues studied by the UF team.

R.L. Coldwell will be responsible for some of the simulations required for the specifications of the Direct energy Converter based on the reversed cyclotron (or reverse-tron). He will also assist in software development for the FRC-related 1D and 2D kinetics codes.

E.D. Adams will be involved with technical cryogenic issues connected with the magnetic design activities at the NHMF. He already has a working relationship with laboratory in microkelvin-range low temperature physics.

C.R. Bowers will be in charge of the spin-polarized B^{11} atomic beams. Initially these will be used for nuclear experiments at TUNL (see C.2 below).

W. Happer (Princeton University)will act as a consultant for the nuclear polarization to the hydrogen and B^{11} beams. Dr. Happer is considered to be the nation's foremost expert in optical pumping techniques. He has already been consulted by H.J. Monkhorst during the Fall of 1996.

M. Binderbauer, currently at UCI, will be responsible for the numerical and analytical simulations for the generation, stability and performance of the FRC plasma with hydrogen and boron-11 ions. His work should lead to the specification of the proper parameter values controlling and optimizing the burning of this plasma. It will

involve large-scale computer simulations and its color-graphical representation.

D. Hendricks, currently in Newport Beach, Ca. With Dr. Binderbauer, he will be responsible for the simulations of the FRC plasma, and its optimization of its reactor conditions.

A Postdoctoral Associate will be hired to perform the boron-11 nuclear polarizations and he/she will be supervised by Dr. Bowers.

S. Gorlinko, T.H. Waddington, and A.J. Qerushi, UF graduate students. They will be involved with all aspects of the CBFR development, particularly various theoretical issues.

2. **Equipment**

Lasers: Our analysis has shown that, most probably, the optimal technique for B11 nuclear polarization will be a combination of a tuned KrF laser (at $\lambda = 249.816$ nm) and a Stern-Gerlach beam splitting stage. Very powerful KrF lasers are commercially available, but will require modification for tuning purposes. For hydrogen nuclear polarization we will initially rely on existing facilities at TUNL (see C.2 below).

Stern-Gerlach Apparatus: we intend to have built at the NHMFL. The estimated requirement of a field gradient on the order of a few T/cm is feasible.

Vacuum system, Boron Beam Generator: Various possibilities for making boron atom beams exist. However, not all are compatible with the requirements of purity, beam densities of approximately $10^{13}/cm^3$ and superthermal velocities. Therefore more study is needed to fine tune the chemistry and physics of this stage.

High-resolution color terminals for Drs. Monkhorst, Coldwell, Binderbauer, and Henricks will be required for simulation displays. The entire UF team will be connected to the QTP computer system. This system is very stable, high-powered, and continually upgraded to state-of-the-art level and is very well managed.

Software for various plasma and other simulations, if available, will be bought to expedite the work and/or to provide independent verification of our own software performance.

3. Other

Computing charges are for use of the QTP computational Facility and off-campus large-scale computing, if needed.

Experiments at the Triangle University Nuclear Laboratory (or TUNL) will be conducted to measure the enhancement in the p-B11 fusion cross section under nuclear spin polarization. The estimate of $100,000 in the third year (possibly starting before the end of the second year) is rough (quoted by Drs Gould, Clegg, and Ludwig from TUNL). Budget figures with an asterisk (*) are contingent upon TUNL estimate. These are excluded from IDC.

4. Budget

A. Personnel	Year One	Year Two	Year Three
1. R.J. Monkhorst (12 Months)	90000	95000	100000
2. R.L. Coldwell (9 Months)	38000	40000	42000
3. E.D. Adams (1 Month)		10000	10000
4. C.J.R. Bowers (2 Months)	9500	10000	10500
5. W. Happer (1 Month)	10000	10000	0
6. M. Binderbauer (12 Months)	38000	40000	42000
7. D. Hendricks (12 Months)	38000	40000	42000
8. Postdoc Assoc (12 Months)	30000	31000	32000
9. Grad students (3x12 Months)	46500	46500	46500
10.Secretary (3 Months)	5000	5200	5400
Total Personnel	305000	327700	330400

B. Equipment			
1. Lasers	240000		
2. Stern-Gerlach stage	100000		
3. Misc. Optics, table	20000		
4. Scanning etalon	10000		
5. Vac. System, Boron Beam Generator	15000	2000	2000
6. Color Terminals (3)	15000		
7. Software	10000		
Total Equipment	410000	2000	2000
C. Other			
1. Computing ($2000/Month)	24000	24000	24000
2. Experiments at TUNL (EDC Exempt)			100000
3. Travel	15000	15000	15000
4. Graduate Student Tuition (IDC Exempt)	7606	7606	7606
Total Other	46606	46606	1466606
D. Benefits			
1. 26% of A1-A4, A6, A7, A10	56810	62452	65494
2. 8.3% of A8	2490	2573	2656
Total Benefits	59300	65025	68150
Total Direct Costs	820906	441331	547156
Indirect Costs (45% of A, C, & D less C2 & C4)	181485	194277	198898
Total	1002391	635608	744054

3. National High Magnetic Field Lab

Feasibility Study for a p-B11 Aneutronic Fusion Reactor

Summary

We propose a study to investigate the feasibility of the major systems of a 100 MW fusion reactor based on a novel principle described in several recent papers by Rostoker, Binderbauer and Monkhorst. The study will analyze, optimize and design the energy extraction system, the magnetic field configuration, and conclude with a general technical feasibility study and cost of a prototype fusion reactor. A total cost of $3.100k is required to perform this three year study.

a) Introduction

The reactor consists of several ion accelerators for hydrogen ions with an energy of about 1000 keV and a current of about 5 A, one or more boron11 atomic beam injectors, a fusion reactor chamber and a cyclotron decelerator at each end. The fusion reaction between the hydrogen and boron ions generates helium atoms with energy of 8.7 MeV. Their kinetic energy is converted to electrical energy in the decelerators. The second source of energy, bremsstrahlung, is generated in the reaction chamber which loads the reaction chamber walls. The required cooling provides thermal energy in the order of 10 MW which can be used for power generations with standard technologies. Both the reaction chambers and the decelerators are immersed in a magnetic field which is preconditioned for the operation of the reactor, i.e., the confinement of the hydrogen and boron11 ion beams and the fusion products.

b) Energy extraction and magnetic field configuration.

We propose to investigate two of the major subsystems, the energy extraction and the magnetic field generation, and, based on these results, deliver an engineering and feasibility study of the fusion reactor.

The energy extraction is an important part of a fusion reactor, and an optimized design is required. Most of the fusion energy is contained in the α particles. The use of an inversed cyclotron, which slows down the

rotating α particles generating about 100 MW at 5 MHz, has been proposed. Electrodes will collect the particles below 1 MeV. The study will result in the design of a high power electronic converter system that transforms the high frequency power into usable 60 Hz power. Electrode loading and cooling will be investigated and a solution proposed. The second source of energy is the power from the bremsstrahlung losses which is absorbed by the walls of the reaction chamber. A highly efficient heat exchanger with minimal wall thickness will be required and designed.

As in all fusion devices, a magnetic field is required to confine the plasma within defined boundaries. In the steady state operating condition a magnetic field is applied in a) the fusion reactor chamber (high field with a transition into low field), b) the cyclotron decelerator (low field but of opposite direction) and c) the magnetic cusp configuration (transition between the two).

The estimated field requirements for the superconducting magnets of the fusion reactor chamber are: 0.3 T starting field which has to be increased to about 10 T operating field within about 2 minutes. The volume of the reaction chamber will be roughly 1.0 m in diameter and 4 m long. The field requirements for one decelerator and the cusp region are roughly 0.6 T, with approximately the same dimensions as above.

The generation of the reversed field configuration at the beginning of an operating cycle requires a magnet system wherein the main field can be created in few microseconds. This can be done with a resistive coil inside the superconducting magnet. At peak field a crow-bar is applied. The decay time must match the risetime of the superconductive field so that the plasma does not see any major field change. The above-mentioned requirements do not represent a major obstacle for the generation of the magnetic field configuration. Superconducting magnets of this size and field strength can be built with today's technology. For instance, the NHMFL constructs a 16 T system with a bore of 0.6 m. There are, however, several questions which have to be studied in the interest of optimizing the magnet design to integrate the contradictory requirements and reduce the risk of failure. The study will give answers to the following questions:

-Choice of conductor material for the superconducting magnets (NbTi or Nb3Sn for the reactor magnet)

Operating temperature (1.8K or 4.2 K)

Conductor design optimization

-Development of prototype conductor
AC loss studies of the magnet conductor
-Optimum magnet configuration for ion beam penetration
-Impact of pulsed plasma current on field and magnet stability
-Importance of field homogeneity
-Mechanical forces between systems and magnets
-Magnet safety aspects, quench propagation, magnet emergency discharge
-Interaction of ion beam current with the magnetic field
-Loss mechanisms in the magnet winding due to ripple effect of pulsed beam
-Fast field ramp of reactor magnet
-Heat load of magnet cryostat wall by bremsstrahlung
-Optimization of the cusp
-Optimum magnet size and field strength for maximum reactor efficiency.

The technical engineering and feasibility study will investigate the technical feasibility of the entire fusion reactor. This will include a vast variety of questions as civil engineering, construction, environmental questions, regulation and energy storage optimization, switch-off and emergency solutions and procedures, connectivity to electrical power grid, subsystems, modeling or scaling of the reactor and magnets for cost optimization, etc.,, to come up with a realistic and optimized reactor prototype design. The final step will be the costing of a prototype reactor.

c) Cost Breakdown

It is estimated that over a three year period a total amount of $3.100k is required. The deliverables consist of a feasibility study and a conceptual prototype design including optimization of the magnets' lay-out, design and expense of the total reactor device. The proposed program also contains an experimental element that simulates plasma current interaction with the magnet, and develops and characterizes the conductor. Magnet and reactor prototype construction could start after completion of this study, i.e., in year four. We propose to locate the experimental fusion reactor test device at the MHMFL in Tallahassee, as the magnets will be the major items of this device. Construction and operation could reality be controlled.

(Manpower costs include fringe benefits, overhead, other support as students or post-doc, all costs are in k$ per year)

First Year 720

(Analysis of superconducting and pulsed magnet geometry, preliminary design of direct converter)

1 magnet analyst	200
1 magnet engineer	200
1 electrical engineer	300
Travel	20

Second year 1060

(Design optimization, conductor development, plasma current interaction, reaction chamber cooling, direct converter design, preliminary reactor prototype design)

1 magnet analyst	200
1 electrical engineer	300
1 system engineer	200
½ cryo engineer	100
⅓ magnet engineer	70
⅓ hydraulic engineer	60
Experimental costs	100
Travel	30

Third year 1320

(Materials and conductor testing, cryostat design, AC loss measurements, design finalization, prototype design and costing)

2 system engineers	400
1 magnet engineer	200
½ cryo engineer	100
1 materials testing specialist	150
Experimental costs	
a) wire development	200
b) wire characterization	250
Travel	20

Following each year an external review committee comments on progress and continuation of program.

d) Personnel

Senior NHMFL employees who will participate in the project.

Person	Education	Experience	Responsibility
Bird, Mark D.	Ph.D. Mechanical Engineering, Stanford, 1992	5 years in resistive magnet design and construction. 6 world record magnets completed on schedule and budget, management experience	Pulse magnet design, reaction-wall-channel heat exchanger design
Eyssa, Yehia M.	Ph.D. Nuclear Engineering, University of Wisconsin Madison, 1973	24 years in superconducting and resistive magnet design, analysis, and modeling including quench propagation and fault scenarios	Magnet analysis
Miller, John R.	Ph.d. Physics, University of Virginia, 1973	24 years in superconducting magnet design, construction, and testing, particularly cable-in-conduit coils for fusion. Former magnet project leader for ITER. Group leader for large superconducting magnet systems (NHMFL 45 T hybrid)	Superconducting magnet conductor and joint design and testing
Painter, Thomas A.	M.S. Mechanical engineering, Massachusetts Institute of Technology, 1988	9 years in superconducting magnet design, construction, and testing, particularly cable-in-conduit coils for US-DPC and the NHFML 45 T hybrid outsert	Magnet fabrication and system studies
Schneider-Muntau, Hans J.	Ph.D. electrical engineering,	36 years in magnet design, analysis,	Coordination

	University of Munich, 1967	construction, testing, and technical management	
Van Sciver, Steven W.	Ph.D. Physics, University of Washington, Seattle, 1976	21 years in cryogenic development, 5 years in high Tc superconductor development	Cryostat design and construction, 2-phase flow testing
Boenig, Heinrich J.	Ph.D. Electrical Engineering, University of Wisconsin	23 years in electrical power engineering, energy storage, fusion machines, power electronics	Electrical power converter, system studies, power supplies

NHMFL employees who will be part of the project team pool.

Person	Education	Experience
Bartholomew, Keith	M.S. Physics, U. of Florida, 1992	5 years cryogenics
Bole, Scott	B.S. ME, U. of Florida, 1980	17 years mechanical engineering
Goddard, Robert	M.S. Geology, U. of Florida, 1984	13 years optical and electron microscopy
Gundlach, Scott	A.S. Mech. Design, Mich. Inst. Of Tech., 1984	13 years mechanical design
Walsh, Robert	B.S.M.E., Roch. Inst. Of Tech., 1982	15 years mechanical testing
Welton, Scott	B.S.M.E., Brigham Young U., 1988	9 years cryogenic engineering
Marshall, Scott	M.S.M.E., Fla. State U 1994	7 years mechanical engineering
Miller, George	B.S.M.E., Fla. State U., 1987	10 Years mechanical engineering
Smith, Michael	Ph.D. Physics, Univ. of Ore., 1992	5 years cryogenics testing
Toplosky, Vince	B.S.M.E., Concordia U., 1993	4 years mechanical engineering
Kenney, Jerry		25 years superconducting magnet construction and testing
Kenney, Steve		4 years superconducting magnet construction and testing

FAX TRANSMISSION

Date: 12/15/97 9:56 PM

FAX TO:
Name: Harry Hamlin - Guest
Address: Four Seasons
FAX #: (202) 944-2076

FAX FROM: **David Schetter**
4605 Green Tree Lane
Irvine, California 92717
FAX #: (714) 786-2327
Telephone: (714) 786-5076

Number of pages (including this cover sheet) 6

Message: Harry: Congratulations on the fantastic connections you made tonight. We seem to have reached the primary targets all in one evening!

Here are the written products we prepared on Saturday. Comments and observations are most welcome. We still need a legal review of the Tandem letter to ensure it sticks (to be carried out by Walsh's retained lawyers). Let me know as soon as you want me to send the Seaborg letters to him via email. I'll be in all week. Would like to meet with you privately on the start-up issue as soon as we can find a convenient time after you return. Thanks for all your help and support.

Best regards,

Dave Schetter

HARRY R. HAMLIN
3007 LAKE GLEN DRIVE
BEVERLY HILLS, CALIFORNIA 90210

Senator Barbara Boxer
1700 Montgomery St.
Suite 240
San Francisco, CA 94111

December 23, 1997

Dear Senator Boxer,

It was a pleasure meeting you a few weeks ago in Los Angeles and I am glad that you share my enthusiasm for this new CBFR technology.

On behalf of the CBFR Project National Advisory Committee, I want to thank you for your prompt letter to the Vice President. Hopefully, he will respond quickly and we will have a meeting in Washington, DC.

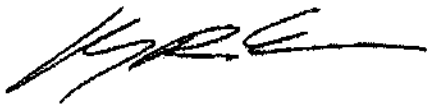
As an update, I should tell you that we had an excellent Advisory Committee meeting in Florida last week and the National High Energy Magnet Lab officially joined the project. After careful study, the Magnet Lab has concluded that the engineering for the project is feasible and that the reactor is buildable. This was a milestone for the project. You should also know that Vice President Gore personally dedicated the lab in Oct. 1995

I was at the National Science and Technology Awards dinner in Washington last week and I spoke briefly the project to John Gibbons, the Presidential Science and Technology Advisor and Ernie Moniz, Undersecretary of Technology for the Department of Commerce. They both seemed interested and I sent follow up letters to them.

I feel confident that we will gain the attention of the administration and it is difficult to imagine that we would see anything but a positive response.

Thank you for your help. Have a great Holiday Season.

Yours truly,



Harry R. Hamlin

United States Senate
HART SENATE OFFICE BUILDING
SUITE 112
WASHINGTON, DC 20510-0505
(202) 224-3553

FACSIMILE FROM

U.S. SENATOR BARBARA BOXER

LOS ANGELES, CALIFORNIA
2250 E. IMPERIAL HIGHWAY
SUITE 545
EL SEGUNDO, CA 90245

310-414-5700 PHONE
310-414-0980 FAX

DATE: 12/19/97

DELIVER TO: Harvey HAMLIN

COPIES TO:

FROM: Larry Kaplan (dir. line: 310-414-5748)

NUMBER OF PAGES INCLUDING COVER: 3

NOTES:

This was mailed on Thursday Dec 18. I'll ask our DC office call the VP's office as a follow up after the New Year. Happy Holidays!

PRINTED ON RECYCLED PAPER

BARBARA BOXER
California

COMMITTEES:
APPROPRIATIONS
BANKING, HOUSING, AND URBAN AFFAIRS
BUDGET
ENVIRONMENT AND PUBLIC WORKS

United States Senate
HART SENATE OFFICE BUILDING
SUITE 2
WASHINGTON, DC 20510-0505
(202) 224-3553
senator@boxer.senate.gov
http://www.senate.gov/~boxer

December 16, 1997

Hon. Al Gore
Vice President of the United States
The White House
Washington, D.C. 20500

Dear Mr. Vice President:

I want to call your attention to work being done which may lead to a possible new energy source.

The "Colliding Beam Fusion Reactor" was designed by scientists from the University of California and the University of Florida, and was recently featured in the highly-respected journal Science. It was brought to my attention by Mr. Harry Hamlin of Los Angeles. Nobel Prize winner and former chairman of the Atomic Energy Commission, Glenn Seaborg, has also spoken favorably about the concept.

The reactor is envisioned to work by bending boron and hydrogen beams, causing their nuclei to collide and fuse inside a chamber and release particle energy that is then converted into electricity.

I request that you consider meeting with Mr. Hamlin, the scientists who developed the Fusion Reactor, and their associates in order to learn more about this project. At this time, they are not seeking funding from the federal government, but plan on privately financing the development of a working prototype. They are willing to travel to Washington for a meeting.

Because of your leadership in promoting cutting edge technologies and your commitment to environmental protection, I thought familiarizing yourself and your staff with the Fusion Reactor would serve a dual purpose: it would provide you with information on another possible approach to solving our long-term energy needs and environmental challenges, and it would provide the creators of the Fusion Reactor with additional encouragement to continue their potentially ground-breaking work.

Vice President Gore
Page Two

Please give this request your serious consideration. Should you decide to meet with them, I will be pleased to accompany them and make the introductions. Should you have any questions, please contact me or Stephanie Bott in my Washington office at (202) 224-9178. Thank you for your consideration and interest.

Sincerely,

Barbara Boxer
United States Senator

BB/lk

Mr V.P. —
I really would
appreciate your
taking this
meeting with me —
BB
P.S. They don't want funding
P.P.S. Harry Hamlin was a Star of LA Lewis

HARRY R. HAMLIN
3007 LAKE GLEN DRIVE
BEVERLY HILLS, CALIFORNIA 90210

Ernest J. Moniz
Under Secretary
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

December 17, 1997

Dear Ernest,

It was a pleasure meeting you on Monday night at the National Science and Technology Awards Dinner. As I mentioned then, I have an extremely important matter to discuss with you.

I have enclosed materials related to the joint CBFR or Colliding Beam Fusion Reactor Project being undertaken by scientists from UC Irvine, University of Florida and the National High Energy Magnet Lab in Tallahassee. This project involves the development of a direct conversion, non-radioactive fusion reactor for the production of electricity. A recent article entitled "CBFR" was published in the journal "*Science*" (Nov. 21, 1997) and a subsequent article in the "*Economist*" (Nov. 22, 1997). Both articles outline its application and potential to solve some of the major problems associated with current methods of energy production that now contribute to global warming.

This new technology presents a clear opportunity to face some of the greatest challenges that we will encounter in the coming century. It is my goal as co-chairman of the CBFR National Advisory Committee to bring the matter to the attention of the Department of Energy and furthermore to seek your advice and council as to how best to proceed with the project.

Along with the enclosed articles from "*Science*" and the "*Economist*" is a letter of endorsement from Dr. Glenn Seaborg and a brochure that contains a list of our committee members.

Please feel free to write or call my office for further information. I thank you in advance for your attention to this matter.

Sincerely yours,

Harry R. Hamlin

cc: David Shetter

HARRY R. HAMLIN
9007 LAKE GLEN DRIVE
BEVERLY HILLS, CALIFORNIA 90210

Dr. John Gibbons
Presidential Advisor of Science & Technology
Executive Office of the President
Washington, DC 20502

December 17, 1997

Dear Dr. Gibbons,

We met Monday night at the National Science and Technology Awards. I hope it was not too presumptuous of me to discuss the Colliding Beam Fusion Project with you at dinner. I apologize for my approach, which in my business would be considered somewhat unorthodox. Your remarks, however, were inspiring to me as you spoke of the kind of passion and perseverance that has played such a major role in the development of many of our most valuable technologies. I was moved by your speech to approach you with this new idea because I have a deep passion for its potential to provide a solution to many of the greatest challenges faced by the United States and the world today. I especially foresee its potential in terms of global warming, pollution and our dependence on foreign sources of oil to provide our energy. Knowing that these matters are of vital importance to you and the administration, I urge you to become more aware of this technology.

I have enclosed a recent article published in "*Science*" (Nov. 21, 1997) and a subsequent article that appeared in the "*Economist*" (Nov. 22, 1997). I have also enclosed a letter of support from Dr. Glenn Seaborg.

As co-chairman of the national advisory committee for the CBFR Project, it is my goal to bring this technology to your attention and further to seek advice and counsel from you as to how best to proceed with its development.

Please feel free to write or call my office for further information. I thank you in advance for your attention to this important matter.

Sincerely yours,

Harry R. Hamlin

cc: David Shetter

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF SCIENCE AND TECHNOLOGY POLICY
WASHINGTON, D.C. 20502

January 22, 1998

Mr. Harry R. Hamlin
3007 Lake Glen Drive
Beverly Hills, CA 90210

Dear Mr. Hamlin:

Dr. John H. Gibbons asked me to reply to your letter regarding the Colliding Beam Fusion Reactor (CFBR) project, which enclosed copies of the recent articles from *Scienc* and the *Economist.*

The Department of Energy's (DOE) Fusion Energy Sciences Program is undergoing a transition to having as the central theme of the domestic program the development of fusion science, fusion technology, and plasma confinement innovations. The available budget for fusion has lengthened the transition period, compared to the original plan. Nonetheless, we believe that the new emphasis on diverse scientific and technological approaches to the goal of fusion energy is desirable, and it was recently endorsed by the President's Committee of Advisors on Science and Technology (PCAST). I have enclosed a copy of this PCAST report on energy R&D, which includes fusion, along wit other energy technologies that can help address the challenges of global warming, pollution, and dependence on foreign oil mentioned in your letter.

Professor Monkhorst has discussed the CBFR and its situation more thoroughly with me As a result, I understand that you and your colleagues are also seeking private sector support, and wish you success.

Sincerely,

Beverly K. Hartline
Assistant Director for
Physical Sciences and Engineering

Enclosure: *Federal Energy Research and Development for the Challenges of the Twenty First Century*, PCAST, November 1997.

cc: John H. Gibbons

HARRY R. HAMLIN
2007 LAKE GLEN DRIVE
BEVERLY HILLS, CALIFORNIA 90210

Gary Bachula
Administration of Technology
Rm. 4822
US Department of Commerce
Herbert C. Hoover Bldg.
14th St. & Constitution Ave. NW
Washington, DC 20230

December 17, 1997

Dear Gary,

It was a pleasure to see you again at the National Science and Technology Awards Dinner. I'm glad to see that you are doing well in your new position with Commerce and I found your remarks that night to be inspiring and impressive. In fact, the whole evening was an inspiration to me and I hope that someday such ceremonies will reach and inspire a broader audience.

As I discussed with you that night, I am co-chairman of the National Advisory Committee of the joint CBFR or Colliding Beam Fusion Reactor Project being undertaken by scientists from UC Irvine, University of Florida and the National High Energy Magnetic Lab in Tallahassee. The CBFR project is a revolutionary approach to energy production with the potential to solve many of the problems that are associated with current energy production methods such as low efficiency, pollution, global warming and dependence of foreign oil sources.

I have enclosed a recent article entitled "CBFR" published in the Journal "*Science*" (Nov. 21, 1997) as well as a follow-up article in the "*Economist*" (Nov. 22, 1997). I have also enclosed a letter of support from Dr. Glen Seaborg and a short brochure of the project

It is my goal as co-chairman of the CBFR National Advisory Committee to bring this new approach to your attention and also to seek your advice as to how best to proceed with the project relative to Department of Commerce Issues.

Please feel free to write or call my office for further details. I thank you in advance for your attention to this important matter.

Sincerely yours,

Harry R. Hamlin

cc: David Shetter

CONFIDENTIAL

HYATT REGENCY ORLANDO INT'L AIRPORT

COULD HELP REDUCE GREENHOUSE EMISSIONS LEVELS TO BELOW 1990 LEVELS —

DEAR V.P. GORE.

IN LIGHT OF THE RECENT DEVELOPMENTS RE GLOBAL WARMING AND EMISSIONS-CONTROL SUMMARIZED RECENTLY IN KYOTO I WOULD LIKE TO SUGGEST THAT YOU BECOME AWARE OF A NEW TECHNOLOGY WHICH I BELIEVE MAY PROVIDE A POSSIBLE SOLUTION TO SOME OF THE MOST CRITICAL PROBLEMS CONTRIBUTING TO THE GLOBAL WARMING EFFECT. THIS TECHNOLOGY HAS BEEN DEVELOPED BY A GROUP OF SCIENTISTS AT UNIVERSITY OF CENTRAL FLORIDA, FORMER UNIV OF FLORIDA AND THE NATIONAL HIGH MAGNETIC FIELD LAB IN TALLAHASSEE (WHICH, BY THE WAY, WAS DEDICATED BY YOU IN OCTOBER 1994)

DISCUSSES GLOBAL POWER GENERATION AS CONTRIBUTING TO GLOBAL WARMING

THE TECHNOLOGY INVOLVES THE DEVELOPMENT OF A NON RADIOACTIVE COLLIDING BEAM FUSION REACTOR THE WHICH

HAND WRITTEN FIRST DRAFT OF LETTER WRITTEN BY ME FOR GLENN SEABORG.

(1)

HYATT

Would David Sher, Glen,
Excellent and Approach
Easing in the way of Electricity.

A Recent article published in
the Nov 21 issue of Science
Magazine discusses that new
Research and Policy
Group Support in the Scientific
Community.

For in my opinion - Hope this
Important Research & Some
and Viable Opportunity To
Plan A Solution To the
Global problem I highly
Recommend that your office
give this New Technology Some
Full Attention.

Yours Very Sincerely

Glen T. Sabo

2

Glenn T. Seaborg
1154 Glen Road
Lafayette, California 94549-3012
(510) 283-3418

January 6, 1998

Vice President Albert Gore, Jr.
The White House
1500 Pennsylvania Avenue, NW
Washington, DC 20500-0003

Dear Al:

In light of the recent worldwide interest in the problem of global warming, I would like to bring to your attention a new kind of technology that could provide the United States with the opportunity to adopt a leadership position in the reduction of damaging greenhouse emissions. At the same time, it could provide the world with a safe, non-radioactive, and affordable means of providing electric energy along with exciting new opportunities and jobs for US industry.

This new, non-radioactive system for generating electric power is called the CBFR, or Colliding Beam Fusion Reactor. This process has been jointly conceived by the scientists at University of California, Irvine, the University of Florida, and the National High Magnetic Field Laboratory in Tallahassee. You dedicated the latter on October 1, 1994.

A recent article in *Science* (November 21, 1997 - Vol. 278) entitled "Colliding Beam Fusion Reactor" by Drs. Norman Rostoker, Michael W. Binderbauer and Hendrik J. Monkhorst (copy enclosed) presents this novel procedure for electric energy production. These scientists have designed a fusion reactor that would efficiently produce energy using low cost, non-radioactive fuels while not producing harmful waste products or significant heat pollution. Also, these reactors would be compact, exportable, non-proliferating, and buildable at competitive prices.

Having read and studied the *Science* article, I find this approach, though still experimental, to be sound and viable and representing a clear opportunity to provide the world with clean, safe, *non-radioactive* energy without the deleterious side effects currently associated with most methods of energy production.

I strongly recommend that you review this exciting new idea and sincerely hope that you share in my enthusiastic support of this technology.

Cordially,

Glenn

Glenn T. Seaborg

bcc: Harry Kamlin

COLLIDING BEAM FUSION REACTOR INC.

Action by Written Consent in Lieu of First Meeting of the Board of Directors

April 10, 1998

Pursuant to Section 307(b) of the California Corporations Code, the undersigned, being the sole director of COLLIDING BEAM FUSION REACTOR INC. a California corporation, in lieu of a Special Meeting of the Board of Directors, hereby adopts the following preambles and resolutions without a meeting:

DIRECTOR ACCEPTANCE

WHEREAS the undersigned has been appointed by the sole incorporator to serve as the first Board of Directors of this Corporation:

RESOLVED that the undersigned hereby accepts such appointment and agrees to serve until the conclusion of the next annual director election by shareholders of this Corporation or otherwise in accordance with the Bylaws of this Corporation.

ARTICLES FILED

WHEREAS the original Articles of Incorporation of this Corporation had been filed in the office of the Secretary of State of California on April 10, 1998:

RESOLVED that a certified copy of the Articles of Incorporation of this Corporation, showing the filing be inserted in this Corporation's Minute Book, together with the signed Appointment of Board of Directors by the Incorporator of this Corporation.

BYLAWS

WHEREAS it would be appropriate to adopt Bylaws for the regulation of this Corporation:

RESOLVED that the Bylaws dated April 10, 1998 be, and hereby are, adopted as the Bylaws of this Corporation; and that the Secretary of this Corporation be, and hereby is, authorized

and directed to execute a certificate of the adoption of the Bylaws and to insert the Bylaws as so certified in the Minute Book of this Corporation, and to see that a copy of the Bylaws, similarly certified, is kept at the principal office for the transaction of business of this Corporation.

ELECTION OF OFFICERS

WHEREAS this Corporation needs officers to implement the decisions of the Board of Directors and to supervise the business of this Corporation:

RESOLVED that the following persons are elected to serve, in accordance with the Bylaws of this Corporation, in the offices set forth opposite their names:

President and Chief Executive Officer:	George Sealy
Vice President, Chief Operating Officer and Chief Financial Officer:	Andrew Conrad
Vice President and Secretary:	Harry Hamlin

CORPORATE SEAL

WHEREAS it is appropriate for this Corporation to have a corporate seal:

RESOLVED that the seal impressed in the space below, consisting of two concentric circles with the name of this Corporation in one circle and the word "INCORPORATED," the date of incorporation, and "California,"

(Seal)

be, and it hereby is, adopted as the seal of this Corporation.

SHARE CERTIFICATE

WHEREAS this Corporation will need share certificates to represent the shares of Common Stock of this Corporation issued from time to time:

RESOLVED that the specimen of share certificate attached hereto be, and the same hereby is, approved and adopted, as the form for certificates for shares of the Common Stock of this Corporation.

CHECKING ACCOUNT

WHEREAS this Corporation will need a checking account for the funds of this Corporation:

RESOLVED that this Corporation open a commercial checking account at Rancho Santa Fe National Bank and that the standard resolution form for such accounts may be certified by the Secretary of this Corporation as having been adopted as resolutions of this Board of Directors on the date hereof with the same force and effect as if set forth herein; and that the Secretary of this Corporation is directed to file a copy thereof with these minutes upon such certification.

ISSUANCE OF SHARES

WHEREAS this Corporation desires to offer for sale and issue shares of its capital stock as authorized by its articles of incorporation; and

WHEREAS this Corporation desires to issue its shares in such manner and to such persons that the transaction will fall within the qualifications exemption afforded by Section 25102(f) of the California Corporations Code:

RESOLVED that sales of shares in the offering shall be made to no more than thirty-five (35) persons, in addition to any persons excluded from this number limitation by the California Commissioner of Corporations (e.g., officers, directors, and affiliates of this Corporation);

RESOLVED that sales shall be limited to persons who have either (1) a pre-existing personal or business relationship with this Corporation or its officers, directors, and controlling persons, or (2) business or financial experience (either personally or through their professional advisors), such that they can reasonably be assumed capable of protecting their own

interests in purchasing the shares;

RESOLVED that this Corporation shall require and shall immediately obtain from each purchaser his written representation that he is purchasing the shares for his own account and not with a view to resale or distribution of the shares;

RESOLVED that the offer and sale of the shares shall not be accomplished by the publication of any advertising;

RESOLVED that the notice required by the Commissioner of Corporations, containing the above information, shall be filed by the Secretary or any other officer of this Corporation, or shall be mailed for filing (with certificate of service by mail to be retained in this Corporation's corporate records) within 15 calendar days after the sale of the shares; and

RESOLVED that, upon receipt of consideration for the issuance of shares, the President and the Secretary of this Corporation be, and they hereby are, authorized to issue and deliver this Corporation's capital stock to the following named person (which this Board of Directors find to be within the limits of the foregoing resolutions), to be recorded in the records of this Corporation as shown, for the consideration described herein:

Name of Issuee	Number of Shares	Consideration
Buzz Aldrin	10,000	$1,000.00
Frank Braun	10,000	1,000.00
Dr. Andrew Conrad	10,000	1,000.00
Harry Hamlin	10,000	1,000.00
Dr. Alan E. Puckett	10,000	1,000.00
Dr. Glenn Seaborg	10,000	1,000.00
George Sealy	20,000	2,000.00
Gerald Simmons	10,000	1,000.00
	90,000	$9,000.00

AND RESOLVED that this Corporation join with its shareholders in a Stock Restriction Agreement in the form of the Agreement dated April 14, 1998, the form, terms and

provisions of which are hereby approved, to avoid transfers of shares to persons who might not have the best interests of this Corporation at heart; that George Sealy, as President of this Corporation, is hereby authorized to execute and deliver such agreement in the name and on behalf of this Corporation; and that each person authorized to purchase shares of this Corporation be asked to sign such Agreement and obtain consent thereto by his spouse.

ACCOUNTING YEAR

WHEREAS this Corporation needs a fiscal year for accounting purposes:

RESOLVED that this Corporation adopts as its accounting year the following:

DATE ACCOUNTING YEAR BEGINS: April 1

DATE ACCOUNTING YEAR ENDS: March 31

INCORPORATION EXPENSES

WHEREAS this Corporation should provide for the payment of the expenses of incorporation and organization of this Corporation:

RESOLVED that the sole officer of this Corporation be, and he hereby is, authorized and directed to pay or reimburse the expenses of the incorporation and organization of this Corporation.

LEGAL COUNSEL

WHEREAS it would be in order to approve the arrangements this Corporation would have for legal services, and it would be convenient for this Corporation to use the services of Lewis, Hoxie & Spear, A Professional Law Corporation, which is a law firm which concentrates in the field of business law:

RESOLVED that this Corporation engage as legal counsel the firm of Lewis, Hoxie & Spear, A.P.L.C.; that the forms, terms and provisions of the retainer agreement submitted to this Corporation be, and they hereby are, approved; and that

George Sealy, as President of this Corporation, be, and he hereby is, authorized to execute and deliver a retainer agreement in the name and on behalf of this Corporation.

PURCHASE/LEASE AUTHORITY

WHEREAS, in the course of running a business, it is sometimes necessary to lease equipment and to make various purchases of materials, supplies and services;

RESOLVED that the President of this Corporation is authorized to purchase or lease equipment and supplies up to a value of $25,000 per transaction; and that the President be, and he hereby is, authorized and directed to execute any such documents as he deems necessary or appropriate to carry out the intent of this Resolution.

AGENT FOR SERVICE OF PROCESS

WHEREAS the Incorporator had been appointed as the initial agent for service of process in connection with the incorporation of this Corporation and it would be more appropriate for an officer of this Corporation to serve in such capacity;

RESOLVED that George Sealy be, and he hereby is, appointed as the agent for service of process of this Corporation and that the Statement of Domestic Stock Corporation required to be filed with the State of California show such appointment.

NEGOTIATIONS WITH UNIVERSITY OF CALIFORNIA AND UNIVERSITY OF FLORIDA RESEARCH FOUNDATION

WHEREAS this Corporation is pursuing a theory which would make it feasible to produce fusion energy without radioactivity and to this end has contacted the University of California and the University of Florida Research Foundation;

RESOLVED that this Corporation pursue negotiations with the University of California and the University of Florida Research Foundation for an option or license to the Rostoker and Monkhorts "Fusion Reactor That Produces Net Free P-B11 Reaction";

FURTHER RESOLVED that this Corporation is authorized to make a $3,000.00 payment to said institutions for a letter of intent to pursue such negotiations and research; and that the officers of this Corporation, be and they each hereby are, authorized, in the name and on behalf of this Corporation, to execute and deliver any and all documents deemed necessary or appropriate to carry out the intent of this resolution.

Dated: April 10, 1998

George Seely

APRIL 6, 1968

INCORPORATED UNDER THE LAWS

OF THE STATE OF CALIFORNIA



COLLIDING BEAM FUSION REACTOR INC.

Authorized Capital Stock: 10,000,000 Common Shares

SPECIMEN

THIS CERTIFIES THAT _____ is the registered holder of _____ Shares transferable only on the books of the Corporation by the holder hereof in person or by Attorney upon surrender of this Certificate properly endorsed.

In Witness Whereof, the said Corporation has caused this Certificate to be signed by its duly authorized officers and its Corporate Seal to be hereunto affixed this _____ day of _____, A. D. _____

_____ SECRETARY

_____ PRESIDENT

COLLIDING BEAM FUSION REACTOR INC.

Written Consent to Action Taken in Lieu of Special Meeting of Board of Directors

April 13, 1998

Pursuant to Section 307(b) of the California Corporations Code, the undersigned, being the sole director and there being no shareholders of COLLIDING BEAM FUSION REACTOR INC., a California corporation, in lieu of a special meeting of directors, hereby unanimously adopts the following Resolutions without a meeting:

RESOLVED that Section 2 of Article 3 of the Bylaws of this Corporation be amended to read as follows:

Section 2. Number and Qualification of Directors. The authorized number of directors shall be nine.

RESOLVED FURTHER that, effective April 14, 1998, the following persons be, and they hereby are, appointed to serve as additional directors of this Corporation:

Buzz Aldrin
Frank Braun
Dr. Andrew Conrad
Harry Hamlin
Dr. Alan E. Puckett
Dr. Glenn Seaborg
Gerald Simmons

and that there remain one vacancy on the Board of Directors until further action by the shareholders of this Corporation.

RESOLVED FURTHER that the following persons shall constitute the Executive Committee of the Board of Directors with the full power of the Board of Directors to act between meetings of the Board of Directors:

Andrew Conrad
Harry Hamlin
George Sealy

RESOLVED FURTHER that the following persons be, and they hereby are, elected to serve in the offices set forth opposite their names:

Stock Option Plan

Chairman Puckett indicated that officers had been discussing the adoption of a stock option plan, concluding that a number of shares should be set aside for the officers, directors and key researchers. Following discussion, on motion duly made and seconded, the following resolution was unanimously adopted:

> RESOLVED that this Corporation adopt a stock option plan, setting aside 500,000 shares for the officers, directors, employees, advisory board members and consultants; that the offered options be for a term of five years for 10,000 shares at $1.00 per share; that George P. Sealy, James I. Valentine and Andrew Conrad are appointed as members of the Stock Option and Compensation Committee; and that George P. Sealy is authorized to work with this Corporation's legal counsel to prepare the necessary documents to carry out the intent of this Resolution.

Advisory Board

A discussion followed regarding the make-up of the Advisory Board and the fact that considerable time has passed and that monumental events had occurred since the appointment of the original Advisory Board following incorporation in 1998. On motion duly made and seconded, the following Resolution was adopted:

> RESOLVED that David Poticny of Lucent Technologies and Dale A. Prouty be named as additional members of this Corporation's Advisory Board.

Employment of Chief Technical Officer

Dr. Conrad and Mr. Valentine brought up the need for the Corporation to appoint a Chief Technical Officer who would be responsible for moderating disputes among the various elements of the Corporation's research teams. It was noted that the Chief Technical Officer would, for all practical purposes, be the face, voice and brains behind the whole research effort of the Corporation. Dr. Conrad agreed to prepare a draft of job description. On motion duly made and seconded the following Resolution was adopted:

> RESOLVED that this Corporation employ Michl Binderbauer to serve in the capacity of Chief Technical Officer; and that, for the performance of the services of such position, Mr. Binderbauer be paid $7,000.00 per month.

Dr. Glenn Seaborg	Chairman Emeritus
Dr. Alan E. Puckett	Chairman of the Board

RESOLVED FURTHER that is it in the best interest of this Corporation to have, as an advisory Board of Directors, persons who are conversant with the field of endeavor of this Corporation; and that the following persons be, and they hereby are, appointed as members of an Advisory Board to the management of this Corporation:

Bruno Coppi
Dr. Russell Kulsrud
Henk Monkhorst
Dr. Norman Rostoker
Dr. Ronald Sagdeev
Dave Schatter
Hans J. Schneider-Muntau
Dr. Glenn Seaborg
Tom Walsh

Dated: April 13, 1998

GEORGE SILLY

COLLIDING BEAM FUSION REACTOR, INC.

Written Consent of Executive Committee
of Board of Directors in Lieu of a Meeting

December 15, 1998

Pursuant to section 307 (b) of the California Corporations Code, the undersigned, being all the members of the Executive Committee of the Board of Directors of COLLIDING BEAM FUSION REACTOR, INC., a California corporation, do by this writing, consent to the following action being taken without a meeting and adopt the following Preamble and Resolution:

WHEREAS this Corporation is in need of additional capital and several shareholders have agreed to provide such additional capital:

RESOLVED that this Corporation issue the following additional shares to the following named individuals for the consideration specified:

Shareholder	No. of Shares	Consideration
Andrew Conrad	40,000	$ 4,000.00
Harry Hamlin	10,000	1,000.00
Gerald Simmons	10,000	1,000.00
Allen E. Puckett	20,000	2,000.00
George Sealy	30,000	3,000.00
	110,000	$11,000.00

that the fair market value of the shares remains at $.10 per share; and that the officers of this Corporation be, and they hereby are, authorized, in the name and on behalf of this Corporation, to issue such shares and to execute any other documents they deem necessary or appropriate to carry out the intent of this Resolution.

Dated: December 15, 1998

GEORGE SEALY

ANDREW CONRAD

HARRY HAMLIN

COLLIDING BEAM FUSION REACTOR, INC.

Written Consent of Executive Committee
of Board of Directors in Lieu of a Meeting

January 31, 1999

Pursuant to section 307 (b) of the California Corporations Code, the undersigned, being all the members of the Executive Committee of the Board of Directors of COLLIDING BEAM FUSION REACTOR, INC., a California corporation, do by this writing, consent to the following action being taken without a meeting and adopt the following Preamble and Resolution:

WHEREAS this Corporation is in need of additional capital; that colleagues of one or more of this Corporation's directors or shareholders have expressed interest in becoming shareholders to provide such additional capital;

RESOLVED that the officers of this Corporation are authorized to issue up to the following amounts of additional shares of this Corporation to the specified individuals and for the consideration specified as follows:

Shareholder	No. of Shares	Consideration
Melvin Gottlieb	10,000	$10,000.00
James Kyles	10,000	10,000.00
Leopold Halperin	5,000	5,000.00
	25,000	$ 25,000.00

that the fair market value of the shares is $1.00 per share, and that the officers of this Corporation be, and they hereby are, authorized, in the name of, and on behalf of this Corporation, to issue such shares and to execute any other documents they deem necessary or appropriate to carry out the intent of this Resolution.

Dated: January 31, 1999

GEORGE SEALY

ANDREW CONRAD

HENRY HAMLIN

COLLIDING BEAM FUSION REACTOR INC

Minutes of Special Meeting of Board of Directors

April 18, 1998

The Board of Directors of COLLIDING BEAM FUSION REACTOR INC., a California corporation (the "Corporation"), held a special meeting on April 18, 1998 at 12:00 m., at the Sofitel Hotel, in Los Angles, California, pursuant to personal notice duly given by the Secretary in accordance with the Bylaws of the Corporation.

Present at the meeting were Dr. Buzz Aldrin, Frank Braun (who arrived during the meeting), Dr. Andrew Conrad, Harry Hamlin, Dr. Glenn Seaborg, Gerald Simmons and George P. Sealy, being a majority of the directors of the Corporation and thereby constituting a quorum. Also present, by invitation, were Dr. Norman Rostoker, Dr. Frank Wessel and Dr. Mickl Binderbauer.

George Sealy, President of the Corporation, acted as Chairman of the meeting and presided thereat. Harry Hamlin, Secretary of the Corporation kept the minutes of the meeting. The reading of the Minutes of the previous meeting of the Board of Directors was waived by unanimous consent.

The Chairman reported that the meeting was being held to discuss the recent corporate formation and to bring the Board up to date on current projects.

Dr. Conrad briefed the Board on his study regarding an overview of the project.

Dr. Aldrin discussed various government contacts that might prove helpful to the Corporation's efforts. He mentioned a contact with Governor Pete Wilson and indicated he would follow-up the preliminary lead. Harry Hamlin stated that he had had no further contact with Senator Barbara Boxer, but would continue to try to reach her. He also suggested that he could pursue some wealthy businessmen that he knew socially.

The Chairman complimented Frank Wessel for his hard work in preparing the business plan and the consensus of the directors was that the final product was excellent.

Gerald Simmons stated that initial indications looked promising for some business arrangement with STL Ministries.

Mr. Hamlin discussed the idea of forming a National Scientific Advisory Board to add additional scientists that were not already on board. Dr. Seaborg said he would contact Dr. Murray Gell Mann and Dr. Aldrin mentioned that Sally Ride might agree to be on the advisory board.

The Chairman advised that he had completed a mailing to various corporations with an invitation for each to join the Corporation as a strategic partner. Mr. Hamlin stated that a revised pamphlet describing the Corporation's goals was in the preparation stage and would soon be ready for dissemination. Dr. Rostoker mentioned the possibility of adding Joe O'Toole of the Los Alamos National Lab to the project.

The Board then discussed a new article proposal for Science Magazine which in essence would explain that equations relating to an ongoing reaction cannot be compared with previous equations that were based on "one-time" events. No agreement was reached that submission of such an article was appropriate at this time. Further discussion revolved around the possibility of a meeting of Paul Grant of EPRI with the concept of forming a collaboration with other universities or utilities.

Mr. Hamlin stated that he had sent information packets to Scientific Magazine and ABC News, but had not as yet heard back from them.

The Chairman distributed various corporate documents for discussion and execution by the Board.

There being no further business, the meeting was adjourned at 3:30 p.m.

HARRY HAMLIN, Secretary of the Meeting

APPROVED:

GEORGE P. SBALY, Chairman of the Meeting

COLLIDING BEAM FUSION REACTOR, INC.

Written Consent of Executive Committee
of Board of Directors in Lieu of a Meeting

February 15, 1999

Pursuant to section 307 (b) of the California Corporations Code, the undersigned, being all the members of the Executive Committee of the Board of Directors of COLLIDING BEAM FUSION REACTOR, INC., a California corporation, do by this writing, consent to the following action being taken without a meeting and adopt the following Preamble and Resolution:

WHEREAS this Corporation is in need of additional capital; that a colleague of one or more of this Corporation's directors or shareholders has expressed interest in becoming a shareholder to provide such additional capital.

RESOLVED that the officers of this Corporation are authorized to issue up to the following amount of additional shares of this Corporation to the specified individual and for the consideration specified as follows:

Shareholder	No. of Shares	Consideration
M.Y.F. Monkhorst	5,000	5,000.00
	5,000	$ 5,000.00

that the fair market value of the shares is $1.00 per share; and that the officers of this Corporation be, and they hereby are, authorized, in the name of, and on behalf of this Corporation, to issue such shares and to execute any other documents they deem necessary or appropriate to carry out the intent of this Resolution.

Dated: February 15, 1999

GEORGE SEALY

ANDREW CONRAD

HARRY HAMLIN

COLLIDING BEAM FUSION REACTOR, INC.

Written Consent of Executive Committee
of Board of Directors in Lieu of a Meeting

March 15, 1999

Pursuant to section 307 (b) of the California Corporations Code, the undersigned, being all the members of the Executive Committee of the Board of Directors of COLLIDING BEAM FUSION REACTOR, INC., a California corporation, do by this writing, consent to the following action being taken without a meeting and adopt the following Preamble and Resolution:

WHEREAS this Corporation is in need of additional capital and colleagues of one or more of this Corporation's directors or shareholders have expressed interest in becoming shareholders to provide such additional capital.

RESOLVED that the officers of this Corporation are authorized to issue up to the following amounts of additional shares of this Corporation to the specified individuals and for the consideration specified as follows:

Shareholder	No. of Shares	Consideration
Mika A. Valenik	10,000	$5,000 and cancellation of $5,000 loan to Corporation
Corrine Rostoker	10,000	$5,000.00 And cancellation of $5,000 loan to Corporation
Frank Wessell	5,000	Consulting Services to Corporation valued at $5,000
Michl Binderbauer	5,000	Consulting Services to Corporation valued at $5,000
Joseph A. O'Toole	5,000	Consulting

		Services to Corporation valued at $5,000
Leopold Halpern	5,000	$5,000.00
John Rees	5,000	$5,000.00
James I. Valentino	5,000	$5,000.00
	50,000	$25,000.00

In cash and for other consideration

that the fair market value of the shares is $1.00 per share, and that the officers of this Corporation be, and they hereby are, authorized, in the name of, and on behalf of this Corporation, to issue such shares and to execute any other documents they deem necessary or appropriate to carry out the intent of this Resolution.

Dated: March 15, 1999

GEORGE SMALY

ANDREW CONRAD

HARRY HAMLIN

COLLIDING BEAM FUSION REACTOR, INC.

Written Consent of Executive Committee
of Board of Directors in Lieu of a Meeting

May 6, 1999

Pursuant to section 307 (b) of the California Corporations Code, the undersigned, being all the members of the Executive Committee of the Board of Directors of COLLIDING BEAM FUSION REACTOR, INC., a California corporation, do by this writing, consent to the following action being taken without a meeting and adopt the following Preamble and Resolution:

WHEREAS the printed certificates for shares of this Corporation, numbered 1-20, have been used, and

WHEREAS such printed form is no longer available;

RESOLVED that this Corporation hereby adopts as an additional approved form of certificate for shares of this Corporation the form attached hereto.

Dated May 6, 1999

GEORGE SEALY

ANDREW CONRAD

HARRY HAMLIN

APRIL 6, 1998

INCORPORATED UNDER THE LAWS

OF THE STATE OF CALIFORNIA

Number 21

Shares

COLLIDING BEAM FUSION REACTOR INC.

Authorized Capital Stock: 20,000,000 Common Shares

THIS CERTIFIES THAT

registered holder of _____ is the

transferable only on the books of the Corporation by the holder hereof in person or by Attorney upon

surrender of this Certificate properly endorsed

In Witness Whereof, the said Corporation has caused this Certificate to be signed by its duly

authorized officers and its Corporate Seal to be hereunto affixed

this _____ day of _____ 1998

SECRETARY

PRESIDENT

COLLIDING BEAM FUSION REACTOR INC.

Appointment of Board of Directors
by Incorporator

April 10, 1998

The incorporator named in the Articles of Incorporation of the above-named corporation appoints the following person to the Board of Directors of the corporation:

George Sealy

Dated: April 10, 1998

Marshall A. Lewis

By my signature below, I hereby accept appointment as a director of the above-named corporation.

Dated: April 10, 1998

George Sealy

Boilerplate Minutes

TRI ALPHA ENERGY, INC.

Minutes of Special Meeting of Board of Directors

March 12, 2000

The Board of Directors of TRI ALPHA ENERGY, INC., a California corporation (the "Corporation"), held a special meeting on March 12, 2000 at 4:35 p.m., at the University of California at Irvine, in Irvine, California, pursuant to personal notice duly given by the Secretary to each director in accordance with the Bylaws of the Corporation.

Present at the meeting were Frank Braun, Dr. Andrew Conrad, Harry Hamlin, Dr. Allen E. Puckett, Gerald Simmons, George P. Sealy and James I. Valentine, being a majority of the directors of the Corporation and thereby constituting a quorum. Absent was Buzz Aldrin.

Allen E. Puckett, Chairman of the Board of the Corporation, acted as Chairman of the meeting and presided thereat. Harry Hamlin, Secretary of the Corporation kept the minutes of the meeting.

The Minutes of the January 7, 2000, meeting of the Board of Directors were approved as previously distributed.

Lost Stock Certificate

George Sealy, Chief Executive Office of the Corporation, reported that shareholder Buzz Aldrin had informed the corporation that he had lost or misplaced his original certificate, numbered 1; and that, on behalf of Dr. Aldrin, he had contacted the Corporation's legal counsel, Lewis, Hoxie & Spear, APLC, who had prepared An Affidavit Respecting Lost Stock Certificate and secured Dr. Aldrin's signature. On motion duly made and seconded the following resolution was adopted:

> RESOLVED that this Corporation authorize the acceptance of Affidavit Re Lost Stock Certificate dated September 7, 1999, signed by Buzz Aldrin; and that this Corporation issue a replacement certificate to replace the lost certificate, numbered 1, originally issued to shareholder Buzz Aldrin for 10,000 shares; and that the President and Secretary of this Corporation are authorized and directed to execute and deliver said certificate and any other documents each may deem necessary to carry out the intent of this Resolution.

Financial Report

Messrs. Valentine and Sealy reviewed the Corporation's most recent financials, noting the major sources of funds, the expenditures and current cash balances, and responded to questions.

Stock Option Plan

Chairman Puckett indicated that officers had been discussing the adoption of a stock option plan, concluding that a number of shares should be set aside for the officers, directors and key researchers. Following discussion, on motion duly made and seconded, the following resolution was unanimously adopted:

> RESOLVED that this Corporation adopt a stock option plan, setting aside 500,000 shares for the officers, directors, employees, advisory board members and consultants; that the offered options be for a term of five years for 10,000 shares at $1.00 per share; that George P. Sealy, James I. Valentine and Andrew Conrad are appointed as members of the Stock Option and Compensation Committee; and that George P. Sealy is authorized to work with this Corporation's legal counsel to prepare the necessary documents to carry out the intent of this Resolution.

Advisory Board

A discussion followed regarding the make-up of the Advisory Board and the fact that considerable time has passed and that monumental events had occurred since the appointment of the original Advisory Board following incorporation in 1998. On motion duly made and seconded, the following Resolution was adopted:

> RESOLVED that David Poticny of Lucent Technologies and Dale A. Prouty be named as additional members of this Corporation's Advisory Board.

Employment of Chief Technical Officer

Dr. Conrad and Mr. Valentine brought up the need for the Corporation to appoint a Chief Technical Officer who would be responsible for moderating disputes among the various elements of the Corporation's research teams. It was noted that the Chief Technical Officer would, for all practical purposes, be the face, voice and brains behind the whole research effort of the Corporation. Dr. Conrad agreed to prepare a draft of job description. On motion duly made and seconded the following Resolution was adopted:

> RESOLVED that this Corporation employ Michl Binderbauer to serve in the capacity of Chief Technical Officer; and that, for the performance of the services of such position, Mr. Binderbauer be paid $7,000.00 per month.

There being no further business, the meeting was adjourned at 5:25 p.m.

Harry Hamlin, Secretary

APPROVED:

Allen E. Puckett, Chairman

MICHL BMOCHNIK MIRED -

PART TIME NOTES BY E.A.

Tri Alpha Energy, Inc. Board Meeting
Monday March 12, 2000

1. Seven members called to order at 4:35 PM all present: Harry Hamlin, Andrew Conrad, George Sealy, Frank Braun, Allen Puckett, Jim Valentine, and Gerald Simmons.
2. At that time the minutes were approved unanimously.
3. The members unanimously authorized the replacement of a lost stock certificate for Buzz Aldrin.
4. Jim Valentine and George Sealy reviewed the financials with the company.
5. Approval of option:

   During a review of the stock option plan for officers, directors, employees, advisory board members, and consultants, it was discussed that each member would get options for five years of 10,000 shares at $1.00 per share.

   Also discussed, granting of options is discretionary, and a Compensation Committee to be formed to oversee the 500,000 shares set-aside for the option pool.

   It was also discussed, that additional stock must be set aside for warrants, and that warrants will be awarded according to market value.

   The board nominated George Sealy, Jim Valentine, and Andrew Conrad to be on the Compensation Committee.

   A motion to create the pool and approve the committee was brought before the members and was approved unanimously.

6. Approval of business advisory board members:

   The following people were recommended for the Business Advisory Board:

   1. Dave Bitickney in change of works strong from Lucent Tech.
   2. Bill Shuestoer head of Baker & Hostetler
   3. Robert Segal
   4. Larry Pressler Ex Senator
   5. Dave Peouty
   6. Dick Jegmeyer – currently on the Scientific Advisory Board

10,000 shares to compensate the member of the business

It was discussed that perhaps 10,000 shares could be used to compensate the business advisory board. It was decided that the main function of the Business Advisory Board would be networking and fundraising.

Jim Valentine made a motion to invite the above people onto the Business Advisory Board. The motion was seconded and unanimously approved.

A brief discussion on the upcoming Apollo XIII Gala ensued. There was some debate about the relevance of a Tri Alpha table at the event. It was felt that such a presence might be appropriate for Tri Alpha at this point.

Andrew Conrad brought up the need for a Chief Technical Officer, as did Jim Valentine. They offered that this person would likely be the "face, voice, and brains" behind the whole effort.

Several candidates for the CTO Post were brought up.

1. Michael Binderhauer
2. Tom Loadington
3. Frank Wessel

It was decided that Andrew Conrad would write a job description for the CTO and that among the various responsibilities of the CTO would be the need to moderate disputes between the various labs.

It was discusses that $7,000.00 per month will be offered for the job. There was a motion to adjourn at 5:25 PM.

TRI ALPHA ENERGY, INC.

Minutes of Special Meeting of Board of Directors

March 12, 2000

The Board of Directors of TRI ALPHA ENERGY, INC., a California corporation (the "Corporation"), held a special meeting on March 12, 2000 at 4:35 p.m., at the University of California at Irvine, in Irvine, California, pursuant to personal notice duly given by the Secretary to each director in accordance with the Bylaws of the Corporation.

Present at the meeting were Frank Braun, Dr. Andrew Conrad, Harry Hamlin, Dr. Allen E. Puckett, Gerald Simmons, George P. Sealy and James I. Valentine, being a majority of the directors of the Corporation and thereby constituting a quorum. Absent was Buzz Aldrin.

Allen E. Puckett, Chairman of the Board of the Corporation, acted as Chairman of the meeting and presided thereat. Harry Hamlin, Secretary of the Corporation kept the minutes of the meeting.

The Minutes of the January 7, 2000, meeting of the Board of Directors were approved as previously distributed.

Lost Stock Certificate

George Sealy, Chief Executive Office of the Corporation, reported that shareholder Buzz Aldrin had informed the corporation that he had lost or misplaced his original certificate, numbered 1; and that, on behalf of Dr. Aldrin, he had contacted the Corporation's legal counsel, Lewis, Hoxie & Spear, APLC, who had prepared An Affidavit Respecting Lost Stock Certificate and secured Dr. Aldrin's signature. On motion duly made and seconded the following resolution was adopted:

> RESOLVED that this Corporation authorize the acceptance of Affidavit Re Lost Stock Certificate dated September 7, 1999, signed by Buzz Aldrin; and that this Corporation issue a replacement certificate to replace the lost certificate, numbered 1, originally issued to shareholder Buzz Aldrin for 10,000 shares; and that the President and Secretary of this Corporation are authorized and directed to execute and deliver said certificate and any other documents each may deem necessary to carry out the intent of this Resolution.

Financial Report

Messrs. Valentine and Sealy reviewed the Corporation's most recent financials, noting the major sources of funds, the expenditures and current cash balances, and responded to questions.

There being no further business, the meeting was adjourned at 5:25 p.m.

Harry Hamlin, Secretary

APPROVED:

Allen E. Puckett, Chairman

From: **Dale Prouty** dprouty@trialphaenergy.com
Subject: **Re: BOD Meeting**
Date: **June 25, 2015 at 8:40 PM**
To: **Harry Hamlin** hrbone@aol.com

You started it all.

Regards,
Dale Prouty
CEO
Tri Alpha Energy, Inc.
Ofc 949-830-2117 x102
Cell 858-353-3865

> On Jun 25, 2015, at 8:37 PM, Harry Hamlin <hrbone@aol.com> wrote:
>
> Hi Dale: I didn't get a chance to talk to you today after the meeting and I wanted to tell you how proud I am of you and what you have accomplished since you came onboard so many years ago. I am constantly amazed, delighted and impressed by the results of your tireless

efforts on behalf of this technology. I can't imagine a better captain of this ship. It is clear that your leadership has resulted in the phenomenal results that are continually reported to the board. A great work environment that produces continual positive results and positive reviews from the staff can only be engendered from the top down and, believe me, this does not go un-noticed or un-appreciated. Thank you for your endless enthusiasm, unparalleled work ethic and obvious devotion to the project. When I see how far we have come and what this could mean for the world, I am left speechless and I only wish I had the words to express my gratitude.
Respectfully yours, always, Harry

UF UNIVERSITY of FLORIDA

College of Liberal Arts & Sciences
Department of Physics

PO Box 118440
Gainesville, Florida 32611-8440
352-392-0521
352-392-0524 Fax

Gainesville, June 14, 2022

TO WHOM IT MAY CONCERN

To the extent I was witness to, was present at pivotal meetings, have my recollections, conversations I had with others mentioned and have personal documentation, the following statement is an affirmation of the veracity of the history statement by Harry Hamlin, Co-Founder and Secretary of TAE Technologies, Inc. he shared with me about the founding of TAE Technologies, Inc. It covers the period from its earliest gestation days in the 1970's till the formal incorporation as Colliding Beam Fusion Reactor, Inc. in April 1998, later renamed as TAE Technologies, Inc.

For the record, I became only aware of its gyrating, birthing path in September of 1994, after I contacted Norman Rostoker with the suggestion that the path to a fusion reactor should be paved with the nuclear reaction $p + {}^{11}B \rightarrow 3\ {}^{4}He$. It was recognized as the only, truly aneutronic fusion reaction of practical value for a fusion reactor and the least engineering problems. This was pointed out, maybe in the starkest possible terms, by Lawrence Lidsky in an impactful MIT publication in 1983. I had become aware that some problems existed with the physics of this reaction's measurements, and that it would be even slightly more advantageous for a fusion reactor. This communication with Norman marked the beginning of our fusion research collaboration and involvement with TAE until his death on Christmas Day, December 2014.

As written in Harry's report, I became involved in the eventual foundation process in November 1997, after Norman, Michl and I succeeded to publish an article in Science, "Colliding Beam Fusion Reactor", November 19, 1997. This publication triggered the gradual development of TAE Technologies, Inc. of today.

In conclusion, an objective reading of Harry's writing and of the attached copies of documents shows the crucial, at times pivotal, persistent and even political role Harry has played in the existence and promise of today's TAE Technologies, Inc.

Signed,



Hendrik J. Monkhorst, co-Founder and Full-Time Consultant, TAE Technologies, Inc.
Professor Emeritus of Physics and Chemistry, University of Florida
(352)-213-6877 (c)

UF UNIVERSITY of FLORIDA

College of Liberal Arts & Sciences
Department of Physics

PO Box 118440
Gainesville, Florida 32611-8440
352-392-0521
352-392-0524 Fax

Gainesville, June 14, 2022

TO WHOM IT MAY CONCERN

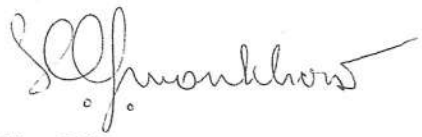
To the extent I was witness to, was present at pivotal meetings, have my recollections, conversations I had with others mentioned and have personal documentation, the following statement is an affirmation of the veracity of the history statement by Harry Hamlin, Co-Founder and Secretary of TAE Technologies, Inc. he shared with me about the founding of TAE Technologies, Inc. It covers the period from its earliest gestation days in the 1970's till the formal incorporation as Colliding Beam Fusion Reactor, Inc. in April 1998, later renamed as TAE Technologies, Inc.

For the record, I became only aware of its gyrating, birthing path in September of 1994, after I contacted Norman Rostoker with the suggestion that the path to a fusion reactor should be paved with the nuclear reaction $p + {}^{11}B \rightarrow 3\ {}^{4}He$. It was recognized as the only, truly aneutronic fusion reaction of practical value for a fusion reactor and the least engineering problems. This was pointed out, maybe in the starkest possible terms, by Lawrence Lidsky in an impactful MIT publication in 1983. I had become aware that some problems existed with the physics of this reaction's measurements, and that it would be even slightly more advantageous for a fusion reactor. This communication with Norman marked the beginning of our fusion research collaboration and involvement with TAE until his death on Christmas Day, December 2014.

As written in Harry's report, I became involved in the eventual foundation process in November 1997, after Norman, Michl and I succeeded to publish an article in Science, "Colliding Beam Fusion Reactor", November 19, 1997. This publication triggered the gradual development of TAE Technologies, Inc. of today.

In conclusion, an objective reading of Harry's writing and of the attached copies of documents shows the crucial, at times pivotal, persistent and even political role Harry has played in the existence and promise of today's TAE Technologies, Inc.

Signed,



Hendrik J. Monkhorst, co-Founder and Full-Time Consultant, TAE Technologies, Inc.
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