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OA/ID Number: 4299
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Folder Title:
Seaborg/Hobin Non-Radioactive Fuel Fusion

Stack:	Row:	Section:	Shelf:	Position:
S	61	7	1	3



Department of Energy
Washington, DC 20585

July 23, 1993

Ms. Joan B. Hobin
Corporate Secretary
Advanced Physics Corporation
680 University Tower
4199 Campus Drive
Irvine, California 92715

Dear Ms. Hobin:

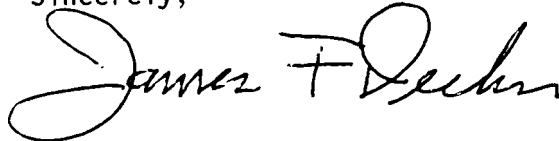
Your letter to Ms. Kathleen A. McGinty, Director, White House Office on Environmental Policy, dated May 17, 1993, regarding nonradioactive-fuel fusion, has been referred to this office for additional response. We have read the white paper "New Fusion Energy Option: Nonradioactive Fuel Fusion" sent to President Clinton by Dr. Glenn Seaborg. It is well-reasoned and makes a strong case for the desirability of fusion based on reactions of deuterium with helium-3 in a small scale device. While we do not completely agree with all the points made in the white paper, we do recognize the programmatic desirability of "aneutronic" fusion.

We have followed the status of the self-collider approach since the 1970s, and we would be pleased if it could ultimately be successful. The Department, however, has not funded proposals on "aneutronic" fusion submitted by Dr. Bogdan Maglich because of concern about scientific issues associated with the proposals. Consistently, both scientific reviews and general scientific community discussion of the self-collider approach have centered on the issue of instabilities. The fundamental question has been whether such self-collider reactions can be sustained at a rate that could produce net energy. From previous research with a related concept, the magnetic mirror, much is known about the instabilities that prevent the conditions needed for fusion energy. So far, scientific judgement has been that approaches proposed by Dr. Maglich and his colleagues will encounter such instabilities and cannot attain the desired condition of sustained nuclear reactions. Thus, we do not have the scientific basis required for support of these proposals.

Nevertheless, the basic concept of obtaining fusion energy from colliding particles has not been completely rejected by the scientific community. The final state of the self-collider approach could be stable. The path to obtaining this state is the issue. Following the recent Office of Fusion Energy solicitation for innovative ideas for fusion, two small-scale proposals based on related concepts have been funded. They were successful in the scientific review specifically because they proposed to test approaches that the scientific reviewers judged could reach the final state.

We hope that an approach to fusion energy like the one you advocate can be successful some day. Given accumulated knowledge of the difficulties, we must proceed on a sound scientific basis following the processes that we have established. We will continue to try to be responsive to any inquiries or proposals you or your colleagues may have. We seek to be objective and fair in our consideration of all proposals that we review, and we will continue this commitment in the future.

Sincerely,

A handwritten signature in black ink, reading "James F. Decker". The signature is fluid and cursive, with the first name "James" being larger and more prominent than the last name "Decker".

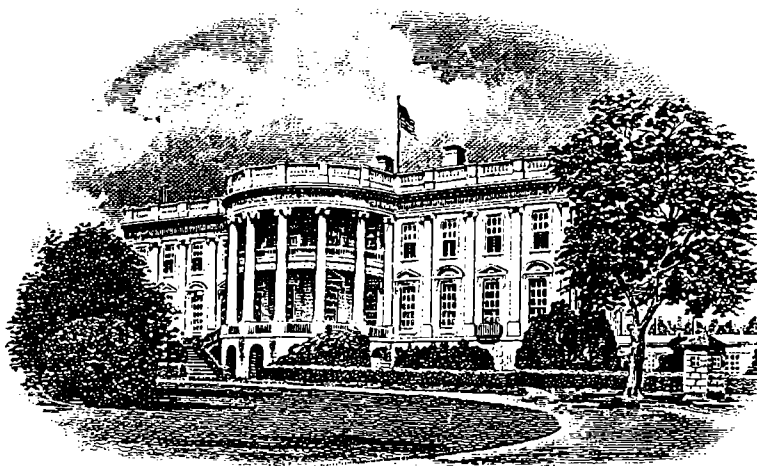
James F. Decker
Acting Director
Office of Energy Research

cc:
Ms. Kathleen A. McGinty, Director
White House Office on
Environmental Policy

OFFICE ON ENVIRONMENTAL POLICY

TO: Math Delao
FROM: Trey Lindseth
DATE: _____
FAX: 228-3954
Number of pages including cover: 3

COMMENTS: Here is DOE's response
to our request for their input.
Trey



PHONE - (202) 456-6224 FAX - (202) 456-2710
ROOM 360 OLD EXECUTIVE OFFICE BUILDING
WASHINGTON, DC 20501

FYI
MEMORANDUM
OF CALL

Previous editions usable

TO: Katie - Trey I put this on

☐ YOU WERE CALLED BY- Matl Delao ☐ YOU WERE VISITED BY Km's

OF (Organization) Sen Feinstein call select

☐ PLEASE PHONE 224-9624 ☐ FTS ☐ AUTOVON 20

☐ WILL CALL AGAIN 228-3954 ☐ IS WAITING TO SEE YOU MM

☐ RETURNED YOUR CALL 228-3954 ☐ WISHES AN APPOINTMENT

MESSAGE

re: on behalf
 of Glen Seborg

Sen. Aggravated that our office
 sent a general letter to him. He
 is a very well respected scientist in
 CA. He wrote requesting a review of
 a science project

RECEIVED BY <u>Shelley Cohen</u>	DATE <u>7/29</u>	TIME <u>11:50</u>
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July 6, 1993

Ms. Joan Hobin
Corporate Secretary
Advanced Physics Corporation
680 University Tower
4199 Campus Drive
Irvine, CA 92715

Dear Ms. Hobin:

Thank you for contacting my office again. I appreciate hearing from you.

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With regard to your particular concerns, my staff has read and kept on file Dr. Seaborg's White Paper on New Fusion Energy Option: Nonradioactive Fuel Fusion. As you may know, I have met on several occasions with supporters of Dr. Seaborg and appreciate all his pioneering work.

However, as I'm sure you can understand, my staff of 9 does not have the technical expertise to comment on Dr. Seaborg's work. Therefore, I have asked the Department of Energy to review the White Paper as well.

Again, thank you for sharing this information with me.

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Kathleen A. McGinty
Director, White House Office on
Environmental Policy

KAM/avl

OFFICE ON ENVIRONMENTAL POLICY

KATHLEEN A. McGINTY

DIRECTOR AND DEPUTY ASSISTANT TO THE PRESIDENT

TO:

Math Delao

FROM:

Wey Lindseth

DATE:

8-2

FAX:

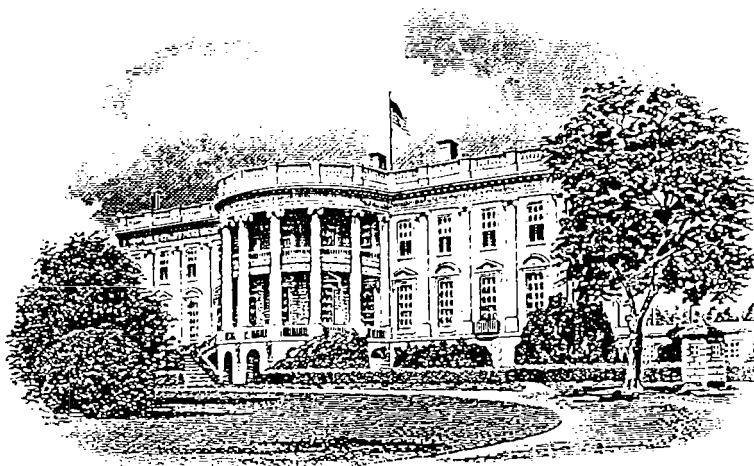
228-3954

Number of pages including cover:

2

COMMENTS:

Attached is copy of correspondence
to Ms. Hobie, an associate of Dr.
Seaborg.



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WASHINGTON, DC 20501

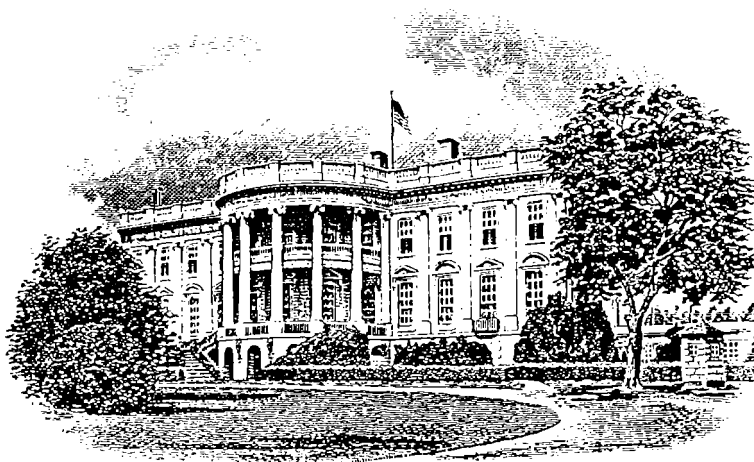
OFFICE ON ENVIRONMENTAL POLICY

KATHLEEN A. McGINTY
DIRECTOR AND DEPUTY ASSISTANT TO THE PRESIDENT

TO: Jim Cesanek
FROM: Keith Laughlin
DATE: 8/2
FAX: 586-7757

Number of pages including cover: 9

COMMENTS: _____



PHONE - (202) 456-6224 FAX - (202) 456-2710
ROOM 360 OLD EXECUTIVE OFFICE BUILDING
WASHINGTON, DC 20501

THE WHITE HOUSE

WASHINGTON

July 6, 1993

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Corporate Secretary
Advanced Physics Corporation
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Irvine, CA 92715

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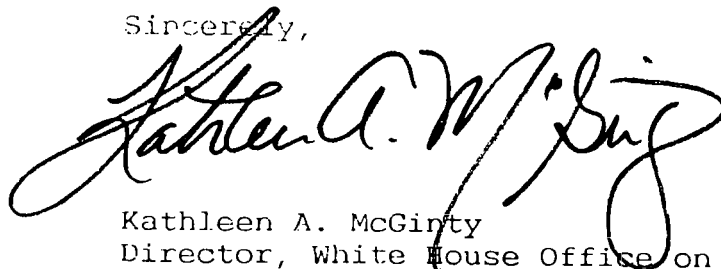
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Kathleen A. McGinty
Director, White House Office on
Environmental Policy

KAM/avl



Department of Energy

Washington, DC 20585

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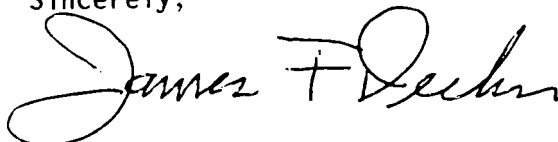
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James F. Decker
Acting Director
Office of Energy Research

cc:
Ms. Kathleen A. McGinty, Director
White House Office on
Environmental Policy

THE WHITE HOUSE

WASHINGTON

July 6, 1993

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Corporate Secretary
Advanced Physics Corporation
680 University Tower
4199 Campus Drive
Irvine, CA 92715

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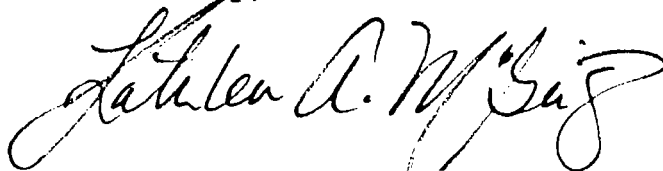
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A handwritten signature in dark ink, appearing to read 'Kathleen A. McGinty', written in a cursive style.

Kathleen A. McGinty
Director, White House Office on
Environmental Policy

KAM/avl

Advanced Physics Corporation

680 University Tower
4199 Campus Drive
Irvine, California 92715
Telephone: 714-854-6919
Fax #: 714-854-3065

May 17, 1993

Ms. Kathleen A. McGinty
Director, Office on Environmental Policy
The White House
Washington D.C. 20515

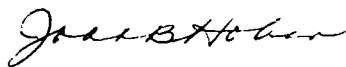
Dear Ms. McGinty:

We at Advanced Physics Corporation are appalled at the lack of homework done by your staff in regards to the letter of February 17, 1993 by Dr. Glenn T. Seaborg. Certainly Dr. Seaborg, Head of the Atomic Energy Commission under three presidents, Nobel Laureate, Director of Lawrence Berkeley Laboratory and, without question, the most important U.S. scientist alive today, deserves something more than a FORM letter. See attached correspondence of May 5, 1993.

*Harry
Hamlin
info*

Perhaps a second response is in order.

Yours truly,
Advanced Physics Corporation by



Joan B. Hobin
Corporate Secretary

cc: Senator Diane Feinstein
Senator Barbara Boxer
Congressman Christopher Cox

S.A.F.E. University-Industry Research Consortium

Advanced Physics Corporation — Industry Lead Member

Consortium Members - USA

Advanced Physics Corp.
Industrial Lead Member

Univ. of California at Irvine
Academic Lead Member

Advanced Reactor Group
Prof. L. L. Lidsky
Dept. of Nuclear Engineering
Mass. Inst. of Technology

Guilford Transportation Inds., Inc.
Merrimack, N.H.

General Electric Corp. R&D Center
Schenectady, N.Y.

Maxwell Laboratories, Inc.
San Diego, CA

Consortium Members - Russia

Institute for Technical Physics
Chelyabinsk-70, Lead Member

Russian Academy of Science
Ural Division, Yekaterinburg

Institute of Electrophysics
Ekaterinburg

High Current Electronics Institute
Tomsk

Kurchatov Atomic Energy Institute
Moscow

Budker Nuclear Physics Institute
Novosibirsk

Institute for Theoretical and
Experimental Physics
Moscow

Directors

Glenn T. Seaborg, Nobel Laureate
Chairman

Bogdan C. Maglich
President and Chief Scientist

Murray Gell-Mann, Nobel Laureate

Buzz Aldrin, Apollo 11 Astronaut

Harry Hamlin
Actor & Environmentalist

Ken Boxley, Publisher,
Philanthropist, Los Angeles

Marilyn Chandler Stuart, Urban
Planning Executive, Los Angeles

Edgar Appleby, Lawyer, New York

David Bird, Economist, Boston

Alec Trembley, Banker, Phoenix

Harb Alzuhair, Industrialist
Saudi Arabia

Scientific Board

Prof. Keith Brueckner
UC San Diego, (ret.)

Dr. Albert Ghiorso
Lawrence Berkeley Laboratory, (ret.)

Acad. Gennady A. Mesyats
VP Russian Academy of Science,
Moscow

Prof. N. Rostoker, UC Irvine

Prof. Liu Chen, UC Irvine

Prof. Martin Deutsch, MIT, (ret.)

Prof. Russell Kulsrud, Princeton U

Prof. Bruno Coppi, MIT

Honorable
Bill Clinton
President of the United States
The White House
Washington, DC 20500

February 17, 1993

Dear Mr. President:

I am taking the liberty of enclosing with this letter, for your personal attention, the *White Paper on New Fusion Energy Option: Nonradioactive Fuel Fusion*.

Since 1982, I have actively followed, encouraged and supported — as much as my time and other obligations allowed — this pioneering work of a small group of scientists carried out independently on the East and West Coasts of the US. The progress made within the past years makes it "an idea whose time has come." Although not without risk, a successful completion of the final (5th) stage of this research (which can be decided only with laboratory tests, not by computations) could have a major impact on the national economy, the environment, oil independence and non-proliferation efforts. Most (91%) of this research was privately funded. It is felt that this final stage of research ought to be funded by the government.

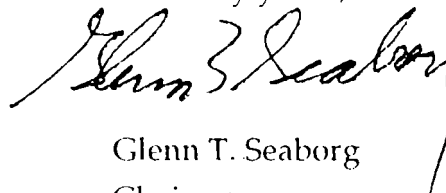
In early April, scientific and environmental spokesmen for this project will testify before George Brown's House Committee on Science, Space and Technology and Tom Beville's Subcommittee on Energy and Water Appropriations.

I commend this enthusiastic and deserving group of forward-thinking Americans and hope you can receive them during this period.

Thank you very much.

With best wishes for a successful first term,

Cordially yours,



Glenn T. Seaborg
Chairman

BCM:rc

Enclosures

680 University Tower • 4199 Campus Drive • Irvine, California 92715
Telephone: 714-854-6919 • Fax #: 714-854-3065

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S.A.F.E. University-Industry Research Consortium

Advanced Physics Corporation — Industry Lead Member

February 17, 1993

Consortium Members - USA

Advanced Physics Corp.
Industrial Lead Member

Univ. of California at Irvine
Academic Lead Member

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Chelyabinsk-70, Lead Member

Russian Academy of Science
Ural Division, Yekaterinburg

Institute of Electrophysics
Ekaterinburg

High Current Electronics Institute
Tomsk

Kurchatov Atomic Energy Institute
Moscow

Budker Nuclear Physics Institute
Novosibirsk

Institute for Theoretical and
Experimental Physics
Moscow

Directors

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Chairman

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Prof. Martin Deutsch, MIT, (ret.)

Prof. Russell Kulsrud, Princeton U.

Prof. Bruno Coppi, MIT

TO: The President of the United States of America
The Congress of the United States of America

WHITE PAPER

ON

NEW FUSION ENERGY OPTION: NONRADIOACTIVE-FUEL FUSION

In the five-year period, 1988-1992, scientific foundations have emerged for a new nuclear fusion energy technology whose successful completion will have a major impact on the national and world economy. It would also have a major impact on the reduction of global warming. Unlike conventional fusion, it is based on nonradioactive fuel, helium-3, and on a compact, modular power plant; and — because it does not produce significant neutron radiation — it cannot breed or proliferate nuclear weapons. The nonradioactive-fuel fusion technology would be cost effective as either an electric power plant or as a mobile power plant, and is environmentally safe. Helium-3 fuel is terrestrially available and can be manufactured from sea water.

Six major Russian nuclear centers, including the weapons laboratory Chelyabinsk-70, are participating in the project.

"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," wrote Glenn T. Seaborg, Nobel Laureate pioneer of peaceful nuclear technology and Ambassador Paul H. Nitze, arms control adviser to every President from Harry Truman to Ronald Reagan (*New York Times*, 11/23/91). The helium-3 fusion cycle "would change the entire energy picture," according to a panel of experts co-chaired by Dr. John Foster, Chairman of the DOD's Science Board, and Nobel Laureate physicist Berton Richter

S.A.F.E. System for Aneutronic Fusion Energy
680 University Tower • 4199 Campus Drive • Irvine, California 92715
Telephone: 714-854-6919 • Fax #: 714-854-3065

(1978). Because the devices are small, it could be tested on a time scale of 3-5 years and, if successful, become commercially available 5-10 years thereafter, depending on the plant size. The entire program would cost \$100 million/5 years.

Is "exclusively peaceful" nuclear energy possible?

The United States has made no effort thus far to develop an **exclusively peaceful** nuclear energy technology. For reasons more historical and institutional than scientific and technical, our nation has been developing as nuclear energy sources chiefly those concepts and technologies which have first served military purposes or were derived from them. The pressurized light fission reactor is an adaptation of the first nuclear submarine reactor. The present US Department of Energy fusion research programs are based on the fuels and concepts of the hydrogen bomb — a fact reflected in the popular slogan "Taming the H-bomb." Both present fission reactors and the planned fusion reactors could be used to breed plutonium and tritium for nuclear weapons.

The USA-Russian Industry-University Research Consortium S.A.F.E. System for Aneutronic Fusion Energy proposes to show that the time has come for a concerted research and development effort toward **second-generation fusion energy** that has been conceived with **purely peaceful purposes, people's needs and market demands** in minds.

The helium-3 fueled fusion processes —

- burn **nonradioactive fuel** — helium-3, rather than radioactive tritium;
- emit **negligible neutron radiation** — 1% or less of that produced by fission and other fusion reactors — thus called **aneutronic**;
- **cannot breed or proliferate nuclear weapons**;
- produce **minimal heat pollution (waste heat)** — at most, 50% of that produced by any other fuel-powered energy generator. This is because the helium-3 reaction releases energy in the form of **electrically charged atomic nuclei** rather than neutron radiation which opens the way for **electric power generation by direct conversion of nuclear energy into electricity**.

The difficulty that long faced nonradioactive-fuel fusion was that the helium-3 reactor requires 10 times the temperature needed for conventional fusion (1 billion as opposed to 100 million degrees centigrade). A solution to this problem came, unexpectedly, from another field, High Energy Particle Physics. It was shown that the **ultra-high temperatures** needed to ignite helium-3 based-fuel can be reached relatively easily without heating, by firing atomic nuclei head-on against each other like in the particle colliders.

Major scientific advances within past 5 years

A series of investigations, carried out in the period 1988-1992, by over 200 scientists worldwide — reported in over 100 scientific papers and technical reports and in six international conferences — indicate a high probability, if not certainty, that an **entirely novel class of fusion reactors is possible**. Known as **self-colliders**, they are based on an adaptation and miniaturization of the technologies of accelerators and colliders.

Self-colliders —

- have achieved 100 times hotter fuel than the orthodox fusion systems based on plasma heating. Temperatures of over 1 billion degrees have been

routinely achieved in the laboratory models since 1985. The January 18, 1993 issue of *The Physical Review Letters*, a journal of the American Physical Society for important communications, reports measurement of fusion fuel kinetic temperature of 10 billion degrees centigrade in a small (150 cc) test "self-collider" reactor;

- can be made compact. *The Physical Review Letters*, in its March 22, 1993 issue, will publish a joint study from the University of California at Irvine and at Riverside, the Naval Research Laboratory and two California R&D companies that dispels the 30-year old tenet that fusion reactors must be large. They present the measurements in tokamaks and theory for a small self-collider reactor. Similar conclusions were presented in the October 1992 issue of *Comments on Plasma Physics and Controlled Fusion*;
- are intrinsically stable because they use directed and focused rather than randomly moving fuel atoms. Scientists from the Institute for Fusion Studies at the University of Texas presented the theory of stability of the focused self-collider in 1990;
- can have self-sustained burn, i.e. be "ignited," contrary to previous beliefs — and emit less than 1% energy in neutron radiation. These results, obtained from the USAF supercomputer simulations in 1989, were declassified in August 1992. From the design for an aneutronic helium-3 space power plant made by Bechtel National, Inc. for USAF, it can be projected that nonradioactive-fuel self-collider reactors could have 100 times greater power-to-weight ratio than any planned aerospace power plant.

Fuel availability (helium-3) and low cost of power

- Large probable terrestrial reserves of helium-3 fuel in the earth's mantle have been revealed that could supply the world's electricity for 10,000 years. According to the Woods Hole Oceanographic Institution, the sea water samples from deep ocean (2,500 m) hydro-thermal vents are 1000 times enriched in helium-3.
- Helium-3 breeding from heavy water (deuterium) using self-colliders at a cost of 5% of the present cost of fission reactor-produced tritium was reported at an American Nuclear Society international conference in 1989.

The nonradioactive fuel has —

- the potential to produce energy at the equivalent of \$6 per barrel of crude oil;
- the potential to produce ten times more energy per gram of helium-3 than is generated per gram of uranium in a conventional nuclear power plant;

In July 1991, the American Physical Society's quarterly *Physics and Society* carried a debate on nonradioactive *versus* radioactive fuel fusion. Even the pro-radioactive fuel side of the debate stated that helium-3 would be the ultimate fuel. An MIT nuclear engineering study has shown that nonradioactive fusion fuel cannot burn efficiently in the conventional fusion reactor (1982). An analogy would be a low compression car engine, which cannot economically burn high-octane gasoline. Self-colliders could have sufficiently large fuel compression and sufficiently high temperature — billions of degrees — to burn helium-3 fuel.

Russian participation

Helium-3 self-collider reactor studies are being pursued jointly through a Research Consortium by six American and six Russian research institutes (see left margin on p.1). One hundred Russian scientists and 100 technical assistants are to participate in the project. The Russian lead member of the Consortium is the weapons laboratory Chelyabinsk-70, where 42 scientists have decided to switch to this peaceful research. The leader of the Russian side is Chelyabinsk's director, Academician E. N. Avrorin.

On April 16, 1992, Academician N. G. Malishev, Science Advisor to President Yeltsin, informed his American counterpart Dr. D. Allan Bromley and Rep. George Brown, Chairman of the Science, Space and Technology Committee of the House of Representatives:

"that the Government of Russian Federation supports the pursuit of an alternative approach to fusion and specifically this project. Fusion experts from several leading Russian and USA institutes have concluded that, while not without risk, the aneutronic concepts are scientifically sound. These concepts involve modestly sized devices and short experimental time scales, and should therefore be tested in both countries... Such a program would also help in the transfer of defense oriented pulsed power technology to civilian application."

An environmentally acceptable nuclear fusion option

The main critique of nuclear energy on the part of the environmentalist movement is that there can be no exclusively peaceful nuclear power; every nuclear generator is either a spin-off of nuclear weapons, or can be converted into a weapon, or can breed nuclear weapons. Helium-3 based fusion in self-collider dispels this tenet.

Conventional fusion has been investigated for commercial use by the ultimate users, the utility industry. Because of the radioactive fuel, radioactive waste and proliferation potential, it was not considered acceptable for public use. The gigantic size and engineering problems make the economics doubtful. None of these concerns exist with helium-3 self-collider fusion; it is the only environmentally acceptable fusion option.

Because an aneutronic self-collider power plant can either be small, large, or modular, and is ecologically acceptable, it has a great variety of potential applications:

- **terrestrial electric power plants of many kinds**
- **aerospace power plants (planes, space labs, space power plants)**
- **nautical propulsion plants (ships and submarines)**
- **railroad locomotive power plants**
- **energy-economic production of hydrogen for a hydrogen economy.**
- **Power stations can be made large or small. As a result, the pattern of power distribution will change. Local stations for peak load will become possible. Costly power transmission can be reduced. A separate and independent power plant for a large building or block of houses will make consumers independent of the major power grid — and the country less vulnerable to both natural disasters and international terrorism. In short, helium-3 fusion will decentralize power generation.**

Status of research

The research on helium-3 fusion has progressed to the point that only one more laboratory test may be sufficient to demonstrate net energy production (DEP). Advanced Physics Corporation (APC), the lead company of the consortium S.A.F.E., has developed the "self-collider" to this point with \$28 million (1992 dollars), 91% of which is private money invested over 20 years and 9% USAF (1985-1988); UCI has spent \$10 million/10 years. The scientific principles have been validated in four laboratory models. Adequate fuel temperatures and confinement times for aneutronic fusion have been achieved. Self-collider has met 9 out of 10 requirements for an economically, environmentally and societally acceptable power source; (see table below).

Requirements for Nonradioactive Fusion Reactor

Requirement	Requirement met?	
	Self-collider	Conventional fusion
1. Low cost	yes	no
2. Nonradioactive fuel	yes	no
3. Nonradioactive waste	yes	no
4. Ultra-high fuel temperature	yes	no
5. Fuel confinement time	yes	almost
6. High fuel density	no	almost
7. Compactness	yes	no
8. Minimal heat pollution	yes	no
9. Terrestrial reserves of fuel	yes	no
10. Weapons proliferation resistant	yes	no

The only requirement not met by the self-collider technology is the fuel density. Over the past 20 years, the fuel in self-colliders has been compressed 100 million-fold. Another 1,000 fold fuel compression is needed. To accomplish this, S.A.F.E. is seeking funds of \$30 million over a period of 3 years from US-DOE matched by private sources. The entire 5-year program using 6 different methods proposed by APC to DOE is \$50 million/5 years.

Energy Policy Act of 1992: Broadly Based Fusion Energy Program Mandated

The Energy Policy Act of 1992 (Public Law 102-486 of 10/24/92) sets forth a fusion energy 5-year program. The first fusion goal under the Law is "a broad based fusion energy program." The law also gives priority to environmentally clean energy technologies and to programs in which private industry participates 20% or more. Federally funded research has been confined to the same radioactive fuels used in thermonuclear weapons.

The current DOE radioactive fuel program has reserved only \$500,000 out of the \$340 million, or 0.1%, of the fusion budget for the nonradioactive energy option. The DOE's "mainline" fusion program, based on the radioactive fuel tritium, began in 1975, and the "demo" date is set for 2025. This implies a virtual exclusion of new ideas on nonradioactive-fuel based systems for 58 years, i.e. for almost three generations of American inventors.

A nonradioactive-fuel fusion program would involve a modest cost. The cost of equipment is in the \$3-5 million range, and the cost of an entire scientific test is in the \$10 million/3 years range. This would allow for broad participation of the nation's

scientific talent from the industrial and academic communities. It would cap 19 years of research and development in which the Federal Government has been a minor partner. It seeks not to establish an open-ended research program, but to demonstrate the actual production of electric power. While it is not without risk, the ramifications of success are considerable.

The President and the Congress need to act now

- to make a historical departure from the nation's military-spinoff nuclear energy orientation and to launch research and development toward second-generation fusion energy that has been conceived with purely peaceful purposes, consumer and market demands in mind; and
- to implement a small scale, practical demonstration of helium-3 fusion energy generation on the power grid of a leading public utility.

Development of environmentally, politically and economically acceptable power sources like the nonradioactive-fuel self-collider reactor is a task of vital national interest. It would provide industrial and economic opportunities to the USA of virtually unlimited proportions. It warrants a well-balanced program and the kind of serious support only presently directed to defense because, like defense, it has to do with our survival. In order to stimulate research in nonradioactive-fuel fusion and to take advantage of the great opportunity it presents without delay, we propose that

- THE DOE ESTABLISH A NEW "OFFICE OF NONRADIOACTIVE-FUEL FUSION ENERGY" (ONFFE);
- GREATER CONSIDERATION BE GIVEN TO
 - COMPACT REACTOR CONCEPTS THAT COULD BE TESTED IN GO-NO-GO EXPERIMENTS ON THE USUAL PHYSICS RESEARCH TIME SCALE OF 3-5 YEARS, AND
 - RESEARCH WITH FINANCIAL PARTICIPATION FROM THE PRIVATE SECTOR OF 20% OR MORE.