EXECUTIVE NEWSLETTER

JANUARY 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

RUTHERFORD AND ZIMMERMAN WIN LAWRENCE AWARD

The U.S. Department of Energy has announced that fusion scientists Paul Rutherford and George Zimmerman will be two of five recipients of the 1983 Ernest Orlando Lawrence Award. Rutherford is Associate Director of the Princeton Plasma Physics Laboratory. Zimmerman is Associate Director of X Division at Lawrence Livermore National Laboratory. The Award consists of a medal, a citation and $5,000. Rutherford was cited for "his outstanding contributions to the basic theory of plasma confinement and to the toroidal fusion reactor concept." Zimmerman was cited for innovative calculations resulting in the incorporation of complex physical phenomena into computer codes for inertial confinement fusion. Fusion scientists who have received the Lawrence Award in previous years include John Emmett, Grant Logan, Harold Furth, John Nuckolls and Marshall Rosenbluth. The awards will be presented at a ceremony to be held in the U.S. DOE Forrestal Bldg., Washington, D.C. on February 15.

LAWRENCE AWARD WINNER PAUL RUTHERFORD

ERAB FUSION PANEL READIES REPORT

The DOE Energy Research Advisory Board's Technical Panel on Magnetic Fusion, chaired by ERAB chairman Lou Roddis, is putting the finishing touches on its report. A meeting of the panel has been tentatively scheduled for January 17 in Washington, but will only be held if the editing job cannot be completed by mail and phone. The report will be discussed again with the full ERAB at its regularly scheduled meeting February 2-3 in Washington. Chairman Lou Roddis told us that there were no substantive changes in the panel's conclusions from those we reported in our September newsletter. The panel has concluded that a new facility is essential if fusion development is to proceed in an orderly fashion. They believe that we must proceed now to create conditions in which the plasma ignites and burns for several minutes and that none of the machines presently operating or under construction throughout the world can reach these critical experimental conditions.

Acceptance of the panel's recommendations by DOE, OSTP, and OMB would require a change in the administration's fusion policy which supports fusion research that can be done on existing facilities. The administration's resistance to new fusion facilities stems in part from fear of future budget requirements and in part from a philosophical stance that views fusion development as "not urgent."

The priority attached by the fusion community to starting a major new fusion construction project has been evolving. A year ago such a project was viewed as only being justified if additional funds were added to the fusion budget. During the MFAC process, a position emerged (see our October newsletter) which urged the adoption of "a new program strategy" based upon the "initiation in FY 86 of the Tokamak Fusion Core Experiment (TFCX)." According

to MFAC the "priority for this project is second only to maintenance of a vigorous base program." MFAC, OFE and PPPL were unanimous in their (new) view that a substantial contribution to the cost of TFCX could be made from within the base program so that, according to MFAC, the program would require only "a budget that ramps up over a period of several years to a new budget level 25-40 percent above the present level in constant dollars."

The forthcoming ERAB fusion panel report is expected to recommend reversing the order of MFAC's priorities, raising the priority of a new machine (which they call BCX for Burning Core Experiment) to first priority, i.e., above that of the so-called "base program." The November 3 draft of the panel's report states "the Panel would recommend commitment to BCX even under the constraint of a constant fusion program budget in real terms over the next several years." The panel notes that funding requirements for the new machine would not peak until late in the decade or early in the 1990's in any case.

OFE fusion director John Clarke seems inclined toward the ERAB panel's approach. But whether he can convince the administration to back a new fusion facility is problematical.

TFTR EXTENDS RECORD CONFINEMENT

Experiments on TFTR continue to set new records for plasma confinement. Recent experiments have reached about 0.3 seconds for the energy confinement time, approximately double the previous record also set in TFTR (see our August newsletter). The new record was achieved at a density of approximately 2.7 x $10^{13}cm^{-3}$ with a plasma current of about 1 MA. The plasma temperature was approximately 1 keV. The first application of auxiliary heating to the TFTR plasma is currently scheduled to begin in the summer of 1984. Meanwhile, the Joint European Torus (JET) in England is in initial operation and community sources indicate that they are routinely running at plasma currents of 2-3 MA in 10 second pulses. JET sources have not yet quoted confinement times achieved but they are expected to be comparable to those achieved in TFTR.

MCDONNELL DOUGLAS WINS TFTR JOB

McDonnell Douglas Corporation has recieved a $9 million contract to build the inner protective armor for the Tokamak Fusion Test Reactor (TFTR) at the Princeton Plasma Physics Laboratory. The armor will consist of 2,400 individually contoured graphite tiles attached to a water-cooled metal plate structure. It is designed to protect the stainless steel reactor walls from contact with the high temperature fusion plasma. The tiles are double-contoured to accommodate the reactor's toroidal or doughnut-shaped vacuum vessel. Computer aided design and manufacturing will be used to meet a December 1984 delivery schedule. McDonnell Douglas is one of the founding corporate members of Fusion Power Associates.

FPA SETS ANNUAL MEETING DATES

Fusion Power Associates will hold its annual meeting and symposium April 2-3 in Livermore, CA. The theme of the meeting will be "Fusion Power Development--The Next Decade" and will emphasize the status and needs of nuclear technology development for future fusion reactors. Details of the meeting will be provided in a separate mailing in the near future.

ELLIS RECEIVES DOE BRONZE MEDAL

The U.S. Department of Energy has awarded Dr. William R. Ellis its Exceptional Service Award. The award consists of a bronze medal and citation. The citation commends Bill "for his initiative and diplomacy which have led to worldwide recognition of key technical issues and have resulted in more efficient utilization of international mirror research efforts."

SECOND PRINTING FOR NUCLEAR POWER: BOTH SIDES

W.W. Norton & Co. Inc. (New York) has announced that the book Nuclear Power: Both Sides has gone into a second hardcover printing and is now also available in paperback. The book, edited by M. Kaku and J. Trainer, contains twenty-one essays on all sides of the nuclear controversy, including a chapter on fusion by FPA president Steve Dean.

MARTIN MARIETTA TO RUN OAK RIDGE

The DOE has awarded Martin Marietta Corp. the responsibility to manage its facilities in Tennessee and Kentucky, including the Oak Ridge National Laboratory and various uranium enrichment and weapons fabrication plants. The facilities include that part of the DOE magnetic fusion program which is located in

Oak Ridge, including the Fusion Engineering Design Center, the Large Coil Test Facility, tokamak, stellarator, and EBT research programs and heating and materials technology programs.

DOE SETS EBT REVIEW

DOE, at the request of ORNL, is convening the EBT Senior Review Panel (see our March 1983 newsletter) to consider ORNL's request to shut down the present EBT-S device and convert it to a "square." Previously DOE and ORNL had established next fall as the date for evaluating the future of EBT. The ORNL proposal stems from ORNL's assessment that they cannot reach the agreed upon milestones in the present EBT-S device, that the traditional EBT configuration (toroidal array of magnetic mirrors) does not scale to an attractive reactor and their view that a "square" configuration represents the best near-term alternative to investigate more attractive configurations (see our August newsletter).

MUON-CATALYZED FUSION WORKSHOP SCHEDULED

EG&G Idaho, Inc. will sponsor a workshop on muon-catalyzed fusion reactions June 7-8, 1984, in Jackson, Wyoming. This is the first in what is hoped to be a continuing series of workshops in this recently rejuvenated field (see our August newsletter). Muon catalysis occurs when the electron binding a deuterium-tritium hydrogen molecule is replaced by an artificially-created muon. Idaho and Los Alamos scientists recently demonstrated the production of 70 such fusion reactions by each muon during its microsecond lifetime. Topics to be discussed at the workshop, which will be held at the Americana Snow King Resort, include mesomolecular formation rates, muon exchange rates, hyperfine effects, α -sticking fractions and fusion rates. Jackson, Wyoming is at the entrance to Grand Teton and Yellowstone National Parks. Information on the workshop can be obtained from Dr. Steven E. Jones, TSB#4, Idaho National Engineering Laboratory, EG&G Idaho, Inc., P.O. Box 1625, Idhao Falls, ID, 83415, (208) 526-0119, FTS 583-0119.

PEOPLE

David E. Baldwin has been named deputy associate director for magnetic fusion at the Lawrence Livermore National Laboratory. Dave, a long-time leader of the magnetic mirror theory effort, succeeds Bob Borchers as principal deputy to LLNL magnetic fusion leader Ken Fowler.

NEWLY APPOINTED MAGNETIC FUSION PROGRAM DEPUTY DAVE BALDWIN (r) TALKING SHOP WITH TRW FUSION DIRECTOR PETE STAUDHAMMER.

Harold K. Forsen has been named Manager, Advanced Systems Department, Bechtel National, Inc. He was previously Manager, Engineering and Materials, Bechtel Group, Inc. He can be reached at Bechtel National, Inc., P.O. Box 3965, San Francisco, CA, 94119, (415) 768-6020. Harold is also vice-chairman of Fusion Power Associates Board of Directors.

Edwin E. Kintner has been named Executive Vice President of GPU Nuclear Corp. He succeeds Phillip Clark who was named president of GPU Nuclear following the resignation of the previous president, R. C. Arnold. Kintner is a former director of the U.S. magnetic fusion program and was the recipient of Fusion Power Associates' 1981 Leadership Award. Ed can be reached at (201) 265-6155.

Bruce Twining has been appointed Assistant Manager for Energy Research and Technology at the U.S. DOE's San Francisco Operations Office. Bruce was DOE's on-site manager for the construction of the Mirror Fusion Test Facility at LLNL and had previously worked in the Development and Technology Division of the Office of Fusion Energy, DOE, in Washington.

John Marcum and Doug Pewitt have left the White House Office of Science and Technology Policy (OSTP). They were deputies to presidential science advisor Jay Keyworth. Marcum is now Director for Science, Technology and Industry at OECD in Paris.

OMB fusion budget examiner Tom Price will transfer from the Office of Management and Budget to OSTP, within the White House Executive Offices of the President. Tom will assist in the development of general science and energy policy.

IN MEMORIAM

The fusion community is saddened to learn of the death of Renate Sleeper, wife of fusion scientist Arthur Sleeper. Art and Renate's many friends have empathized with them during her long bout with cancer, as they traveled and tried many treatments over the last ten years. Their hopes and dreams alternately have risen and fallen. Their zest for life, combined with their courage and love, was a source of inspiration to all of us. Expressions of sympathy may be sent to Art at 3026 Award Row, San Diego, CA, 92122.

MEETINGS

January 16-20 IAEA meeting on Large Tokamaks, at PPPL. Contact Bob Ellis (609) 683-3302.

January 17 Possible ERAB Magnetic Fusion Panel Meeting. DOE Forrestal Bldg., D.C. Contact Tom Kuehn (202) 252-5444.

February 9-10 Magnetic Fusion Advisory Committee (MFAC) public meeting. At GA Technologies, San Diego, CA. Contact John Cowles (301) 353-3598.

February 26-29 Atomic Industrial Forum Conference on Industry's Role in Development of Fusion Power. Mayflower Hotel, Washington, D. C. Registration Fee. Contact Frank Graham (301) 654-9260.

March 21-28 Symposium on Heating in Toroidal Plasmas. Rome. Contact H. Knoepfel, ENEA-Energy Research Center, C.P. 65, 00044 Frascati, Italy. Telex 680492 ENEAFRI. Tel. (06) 9421041.

March 29-30 Topical Conference on Dense Z Pinches for Fusion. Sponsored by U.S. Naval Research Laboratory. Old Town Holiday Inn, Alexandria, VA. Contact John D. Sethian (202) 767-2705.

April 2-3 Fusion Power Associates Annual Meeting and Symposium, "Fusion Power Development--The Next Decade". Livermore, CA. Contact Ruth Watkins (301) 258-0545.

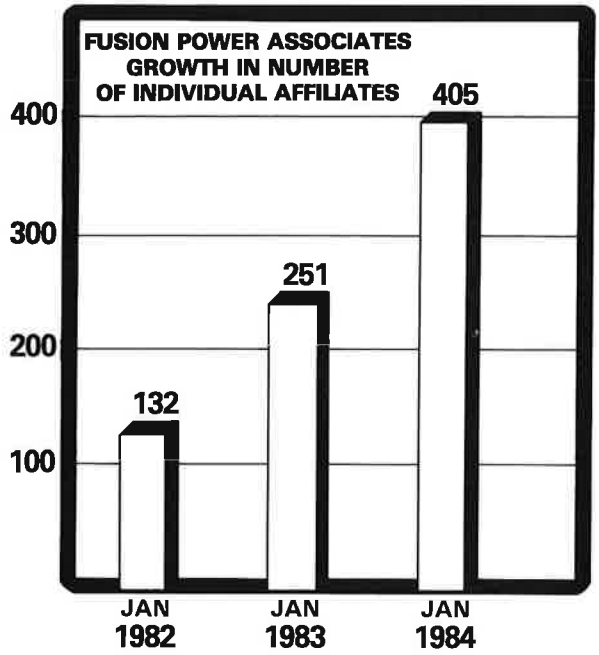
EXECUTIVE NEWSLETTER

FEBRUARY 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545



GROWTH IN INDIVIDUAL AFFILIATES

We are pleased in the growing interest shown by individuals in becoming affiliated with Fusion Power Associates. As the accompanying graph shows, we now have approximately 400 individual affiliates. We very much appreciate your support.

TSONGAS TO LEAVE U.S. SENATE

Senator Paul Tsongas of Massachusetts has announced his intention not to seek reelection in the fall due to health problems. With his departure the fusion community will lose a thoughtful and effective supporter in the U.S. Senate. Senator Tsongas was the principal sponsor in the Senate of the Magnetic Fusion Energy Engineering Act of 1980 and was a recipient of Fusion Power Associates' Leadership Award for that year. We wish him a successful recovery. We have very much appreciated his interest in our programs and will miss him after his term expires at the end of the year.

FUSION FY 85 BUDGET REQUESTS

The Administration has submitted the following FY 85 fusion budget requests to Congress.

	FY 84	FY 85
Magnetic Fusion		
Operations	$396.5	$417.2
Equipment	37.8	33.4
Construction	36.5	32.5
Total	$470.8	$483.1
Inertial Fusion		
Operations	$145.0	$125.0
Equipment	11.8	9.5
Construction	12.9	3.5
Total	$169.7	$138.0

SUPERCONDUCTING TOKAMAKS ADVANCE

The world's first, and thus far only, tokamaks with superconducting magnets are under construction in France and in the USSR. Reports on construction progress of the two devices, named TORE-SUPRA and T-15, respectively, were given in a recent IAEA workshop at Princeton by R. Gravier of Fontenay-aux-Roses and by N. Semashko of the Kurchatov Institute. Completion of the two projects is expected in 1986. The projects will provide important physics and engineering data to complement the larger tokamaks like TFTR, JET and JT-60, which have limited pulse length capability due to having copper magnets. A comparison of the two devices is given below.

Superconducting Tokamaks

	TORE-SUPRA	T-15
Major Radius, m	2.42	2.43
Plasma Radius, m	0.7-0.83	0.7
Magnetic Field, Tesla	4.5	3.5-4.5
Number of Coils	18	24
Plasma Current, MA	1.7-2.5	1.4-2.3

WISCONSIN RECEIVING FOUNDATION GRANT

The Grainger Foundation of Skokie, Illinois, has given a $500,000 grant to the University of Wisconsin-Madison, Fusion Engineering Technology Program. The grant will be used to support students, initiate research projects and provide long-range fusion research funding for staff scientists. Use of the funds will be supervised by Nuclear Engineering Professor Gerald L. Kulcinski. David W. Grainger, president of the foundation, is a 1950 University of Wisconsin engineering graduate.

VELIKOV BECOMES FPA AFFILIATE

Dr. E. P. Velikov, vice chairman of the Soviet Academy of Sciences and leader of the fusion effort in the USSR, became an individual affiliate of Fusion Power Associates during a recent visit to the U.S. We welcome his participation.

ANSEL ADAMS BECOMES FPA AFFILIATE

Famous nature photographer Ansel Adams recently became an individual affiliate of Fusion Power Associates. Readers of our newsletter will recall (see our September newsletter) that Adams urged President Reagan to support the fusion program during a visit at the White House. We welcome his participation.

OSTP REORGANIZES

The deputy director and all four assistant directors of the Office of Science and Technology Policy at the White House have departed. The announcement by presidential science advisor George Keyworth also indicates the appointment of a fifth assistant director. The new deputy is John P. McTague, a physical chemist from Brookhaven and Columbia University.

Ralph M. DeVries, a nuclear physicist from Los Alamos, will oversee General Sciences. He succeeds N. Douglas Pewitt who has gone to Western Research Corp. in San Diego and Arlington, VA. Fusion will be reviewed in this directorate. DeVries taught at the Center for Nuclear Studies at Saclay, the University of Washington and the University of Rochester. He joined Los Alamos in 1978.

Richard G. Johnson, a physicist from Lockheed, will oversee Space Science and Technology.

James G. Ling will oversee Institutional Relations and Life Sciences.

Wallace R. Kornack, a mechanical engineer from DOE, will oversee Energy, Natural Resources and International Affairs. He replaces John Marcum.

Maurice A. Roesch III, a marine corps colonel on active duty, will oversee Defense Technology and Systems. He replaces Victor Reis who has joined Science Applications, Inc.

LANL DEDICATES LASER FUSION FACILITIES

Los Alamos National Laboratory dedicated two new inertial fusion facilities on January 20: the Antares carbon-dioxide laser system and the Target Fabrication Facility. Speakers at the dedication included Herman Roser, recently retired DOE Assistant Secretary for Defense Programs; Richard Schriever, Director, Office of Inertial Fusion, DOE; and Donald M. Kerr, Laboratory Director. Stephen D. Rockwood, Deputy Associate Director for Isotopes and Fusion at the laboratory was master of ceremonies.

Antares is the world's largest carbon-dioxide laser and was commissioned in 1975 at a cost of about $62 million. It is the fourth generation of high-power, short-pulse, carbon-dioxide lasers to be developed at Los Alamos, and is part of the national inertial fusion program, supported by the Department of Energy. It will be used to study the physics of thermonuclear weapons on a laboratory scale, and ultimately to provide a controllable source of thermonuclear power for commercial application.

The Target Fabrication Facility produces the tiny glass pellets, or microballoons, which will be filled with deuterium and tritium and used in the Antares experiments. Lasers are used to produce inertial fusion by compressing and heating the atoms of hydrogen held captive within the pellets. Mirrors focus the laser beams on the targets, collapsing the inner shell and compressing the fuel, causing the atoms to fuse.

EXECUTIVE NEWSLETTER

MARCH 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

FPA FINANCIAL STATUS

Fusion Power Associates' financial position as of December 31, 1983, and compared to 1982 and 1981 is as follows:

	1983	1982	1981
Income			
Research	$270,226	$446,716	$120,833
Fees and Dues	80,275	94,720	42,290
Other	17,723	13,125	37,102
Prior Year Carryover or (Deficit)	28,220	(3,360)	4,307
Total	$396,444	$551,201	$204,582
Expenses			
Research	271,169	446,773	127,787
Education	29,009	28,325	32,019
Administration	87,713	47,883	48,136
Total	$387,891	$522,981	$207,942

ADVISORY GROUPS SET IGNITION AS GOAL

Two senior advisory groups to the Department of Energy have recommended that the achievement of ignition should be pursued as the next major goal of fusion research. Ignition is the condition of plasma temperature, density and degree of confinement which permits the fusion energy released to self-sustain the fusion reaction. The Energy Research Advisory Board (ERAB) in a letter transmitting their report to Secretary of Energy Donald Paul Hodel, calls upon the department "to commit to building a Burning Core Experiment to explore ignition physics as a high priority in the fusion program." The letter further states "Under present budget restraints, it appears feasible to pursue this course within the present budget levels for several years, although additional funds will eventually be required to complete construction." Copies of the report, which has been published as DOE/S-0026, February 1984, can be obtained from Tom Kuehn at DOE (202) 252-5444.

Echoing the ERAB view, the DOE's Magnetic Fusion Advisory Committee (MFAC) in a letter to DOE Director of Energy Research Alvin W. Trivelpiece, states that a Tokamak Fusion Core Experiment (TFCX) "is the necessary next major step in the U.S. magnetic fusion program," and that "high priority should be given to TFCX and to the confinement and development and technology programs in support of that project." In addition, MFAC states "We recommend that DOE invite the fusion community to plan TFCX as a National Project organized around Laboratory, University and Industry teams."

ERAB, in its report, recommends that the Burning Core Experiment (BCX), "should specifically provide for future upgrades of the facility." "In addition," ERAB says, "the BCX should incorporate, as far as practicable, those component technologies and engineering design features that can serve as a focus for future reactor technologies."

Although Princeton Plasma Physics Laboratory is providing community leadership for the design of the new ignition experiment, the ERAB panel recommends that "locating the BCX experiment at a dedicated site that could be used for subsequent upgrades and other major experiments should be investigated."

INTERNATIONAL JOINT VENTURE RAISED AS ISSUE

In the letter to Secretary Hodel recommending a new ignition experiment, ERAB chairman Lou Roddis states that "The Board strongly urges that the United States vigorously seek bilateral or multilateral collaboration for the development, construction and operation of the proposed BCX. Such collaboration would permit more aggressive technological objectives and accelerate the time frame for proving the technological feasibility of

fusion for the benefit of all mankind. Such an international joint venture would have to be negotiated at the highest levels of government and provide a commitment of resources for the duration of this scientific enterprise. This effort we believe is deserving of your personal attention. However, to maintain credibility as a partner, the United States must also be prepared to proceed alone and should begin the planning and design of the BCX without delay."

The pursuit of a potential international joint venture raises programmatic and political issues which will be difficult to resolve and which have the potential to further delay this important next step project. A committee of the National Research Council has been reviewing this issue in general terms for several months (see our October 1983 newsletter). More specifically, however, recent fusion meetings with international participants indicate that European sentiment is to proceed with a much more ambitious project than is currently favored in the U.S. Although six preconceptual design options are currently being studied in the U.S., the designs are dominated by physics criteria and none seems to be capable of sufficient upgrade to address significant nuclear engineering test issues.

REACTOR ENGINEERING ISSUES

In its report, the ERAB panel states "Reactor engineering efforts must be postponed until resources are available. Under a constrained budget, technology and engineering component development must be focused on the next generation devices, with the exception of long-term generic problems such as materials." While appreciating the panel's desire to delineate program priorities, Fusion Power Associates president Steve Dean, in a speech to the AIF fusion conference February 27, indicated that he disagreed with the statement as phrased. The Board of Directors of Fusion Power Associates, in its recent statement of recommended policies, states "the engineering aspects of fusion development require substantial additional effort now." In his AIF speech, Dean stated, "Although physics programs clearly require the bulk of fusion program funding at this time, a clearly-established and well-maintained reactor engineering program is equally essential. It should be an objective of the fusion program to ensure balanced effort and good coordination among the various essential elements of the program, e.g., physics innovation, parameter demonstrations, technology development, systems analysis and reactor conceptual design." In testimony to the House Science and Technology Committee fusion hearing February 29, Dean expressed his dismay that DOE has not carried out an up-to-date tokamak fusion reactor design since the STARFIRE study was completed in 1980 and has also indicated its intent not to update the magnetic mirror reactor (MARS) design for several more years. The result is to give credence to critics who claim that current fusion activities are not leading in the direction of a competitive commercial product. Dean points out that the recent article by Larry Lidsky claiming that fusion, based on D-T fuel cycles, would not be competitive (see our November newsletter) was based almost wholly on reactor engineering issues. For the fusion program to focus its priorities on physics at the expense of addressing critical reactor engineering issues places the entire program, including the physics program, in jeopardy. "We must get our house in order on these reactor engineering issues at the earliest practical time as a justification for the level at which we wish to carry out this program," Dean said.

CPMP: RIP

The ERAB fusion panel made its views of the DOE's fusion "Comprehensive Program Management Plan" (CPMP) most explicit. Said ERAB, "the strategy implicit in the DOE Comprehensive Program Management Plan should not be followed" because "it imposes an unnecessary hiatus on the advancement of magnetic fusion and imposes an artificial schedule on the development of both mirror and tokamak programs, a schedule that could prove to be detrimental to both efforts." The ERAB reports says the CPMP "is further unrealistic in that it calls for an ETR (Engineering Test Reactor), presumably with substantial engineering testing objectives, without providing for the prerequisite technology and engineering component development." As for the CPMP's statement that the 1980's will be a time of "product definition," with "product development" occurring in the 1990's, ERAB says that "This rationale is inconsistent with industry meaning of these terms and is misleading with respect to the experimental nature of fusion research over the next two decades."

As readers of this newsletter are aware, Fusion Power Associates has been an outspoken critic of the CPMP since its genesis. DOE began trying to convince the fusion community of its new logic at a meeting of the community on May 24-25 1982 in Germantown. Commenting on the meeting in a letter dated May 26, 1982, to DOE Director of Energy Research Alvin Trivelpiece, FPA president Steve Dean stated "There is virtually no support in the fusion community for the so-called 'new strategy' which the Office of Fusion Energy presented." In the letter Dean also said "The basic problems with the draft plan as I see it are that the focus of the fusion program becomes one of preparing for a decision which is ten years in the future and the size of step which is envisioned at that time is not technically credible based on what is proposed to be done during the 1980's."

The recent MFAC and ERAB reports urge DOE to re-establish a near-term focus for the program based on the construction of a device capable of ignition and the sustained ($\sim$5 minute) release of fusion power. This proposed goal is fully consistent with Fusion Power Associates recent Board of Directors policy recommendations: "Commitments to new and improved experimental facilities are urgently needed to insure continued program momentum and progress into the 1990's," and with the intent of the Magnetic Fusion Energy Engineering Act of 1980 which requires that "The Secretary shall initiate design activities of a fusion engineering device using the best available confinement concept to ensure operation of such a device at the earliest practicable time...."

ENGINEERING TECHNOLOGY CONFERENCE

The 11th Energy Technology Conference and Exposition will be held March 19-21 at the Sheraton Washington Hotel in Washington, D. C. Primary sponsors of the conference are the American Gas Association, the Electric Power Research Institute, the Gas Research Institute and the National Coal Association. The conference will contain approximately 250 papers in 73 sessions on all aspects of energy technology. Fusion Power Associates was asked to organize a session on fusion which will be held on Tuesday morning March 20 from 10:30 until noon. The session, which Steve Dean of FPA will chair, consists of the following three papers: "Magnetic Mirror Fusion Power Systems" by Jim Gordon (TRW) and Grant Logan (LLNL), "Toroidal Fusion Power Systems" by Dale DeFreece (McDonnell Douglas) and Charles Baker (ANL), and "A Look at the Future of Inertial Fusion for Electric Power Production" by Mike Monsler (KMS Fusion, Inc.) and Gerald Kulcinski (U. of Wisconsin and Fusion Power Associates).

APS SETS FUSION SESSIONS

The spring meeting of the American Physical Society, April 23-26 at the Shoreham Hotel, Washington, D. C., will feature two fusion sessions on April 25 of special interest. The morning session (Blue Room, 9:00 A.M.) is entitled "Prospects for Commercial Fusion Power Applications." Session chairman is Herb Woodson, University of Texas. Invited papers will be presented by Harold Furth (PPPL), Robert Conn (UCLA), Lin Draper (Gulf States Utilities) and Lawrence Lidsky (MIT). The papers will be folowed by a panel discussion. Panelists are Norm Rasmussen (MIT), Bill Stacey (Georgia Inst. of Technology), Jim Crocker (EG&G-Idaho) and Bob Krakowski (LANL).

The afternoon session (2:00 P.M.) is entitled "New Developments in High Current Accelerators." Christos Kapetanakos, NRL, will chair the session. Invited papers will be by Dan Prono (LLNL), Charles Kim (LBL), Gerald Cooperstein (NRL), John Greenly (Cornell U.) and Hiroshi Ishizuka (U. of Ca., Irvine).

FUSION SPINOFF

KMS Fusion, Inc. a subsidiary of KMS Industries, Inc. of Ann Arbor, Michigan, has been awarded a patent for a process for the production of tiny glass beads on which living cells can grow while suspended in a nutrient medium. KMS has also been awarded funds from the National Cancer Institute to develop the process.

The beads, called microcarriers, are used in cell culture research and in the large scale commercial manufacture of biological products. Microcarriers are extremely small--a few thousandths of an inch in size--but they provide a very large surface area for cell growth and thus allow scientists to obain high cell yields without having to use large or bulky equipment. Cells grow on microcarriers while suspended in a nutrient solution. These "anchored" cells can then be

induced to produce such important biological materials as vaccines, enzymes, hormones, antibodies, interferons, and nucleic acids.

LAB-INDUSTRY COOPERATIVE VENTURE

Los Alamos National Laboratory's Structural Ceramics Program and a subsidiary of Atlantic Richfield Company (ARCO) were recently awarded contracts totaling almost $3 million by the Defense Advanced Research Projects Agency (DARPA). The Laboratory will receive approximately $2 million to continue research into single-crystal, silicon carbide "whiskers," and the ARCO subsidiary will spend its portion developing a commercial production process for these fibers, possibly the world's strongest structural material.

"DARPA, a federal agency, has made money available to the Laboratory and to industry for the separate objectives of developing both the science and an industrial process," says George Hurley, manager of the project and a member of the LANL's Materials Technology Group.

The South Carolina-based Silag Division of ARCO will send a staff member to work as part of the Los Alamos research and development team. That person will also help ARCO incorporate the process into the industrial scale-up. The Los Alamos objective is not to manufacture whiskers but to improve the materials. The Laboratory is funded to contribute to the basic science and understanding of the process, while ARCO handles the manufacture of the product.

GRUMMAN TEAM SUPPORTS DOE FUSION OFFICE

Grumman Aerospace Corp. has established an office at 1803 Research Blvd., Suite 301, Rockville, MD 20850, under contract to the DOE to provide technical support services to the Office of Fusion Energy's magnetic fusion reactor design studies program. The office is headed by Donald L. Moyer, who previously had worked as a Grumman employee on TFTR at the Princeton Plasma Physics Laboratory. Boeing Engineering Company, Duke Power Company and PSE&G Research Corp. are also participants in the support contract as subcontractors to Grumman. The group supports the Reactor Systems Design Branch, headed by Phil Stone, a part of the Office of Fusion Energy's Development and Technology Division. Staff members of the group are John Erickson, Erick Stern and Carl von Keszycki (Grumman), Paul Gillum (Boeing), Bill Rasin (Duke Power) and Betty Jensen (PSE&G). The group recently issued their first quarterly report for the period September 1-December 31, 1983. They indicate that an initial set of parameters to be used in normalization and for comparison of designs has been "distributed for internal review." They also indicate that a "major activity" has been the initiation of "a study of the viability of fusion power, with the goal of determining the potential of fusion power reactors to compete economically, technologically and socially within the marketplace of the electric power industry." The group is also conducting a study "to consider the site selection process for the TFCX experiment" and "to define the work required to produce site requirement and site selection documents." Members of the group can be reached at (202) 424-1720.

MEETINGS

March 19-21. 11th Energy Technology Conference. Sheraton Washington Hotel. Fusion session, March 20, 10:30 A.M. Contact (301) 251-9250.

March 20. Senate (Authorization) Subcommittee on Energy Research and Production--Hearings on Magnetic Fusion Energy. Dirksen Bldg. Rm. SD-366, 2:00 P.M.

March 24-30. Seminar on Dense Z-Pinches for Fusion. Alexandria, VA. Contact John D. Sethian, U.S. Naval Research Lab (202) 767-2705.

April 1. Fusion Power Associates Board of Directors Meeting, Carmel, CA.

April 2-3. Fusion Power Associates Annual Symposium. "Fusion Power Development--The Next Decade", Livermore, CA. Contact Ruth Watkins (301) 258-0545.

April 4. Meeting of Fusion Public Information Specialists. At Lawrence Livermore National Laboratory, sponsored by Fusion Power Associates. Contact Ruth Watkins (301) 258-0545.

April 10-11. ORNL Annual Information Meeting of the Fusion Energy Division. Contact O. B. Morgan (615) 574-0988.

April 11-13. 1984 Sherwood Theory Meeting. Lake Tahoe, NV. Contact Dona Richards, LLNL, Box 5511, L-630, Livermore, CA 94550.

EXECUTIVE NEWSLETTER

APRIL 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

DEPARTMENT OF NUCLEAR WEAPONS AND ENERGY

The so-called Department of Energy continues its transition to become the Department of Nuclear Weapons and Energy (DONWE). The President's budget request to Congress asks for about a billion more dollars for weapons (see Table at right). Weapons account for 60% of the $12,815,000,000 request. The weapons people, who manage the nation's inertial confinement fusion (ICF) program showed their largesse by slashing the ICF budget from $170 million to $138 million. Most energy programs were more or less constant from FY 84 to FY 85, although the High Energy Physics (HEP) program continues its "fair haired boy" status, getting a $561 million request for FY 85 compared to $480 in FY 84 and $422 in FY 83. Presidential Science Advisor George Keyworth is encouraging the HEP community to request approval for a new "Superconducting Super Collider" accelerator rumored to cost $4-6 billion. Intense competition among state governments wishing to become the site of the accelerator has already begun, with Texas said to be the most aggressive. The accompanying table shows the DONWE requests.

Department of Nuclear Weapons and Energy
($ in Millions)

	FY 83	FY 84
Nuclear Weapons	$6,548	$7,693
Energy Production	1,008	885
Nuclear Fission	675	618
High Energy Physics	480	561
Magnetic Fusion	471	483
Basic Energy Sciences	337	420
Conservation	431	400
Strategic Petrol. Reserve	159	364
Nuclear Waste Disposal	320	328
Fossil Energy	330	273
Environment	219	228
"Support Activities"	219	218
Solar and Renewables	215	191
General Sciences	161	185
Inertial Fusion	170	138
"Other Energy Functions"	138	126
Supporting Research	58	60
Electrical Energy Systems	44	35
Adjustments	(323)	(391)
Totals	$11,660	$12,815

A BUSY MONTH

Late February to early April has been a busy time. It was a time of congressional hearings, meetings and conferences. DOE presented its FY 85 budgets to the Congress. The AIF sponsored a conference in Washington on "The Role of Industry in Fusion Power Development", February 27-29. Fusion Power Associates Steve Dean participated in a panel discussion on "Goals for the Fusion Program" at the AIF conference and sponsored a dinner for FPA representatives and government officials February 27. On February 29, FPA and other groups testified on fusion to the House Science and Technology Subcommittee chaired by the Honorable Marilyn Lloyd. We have also been participating in MFAC's panel 7 on "Industrial Participation in Fusion." The panel met March 15-16. We organized and chaired a session of fusion papers at the Energy Technology Conference March 20 in the morning and testified on the fusion budget to Senator Domenici's subcommittee in the afternoon. We also were invited to send, and we sent, written testimony on inertial confinement fusion to the House Armed Services Committee in March. And we also have been working to get fusion mentioned in the Republican and Democratic party platforms.

Now it is time for a breather, or is it? Our Board of Directors meets April 1 and our annual symposium "Fusion Power Development--The Next Decade" is scheduled for April 2-3 at Livermore. We will host a workshop for fusion public information specialists April 4 and we will testify to the House (AM) and Senate (PM) Appropriations

Committees on April 5. The rest of this newsletter contains excerpts from some of our statements. Complete copies are available upon request.

GOALS FOR THE FUSION PROGRAM

At the AIF conference February 27-29, Steve Dean stated that "Concrete, bold and imaginative research and development goals are essential, lest the fusion program drift aimlessly and expensively into the future." He recommended that "the goal of the fusion program should be to develop practical fusion power for a variety of applications." He listed several objectives he considered important:

- The federal government should stimulate the development of fusion capability in U.S. industry so that a strong capability develops in U.S. industry to compete for national and international project tasks.

- There should be a heavy reliance on conceptual reactor design studies to guide the R&D program.

- The fusion program should initiate commitments to new facilities on a timely basis and manage research and development activities to assure their success.

- The program should aggressively seek concept improvements and give this search high priority and high visibility in program discussions and in decision making activities.

- Although physics programs clearly require the bulk of fusion program funding at this time, a clearly-established and well-maintained reactor engineering program is equally essential.

- The program should continually improve and implement a coordinated management system.

CONGRESSIONAL TESTIMONY

In congressional testimony Dean noted the achievement of the Lawson product at MIT in late 1983, saying that it had been "a major milestone goal of the fusion program for over 25 years" and calling its achievement "an historic event." He pointed out the new confinement time records already achieved this year in TFTR and JET and called for the initiation of the "Burning Core Experiment" recommended by ERAB. He also called on Congress to request DOE to rewrite its so-called Comprehensive Program Management Plan to reflect the new strategy recommended by ERAB (see our March newsletter). Commenting on recent criticisms of the fusion program Dean said "I believe we must seriously...attempt to seek concept improvements that will eliminate the impression that we do not have a commercially attractive product. I believe it is essential, if the fusion program is to maintain public support, that we be perceived to be going along a path that brings us into a competitive product position." Speaking of the designs now evolving for the proposed Tokamak Fusion Core Experiment (TFCX), he said he hoped we could "continue to improve the performance of the machine relative to its cost" and that "we can do that in a way that connects us with the future," i.e., "connect it in to a path that looks like it is leading towards a better fusion reactor." Speaking of the so-called "alternate concepts," Dean said "Each of these concepts has immediate needs that should be taken care of. They are relatively inexpensive. We should continue to pursue them at levels that are appropriate for their stage of development."

Speaking of private ventures like INESCO, the GA/Phillips OHTE project, and Math Sciences Tract project, Dean said "I think we need to encourage extrepreneurship." He said that "if things are reasonable in cost relative to the national (fusion) budget the program could well afford to take a flyer now and then in hopes of getting something that might pay off sooner."

INERTIAL CONFINEMENT FUSION

By invitation of the committee, FPA president Steve Dean submitted the following statement to the House Armed Services Committee. The same statement was also submitted to the Senate Energy Committee and to the House and Senate Appropriations Committees:

"I am deeply concerned with the Department of Energy's FY 1985 budget request for inertial confinement fusion. For several years now the Department has systematically reduced their requests for operating funds in this program relative to prior years. Only the foresight and vision of the Congress, which has regularly added money

to the DOE request, has kept us from losing considerable numbers of talented scientists from this very productive program.

The people working in this program have constructed and operated laser and particle beam facilities at power and energy levels which seemed impossible 15 years ago. They have extended our understanding of the interactions of intense laser and particle beams with matter. In the process, important additional benefits have been spawned, including the new field of laser isotope separation, studies of weapons-related phenomena and direct energy beam weapons technology.

In light of the outstanding record of accomplishments established by workers in this field, it is incredible to me to witness the short-sighted budget cutbacks imposed on this program within a DOE defense budget which is expanding enormously.

I urge the Congress to continue to provide the support necessary to maintain momentum, progress and enthusiasm within the inertial confinement fusion program.

I also urge the committee to maintain an interest in the civilian applications of inertial fusion, which I believe remains promising. The Board of Directors of Fusion Power Associates has issued the following statement of views on the subject:

"Inertial Confinement Fusion -
Energy Applications

There have been considerable pressures exerted on ICF program managers to downplay studies aimed at energy applications of inertial fusion. Fusion Power Associates believes that to respond to these pressures by reducing the minimal ongoing studies of potential energy applications of ICF is not in the national interest. Military research and development has historically led to many important contributions to the civilian sector and to the economy. Government sponsors should be proud of, and encourage, these connections. Permitting a reasonable percentage of the ICF funding to continue to be spent on energy applications is the best way to ensure that the nation ultimately derives full benefit from the ICF program."

NEW FUSION BOOK PUBLISHED

Little, Brown and Company (20 Beacon St., Boston, MA, 02106) has just published a book entitled The Man-Made Sun, subtitled "The Quest for Fusion Power." The 347 page book lists for $19.95. Author Tom Heppenheimer has been a frequent visitor to fusion labortories and meetings over the past few years, gathering material and interviewing fusion personnel.

His penchant is for the personal, although the book is also filled with colorful and imaginative descriptions of plasma physics and fusion devices for the layman: "The plasma, for its part, behaves like a Chesire cat, fading away and disappearing. When it does this, however, it leaves no smile. Rather, it leaves worried frowns on the faces of the physicists, who would like to know how it got away and what it has been up to this time."

Describing the Princton Large Torus (PLT) device, Heppenheimer says, "Since a torus is a thick ring, like a doughnut or life preserver, you might expect, entering the PLT room, to see something like the tire of some colossal truck. What is actually there is more nearly reminiscent of the inside of your car's engine compartment, blown up to the size of a house. An auto engine is basically a set of pistons within cylinders, a rather simple mechanical arrangement. But this basic simplicity is surrounded by so many auxiliary mechanisms and equipment that only a trained mechanic can dig down through the complexity to the pistons and cylinders at the core. That is how it is with the PLT."

But Heppenheimer's real purpose is to describe the more personal aspects of the saga and to generally educate the layman on the maneuvering of the more politically-motivated people in the program. Thus the book begins, as if it were a play, with a section titled "Dramatis Personae." Here you can find Heppenheimer's view of who the key players are and what was their role. Here you can find many of your friends, cryptically-described, right up front: Steve Bodner, Keith Brueckner, Sol Buchsbaum, Bob Bussard, John Clarke, Steve Dean, John Deutch, John Emmett, John

Foster, Ken Fowler, Harold Furth, Mel Gottlieb, Bob Hirsch, George Keyworth, Ed Kintner, Mike McCormack, John Nuckolls, Doug Pewitt, Don Repici, James Schlesinger, Al Trivelpiece, to name a few. Not all will agree that their characterizations are accurate or complete, let alone agree with how their roles are described later in the book.

Heppenheimer hits the peak of his stride in describing two traumatic events in the life of Ed Kintner: the "PLT weekend" of 1978 and the events leading to Kintner's resignation in 1981. The "PLT Weekend" refers to the weekend of August 12, 1978 when news of PLT surpassing the minimum temperature required for fusion ignition broke big in the national and international press. DOE Secretary James Schlesinger was so upset that he was not in control of the release of the news that he threatened to fire Ed Kintner and Steve Dean. Of that weekend, Heppenheimer reports of a phone call to Mel Gottlieb from Schlesinger's press officer James Bishop accusing Gottlieb "of having invented the PLT story and blown it up for his own purposes." Says Heppenheimer: "Bishop's phone call thus was a direct challenge not only to DOE directors Kintner and Dean but to the professional integrity of Gottlieb and of his entire Princeton lab. Certainly Gottlieb's people hadn't been working their tails off merely so that some high level Washington ignoramus could abuse him by telling him that his people had done nothing."

Heppenheimer was encouraged to write the book by Ed Kintner, but Ed is probably not satisfied with the description of the circumstances surrounding his resignation. The immediate cause of Kintner's resignation (see our January 1982 newsletter) was that Tom Palmieri of OMB, at the suggestion of Steve Bodner of NRL (on loan to OMB) was directing Ed to redirect funds from MFTF-B construction to use for strengthening the physics research programs. Heppenheimer maintains that Palmieri and Bodner were "bluffing" and says of Kintner "Now he was suspicious of even his closest associates."

Having taken the trouble to research and write this book you might ask whether, in the end, Heppenheimer believes in fusion. Here is his closing paragraph:

"Fusion is unquestionably one of the key technologies that will shape the coming millennium. Today we see it as a man-made sun about to rise; tomorrow we will stand in the radiance of its bright promise. Those who say we are in the sunset of our age are surely mistaken, but they can be forgiven; early dawn may look much the same as dusk. We stand today amid the landscape of the future, but we do not perceive it in detail. There are only vague forms and shadows, some of which appear as looming threats. But let us be patient; morning is at hand, and the landscape in all its intricacy will soon be disclosed. For now it is enough to know that that sun is there, its rise appears imminent, and if we look closely we can even now see its glow reflecting off the distant clouds near the horizon."

If you are a fusion researcher, you will undoubtedly find many important events of which you are aware left out of this book, especially if you are not from Princeton or Livermore. Nevertheless, Heppenheimer has written an entertaining and mostly accurate account that brings the fusion story closer to the present then another recent book by Bromberg (FUSION, MIT Press, 1982).

MEETINGS

April 23-26 - Spring Meeting of the American Physical Society. Shoreham Hotel, Washington, D. C. Fusion Session to discuss Larry Lidsky issues (April 25, 9:00 AM, Blue Room) and to discuss high current accelerators (April 25, 2:00 PM.)

May 1-2 - Magnetic Fusion Advisory Committee (MFAC) Open Meeting. Oak Ridge. Contact: John Cowles (301) 353-3598.

May 14-18 - 11th IEEE Conference on Plasma Science, St. Louis. Contact Tom Mense (314) 576-8317.

May 16-18 - IEEE Minicourse on Fusion Experimental Reactor Systems. St. Louis. Contact George Miley (217) 333-2294.

May 24-29 - AAAS Meeting, New York. Contact Rolf Sinclair, NSF, (202) 357-7997.

June 2 - ANS Short Course on Fusion Plasma Engineering. New Orleans. Contact George Miley, U. of Illinois (217) 333-2294.

EXECUTIVE NEWSLETTER

MAY 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

NEW AFFILIATE

The Standard Oil Company of Ohio (SOHIO) has become the nineteenth corporate affiliate of Fusion Power Associates. Dr. Jack Wilson, Research Supervisor, will represent the company. Jack was a guest at our recent Board of Directors meeting in Carmel, April 1, and attended our annual symposium in Livermore, April 2-3. We welcome SOHIO's participation.

JET RECEIVES ROYAL WELCOME

The world's most advanced fusion device, the Joint European Torus (JET) at Culham, England, got the royal treatment April 9 at dedication cermonies presided over by Queen Elizabeth.

In her prepared remarks the Queen said "I am delighted to be able to applaud this magnificent technical achievement, the full potential of which is still to be revealed." The Queen noted that "There is a long way to go before we will know for sure whether fusion can be used to generate electricity reliably and economically and without harm to the environment." "Fortune favors the bold, however," she said, "and the building here, in the heart of Oxfordshire, of the Joint European Torus puts the Community in the very forefront of the attempt to develop the fusion reactor." "In an energy hungry world, the JET may be a step along the road towards a virtually unlimited source of electric power," the Queen said. The United Kingdom is serving as Host Nation for JET which is a joint undertaking of 12 countries. The JET began operation on June 25, 1983, and has since set world's records for plasma current (3 million amperes for 10 seconds), reaching energy confinement time of about one-quarter of a second. The cost of JET, including buildings, facilities and salaries was about $300 million. JET is expected to reach plasma conditions similar to those projected for TFTR in the U.S. during the next few years and to outperform its U.S. counterpart late in the decade due to its larger size and fully remotely maintainable equipment.

"FORTUNE FAVORS THE BOLD," SAID QUEEN ELIZABETH AS SHE DEDICATED JET. SHE WAS JOINED AT THE CEREMONIES BY (seated in foreground l. to r.) HIS ROYAL HIGHNESS THE DUKE OF EDINBURGH AND FRANCOISE MITTERAND, PRESIDENT OF FRANCE.

EMMETT AND FOWLER RECEIVE FPA AWARDS

The Board of Directors of Fusion Power Associates has announced the selection of John L. Emmett and T. Kenneth Fowler to receive the Fusion Power Associates Leadership Awards for 1983. The awards, which were initiated in 1980, are given periodically to persons who have shown "outstanding leadership qualities" in guiding the evolution of fusion towards

becoming a practical energy source. Emmett is currently Associate Director for Lasers of the Lawrence Livermore National Laboratory, Livermore, CA. Fowler is Associate Director for Magnetic Fusion Energy, also of the Lawrence Livermore National Laboratory.

Emmett's award states that "Your outstanding personal, technical and managerial qualities have resulted in the development of laser facilities and technologies that are effectively addressing critical scientific issues and potential applications."

Fowler's award states that "Your outstanding personal, technical and managerial qualities have had a profound effect on the direction of the world effort in magnetic fusion energy development.

POPE APPLAUDS FUSION EFFORT

Pope John Paul II joined the ranks of a growing number of world leaders waxing enthusiastic on fusion. The Pope extended his greetings to those attending the Fourth International Symposium on Heating in Toroidal Plasmas, held in Vatican City, March 21-28. In his welcome the Pope said, "Your activity has effects outside the different nations which support the research. You are called to provide an example of successful international collaboration among the peoples of the earth. By its very nature your work must be aimed towards the peaceful future and the harmonious and fraternal development of man, of each individual human being. For it is to the human person that your efforts, your studies, your research must be directed." The complete text of the Pope's remarks appeared in the 26-27 March edition of the Vatican newspaper "L'OSSEVATORE ROMANO."

KMS FUSION WINS FOURTH SMALL BUSINESS AWARD

The National Science Foundation recently announced that KMS Fusion, Inc., a subsidiary of KMS Industries, Inc. of Ann Arbor, MI, has been granted a Small business Innovative Research (SBIR) award to develop techniques to measure the optical properties of materials used in x-ray mirrors. Dr. Paul Rockett of KMS Fusion is the Principal Investigator on this most recent SBIR award. KMS Fusion is among the most successful participants in the SBIR program in the United States. To date, the company has won four of these awards--one for every category entered.

REICHLE PANEL REPORT

Leonard F. C. Reichle, Executive Vice President of Ebasco Services, Inc., chairs the Advisory Panel on Fusion Energy to the House Science and Technology Committee's Subcommittee on Energy Research and Production. In a March 20 report to chairperson Marilyn Lloyd the panel made the following statement:

"The Panel noted the very strong progress in experimental tokamak research during the past year: particularly, the achievement of a reactor-like Lawson parameter in Alcator C and the discovery of favorable confinement scaling and record-level energy confinement times during the initial operation of TFTR and JET. We expect that during the next several years the experimental data for a tokamak ignition device will be fully documented.

"The panel makes the following comments:

"1. We support the recommendations of ERAB and MFAC that top program priority should be given to the achievement of an ignited long-pulse plasma based on the tokamak principle. (This project is referred to as BCX by ERAB and TFCX by MFAC). We note that the BCX/TFCX project will be a driver of reactor-relevant technologies and a focal point for constructive industrial participation. We agree with the ERAB-MFAC recommendation that international participation should be sought, but that the United States must be prepared to proceed alone and should begin planning and designing without delay.

"2. We support, also, the maintenance of a vigorous base program in magnetic confinement research, with emphasis on the advancement of scientific understanding and the development of optimal fusion reactor concepts and techniques. We believe that there is particularly great economic promise in innovative ideas leading towards higher fusion power density and simplified reactor geometry. We believe that during the peak years of BCX/TFCX construction, the viability of the base program and the opportunity for alternate concepts to emerge will have to be protected by incremental program funding.

"3. We agree that during the present

period of budgetary stringency the development of long-term fusion-reactor technologies, such as the technology of first-wall materials, must necessarily proceed more slowly than had been envisaged several years ago. We do, however, reaffirm the fundamental importance of this work, and particularly the importance of completing the FMIT, to the economic sucess of fusion power. We support the search for international participation in the FMIT project.

"4. In conclusion, the Panel believes that, despite the special problems and difficulties faced by the U.S. nuclear industry at this time, confidence in nuclear power will be fully restored in due course, and the long-term economic and environmental potentials of fusion will become a valuable part of the nuclear power option."

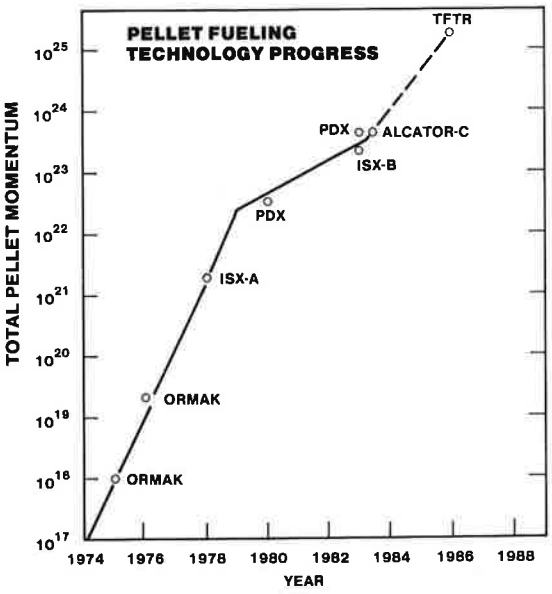
PELLET FUELING COMES OF AGE

With little fanfare but with great skill and precision--traits characteristic of Oak Ridge fusion researchers--members of Hal Haselton's Plasma Technology Section at ORNL have taken pellet injectors from concept to essential experimental component in just a few short years. As the accompanying graph shows, total pellet momentum has increased over seven orders of magnitude since 1976 and the injectors have proven useful, and in some cases essential, to experimental progress.

The most dramatic recent example occurred as part of the Alcator C series of experiments at MIT during which the Lawson Product was surpassed (see our December 1983 newsletter). An ORNL four shot pneumatic solid hydrogen pellet injector was used on the Alcator-C tokamak to raise the density and to produce record levels of the confinement parameter $n\tau$.

Pellet injection has been under development at ORNL for nearly a decade, and substantial advances have been made both in technology as well as in the theory of pellet ablation and fueling. First tests were done on ORMAK, ISX-A and ISX-B. Subsequently, important tests were performed on PDX. In addition to the recent Alcator C work, a centrifugal multi-shot pellet injector is ready for operation on D-III and a tritium pellet injector development program has started for the TFTR deuterium-tritium plasma phase.

Haselton's group is better known for its development of high power positive ion neutral beams. In 1978 four ORNL neutral beam injectors delivered up to 3 MW of power to the PLT tokamak plasma and raised the ion temperature to a record level of 7 keV. These injectors each produced 0.8 MW of atomic hydrogen and deuterium power for 0.3 s with a 40 keV extraction potential. The latest injector, which has been developed as a part of the Advanced Positive Ion System Program, delivers 40A of beam for 30 seconds at 80 keV.



As fusion device designers have shifted the future needs projections from neutral beams to high power RF systems, so too has the ORNL group shifted its emphasis. DOE has recently approved the development of an RF test facility at ORNL to be operated in late 1985. The facility will permit 1 MW steady state tests of ICRH launchers for D-III and TFTR.

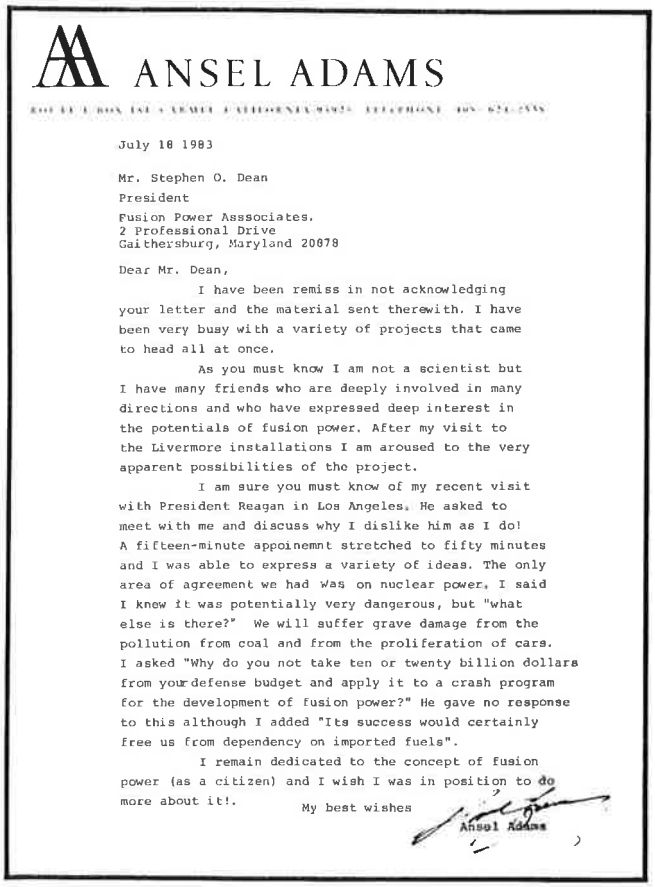
Meanwhile Electron Cyclotron Heating, pioneered by ORNL and Varian Associates for EBT applications, is also finding widespread use in the tokamak and mirror programs elsewhere. The program has already developed and tested 200 kw CW tubes at 28 and 60 GHz. Development of 120 GHz, 1 MW tubes and 140 GHz, 200 kw tubes are also being initiated.

We salute Hal and his group, including Stan Milora, Chris Foster, Dan Schuresko, Steve Combs, Vern Lunsford, Clarence Blue, Kelly Dagenhart, Walt Gardner, Madhaven Manon, Stan Ponte, Phil Ryan, Don Schechter, Will Stirling, Jim Tsai, John Whealton, Glen Barber, Roaul Wright, John Moeller, (Grumman), Will Becrat (GE), Don Hoffman, Harold McCurdy, Bob Wysor, Marshall Loring, and Hal Kimery.

ANSEL ADAMS, 1902-1984

Ansel Adams, 82, celebrated landscape photographer, devoted enviromentalist and friend of fusion, died of a heart ailment April 23 at a hospital near his home in Carmel, California. He was both artist and activist. It is said of him that, for the past three years, he wrote a letter a day to congressmen and to newspapers urging attention to the preservation of our natural environment.

We were honored when he sent us a check and requested to become an individual affiliate of Fusion Power Associates. He had planned to have lunch with our Board of Directors at their meeting in Carmel just three weeks ago, but his health forced a last minute cancellation. We admire him as a creator of art and technology, appreciator of beauty and fighter for the causes in which he believed.



ANSEL ADAMS

[illegible]

July 18 1983

Mr. Stephen O. Dean
President
Fusion Power Asssociates.
2 Professional Drive
Gaithersburg, Maryland 20878

Dear Mr. Dean,

I have been remiss in not acknowledging your letter and the material sent therewith. I have been very busy with a variety of projects that came to head all at once.

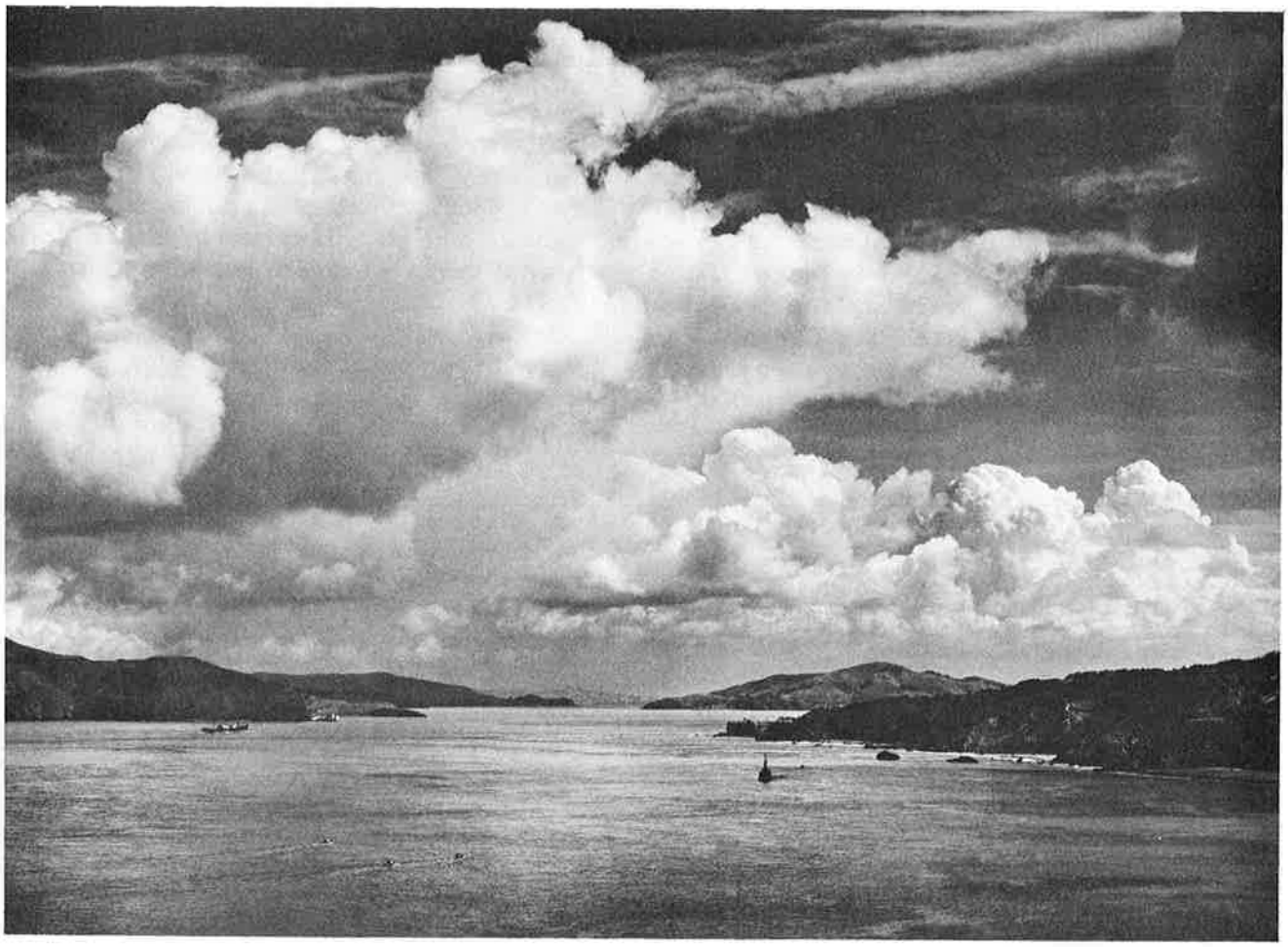
As you must know I am not a scientist but I have many friends who are deeply involved in many directions and who have expressed deep interest in the potentials of fusion power. After my visit to the Livermore installations I am aroused to the very apparent possibilities of the project.

I am sure you must know of my recent visit with President Reagan in Los Angeles. He asked to meet with me and discuss why I dislike him as I do! A fifteen-minute appoinemnt stretched to fifty minutes and I was able to express a variety of ideas. The only area of agreement we had was on nuclear power. I said I knew it was potentially very dangerous, but "what else is there?" We will suffer grave damage from the pollution from coal and from the proliferation of cars. I asked "Why do you not take ten or twenty billion dollars from your defense budget and apply it to a crash program for the development of fusion power?" He gave no response to this although I added "Its success would certainly free us from dependency on imported fuels".

I remain dedicated to the concept of fusion power (as a citizen) and I wish I was in position to do more about it!.

My best wishes

Ansel Adams



THE GOLDEN GATE BEFORE THE BRIDGE, SAN FRANCISCO, 1932--by Ansel Adams

EXECUTIVE NEWSLETTER

JUNE 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

NEW AFFILIATES

The Electric Power Research Institute (EPRI), Palo Alto, CA, has become the twentieth corporate affiliate of Fusion Power Associates. John E. Cummings will represent the company. Cummings is Director, Renewable Resources Systems Dept. and is a member of DOE's Magnetic Fusion Advisory Committee.

The Boston Edison Company has become the twenty-first corporate affiliate of Fusion Power Associates. Michael Mulcahy, Research Manager, will represent the company.

We welcome the participation of EPRI and Boston Edison Company in the activities of Fusion Power Associates.

SANDIA FOCUSES LIGHT IONS

It has been a major goal of the Sandia National Laboratories inertial confinement fusion program to demonstrate the ability to focus a beam of light ions to a small radius spot size at significant current density. Speaking at the IEEE International Conference on Plasma Science May 15 in St. Louis, Dr. David Johnson, lead investigator for the focusing experiment, reported that, using the facility Proto I, a beam of protons with a source current density of 6 kA/cm^2 was focused to 0.65 mm (half-maximum) spot size ("the size of a pinhead") starting with a 4.5 cm radius "applied-B" diode. "For the first time, we were able to show that intense ion beam diodes behave like optical elements--a small change in the lens curvature produces a precisely defined change in the focal spot," said Johnson. Dr. J. Pace VanDevender, manager of Sandia's Fusion Research Department, said "This is a significant advance, similar to the first focusing of high current electron beams in 1972." VanDevender considers the result to demonstrate "proof of principle" for igniting a fusion pellet, using the 100 trillion watt Proto II device in experiments scheduled to begin in 1988. Those experiments require focusing a beam with a source current density of 5 kA/cm^2 to a spot size of 3-4 mm, starting with a 15 cm radius diode. The applied-B diode used in the experiment was invented at Cornell University and was further developed at Sandia.

MURRAY ROSENTHAL, ASSOCIATE LABORATORY DIRECTOR FOR ADVANCED ENERGY SYSTEMS, OAK RIDGE NATIONAL LABORATORY, AND RULON LINFORD, ASSOCIATE DIVISION LEADER FOR CTR, LOS ALAMOS NATIONAL LABORATORY, ARE AMONG THE LEADERS LOOKING FOR IMPROVEMENTS IN FUSION CONCEPTS

SEARCH FOR CONCEPT IMPROVEMENTS

Dr. Alvin W. Trivelpiece, DOE Director of Energy Research, has asked the Magnetic Fusion Advisory Committee to undertake two studies aimed at providing perspectives on fusion concept development and issues associated with "high power density." A "Panel 9" has been established under the chairmanship of Lee Berry (ORNL) to review the scientific contributions to the overall fusion program which

derive from supporting research on stellarators, compact toroids, Elmo Bumpy Torus and reversed field pinch. The panel is holding a four-day workshop in Oak Ridge, June 5-8, and is scheduled to report by September.

A "Panel 10" has been established under the leadership of Bob Conn (Chairman) and Bob Gross (Vice-Chairman) to provide recommendations on the relative emphasis to be placed on "the development of high power-density fusion reactors within the overall fusion program." An interim report is to be made in September with a final report due by December.

Fusion Power Associates had previously reviewed some of these issues in a workshop for the National Science Foundation entitled, "Implications of Compact Fusion Concepts and Their Relationship to the Federal Program." A summary of the conclusions is available from FPA on request. The complete proceedings was recently published by the ANS as a special section of the journal "Nuclear Technology/Fusion" (September 1983) and is available in reprint form. Contact George Miley (217) 333-2294 for information on reprint availability.

BUDGETS--MAGNETIC FUSION

In contradictory actions in the House of Representatives, the authorizing subcommittee, chaired by Marilyn Lloyd (TN), has recommended an increase of $9.2 million to the mgnetic fusion budget, while the appropriations subcommittee, chaired by Tom Bevill (AL), has recommended a cut of $64 million. These amounts are relative to the president's FY 1985 request for $483 million. The approved budget for the current year is $470 million.

Mrs. Lloyd's committee wants $6.7 added to enhance support for the proposed Tokamak Fusion Core Experiment (TFCX) and $2.5 million for "cost-shared fabrication of high-strength, high conductivity copper magnetic coils for use in compact toroid ignition experiments."

Unfortunately, it is the appropriations bill that governs expenditures. Before becoming law, however, action must still occur in the Senate and any differences with the House resolved in conference. The appropriations subcommittee in the Senate has recommended a $27M cut; the full committee "marks up" in early June in the Senate. The reduction proposals represent a serious threat to the pace of the magnetic fusion program.

The report of the House appropriations committee states "It is the sense of the Committee that the fusion program is somewhat earlier in its development cycle than was predicted for this time 10 years ago." The committee report states that "The Secretary of Energy has testified in the past that fusion energy is not commercially viable for another 40 to 50 years." The committee also stated that they are "concerned about the very long-term commitment of vast amounts of funding necessary to prove the scientific feasibility of fusion."

FPA RESPONDS

As we have been articulating in our newsletters, symposia, etc. for the past several years, there is no technical reason why fusion development should take 40-50 years--15-20 years is plenty if the program is managed to produce a practical product. The 40-50 year (OSTP at one point said 70 years!) horizon has been dictated by OSTP and DOE as a planned management approach and policy decision.

When the planned adverse action in the House Appropriations Committee became known, FPA president Steve Dean sent the following letter to all members of the House and Senate Appropriations Committees.

"The President's FY 1985 DOE budget request for magnetic fusion energy research represents less than optimum funding to maintain the momentum of this important program. I urge you to resist any reductions in this program during the appropriations process.

"Several important events of the past year point up the importance of maintaining momentum at this time.

"At MIT, the "Lawson Product" was surpassed last fall. This quality of plasma confinement assures us that net energy from fusion can be achieved. Achievement of the Lawson Product has been a major goal of the fusion program for the past 30 years and its accomplishment represents a truly historic event.

"Recognizing the rapid scientific progress that has occurred, the DOE's Energy Research Advisory Board recommended in February that the Department "commit to building a Burning Core Experiment to explore ignition physics as a high priority in the fusion program." This

represents an important sign of increased enthusiasm for the program at DOE. Congress needs to encourage this enthusiasm and to take advantage of the rapid progress being made in fusion research.

"In April, Queen Elizabeth and President Mitterand dedicated the joint European fusion device, JET, in England. This major fusion facility is larger and more ambitious than the largest U.S. fusion device, TFTR at Princeton. A similar large fusion facility is nearing completion in Japan. The U.S. will lose its lead in fusion by the early 1990's unless steps are taken now to maintain momentum in the U.S. program.

"From the above considerations I hope you will agree that this is a most inopportune time to be considering reductions in the DOE's magnetic fusion energy budget. Rather, modest increases above the President's request should be provided. Thank you for your consideration."

WE STRONGLY RECOMMEND THAT ALL WHO WISH TO SEE FUSION DEVELOPMENT PURSUED EXPEDITIOUSLY WRITE THEIR CONGRESSMEN AND SENATORS IMMEDIATELY.

MFAC PANEL 7 REPORT

MFAC Panel 7, on "Industrial Participation in Fusion Energy Development," issued its final report on May 1, 1984. The panel found that "DOE has not established a clear policy for the national laboratories to follow in subcontracting with industry for supporting R&D in the context of a national long-range plan for fusion development" and stated that "It is not too early to begin to prepare industry for the role of prime contractor and major subsystem supplier to the government and to the utilities." The report made the following recommendations:

"The Office of Fusion Energy, in concert with the national laboratories, universities and industry, should work to identify the activities needed to develop fusion to the point where commercialization decisions can be made. These should include the data requirements and experiments or devices necessary to obtain it and a plausible scenario describing how industry could participate in the development.

"The status of the fusion program is such that it is ready to assimilate a greater intellectual involvement by industry in its development. Therefore, opportunities should be more

PROSPECTS FOR COMMERCIAL FUSION WERE DISCUSSED AT THE APS MEETING IN WASHINGTON APRIL 25. AMONG THE PANELISTS: LYNN DRAPER, BOB CONN, LARRY LIDSKY, HAROLD FURTH, AND MODERATOR, HERB WOODSON.

clearly identified at the national laboratory and national program levels to permit this to happen. These opportunities should include systems, subsystems, engineering, and operational aspects of the fusion program.

"Laboratory managers should specifically review all make or buy decisions in their programs. The principle for these should be that laboratories should not make in-house those products that they can obtain commercially. In particular, more emphasis should be placed on assigning to industry responsibility for a complete scope of work.

"Where clearly defined tasks or service specifications cannot be produced or where prototype equipment has not been developed and made to function properly, fixed price contracting should be avoided.

"Unsolicited proposals from knowledgeable fusion contributors should be encouraged, and the source supported if on review the concept has merit and can serve to expedite the program objectives.

"An integrated engineering program should be maintained under all budget assumptions as a complement to other program elements. The acquisition of engineering data in documented form is a necessary prerequisite for future facility decisions in the fusion program.

"There should be significant industrial participation in developing the fusion engineering data base and in major projects such

as TFCX so that the private sector is better able to make decisions on the commercial potential of fusion energy."

In a letter dated May 3, MFAC transmitted the report to DOE with the following additional comments:

"1. MFAC takes note of the many significant technical contributions of industry to the fusion program over the years, and urges that mechanisms be found to maintain strong industrial expertise and participation in the program in the near future.

"2. In times of budgetary stringency, this may require contractual mechanisms to insure stable relationships between the program and those industries with a strong commitment to fusion development.

"3. There should be a continued effort to broaden the intellectual involvement of industry in task areas where industrial experience can benefit the fusion program. Assignments in such task areas will permit the full scope of industrial skills to be developed and utilized.

"4. The DOE should work towards a uniform policy within the international fusion community with regard to extranational procurements.

"5. The panel has evaluated several models for industrial involvement in major fusion projects (TFTR, MFTF-B, EBT-P). Each of these approaches has special merits and should be evaluated as candidate mechanisms for TFCX.

"6. As the next major step in the fusion program, the TFCX project should be viewed as an opportunity to develop even broader mechanisms for industrial participation. MFAC believes that the approach that will be used during the initial design phase (Phase I) has merit. For subsequent phases of the TFCX, we strongly recommend that DOE explore meaningful industrial roles that can lead to longer-term commitments and interactive projects that will serve the national program.

"7. Industry needs a clearer statement of fusion program goals and approximate timing from DOE in order to properly assess corporate priorities and commitments to this important effort.

"As a final point discussed at our May 2 meeting, we believe that engineering research is basic to fusion energy development. As fusion moves into its immediate next phase, an integrated engineering program should be maintained as a complement to other program elements. The acquisition of engineering data will be a key ingredient in future decisions on fusion facilities and technical program directions."

MEETINGS

June 18-22 - Conference on Lasers and Electro-Optics. Anaheim (CA) Convention Center.

June 20-22 - Third All-Union Conference on Engineering Problems of Fusion Reactors. Leningrad.

June 27-July 3 - International Conference on Plasma Physics. Lausanne, Switzerland.

July 18-20 - Magnetic Fusion Advisory Committee (MFAC) public meeting. MIT, Cambridge, MA. Contact John Cowles (301) 353-3598.

July 30-Aug. 10 - Advanced Course on Physics of Plasma-Wall Interactions in Controlled Fusion. Val-Morin, Quebec. Contact D. Post, Princeton Plasma Physics Laboratory.

Aug. 19-24 - 19th Intersociety Energy Conversion Engineering Conference. San Francisco. Contact W. J. Donson (415) 271-4268.

Sept. 17-21 - Triitum Safe Handling Course. Toronto and Chalk River, Ont. Contact Tom Drolet (416) 823-6654. Course also offered Nov. 5-9. Tuition $1300.

QUOTABLE

One of our most distinguished affiliates sent us the following quote for publication. (From "The Apple Cart", Act II by George Bernard Shaw.)

"Lysistrata to King Magnus:

"Never fear, sir. It is not the most ignorant national crowd that will come out on top, but the best power station; for you can't do without power stations, and you can't run them on patriotic songs and hatred of the foreigner and guff and bugaboo, though you can run nationalism on nothing else."

EXECUTIVE NEWSLETTER

JULY 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

Fusion in the Soviet Union

BACK IN THE USSR

Fusion Power Associates president Steve Dean visited the Soviet Union June 18-28 as guest of the Soviet Academy of Sciences, by invitation of Academy vice-president E. P. Velikhov. While there he attended the Third All-Union Conference on the Engineering Problems of Fusion Reactors and visited the Efremov Institute in Leningrad and the Kurchatov and Lebedev Institutes in Moscow. He first visited the USSR in 1973; his last previous visit was in 1978. He found broad signs of progress in the program and in the society.

NEW EMPHASIS ON ENGINEERING AND APPLICATIONS

The conference in Leningrad, at which over 200 papers were presented, showed a greatly expanded and comprehensive Soviet effort on the engineering and applications aspects of fusion. Especially notable were conceptual design studies on potential next-generation engineering test reactors and designs of commercial facilities. Emphasis in the Soviet program is on the development of a "hybrid" fusion-fission reactor which would produce plutonium for use as fuel in conventional fission reactors.

As in the U.S., the engineering-oriented Soviet fusion specialists are beginning to perform systems studies of compact, high power density fusion reactors. These studies are being used as reference points for evaluating the attractiveness of conventional fusion approaches and to provide parametric guidelines for future development.

In the hardware area, many of the conference papers reported results on magnet and power supply engineering. A listing of the papers presented at the conference is available from Fusion Power Associates.

E. P. VELIKHOV, VICE-PRESIDENT OF THE USSR ACADEMY OF SCIENCES

VELIKHOV ASSUMES MORE NEW DUTIES

Academician E. P. Velikhov, who has provided effective leadership to the Soviet fusion program for many years, continues to assume additional responsibilities. In addition to his position as deputy director of the Kurchatov Institute and vice-president of the Soviet Academy of Sciences, Velikhov has recently been elected to the Supreme Soviet, a legislative body analogous to the U.S. Congress. Velikhov has formed an Energy Committee within the Supreme Soviet and will serve as its chairman. Velikhov will also head a new branch of the Soviet Academy devoted to Information and Computer Science. The activities of this program are being supported now by scientists at several existing institutes but a new institute will be constructed at Yaroslavl, 260 km north of Moscow.

INTENSIFICATION OF SOVIET FUSION EFFORT

A gradual but systematic intensification of the Soviet fusion effort has been and is in progress. The intensification has not been obvious since it is not being accomplished primarily through growth at the traditional fusion laboratories. Rather it is being accomplished mostly by expanding the attention given and effort devoted to fusion problems by specialists at other institutes both in the USSR and in collaboration with institutes in other eastern bloc countries. The growth is primarily in engineering and advanced technology areas such as nuclear sytems, computerized data acquisition, instrumentation and control, materials, optical systems, gyrotron development, power plant design, etc.

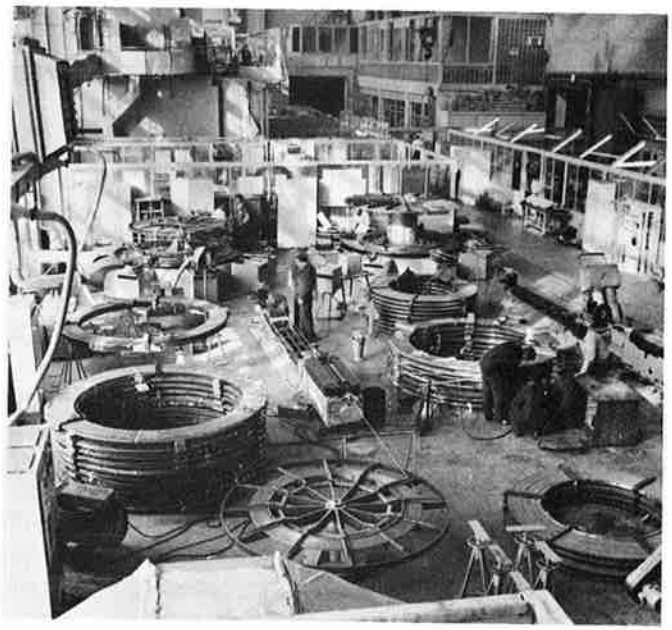
INTERNATIONAL COOPERATION

The Soviets continue to make strong, fundamental contributions to fusion research. They are active, substantive contributors to the "INTOR" next generation tokamak design under the auspices of IAEA. Academician Velikhov was the first to propose the idea that a next generation fusion facility could be a joint international undertaking and he was largely responsible for the INTOR international design team being formed. He continues to be a strong believer in the viability of such a project and expressed the belief that such a project could constitute an important element in improved East-West relations.

T-15 SUPERCONDUCTING TOKAMAK CONSTRUCTION

The first floor of the main tokamak experimental building at the Kurchatov Institute is a beehive of activity as construction workers clear out and remodel a large experimental hall in preparation for the installation of T-15, a superconducting tokamak on the scale of the largest tokamaks elsewhere in the world: TFTR, JET and JT-60. Two prototype superconducting coils for the device have been tested at the Kurchatov Institute and a prototype neutral beam injector for the device is nearing completion there. The injector parameters are 100 Amps at 80 kV for 5 sec and is designed to be upgradable to 160 kV for 20 sec.

The superconducting coils which will actually be used in T-15 are being wound in two coil winding setups at the Efremov Institute in Leningrad. One hundred of the required 144 "pancakes" have been wound and are seen stacked in the accompanying photo. These are assembled in groups of 6 into 24 coil "cans". Two of the 24 cans are now complete.



SUPERCONDUCTING COILS FOR THE T-15 TOKAMAK BEING WOUND AT THE EFREMOV INSTITUTE IN LENINGRAD

The existing large tokamak, T-10, will cease operation and be put in mothballs at the end of this year since its power supplies will be reconfigured to be a part of the T-15 installation. T-15 is expected to operate in late 1986.

RECENT TOKAMAK RESULTS

T-10 has been emphasizing studies of ECRH and combined ECRH and ICRF heating. A total of 1.2 megawatts at 93 GHz from six 200 kw (150 ms) gyrotrons has been fed to the plasma at about $3 \times 10^{13} cm^{-3}$ density. Bulk heating is observed with the central electron temperature rising from 1 to 4 keV. Absorption efficiency of the ECRH is about 75%. Plasma nT_e is proportional to power absorbed to the two-thirds power. Ion temperature is also observed to increase by up to 30% due to classical electron-ion collisions.

Preliminary experiments have been performed adding ICRF. It is planned to devote the period September-December 1984 to studies using up to 1 megawatt of input ICRF in addition to the ECRH power. The absorption efficiency of the ICRF is expected to be lower, however.

T-7, the world's first and only operating superconducting tokamak, has been emphasizing studies of lower hybrid current drive. Using 1 megawatt of input power with a coupling efficiency of about 20%, currents of 300-400 kA have been driven, allowing the initial ohmic current of a similar amount to decay while maintaining plasma current. Work is in progress to attempt to drive the current without the ohmic current by initiating the discharge with a 60 GHz gyrotron to establish a hoped-for initial current of about 2 kA.

The smaller tokamaks T-13 and TO-2 are being devoted to studies of compression and divertors, respectively.

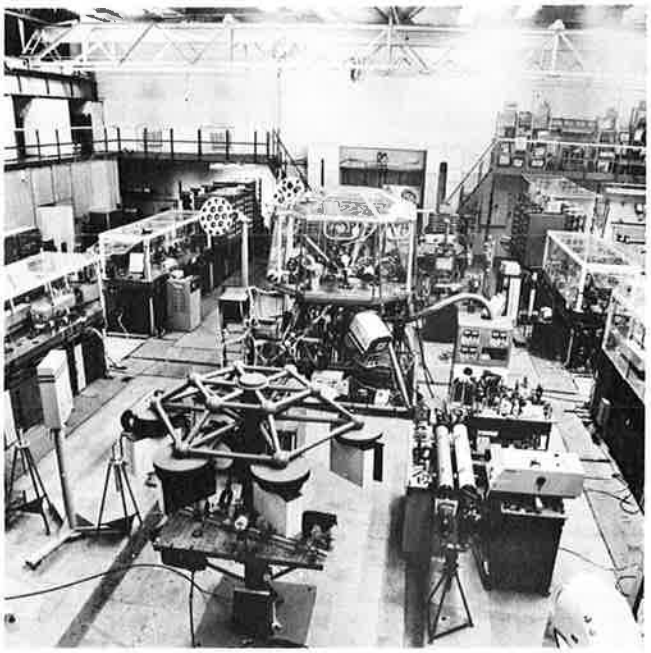
MIRRORS AND TORSATRON/STELLARATORS

Time did not permit visits to the Soviet institutes at Novosibirsk and Kharkov where the major effort on mirrors and stellarators, respectively, is in progress. Our apologies that we cannot therefore do them justice in this report.

The single cell, minimum-B baseball mirror device, OGRA-4, continues in operation at Kurchatov and a new tandem mirror is under construction at Novosibirsk. At the engineering conference, G. I. Dimov of Novosibirsk reported on the design of a possible next generation tandem mirror device which would produce 3.5 MW/m^2 of neutron wall loading from an 8 meter long central cell plasma column.

Also reported at the conference were the design parameters for the URAGAN-2M torsatron under construction at Kharkov. The device is similar to the ATF under construction in the U.S. at ORNL. URAGAN-2M (R=1.7m, a=0.24cm, B=3T) expects to produce plasmas with ion and electron temperatures of 500-1000 eV and beta of 3% at n = 1-2 x $10^{14} cm^{-3}$.

The design of a modular torsatron engineering test reactor, URAGAN-7, was also reported upon at the conference.



DELFIN-1 SIX BEAM LASER AND TARGET CHAMBER AT THE LEBEDEV INSTITUTE IN MOSCOW

INERTIAL CONFINEMENT FUSION

The six-beam Delfin-1 (1.8 kJ, 2 TW on target) glass laser, under the direction of G. V. Shlizkov at the Lebedev Institute in Moscow, has been in operation since 1981 and is the largest high power laser in the USSR. Experiments have emphasized studies showing that high aspect ratio (100-300) deuterium-filled pellets (200 micron diameter glass and plastic) can be stably compressed. Volume compressions of 1000-3500 have been achieved. The group finds that stability is not as sensitive to assymetries as had been expected. Volume compressions of 200 have been achieved even with 20% assymetries in the irradiation.

Upgrade of the facility to "Delfin-2," having 12 beams and several times the energy of Delfin-1, is approved and the group hopes to begin facility modification early next year.

KALMAR, the workhorse 9-beam glass laser since 1971, is still in operation and will be used to test large diameter laser rods being developed for use in Delfin-2. Delfin-1 rods are 4.5cm diam; Delfin-2 is planned to have 15 cm diam rods. Prototype rods of 6.0 and 8.0cm diam have been produced and rods with diameters of 11.0 and 15.0 cm have been designed.

Eventually it is expected that KALMAR will be converted to become a one-beam prototype line for Delfin-2. Thinking to the future, the group talks about a 100 kJ Delfin-5 being designed in collaboration with the Kalinsky Intitute in Poland. The group has also recently reached an agreement for scientific collaboration with the Rutherford Laboratory in England.

Unfortunately it was not possible to visit with L. Rudakov and to see the Angara-5 electron beam facility while at the Kurchatov Institute. However the facility is completed and is in operation with 8 modules. Emphasis at this time is to use the facility for liner compression experiments.

FUSION SCIENTISTS RECEIVE LENIN PRIZE

Several fusion scientists were among those recently selected to receive the prestigious Lenin Prize. The medals were awarded at ceremonies in the Kremlin on June 26 to B. B. Kadomtsev, O. P. Pogutse, R. Sagdeev and V. D. Shafranov for contributions to the theory of tokamak plasma confinement. Congratulations to our Soviet colleagues for their well-earned recognition.

BOOKS

Several recent books of interest were acquired while in the Soviet Union.

E. Kustnetsov of the Kurchatov Institute has published (1982) a 150 pg. history of magnetic fusion in the USSR.

N. G. Basov and colleagues have published (1984) a 368 pg. book summarizing Soviet and world efforts on laser fusion. A previous 2 volume set (1982) by the same authors has been published in English by Cambridge Press.

THE GENERAL SCENE

The standard of living of Soviet citizens is clearly on the rise. Consumer goods, including luxury items, were in plentiful supply in both speciality shops and in department stores. The famed "Beriozka" stores where foreign tourists thought they could buy Soviet goods not generally available to the average Soviet citizen, seem now to be an anachronism. The average man (woman) in the street in Moscow is essentially indistinguishable from his (her)

V. A. GLUKHIKH, DIRECTOR OF THE EFREMOV INSTITUTE AND LENIN PRIZE WINNER B. B. KADOMTSEV OF THE KURCHATOV INSTITUTE

well-dressed counterpart in other European cities. Consumers seem to have money and are spending it.

A massive, dedicated (indeed, devoted) effort has been underway to restore magnificent palaces and cathedrals dating back to the Middle Ages. The museums and theatres are superb.

For the average American, the biggest drawback to visiting the Soviet Union is unfamiliarity with the alphabet and the language. But with just a little preparation, and an adventurous spirit, a tour of the Soviet Union at this time is a richly rewarding cultural, historical and political experience.

FY 1985 FUSION BUDGETS

The Congress has passed the following budgets for fusion for fiscal year 1985 which begins October 1.

For Magnetic Fusion: $440 million. This compares with the current year budget of $470 million. For Inertial Fusion: $169 million. This compares with the current year budget of $170 million. The president had requested $483 million and $138 million for magnetic and inertial fusion, respectively.

For magnetic fusion, the legislation okays "conceptual analysis only" for new facilities, calls upon DOE to seek international participation in the next large facility and asks that a new, up-to-date management plan be prepared.

EXECUTIVE NEWSLETTER

AUGUST 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

EUROPEAN FUSION PROGRAM ADVANCES

The Commission of the European Economic Community (EEC) has put forward a new five-year program plan (1985-1989) of fusion research representing a six percent growth over inflation during the period. The 5-year total European fusion funding (in 1985 dollars) is estimated at $2 billion. In establishing the budget the EEC noted the very successful first year of operation of the Joint European Torus (JET) and the setting up of a project design team for the Next European Torus (NET) as important recent achievements. The plan states that the primary goal of the next period is to establish the basis for the design and construction of NET. The plan also establishes, as an essential goal, "to provide for the technology basis necessary for NET design and construction, which requires a strengthening of the technology program."

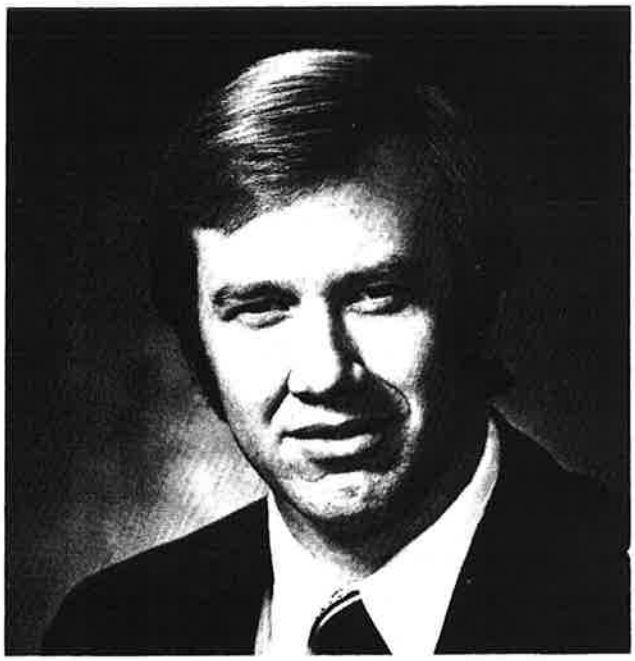
One element of the technology development work is a proposal to set up a special tritium laboratory at the EEC Joint Research Center at Ispra in Italy. The prospective schedule for the NET project involves a design phase during 1985-87 culminating with a proposal to construct the device, to be presented at the next EEC budget review in 1988.

U.S. MAGNETIC FUSION PROGRAM RETRENCHES

Citing budget cutbacks and a lack of interest in practical fusion program goals at the White House Office of Science and Technology Policy (OSTP), the U.S. magnetic fusion program is postponing plans to demonstrate fusion breakeven in the Tokamak Fusion Test Reactor in 1986 by at least 2 years.

The DOE is also delaying the completion of the Mirror Fusion Test Facility (MFTF) at Livermore by about 1 year and making across the board cuts in technology research programs especially in the nuclear areas and materials. The budget cuts will also probably result in the shutting down of some physics experiments, most likely the EBT at Oak Ridge and the PLT at Princeton. The Alcator C at MIT is also said to be in jeopardy.

In addition to the budget cut reported in our last newsletter, the magnetic fusion program has had to absorb an additional $3 million cut as part of a larger cut in DOE expenditures for computers. The resulting FY 85 budget is $437M, which is $33 million below the FY 84 level and $46 million below the FY 85 Presidential request to Congress.



LEE BERRY, HEAD OF THE EBT EXPERIMENTAL SECTION OF THE FUSION ENERGY DIVISION OF ORNL, HAS RECEIVED THE DOE DISTINGUISHED ASSOCIATE AWARD. BERRY WAS CITED FOR HIS "SUPERIOR TECHNICAL LEADERSHIP AND INSIGHT IN MANAGING THE NATIONAL EBT PROGRAM."

THE BUDGET CUTS

The cuts, relative to the president's request level of $483 million have been tentatively distributed as follows:

- $15M - delay of MFTF project by one year.
- $13M - reduction in technology programs including nuclear technologies, materials and design studies of future devices.
- $12M - reduction in Confinement Systems experimental research programs, primarily EBT, PLT and plans for tritium breakeven experiments in TFTR.
- $ 3M - reduction in Applied Plasma Physics program.
- $ 3M - reduction in FMIT materials research project.

The cuts and how they are being taken are expected to make it even more difficult for industry to assist the fusion program. Historically university programs have been protected and laboratories have performed more work in-house when budgets were reduced.

OSTP OFFICIAL SUGGESTS FUSION GOALS

Speaking to fusion personnel gathered for the MFAC meeting at Princeton July 18, Ralph M. DeVries, Assistant Director for General Science, OSTP, suggested the following goal statement for the fusion program:

> "A well-balanced program that combines the scientific richness and inherent relevance of plasma physics, and the production of well-qualified talent, with the prospect of achieving a unique energy resource in the future."

DeVries expressed his view that in order to maintain high priority in difficult financial times the fusion program must give more emphasis to "the excellence of the basic research, the talent it produces, as well as its progress toward a future energy option."

Reading from the DOE FY 1985 budget submission document, DeVries noted that only the Applied Plasma Physics portion of the program was described in a way that makes the program sound like good science. "This effort clearly expands our understanding of basic plasma physics and produces important talent. Those objectives are clearly aligned with administration policy," DeVries said. Of the Confinement Systems, Development and Technology, and Planning and Projects divisions' program descriptions, DeVries said that it sounds like these programs aim "explicitly toward the definite construction and operation of large reactor-like machines." DeVries appeared either to not understand or to not believe that the larger experiments were designed in the minimum size necessary to advance the understanding of the physics of fusion plasmas. This led one member of MFAC to ask whether he was saying that we had a "packaging" problem or a "substantive" problem. DeVries' response was that he thought we had a little of both. Copies of DeVries' speech are available from Fusion Power Associates.

TFCX: NOT LIKELY NOW

Prospects for proceeding with the Tokamak Fusion Core Experiment (TFCX) have dimmed dramatically, partly as a result of the FY 1985 budget cut and partly because of the executive branch attitude on large fusion experiments.

In addition, the four TFCX design options presented at Princeton were judged by MFAC to represent too narrow of a choice range. Specifically, MFAC has asked the community to develop two other options: "(1) a copper-coil design that is optimized for minimum cost, while meeting the basic scientific objectives and (2) a superconducting-coil design that is optimized for the highest possible scientific and technological relevance and upgradability."

COPPI PROPOSES SMALL IGNITION EXPERIMENT

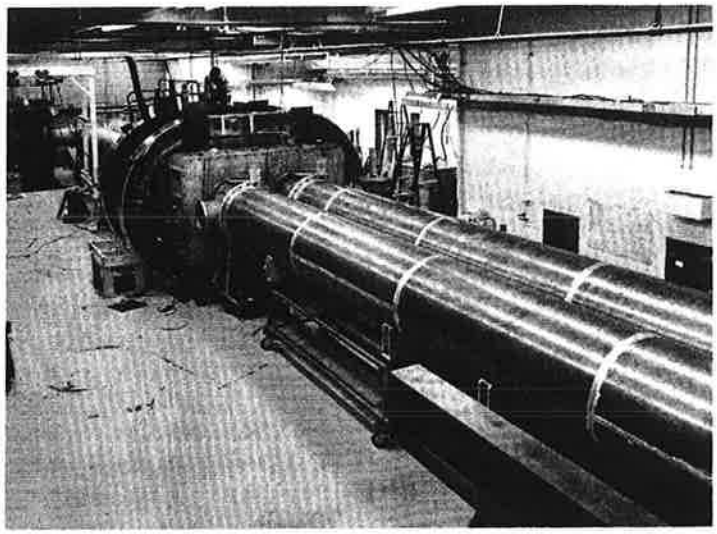
A highlight of the MFAC meeting was a presentation by Bruno Coppi of MIT on the "IGNITOR". Coppi described the device as a low cost, near-term facility "to study the alpha-particle heating of high density plasma." The tokamak would be based upon a combination of ohmic and adiabatic compression heating to reach fusion conditions. The facility has been under design by Stone and Webster Corp. and Brown-Boveri Corp. and has been proposed to the European Economic Community (EEC). Coppi estimates the cost of the device to be about $40 million exclusive of conventional facilities and power supplies. Such auxiliary facilities are available in Ispra, in Italy and at the JET site in England, he said.

The proposal was reviewed favorably over a year ago by a panel headed by the late John Adams, former director of CERN. The other panel members were Roy Bickerton (JET), Paul Reardon (formerly of TFTR, PPPL), Paul Rebut (JET) and Marshall Rosenbluth (U. of Texas). The report states "The Panel arrived at the conclusion that the physical basis for IGNITOR has been well thought out and that it is at least as good as that which exists for the design of other experiments such as TFTR and JET." The Panel made several suggestions for design changes to increase the probability that the device would reach its performance goals.

In the public discussion following Coppi's presentation, FPA president Steve Dean stated that he thought DOE should establish a senior review panel to review Coppi's ideas and that the panel should report its findings "within 6 weeks, not 6 months." He also stated that if the U.S. was serious about its recent statements on international joint fusion ventures "this project might provide an ideal candidate to get something meaningful and important done in fusion at reasonable cost in a reasonable time." He expressed continued dismay at the U.S. government's lackadaisical plans for the future and its pre-occupation with a seemingly endless series of design iterations and committee studies as a substitute for making decisions, building experiments and getting results. "We are spending over a million dollars a day while this process goes on," Dean said.

KrF LASER ADVANCES AT LANL

Los Alamos National Laboratory has announced the the production of 3000 joules of laser energy in an unfocussed beam 39 inches in square cross section using krypton-fluoride (KrF). The KrF laser's short wavelength (quarter micron), relatively high efficiency (over 6 percent) and expected capability for pulse repetition make it an interesting candidate for development for fusion applications. Work in progress is aimed at shortening the pulse from its present value of 400 nanoseconds to about 5 nanoseconds via an angular multiplexing system. Plans call for increasing the beam energy toward 10 kilojoules. A new 50 kilojoule system, called Polaris, is in the design stage. About 1 megajoule is believed necessary to ignite a fusion pellet. Louis Rosoche heads the project.



LOS ALAMOS KRYPTON-FLUORIDE LASER

SUPPORTING CONCEPTS PANEL REPORT

An MFAC panel under the chairmanship of Lee Berry presented its report at the Princeton meeting July 18-20. In a letter transmitting the report to DOE Director of Energy Research Al Trivelpiece, MFAC chairman Ron Davidson made the following points:

"1. We agree with the Panel that the supporting concepts activities have made 'large contributions to the physics, technology and reactor conceptualization of the fusion program.' These research activities are making impressive technical progress in their own right, and they also contribute to the tokamak and mirror programs through advances in the basic understanding of plasma confinement properties, and through the development of advanced technologies. We recommend continued strong support for the supporting concepts activities.

"2. In the current constrained budget circumstances, the present level of support for the supporting concepts activities as a group is about correct. However, some redistribution of funding along the lines of the priorities established by the Panel would be appropriate. Specifically, (a) the FRC, Stellarator and RFP programs were recommended by the Panel for increases, (b) the recommended EBT program represented a decrease over FY 1984 levels, and (c) the recommended Spheromak program would lead to reduced budgets over the next few years.

"With regard to the two largest supporting concept programs, the following points are also made:

"3. We agree with the Panel that continued strong support be given to the ATF base program and supporting stellarator activities. As presently designed, the ATF experiment will provide a significant complement to foreign stellarator experiments, and make strong contributions to toroidal concept development.

"4. We agree with the Panel that progress in research on the Reversed Field Pinch has been outstanding, and that this concept is technically ready to proceed with a device that has toroidal current capability in the 2-MA range or beyond. The Committee recommends that present Los Alamos design options be examined to assure that the follow-on experiment to ZT-40 effectively complements the RFX experiment under construction at Padova and the proposed upgrade of OHTE at GA Technologies, Inc."

PEOPLE

Gerold Yonas, director of pulsed power sciences at Sandia National Laboratories and a member of Fusion Power Associates first Board of Directors, has been named Chief Scientist for the DoD's "Strategic Defense Initiative" (also known as "SDI" or "Starwars"). He will be principal scientific advisor to Lt. Gen. James Abrahamsen who heads the program. Gerry will remain a Sandia employee on temporary duty assignment. He expects to be in Washington for about two years. He hopes to secure a broader base of interest and support for SDI in the scientific community. He said that he thinks scientists will be attracted to the idea of working on "purely defensive systems." Pace VanDevender will assume Gerry's duties at Sandia in his absence.

The American Nuclear Society Fusion Energy Division has elected the following officers for 1984-1985: Chair, Dale DeFreece; vice chair/chair elect, Steve Dean; secretary/treasurer, Tom Shannon; program chair elect, Carl Henning; and members of the executive committee, Don Cook, Bernard Engholm and Jim Gordon.

Maurice Sabado has joined Science Applications, Inc. and heads a new SAI office in Princeton, NJ. He was previously deputy project manager for TFTR for Ebasco Services at Princeton. Before that he was manager for mechanical engineering and design for Doublet III at General Atomic Co. He can be reached on (609) 683-2850.

DR. GEROLD YONAS OF SANDIA, NEWLY APPOINTED CHIEF SCIENTIST FOR "STARWARS"

BOOKS

Fusion Energy by Robert A. Gross, Columbia University, a college introductory text on fusion science and engineering, has just been published by John Wiley and Sons, New York. Our congratulations to Bob on a fine job.

Handbook of Plasma Physics, edited by A. A. Galeev and R. N. Sudan, North Holland Publishing Co., is also available Elsevier Science Publishing Co., Vanderbilt Ave., New York, 10017. Vol. I (1983) treats plasma physics, and Vol. 2 (1984) treats more plasma physics, fusion and space plasma. An outstanding US-USSR cooperative effort!

MEETINGS

Sept. 9-13 IAEA Conference on Plasma Physics and Controlled Nuclear Fusion Research, London. Contact Dave Nelson, U.S. DOE.

Sept. 10-14 Short Course on Fusion Physics and Technology (EE-2), University of Tennessee, Knoxville. Contact J. Reece Roth (615) 974-3461.

Sept. 17-21 and again Nov. 5-9 Tritium Safe Handling Course. Toronto and Chalk River, Canada. Contact (416) 823-7487.

Sept. 10-14 Short Course on the Design of Optical Systems (5002). University of Wisconsin, Madison. Contact Diane La (608) 263-3370.

Sept. 24-28 Thirteenth Symposium on Fusion Technology (SOFT). Varese, Italy. Contact P. Schiller, Tel. (0332) 789988/780131.

EXECUTIVE NEWSLETTER

September 1984

FUSION POWER ASSOCIATES

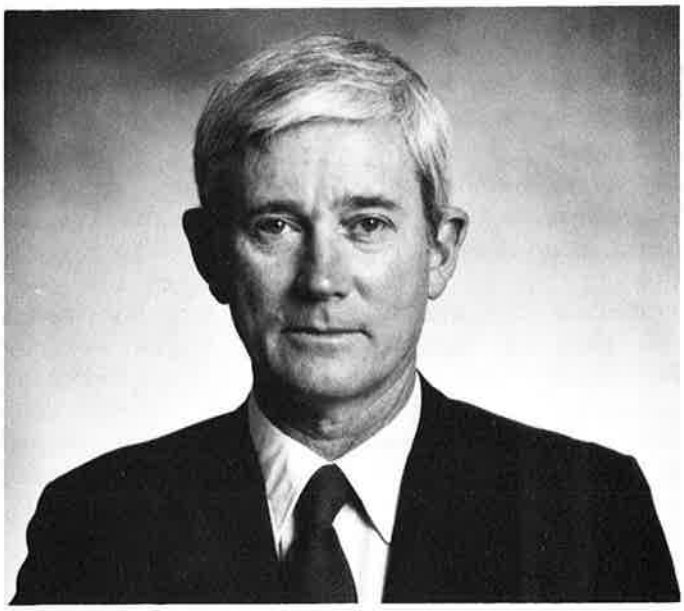
2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

WHERE DO WE GO FROM HERE?

– an exclusive interview with Dr. Alvin W. Trivelpiece, Director Office of Energy Research, U.S. DOE.

Congress recently passed an FY 1985 budget for magnetic fusion that was $43 million less than the President requested. Fusion Power Associates' president Steve Dean discussed the DOE's reactions to the cuts and their vision of the future with DOE Director of Energy Research Alvin W. Trivelpiece.



Alvin W. Trivelpiece

Dean: Were you surprised when Congress cut the magnetic fusion budget and what do you think was the cause?

Trivelpiece: I was both surprised and disappointed. For some time the fusion program has been funded at less than cost of living increases. The last few years this has been due in part to the overall budget stringencies for federal energy programs. The Congress has generally added funds to the Administration's request for fusion research; however, I was pleased that for FY 1985 the Administration asked for a solid program budget of $483M. The House authorization committee even favored increasing the President's budget by $22M. However, the House appropriations committee didn't see it that way. They recommended a $64M cut. The Senate proposed only a $10M cut, but in conference they compromised with a $43M cut which Congress then passed leading to a $440M FY 1985 budget.

There are many versions of why this happened. It is not productive to speculate which version may be right. However, it is my opinion that several members of Congress felt that the fusion program had not adjusted to the realities of the present energy supply situation and the budget deficits. I was told they "wanted to get our attention." They certainly got it!

Dean: How are you going to accommodate the budget cut?

Trivelpiece: After a careful review of where the program is and how it got there, I decided that the best course of action was to take the cut in three places, but primarily from two large projects: TFTR and MFTF-B.

First, we will delay the D-T burning experiment previously scheduled in TFTR for 1986. This will save program funds in two ways. One, it eliminates certain tritium and

remote handling costs that would have to be incurred before doing the experiments, and two, it eliminates the need to have provided additional funds in FY 1985 that would have been needed to maintain the 1986 D-T goal. The actual cut in the TFTR funding will be $9M. This delay in D-T burning of a few years will permit critical hydrogen experiments to be done with much greater efficiency and less inconvenience than would be the case after tritium is used since we would then require remote handling. I want to stress that this is merely a delay. Conducting an energy breakeven experiment utilizing DT in the TFTR is still a critical near-term milestone for the U.S. fusion program.

Second, I decided to reduce the MFTF-B operating budget by $15M. This will delay some of the FY 88 goals to 1989 or 1990. Here again, scientific objectives remain intact; however, we are extending the time frame for their accomplishment.

We have expended a great deal of time, effort and fiscal resources to define and fabricate the hardware necessary to develop the physics of linear and toroidal (tokamak) systems. It would be folly not to exploit the physics capabilities of these devices. As with any program of experimental research, future directions for these systems will depend upon the nature and significance of the scientific results achieved.

Third, I decided to reduce by $13M those development and technology activities that were not directed to support of the nearer-term aspects of the program. I recognize that we must do systems studies to give us perspective. I don't like taking cuts in the technology programs because it is simplistic to think all the good science in fusion is being done only by plasma physicists. Much of our technology development is outstanding "science" in the broad meaning of the term.

These were difficult choices to make and were not taken lightly. Given the present circumstance, I believe these actions are the best way to preserve the essential course of the program in a reduced budget situation.

Dean: Are we likely to get cut further in FY 86?

Trivelpiece: I hope not. The Department is putting together its FY 86 submission to OMB now and many things can happen between now and when the President submits his budget to Congress. I believe the program can justify the money it is getting in terms of the outstanding scientific progress and the results it has achieved. Fusion is excellent science, forefront technology and is making steady progress.

Dean: I've heard a concern expressed in the community that the fusion program may lose its focus and become a "science-only" program. What's your view on that?

Trivelpiece: The fusion program is a mission-oriented energy program and must remain so. Its aim is to ultimately provide the world with an environmentally attractive energy source. This is its long term goal, and we must remain focused on that goal. However, the need to achieve that goal is some time in the future and in the near-term we have a program that is at the forefront of many areas of advanced science and technology. We intend to emphasize the value of the research. The fact that the fusion program is an excellent research effort has gotten somewhat lost in all the energy rhetoric.

In terms of funding, the key term is "balance." I realize that much of what we do in the technology area is either absolutely essential to the scientific experiments or in many cases is contributing to our progress as a high technology society.

Dean: What about university programs. Are they more important than laboratory or industry programs?

Trivelpiece: Again I want to emphasize our intent to maintain "balance." The fusion program has been one of the outstanding examples of a federal program that consistently provided universities and students opportunities and funding to do forefront research. Since 1965, over 1100 students have received Ph.D.'s as a result of fusion support at the universities. Fusion also supports graduate fellowships in our engineering schools. About half of these 1100

students work in high tech industries that contribute to our national competitiveness and security.

Dean: What about industry? Is there a role for industry in the near-term?

Trivelpiece: Industry has played and will continue to play many, varied roles, from component supplier, to R&D, to manufacturer. It's probably true that without a near-term large construction project the dollar value and visibility of industrial opportunities will be reduced. However, this doesn't mean that industry shouldn't be involved in the program. Quite the contrary, the involvement of industry is essential to the fusion program. I hope the fusion program will retain strong industrial participation, but the budgetary pressures and near-term priorities will slow this up, along with the slowing up that will occur in other parts of the program.

Dean: Do any of your recent actions imply that you are discouraged by the prospects of the tokamak concept and feel that we need to find a better alternative?

Trivelpiece: We must continually look for better ideas and I intend to expand our support of other concepts to develop the most promising approach to fusion. At the same time, there is plenty of evidence that the tokamak provides just as good a starting point for improvement and innovation as other concepts. The tokamak provides a standard and a challenge for those who advocate other concepts.

Dean: You just came back from an economic summit follow-on meeting on fusion cooperation in Brussels. What happened at that meeting and does this mean that an international fusion project is possible?

Trivelpiece: Since the Versaille summit, the economic summit process has focused some attention on science and technology. The Versaille summit defined eighteen areas of science and technology for which international cooperation, or collaboration, would be appropriate. Fusion is one. We have the co-lead in this area along with the Commission of the European Communities. We met at Washincton D. C. last November following the Williamsburg summit and in anticipation of the London summit. Based on guidance from the June London summit, we met in Brussels in July.

What we did at Brussels was to establish three subcommittees. One is to be concerned with collaboration on major future facilities. The other two will deal with administrative and technical problems that could impede cooperation. These subcommittees are to report back to the parent committee by January as part of the preparation for the 1985 economic summit in Bonn.

This summit process has created a new channel of communication and involvement at higher political levels than has existed in the past. At higher political levels there is a general concern that there not be duplication of facilities that cost in excess of $1 billion.

I believe that we need a plan that outlines steps required to make fusion work without regard to <u>when</u> or <u>where</u> the work is done. The agreement needs to be developed to do the work world-wide in such a way that duplication of effort is avoided. All of this is difficult and time-consuming. The first few steps using the summit process have been taken. This could lead to a program of international <u>collaboration</u> where greater progress can be made without enlarged in-country levels of support. This may take the form of several bi-lateral or multi-lateral programs similar to the one the Japanese have with us on the Doublet program at GA Technologies.

Dean: What about the future?

Trivelpiece: I am confident that fusion is scientifically and technically possible. I believe that it will be an important future energy option. In the near term we need to continue to pursue research to uncover the best ideas. In the long term it has to compete economically with other energy options. The energy crisis of '75 sent us off on a path that would have had fusion reactors operating by the year 2000. But to do that requires a commitment of resources that are not likely to be forthcoming in the present energy and budgetary climate. A revised plan for the program that takes this reality into account and involves international collaboration needs to be developed. Such a planning effort is underway.

Editor's Note:

The DOE Office of Fusion Energy has indicated its intention to have a public draft of the new fusion planning document available in mid-September. Fusion Power Associates has scheduled a public symposium to discuss the contents of this draft plan. It will be held on Wednesday, October 3 at the Sheraton Potomac Inn in Rockville, Maryland. Call Ruth Watkins for registration information on (301) 258-0545. The Magnetic Fusion Energy Advisory Committee (MFAC) will also discuss the draft plan at a public meeting on October 4-5 at the Forrestal Building, Washington, D. C. Contact John Cowles at DOE for further information on (301) 353-4941.

THURSDAY, AUGUST 9, 1984 TRI-CITY HERALD Pasco, Washington

Opinion

Tri-City Herald

KELSO GILLENWATER, *Publisher*
RICHARD K. PETERSEN, *Executive Editor*
WILLIAM BEQUETTE, *Editor*

GLENN C. LEE, *Publisher Emeritus*

Fuel for the future

The Department of Energy's recent cancellation of the Fusion Materials Irradiation Test project seems a case of robbing our posterity to pick up a little pin money.

The FMIT was probably the most far-sighted of all of Hanford's energy research projects. It was to play a critical role in the nation's effort to generate electricity from fusion, the type of nuclear reaction that powers the sun and stars.

As originally envisioned, the FMIT would have been a laboratory designed to duplicate the ultra-high-energy radiation of a fusion reactor core.

This radiation is so intense that it weakens and distorts all known steel alloys. Completion of the FMIT could have allowed Westinghouse researchers to develop metals impervious to this effect — just as the Fast Flux Test Facility has already enabled them to pinpoint an alloy tough enough for advanced breeder reactors.

Unless such fusion-resistant alloys can be found, fusion reactors cannot be built. And the FMIT was the only plan the Energy Department had to find those alloys. The lack of an FMIT, at Hanford or elsewhere, will seriously delay the nation's attempt to build a commercial fusion device.

Despite the importance of the project, the Reagan administration tried twice to eliminate it from the federal energy budget, and finally agreed to continue it on condition of matching funds from Japan and the European Common Market nations. The Common Market refused to pay a third of the approximately $125 million required to build the laboratory, and the FMIT was canceled.

The loss of the FMIT can hardly be blamed on Europe, though. It was an American project, and the real reason for its demise is a weakening American commitment to ensure sufficient energy supplies for our grandchildren.

A pattern is emerging. In addition to the indefinite delay of the FMIT, Congress and the administration have backed away from plans to build a demonstration fusion reactor and other development projects authorized by the Magnetic Fusion Engineering Act of 1980. There's also an increasing unwillingness to spend money on breeder development, as evidenced by the abandonment of the Clinch River demonstration breeder and major cutbacks in funding for Westinghouse Hanford's breeder research.

The prevailing view seems to be that existing coal and uranium reserves will last far enough into the 21st century that we needn't concern ourselves much with their depletion. So we can gut our long-range energy programs when money gets tight.

Someday we will exhaust our existing energy supplies. The knowledge that it may not happen in our lifetime may be a comfort, but it should not make us willing to bequeath a catastrophe to our children.

EXECUTIVE NEWSLETTER

OCTOBER 1984

FUSION POWER ASSOCIATES

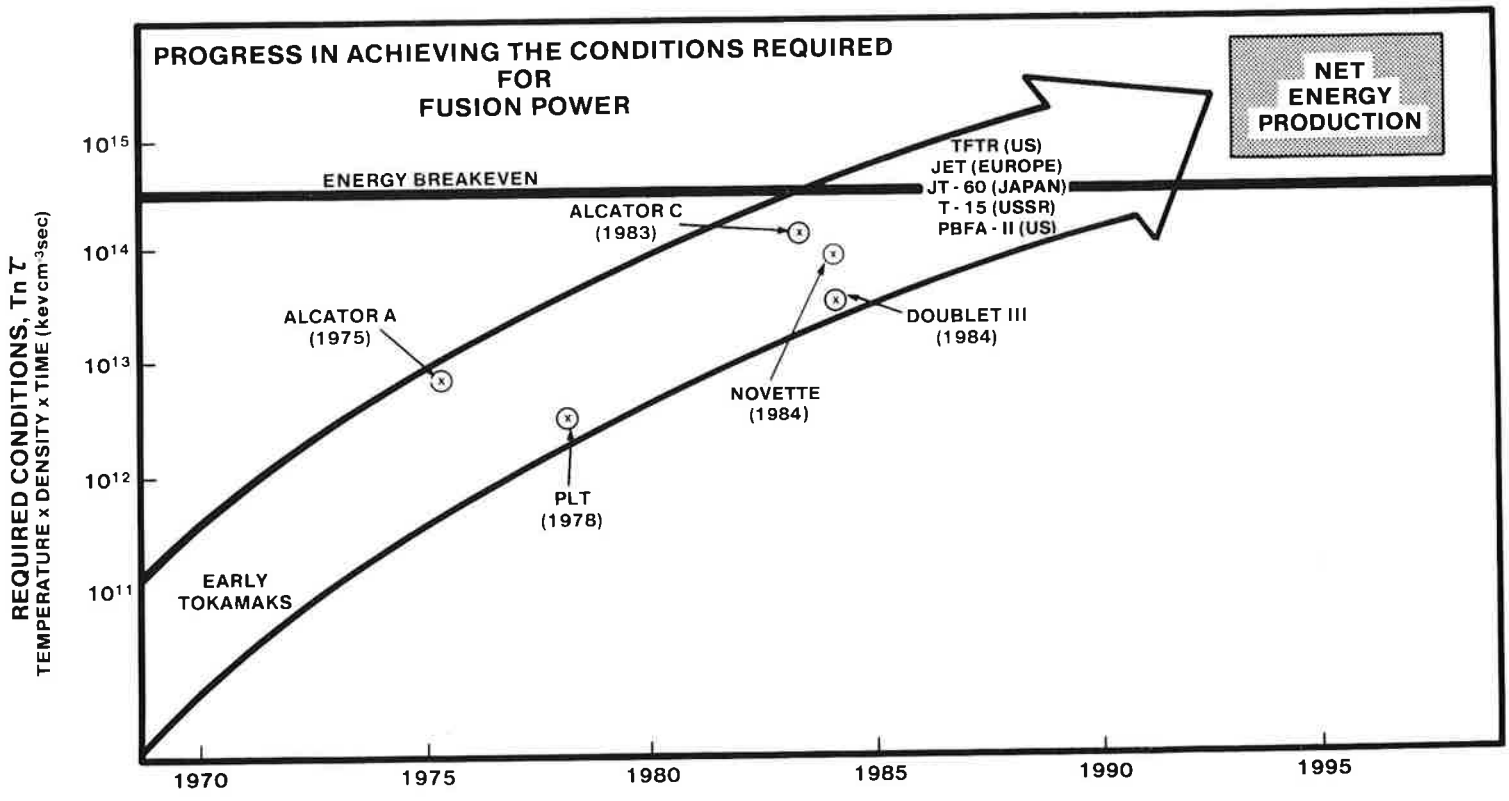
2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

PROGRESS IN FUSION POWER DEVELOPMENT

— HIGHLIGHTS OF THE TENTH IAEA CONFERENCE 12 - 19 SEPTEMBER, 1984. LONDON, ENGLAND.

- RECORD CONFINEMENT ACHIEVED IN JET: 0.62 SEC.
- RECORD PELLET COMPRESSIONS IN NOVETTE: 140 TIMES LIQUID
- FIRST ION HEATING IN TFTR: 3.2 keV
- HIGH $Tn\tau$ PRODUCTS ACHIEVED:
  - IN DOUBLETT III: 4×10^{13}keV cm^{-3}sec
  - AND IN ALCATOR C: 1.6×10^{14}keV cm^{-3}sec
  - AND IN NOVETTE PELLET: $\sim 10^{14}$keV cm^{-3}sec



RECORD CONFINEMENT ACHIEVED IN JET

Paul Rebut reported that scientists working on the Joint European Torus (JET) had set a new world record of 0.62 seconds for energy confinement time of the deuterium plasma. This is twice the previous record set by TFTR in the U.S. (see our January 1984 newsletter). The result was achieved using 3.2 MA of ohmic heating current in a $3 \times 10^{13} cm^{-3}$ average density plasma, with 1.2 elongation. The peak electron temperature was 2.9 keV. The pulse duration was 10 sec, with a flat top of about 6 sec. Later this year the first 5 MW of 80 keV neutral beams will be added to begin ion auxiliary heating. Eventually scientists plan to have 10 MW of neutral beams and 15 MW of radio-frequency (ICRF) heating available. The JET device is expected to produce a deuterium-tritium plasma at near ignition conditions by the end of the decade.

TFTR REPORTS FIRST ION AUXILIARY HEATING

TFTR became the first of the new generation of large tokamaks to achieve ion auxiliary heating using neutral beams. After what his Princeton colleagues called "heroic round-the-clock efforts during the past few weeks", Harold Eubank arrived mid-way through the conference, to report the new results. In a "typical" run, 630 kW of injected power resulted in an increase in ion temperature from 1.8 to 2.3 keV. The maximum temperature achieved was 3.2 keV with 1.15 MW injected. Eventually TFTR will have 25-30 MW of neutral injection power available. The group expects to reach breakeven conditions in deuterium plasmas in about 2 years.

TOKAMAK BUILDERS BASKING IN GLORY: HANS OTTO WÜSTER OF JET AND DON GROVE OF TFTR

DETAILED DATA FROM DOUBLET III

The Doublet III group (US and Japanese teams) at GA Technologies came into its own at this conference, reporting detailed physics results in a series of excellent papers. Topping the list was the report of raising the ion temperature to 5 keV by using up to 8 MW of neutral beam injection, while maintaining a high value for the Lawson parameter $n_o \tau_E$ of 8×10^{12} $cm^{-3} sec$. The plasma beta was also high: 2% on average; 6.5% peak.

The GA group also reported parametric studies of confinement time scaling during auxiliary heating of both ions and electrons, at various values of plasma current and elongation for limiter and divertor discharges. They found plasma current to be the key scaling variable, with confinement time increasing linearly with current.

In still another paper, the Doublet group reported on a comprehensive investigation of beta limits as a function of plasma shape. They found the primary effect to be the role shape plays in allowing the plasma to carry more current. They reported maximum values of average beta achieved of 4.5% and a beta limit scaling formula of

$$\beta \leq 3.5\ I(MA)/a(m)\ B(T),$$

in agreement with recently developed theories. In the experiment I/aB was varied from 0.5 to 1.5. Similar experiments and results were reported by the ASDEX group.

In a post-deadline paper the GA scientists also reported that experiments using an Oak Ridge-developed pellet injector achieved higher central densities and longer energy confinement times than those fueled by gas feed. Further, they found additional improvements in confinement were possible by interrupting the neutral beam injectors just prior to injecting each pellet. The success of the latter technique was ascribed to reduced edge ablation of the pellet, resulting in deeper pellet penetration.

RECORD PELLET COMPRESSION ACHIEVED IN NOVETTE

Eric Storm, newly-appointed Deputy Associate Director for ICF at Lawrence Livermore National Laboratory, reported a new record of 130-140 times liquid density for pellet compressions using the Novette laser. This surpassed the old record of about 100,

achieved using the Shiva laser. About 1000 times compressions are needed for achieving high ($\sim$100) net energy gain from a fusion pellet. The results were achieved with about 4.5 kilojoules of frequency-converted light at 0.53 microns. The NOVA laser, just coming into operation at LLNL, is expected to be capable of delivering 50-80 kJ at 0.5 microns and 40-70 kilojoules at the even more desirable wavelength of 0.35 microns. Such energies as NOVA will provide are sufficient in theory to produce ignition, self-heating, propagating burn and breakeven in a fusion pellet, but Livermore scientists believe that such a result is unlikely due to many "real-world" factors. Instead they believe the inertial fusion program should aim at developing facilities capable of providing pellet irradiation at the few megajoule level, resulting in the achievement of 100-200 times more energy from the pellet than was incident upon it.

OTHER RESULTS IN INERTIAL FUSION

Confidence is now exceedingly high in the inertial fusion community that a pellet containing thermonuclear fuel can be ignited and yield high gain using lasers or particle beams. It is believed that several megajoules (2-5) may be required for the first, unoptimized high gain pellet/driver combinations but that eventually only about 1 megajoule will be required. Solid state and gaseous lasers are believed possible that will have the required characteristics for commercial power plants.

C. Yamanaka reported on work with the 12 beam, 30 kJ GEKKO XII laser and plans for building a 100 kJ system similar to NOVA. Bob McCrory of the University of Rochester and Steve Bodner of NRL reported on progress using direct drive (unclassified) pellet concepts.

At Sandia, experiments using Proto I (see our June newsletter) showed focussing of a 1.4 MV proton beam to a diameter of 1.3 mm. These results indicate that PBFA-II, scheduled to begin operation in 1986, should achieve 125-250 TW/ cm^2 on a 3-4 mm diameter target with a beam voltage of 32 MV. This should be adequate for pellet ignition. Pace VanDevender also reported progress on Li ion diodes and pulse shortening. On the latter problem, progress was reported with the Naval Research Laboratory in which the current rise time was reduced from 40 ns to less than 20. Between 10-20 ns is needed for pellet ignition.

J. PACE VANDEVENDER, RECENTLY PROMOTED TO DIRECTOR OF PULSED POWER SCIENCES AT SANDIA, SUCCEEDING GEROLD YONAS. HIS GOAL: IGNITE A FUSION PELLET BY THE END OF THE DECADE.

OTHER RESULTS IN MAGNETIC CONFINEMENT

Tom Simonen reported observations of thermal barrier formation and radial transport in the TMX-U at LLNL. Grant Logan reported on the conceptual design of a Mirror Advanced Reactor Study (MARS) and ideas for further concept simplification. Supporting mirror research from TARA at MIT and Phaedrus at the University of Wisconsin were also reported.

Compact concept experimental results were reported from ZT-40 by Bob Massey of LANL, from OHTE by Teruo Tamano of GA Technologies, from CTX by Tom Jarboe of LANL, from FRC by Dick Siemons of LANL and from S-1 by M. Yamada of PPPL. Other compact concepts work was reported on at poster sessions. Stellarator research was reported on from scientists in Europe, Japan and the USSR.

M. Greenwald and M. Porkolab reported, respectively, on pellet fueling experiments and lower hybrid heating and current drive on Alcator C at MIT. M. Murakami summarized results of confinement of beam-heated plasmas in ISX-B at ORNL.

NEW AFFILIATE

Hoya Optics, Inc., Fremont, CA, has become the twenty-second affiliate of Fusion Power Associates. Dave K. Segawa, president, will represent the company. We welcome Hoya to participation in Fusion Power Associates.

NEW BOARD MEMBERS ELECTED

The following persons have been elected to three year terms as members of Fusion Power Associates Board of Directors commencing October 1, 1984: Ray Beuligmann, Program Director, Energy Systems, Convair Division, General Dynamics Corp.; John W. Landis, Senior Vice President, Stone and Webster Engineering Corp.; Kenneth L. Matson, Vice President, PSE&G Research Corp., and Robert L. McCrory, Jr., Director, Laboratory for Laser Energetics, University of Rochester.

NEW FUSION FACILITIES COME INTO OPERATION

Several new fusion facilities have begun operation in recent months. The $14 million Tritium Systems Test Assembly (TSTA) introduced tritium for the first time into the facility's pipes, pumps, distillation systems and storage beds. The Los Alamos team used 10.5 grams of tritium, about twice the amount that will eventually be used at Princeton in the TFTR.

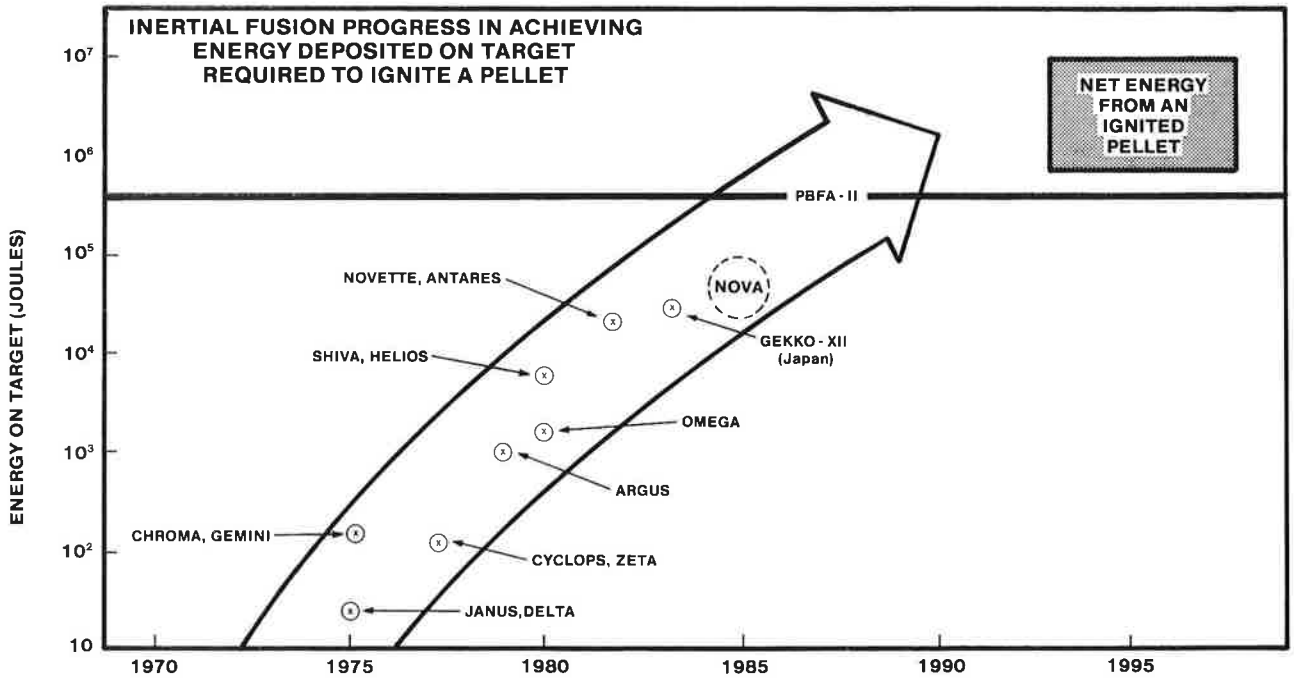
Eight of the eventual ten beams of the $176 million NOVA laser at LLNL were test fired up to an energy of 57 kilojoules in 1 nanosecond, setting a new world record power level of 57 TW. When fully operational at full power, NOVA will deliver about twice this amount of energy at 1 micron wavelength and somewhat less at shorter wavelengths.

An international team of scientists and engineers at the Oak Ridge National Laboratory (ORNL) began operation of the $36 million Large Coil Test Facility. Three large superconducting magnets (one from General Dynamics Convair Division, one from Hitachi Corp. and the Japan Atomic Energy Research Institute, and one begun by General Electric Company and completed by ORNL) are in place and being tested. Three additional coils, from Westinghouse, Switzerland, and Germany, will arrive later.

EDITORIAL COMMENT

As fusion progress has continued over the past decade, fusion skeptics have always said "Yes, but .... " When Alcator reached high Lawson parameter values of density and confinement in 1975 skeptics said "Yes, but you don't have sufficient temperature in that device." And when PLT surpassed the minimum ignition temperature in 1978, skeptics said, "Yes, but you don't have sufficient density and confinement in that device." "Come back and talk to us," they said, "when you have got all three: temperature, density and confinement time, in the same experiment." As the figure on page one of this newsletter shows, high values of temperature, density and confinement are being achieved in the same device. Even better values are on the way.

It is quite clear that fusion technology will not wait until the middle of the next century to be demonstrated as some government officials have suggested. "There is a tide in the affairs of men...", said Shakespeare in his play Julius Caeser. Say we: "There is a tide in the development of science and technology, too."



EXECUTIVE NEWSLETTER

NOVEMBER 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

PENG INVENTS SMALL IGNITION TOKAMAK

Martin Peng, Plasma Engineering Manager at the ORNL Engineering Design Center, has generated some excitement in the fusion community by proposing a tokamak design that is simultaneously small (1.5 m in major radius, 1.0 m minor radius), high beta (24%) and low magnetic field (2T). "An ignition device could be built producing only 50 MW of fusion power," says Peng, "and a breakeven device at only a few megawatts." Such a possibility, if validated, would open up a whole range of possibilities for affordable fusion test facilities.

Peng is quick to point out that such small aspect ratio tokamaks are smaller than anything for which we have current data or theory. But the designs are consistent with all known data and theory for higher aspect ratio tokamaks. (Aspect ratio is the ratio of major to minor radius.) Existing tokamaks typically have aspect ratios of about 2.5-3.5, whereas Peng's tokamaks have aspect ratio of about 1.5.

Peng achieves the reduction in size by having the central conductor be just a single solid bar of copper. There is then no inboard shielding required because there is no insulator in the bore of the machine. Because the tokamak now has a very small hole in its center and very tight aspect ratio, Peng calls his idea the "Spherical Torus."

BEVILL CITES FUSION SUPPORT

Hon. Tom Bevill, Chairman of the Energy and Water Development Subcommittee, House Appropriations Committee, was the guest of honor and luncheon speaker at Fusion Power Associates symposium on "New Directions in Magnetic Fusion" October 3. Bevill told the over 100 attendees, "I think really you're underestimating yourselves in what you've accomplished, what you've done. You are going well comparatively."

MARTIN PENG, ORNL, PROPOSES SMALL IGNITION TOKAMAK CONCEPT

"The fusion program is a good program," Bevill said, "and I have been pleasantly surprised and pleased at the support that the fusion program has received in the Congress. You have certainly come through with flying colors. We would like to see, and certainly I would like to see, much more money put into fusion, because I believe in the program," said Bevill. Regarding the upcoming budget, Bevill said, "This year's cut wasn't something that we felt good about, but I do think the chances of holding the line are good."

NEW FUSION STRATEGY DRAFT ISSUED

The Office of Fusion Energy, DOE, issued a draft "Magnetic Fusion Policy Plan" dated September 31, 1984. The draft was discussed at a Fusion Power Associates symposium October 3 and reviewed by the Magnetic Fusion Advisory Committee (MFAC)

on October 4-5. In describing the policy plan, DOE director John Clarke said that, technically, the fusion program is ready to carry out an ignited burning plasma experiment but that, politically, there is little perceived requirement for a near-term reactor or for scheduled fusion reactor development. The program response to the situation, Clarke said, will be to increase our effort to conceptualize a better ultimate fusion energy system. Such a policy would result in increased emphasis on alternate concepts, university basic research and systems analysis and less effort on reactor component engineering development, component test facilities, prototype reactor facilities and "mainline flagship projects." Clarke said that international collaboration would be used to the greatest extent possible, emphasizing early joint facility planning.

MFAC RESPONDS

After reviewing the draft policy plan the MFAC sent a letter dated 5 October to DOE Director of Energy Research Al Trivelpiece recommending that:

"o There should be a clearer and stronger enunciation of the long-term energy goal of the fusion program. This will have a significant impact on the progam's ability to attract highly talented people. Inclusion of a time frame for fusion energy development would greatly strengthen the document.

"o The strategic plan itself should include, in general terms, a statement of accomplishments to be expected during the next five years, if the proposed strategy is implemented. This should include anticipated progress in the national program, preparation for international collaboration in the future, and the anticipated technical readiness to accelerate reactor development when opportunities and circumstances warrant it.

"o The section on scientific and technological progress (Sec. IV) should also include reference to significant technical advances in the alternate concepts and technology areas. This section should also include progress related to the plasma pressure and beta value.

"o The document should include emphasis on increased understanding of the 'engineering' science as well as the 'plasma' science required to develop fusion as an attractive energy option.

"o International collaboration and joint planning is an appropriate central feature of the strategy. MFAC agrees with the conclusions of the recent NRC study that maintenance of a strong national program is a prerequisite for effective international collaboration."

AIF COMMENTS

Based upon a September 19 meeting, the Atomic Industrial Forum's Committee on Fusion sent the following letter dated October 5 to John Clarke stating:

"The following general comments are submitted with the thought that they may be useful in the preparation of the final policy plan.

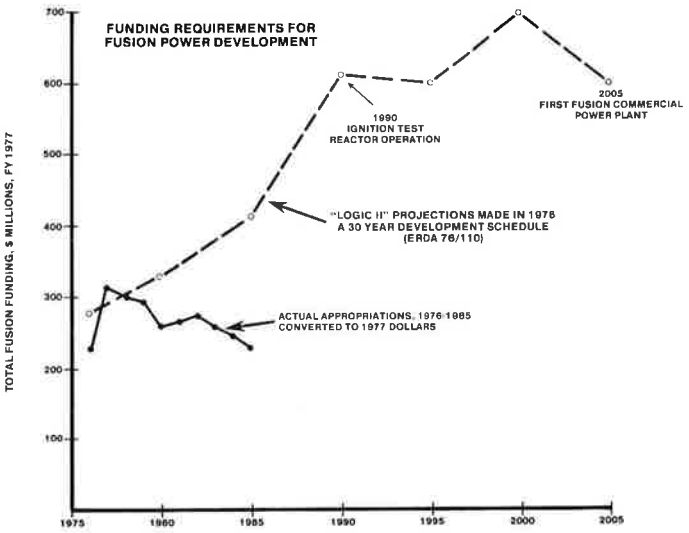
"Foremost is the concern for the enormous gap in perception that exists between industry and government concerning private sector commercialization. The members of the committee believe it is totally unrealistic to assume that once a scientific and related technology data base is established in the program, the stage will be set for 'private sector commercialization of attractive fusion energy sources.'

"Uncoupling program activities from a clearly defined goal of useful energy production in the members' view weakens support and invites cuts in program funding.

"These general comments are believed to represent a fundamental gap in understanding between government and industry that needs to be defined and closed."

AVS TO MEET IN RENO

The 31st National Symposium of the American Vacuum Society will meet in Reno December 4-7 at the MGM Grand Hotel. There will be seven sessions of fusion papers on both magnetic and inertial confinement. For information contact Marion Churchill at ANS, (212) 661-9404.



DEAN LOOKS AT PAST, FUTURE

In his introductory remarks to the FPA October 3 symposium, FPA president Steve Dean took a look back at the 1976 long range plan for fusion (ERDA 76/110) and compared (see figure) the amount of funding actually received since that time to the amount projected to be required for a 30-year development program leading to a first commercial fusion power plant in 2005. "Clearly we have not been on a path that will get us to the end point," Dean remarked. "It is the burden of a plan or planning activity to explain, as best one can, how one is going to get from where one is to where one wants to go," he said. Dean noted that, in addition to base physics and technology programs, proof-of-principal experiments and major scaleups of those experiments it is necessary "to do some other things, like make some energy and study some engineering issues and learn what to do with fusion, if eventually we are to get to commercial fusion power." "This will require building some energy-producing experimental reactors," Dean said.

SMALL BUSINESS AWARDS

Seventeen small business awards for fusion were made from DOE's Small Business Innovative Research Program recently. A total of 106 awards were made in all areas averaging about $50,000 each. Among FPA members, JAYCOR won three and Applied Microwave Plasma Concepts, Inc. won one. KMS Fusion won an award in the environmental effects instrumentation area. Energy Applications & Systems Inc., a firm recently founded by S. Locke Bogart, also won a fusion award.

CONN WINS LAWRENCE AWARD

Robert W. Conn, professor of nuclear engineering, UCLA, is one of six recipients of the 1984 DOE Ernest O. Lawrence Award for outstanding contributions in the field of atomic energy. Bob was cited for his "pioneering contributions to fusion reactor engineering and for his articulate representation of the engineering needs of fusion." Previous fusion recipients of this prestigious award are Paul Rutherford and George Zimmerman (1983), Grant Logan (1980), John Emmett (1977), Harold Furth (1974), John Nuckolls (1969), and Marshall Rosenbluth (1964).

DOE MERITORIOUS SERVICE AWARDS

Three fusion program managers and the manager of the Oak Ridge Operations Office were among 28 recipients of DOE's Meritorious Service Award. The award, consisting of a silver medal and certificate, is the second highest award granted for "achievements which substantially contribute to the accomplishment of the mission or major programs of the Department of Energy." The awardees included N. Anne Davies, Director, Toroidal Confinement Systems Division; James F. Decker, Director, Scientific Computing Staff; Richard L. Schriever, Director of Inertial Fusion; and Joe B. La Grone, Manager, Oak Ridge Operations Office.

AWARD WINNERS (l. to r.) TOP: Bob Conn, N. Anne Davies; Bottom: Jim Decker, Rick Schriever

WISCONSIN FORMS FUSION TECHNOLOGY INSTITUTE

The University of Wisconsin, Madison, has established a Fusion Technology Institute to coordinate, promote and conduct research on the development of fusion as a viable energy source. The institute, located in the College of Engineering, will provide a new administrative structure for more than 15 existing fusion technology research projects and will help initiate new ones.

Gerald L. Kulcinski from the nuclear engineering department will direct the institute. According to Kulcinski, the "institute will focus on the engineering problems of confining fusion reactions and extracting useful energy from them in electrical power plants of the future."

In addition to Kulcinski, institute administration includes associate directors Gilbert A. Emmert, magnetic fusion technology, and Gregory A. Moses, inertial confinement fusion technology. Group leaders are John F. Santarius, plasma engineering; Robert R. Peterson, dense plasma physics; Peter Walstrum, magnetics; Mohamed E. Sawan, neutronics; and Igor N. Sviatoslavsky, blanket and design.

ORNL ORGANIZATIONAL CHANGES

Lee Berry, formerly manager of the EBT program, has been named Associate Division Director for Development and Technology, ORNL Fusion Energy Division. Lee will direct all ORNL D&T activities, with the exception of the Fusion Engineering Design Center. John Sheffield has been named Associate Division Director for Confinement, with responsibility for all Confinement Systems and Applied Plasma Physics Programs. Under Sheffield, Mike Saltmarsh has been appointed head of the Confinement Projects Section and Julian Dunlap will continue as head of the Toroidal Confinement Physics Section.

BOOKS

John Wiley and Sons (New York) has published a book on Statistical Physics and Chaos in Fusion Plasmas as part of a series of texts in Nonequilibrium Problems in the Physical Sciences and Biology. The book was edited by C. W. Horton, Jr., and L. E. Reichl of the University of Texas and contains contributions from 42 scientists from all over the world.

INESCO FOLDS

INESCO, the gutsy company formed by Bob Bussard and Bruno Coppi in 1976, has closed up shop and layed off the remainder of its employees due to a lack of support. The effort has been funded primarily by R. C. Guccione from profits from Penthouse magazine. The current issue of Venture magazine quotes Guccione as saying that he had intended to fund the project in the future from profits of a gambling casino he was building in Atlantic City. However, the construction of that facility has lagged and its completion is uncertain. INESCO decided to close shop after D. H. Blair and Co., a New York brokerage firm, failed to issue a public offering of INESCO's stock. According to a preliminary prospectus the company expended over $15,000,000 since its inception.

LASER PROPOSALS SOUGHT BY ROCHESTER

Proposals to do experiments at the University of Rochester's National Laser Users Facility are due by February 1, 1985. Research funds of approximately $750,000 are available to support the work. Proposals are accepted from any competent group, including university, industry and government laboratories. More information about proposal guidelines and the resources available can be obtained from Thomas C. Bristow, Manager, National Laser User Facility, Laboratory for Laser Energetics, University of Rochester, 250 East River Road, Rochester, NY 14623 (716) 275-2070.

ORNL COMPLETES JET SUPPORT TASKS

Scientists at ORNL have completed tests on the possible use of beryllium as a material for limiters in the Joint European Torus (JET). ORNL received $2.1 million from the European lab to perform the tests in the ISX-B tokamak. The beryllium limiters used in the tests were built by Sandia National Laboratories, Albuqeruque. Peter Mioduszewski was physics project manager and Phil Edmonds designed the experiment and was responsible for its operation. In addition to providing design data for limiters, the test also provided basic knowledge on the material properties.

EXECUTIVE NEWSLETTER

DECEMBER 1984

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

NEW DIRECTIONS IN MAGNETIC FUSION

HIGHLIGHTS OF FUSION POWER ASSOCIATES SYMPOSIUM
October 3, 1984, Rockville, Maryland

Part 1: The Role of Industry

THE SYMPOSIUM

Congressional action on the FY 1985 fusion budget resulted in funding cutbacks and called for the preparation by DOE of a new fusion program plan. This symposium was convened for the purpose of receiving a presentation from Dr. John F. Clarke, head of the U.S. magnetic fusion program, on the first draft of the new policy plan and to conduct panel discussions on several important topics related to the policy plan. The panel discussions covered four areas: the role of industry, the role of tokamak ignition device options, the role of improved fusion concepts and the role of technology research and development.

PLANNING

In his opening remarks, Fusion Power Associates' president Steve Dean stated that "there is a continuing need to develop a spirit of cooperation among all the organizations that are working on the program because we are a small community in a country that has got a lot of fish to fry." "We have a lot of work to do to get people to understand what it is we do and why it is important," Dean said. Dean pointed out (see our November newsletter) that, since 1976, we have not been getting the funding, nor making facility commitments, that would allow us to claim we are on a path to a scheduled endpoint of operating a power plant. "It is the burden of a plan or planning activity to explain, as best one can, how one is going to get from where one is to where one wants to go," he said, "A real plan must contain milestones, activities needed, schedules and costs." He noted that in addition to base physics and technology programs, proof-of-principle experiments and major scaleups of those experiments, it is necessary "to do some other things, like make some energy and study some engineering issues and learn what to do with fusion, if eventually we are to get to commercial fusion power." "This will will require building some energy-producing experimental reactors," Dean said.

NEW DIRECTIONS

In his keynote address, describing the new draft policy plan, John Clarke said that technically, the fusion program is ready to carry out an ignited burning plasma experiment but that, politically, there is little perceived requirement for a near-term reactor or for scheduled fusion reactor development. The program response to the situation, Clarke said, will be to increase our effort to conceptualize a better ultimate fusion energy system. "Given the changed external perception of what is needed from the program, clearly the way in which we organize the pieces has to change," Clarke said. "The changes will consist of different priorities and pacing of the research we are doing." He said the new policy would result in increased emphasis on alternate concepts, university basic research and systems analysis and less effort on reactor component engineering development, component test facilities, prototype reactor facilities and "mainline flagship projects."

"Flagship is a code word around Washington these days," Clarke said. "Just to clue you in on the code, its bad. Flagships are bad."

Clarke contrasted his present draft policy plan with the previously issued Comprehensive Program Managment Plan (CPMP) (see our August 1983 newsletter). The CPMP "tried to bring major elements of the program to an early conclusion in order to free up resources, to rapidly move on to the next step in the program," Clarke said, whereas in the new policy plan "we will be emphasizing breadth in the program and innovation for the development of a more promising reactor concept." "Rather than emphasizing international leadership, it will emphasize international collaboration." Clarke said that international collaboration would be used to the greatest extent possible, "emphasizing early joint planning of programs and projects."

Clarke commented, "In this new program, we visualize the role of industry as more systems analysis. If we are indeed trying to develop a better fusion product, we recognize that we will need the help of industry and the practical engineering orientation of industry to keep us on the right track."

He said, "In the old plan, the national laboratories were envisioned as supporting a reactor thrust, supporting the development of specific components that would be then needed for moving on to the the next step in this reactor development, and the universities were perceived as basically training new people in the implementation of future programs. Now we have to put more emphasis on the development of innovative ideas in fusion because you have to produce a condition that doesn't exist in nature.

We require large facilities. The national laboratories are a unique tool that the United States has available to carry on the kind of large science that is required to address certain problems in fusion, and these innovative ideas will eventually lead, like some of them today demand, to the kind of facilities that the national laboratories uniquely possess. On the other hand, as far as the universities are concerned, in addition to their role of providing new talent for the program, which was our perception of their traditional role, we will be looking to them for these new ideas, for developing the germinal, seminal ideas that years from now hopefully will represent major focuses and thrusts in the program."

Clarke continued, "Somehow we have to develop better, stronger working relationships between the laboratories, universities and industries in order to emphasize the contribution of their unique talents to the needs of the program."

ROLE OF INDUSTRY

The panel on the role of industry in the program plan was chaired by Harold K. Forsen of Bechtel. The panelists were Dale A. DeFreece (McDonnell Douglas Astronautics Company), T. Kenneth Fowler (Lawrence Livermore National Laboratory), James A. Maniscalco (TRW, Inc.), Leonard F. C. Reichle (Ebasco Services, Inc.), and Roger Gould (Princeton Plasma Physics Laboratory).

Forsen summarized the recommendations of MFAC Panel 7 on this subject (see our June 1984 newsletter). Panel 7 noted that "the absence of a DOE document, that describes the many tasks required before fusion commercialization, makes long range planning for laboratories and industry difficult and may lead to false long-range planning assumptions." The Panel 7 also noted that "DOE has not established a clear policy for contracting with industry for supporting R&D programs in the context of a national long-range plan for fusion development." That panel also noted that "industry prefers a role in the fusion program where specific tasks are assigned and where the total experience of a company can be applied to solve these tasks."

Commenting on the new draft policy plan, Forsen said, "What is missing is how the technology will be transferred to industry," and "how (U.S.) industry will not be shut out by selective international collaboration."

DeFreece noted that McDonnell Douglas has now been in fusion about 10 years and believes that industry is "absolutely essential when we think of trying to get to the point of having a data base from which you can assess whether you can go commercial or not." "Absolutely the only way that can happen is where industry has had

a significant and substantial role in that development process," DeFreece said. DeFreece noted that technology transfer to other areas is "automatic where industry is involved" and cited several examples within his company where spinoffs from fusion activities resulted in other business developments. DeFreece noted also that a close association has developed between McDonnell Douglas and universities, including student internships at the company. But "in the final analysis," DeFreece said, "we have to operate it as a business and that requires an accurate assessment of just what our opportunities are in terms of the resources that we need to retain within fusion versus transfer someplace else." "We built up a view of the program that was based on milestones and a planning strategy that went along with that, and when we see things like Q = 1 on TFTR (see our August 1984 newsletter) slipping, that was a symbol greater than the scientific accomplishment, in our planning process. And when we see a pushing off of initiation of something like TFCX that's bad news internally in terms of trying to defend our program," DeFreece said.

Fowler advocated the formation of laboratory-industry partnerships. He stated he believed there would be opportunities for industry to work with laboratories on systems studies, experimental operations and construction. "To me," Fowler said, "a partner is one who is interested in all of the three opportunities I've mentioned. He cares about why we're doing it. Therefore, he wants to analyze this product. He has to understand how it really works. So he wants to participate in the experiments on it, and when there is a new facility to be built, he wants to gain the experience he can from participating in the building of it."

Maniscalco stated "I don't believe that the role of industry in the fusion program has to decrease. In fact, I'm sure that we can't afford to let it happen, because it really could have drastic consequences for the vitality of our program. For example, without meaningful industrial participation, our program could find itself heading in a ridiculous, but unfortunately not too uncommon situation, in which the U.S. could be the first to demonstrate the feasibility of fusion, only to find Japanese industry the first to capitalize on it."

DALE DEFREECE, MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

"I think it's important for us to increase the intellectual involvement of industry in the program, and I think that this can be done within the existing program without requiring large budget increases or large new construction starts," Maniscalco said. He supported the concept of partnerships of industry with both laboratories and universities. One of the advantages of such partnerships, Maniscalco said, is that "they provide rapid transfer of the technology being developed in fusion to industry." "This will accelerate the technology spin-off to commercial markets," he said. "TRW's commitment to fusion is not being justified "on the basis of near-term sales or on the profits we expect to make from commercialized fusion in the future," Maniscalco said, "rather this commitment has been justified on the basis of technology spinoffs."

Reichle pointed out the damage caused when DOE stimulates industry by letting requests for proposals for projects like TFCX and then cancelling them. Reichle said that in view of the changed circumstances "I think industry must recognize that the national labs and the universities have a prime role. I think we should recognize that and industry should get behind the national laboratories and the fusion-funded universities and play a subordinate role on a subcontract advisory basis for the foreseeable future, until we can get a little closer to the end goal. But I think the other side of that coin is that the national laboratories and the universities have to share their budget and involvement with industry."

Areas Reichle recommended, wherein subcontracting to industry could be intensified, included systems integration, design and fabrication, component supply, management, operation and maintenance.

Gould, Director of Procurement at Princeton, said that "It is the intent and has been the intent and will continue to be the intent of the laboratory to augment the staff with industrial participation." He listed a variety of specific examples of industrial work in progress at Princeton.

INTERNATIONAL COLLABORATION RECOMMENDED

A committee headed by Joseph G. Gavin, Jr., president of Grumman Corp. (see our October 1983 newsletter) has submitted its report stating that "On balance, there are substantial potential benefits of large-scale international collaboration in the development of fusion energy." The study was commissioned by the Department of Energy through the National Research Council. DOE Director of Energy Research Alvin W. Trivelpiece told FPA he thought the report was "outstanding" and could serve as "a guide for international collaboration in general, not just in fusion." The report points out that "both European and Japanese planning is detailed and resources are rather firmly committed for the next few years...." It states that overseas "The United States is perceived as being an 'unreliable partner' based on previous experiences...." "There are also perceptions of the United States as not having a firm commitment to develop fusion, nor of having a sound development plan," the report states. Nevertheless the report concludes "There is a host of considerations that must be resolved in implementation, but these appear workable." Copies of the report entitled "Cooperation and Competition on the Path to Fusion Energy" are available from the Energy Engineering Board, National Research Council, 2101 Constitution Ave., N.W., Washington, D. C. 20418 or call John Richardson (202) 334-3344.

WORLD FUSION PLANS PUBLISHED

Overviews of fusion development plans for the U.S., Japan and Europe are among 30 papers on fusion recently published by the American Nuclear Society in a special 224-page issue of Fusion Technology (Sept. 1984, Part 2). The papers were originally presented at an international conference in Madrid Sept. 26-Oct. 1, 1983. The special edition was prepared by guest editor Manfred Kaminsky, assisted by FT editor George Miley. The U.S. paper, co-authored by Bob Dowling, John Clarke and Sam Berk is based on the now-defunct strategy of the Comprehensive Program Management Plan, but otherwise accurately describes the technical content of the U.S. program. Ch. Maisonnier of the Commission of the European Communities is author of the European paper and A. Miyahara of Nagoya is author of the Japanese paper. The issue also contains a paper by Paul Reardon on construction and startup tasks in TFTR. Most of the other papers deal with fusion vacuum and surface-related problems. Single copy price is $52.00, available from ANS, 555 North Kensington Ave., La Grange Park, IL, 60525.

NEGATIVE ION WORK ADVANCES

Scientists at the Lawrence Berkeley Laboratory, in early October, produced a 1 amp beam of negative hydrogen ions from a surface conversion source and accelerated it to 80 keV. The pulse length was 30 sec. LBL senior scientist Bill Cooper sees the result as "a critical step toward the eventual development of high energy, long pulse neutral beam systems based on negative ions."

IN MEMORIAM

We are sad to report the death of our long-time friend and colleague Jim Shearer. For the past several years Jim fought a losing fight against cancer while maintaining a demanding work schedule. Jim received his B.S. and Ph.D. in physics from MIT and, since 1957, worked at the Lawrence Livermore National Laboratory in both the inertial and magnetic fusion areas. Jim was known best for his warm personality and his inclination always to be looking slightly off the beaten track for a new idea. We will miss him.

QUOTABLE

"You have to set doable goals, but you still have to have a very lofty vision. you need a well-articulated vision that people can follow."

- Steven P. Jobs, Chairman
  Apple Computer Inc.