JANUARY 1991

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

EUROPEANS MAP FUSION STRATEGY

- "RETAIN CAPABILITY TO GO AHEAD ALONE"
- "INSISTS ON A BIGGER ROLE FOR INDUSTRY"

EUROPEAN FUSION REVIEW

The Commission of the European Communities (EEC) has issued the "Report of the Fusion Programme Evaluation Board". A summary of the report was presented at Fusion Power Associates recent annual meeting by Dr. H. Bruhns of the EEC. Copies of the report may be requested from Dr. Bruhns at the EEC in Brussels (FAX 32-2-236-4252). Copies of the Preface, Synopsis, and Recommendations can be obtained from Fusion Power Associates.

The report was requested by F.M. Pandolfi, vice-president of the EEC. The nine person Board was chaired by Prof. Umberto Colombo (Chairman, ENEA, Rome, Italy) and, with the exception of Prof. Francis Troyon of Switzerland, none of the Board members worked in the fusion field.

The "Terms of Reference" of the review included the following charges: (1) "to conduct the independent evaluation. . . ; (2) to appraise the environmental, safety-related and economic potential of fusion as an energy source, in particular for the Community; (3) to analyse strategic options for the Community Fusion programme . . . ; and (4) . . . to formulate recommendations on future strategy and on the necessary means for its implementation."

The Board made 38 recommendations; only the highlights are summarized below.

IMPORTANCE OF FUSION

The Board states that "Nuclear Fusion has a great potential for the future of Mankind" and that "fusion can become a reality at a time in the future when the combination of the problem of energy supply and the need to preserve the quality of the environment and global climate mean that it is one of the few remaining practicable options." They recommend that "The European Community should retain fusion as high priority in its R&D strategies." They recommend "a stepwise strategy towards the prototype reactor should include, after JET, an experimental reactor (Next Step) and a demonstration reactor (DEMO). The report states that "The European fusion strategy was conceived in its present form in the 1970's. It is clearly stated and has the benefit of simple logic. It has, moreover, been very vigorously followed ever since. It is thanks to this clear overall view that much of the progress so far achieved by the European Fusion Programme has been attained." The Board states that "a great part of Europe's present leadership is due to the outstanding success of JET. . . which has achieved world records over the last few years. . . ." They recommend extending the life of JET to 1996, "with tritium operation in the last two years."

THE NEXT STEP

The Board states "There is now need for a new device to go beyond the next threshold in fusion research. The Next Step machine must reach ignition and sustain it for long burn times. It must solve all outstanding problems of plasma physics and plasma technology. It must provide the basic data for building a demonstration reactor (DEMO) capable of producing electricity with a capacity comparable

to that of future commercial plants." The Board states that it is preferable to proceed on the next step device on the basis of international collaboration (ITER) rather than as a European-only venture (NET) "for technical and economic reasons," stating that "Moreover, a long term research programme centred on ITER could become the symbol of what science and technology can achieve for Mankind if resources from the World's major industrial countries were pulled together." However, the Board notes "The fact remains that this international initiative is an R&D enterprise of unprecedented complexity, requiring the continuing commitment of four partners over a very long timespan. Europe would be well advised to retain capability to go ahead alone with NET, should undue delay or problems of a political nature arise that might jeopardize the ITER initiative." Furthermore, the Board states that although "Europe must express its full commitment to the ITER concept," it should emphasize "a preference for a widely based ITER Programme rather than an agreement merely for a single device." With respect to the current ITER conceptual design, the Board "recommends that moves be made towards a convergence of the NET and ITER designs in the belief that European preferences in concept and design, as represented by NET, are scientifically sounder, as well as financially more attractive." Specifically they expressed their preference for purchasing tritium rather than having a breeding blanket and their preference for postponing non-inductive current drive until "a subsequent stage of operation."

ON INDUSTRIAL PARTICIPATION

The Board's statements on industrial participation include the following. "The Board insists on a bigger role for industry in the European Fusion Programme, especially in view of the need to inject industrial expertise into realization of the Next Step. The Board recommends that it is important for the success of the fusion effort that all the critical technologies be available in Europe. It is above all essential for European industry to acquire experience in manufacture and testing. In this pre-commercial phase, the Board recognizes that, among various measures, this will require pre-financing of selected suppliers to ensure their ability to develop the required components, sub-sets and sub-assemblies at the time these become critical. The Board recommends that the Commission use all available flexibility in tendering procedures to ensure the desirable continuity in industrial commitment, accepting that open competition among all European firms who wish to tender for a fixed price contract may conflict with the Programme's over-riding requirement of quality as well as industry's need for continuity. This will involve concertation between the Commission, European industrialists, the Associations and other interested parties, and within the Commission itself, to establish modalities for the creation and management of pan-European consortia operating at the cutting edge of technology, several decades away from commercial exploitation of nuclear fusion and designed to place European industry on a level playing field with that in other parts of the world."

ON ALTERNATE LINES AND CONCEPTS

With respect to the Stellarator concept the report states "Although less advanced than the Tokamak, the Stellarator line might offer advantages in terms of a commercial reactor, such as continuous operation and the absence of plasma disruptions which may lead to severe mechanical stresses in a Tokamak, thus improving the reliability and availability of such a plant. Given the long lead time to commercialisation of fusion reactors, the Programme should allow sufficient resources to be devoted to the line."

With respect to the Reversed Field Pinch the report states "The Board recommends that milestones be defined on the path to an adequate demonstration of a possible solution to the two crucial issues of the Reversed Field Pinch configuration, namely: retention of very pure plasmas at up to the highest current and improvement in confinement, both to be explored on RFX."

With respect to Inertial Confinement Fusion the Board states "The Board cannot recommend additional allocation of resources over the current level from the Community's Fusion Programme to support ICF research. At this stage, this line of development is not seen as competitive in Europe with magnetic confinement fusion. The Board believes that, together with results reported from other programmes elsewhere in the world, the nationally-funded exploratory research activities will provide adequate information to judge whether ICF has a real future for commercial power application. Progress should be monitored however and, in the event of any breakthrough, the Community's watching brief should be reviewed."

ON ENVIRONMENT, SAFETY AND TECHNOLOGY

The Board placed special emphasis on environmental and safety aspects of fusion, saying the "Demonstration of the

safety and environmental feasibility of fusion power must be considered a primary objective of the Fusion Programme, to be pursued in parallel with the demonstration of scientific and technological feasibility. Adequate funding and priority must be devoted to this issue." Furthermore, "The Board recommends that environmental and safety criteria should govern the evolution of the European Fusion Programme and be monitored by an Environment and Safety Team." Also, "The Board recommends the launching of a European reference design for a commercial fusion reactor. This design will require periodic updating as research progresses, in particular to incorporate safety and environmental protection features likely to ensure public acceptance and to take into account the requirements of utilities in operating such a reactor."

With respect to technology, "The Board recommends that considerably more attention and resources must be devoted to technological aspects, especially where these aim ultimately at ensuring the economic, and above all the environmental attractiveness of fusion as a commercial power source." Furthermore the Board states "The problem of the need for a powerful source for high energy neutrons for materials testing should be addressed with the utmost urgency. Such a source should be made an integral part of the ITER programme. The Board understands that - as a first step - an international agreement for the adaptation and use of an existing American facility might be possible, and recommends active consideration of how best to investigate this option."

WATKINS SEEKS FUSION FUNDS

Energy Secretary James Watkins, on January 8, sent a request to Congress asking permission to reprogram funds within the Department in order to restore $25 million of the $50 million Congressional cut from this years magnetic fusion budget (see our November and December 1990 newsletters). In a letter to the heads of the relevant authorizing and appropriations committees of both House and Senate, Watkins said "From my perspective, the timing for this ($50 million) reduction could not have been worse . . . . I do not believe a reduction of $50 million is appropriate given the progress that has been made and the program's potential as a future energy source." Watkins proposes to get the additional $25 million by relieving the magnetic fusion program of $9 million of "landlord" responsibility costs at Oak Ridge and by using $16 million of unobligated prior year funds from a variety of sources. As reported in our December newsletter, however, Watkins does not propose to restore funding to any of the concept improvement programs that were ordered to be terminated last month. Princeton Plasma Physics Laboratory is the beneficiary of the largest amount of the restoration, receiving back $8.1 million of the $11.3 cut from their budget last month. General Atomics and MIT also receive funds ($2.9M and $1.7M, respectively) sufficient to restore cuts made in their budget last month. Los Alamos National Laboratory, Oak Ridge National Laboratory and Spectra Technology, Inc. budgets are severly reduced.

The full text of the Watkins letter and its tabular enclosures are available from Fusion Power Associates. Excerpts from the letter are provided below.

"Reducing the FY 1991 MFE budget to $275 million would have severe consequences for this program, making it impossible to implement even FPAC's recommendations for the contrained budget case in FY 1992 and future years. Essential program elements would have to be eliminated, the program's infrastructure would be damaged, and the program's efforts at international collaboration would be undermined. In short, a fusion energy program would not be possible under these circumstances.

"Specifically, it is our assessment that the $50 million reduction would preclude the construction of a Burning Plasma Experiment, directly contradicting FPAC's fundamental conclusion on the MFE program that such an experiment is an essential element in an energy program. A U.S. Burning Plasma Experiment is the only possible near term experiment to address this key fusion science issue, to produce hundreds of megawatts of fusion power, and to provide critical information on how to operate an engineering test reactor such as the International Thermonuclear Experimental Reactor (ITER). It was also considered by FPAC to be the key element in a revitalized domestic program.

"This reduction would require the layoff of between 600 and 750 people and would eliminate alternate concepts and long-range technology. The reduction would require the shutdown of five experimental programs .... I do not believe a reduction of $50 million is appropriate given the progress that has been made and the program's potential as a future energy source. Restoration of $25 million will enable the program to carry on a minimum set of critical activities. It

will not enable us to carry out fully even the constrained program recommended by FPAC and will still require substantial reductions in the current program. Work on alternate concepts and advanced tokamak concepts on the five experimental programs listed above will still be stopped, prematurely narrowing the program to conventional tokamaks only. However, we believe it will permit us to pursue a program aimed at the FPAC goals and the NES philosophy, albeit at increased risk. This additional funding would provide the minimum support for ITER and a burning plasma experiment required for an energy preparation program in FY 1991.

"I hope you will agree with the new focus and direction for the MFE program and will agree to increasing the program as I have outlined. I need your speedy support for this action. In the event that a $50 million reduction must remain in effect for the entire fiscal year, the Department must know as soon as possible as delays in executing program reductions will exaggerate impacts on the program. Once these reductions are implemented, it will be impossible to restoe the program's research in the short term. I hope I can count on your help in setting this program on the proper course."

AMERICAN MEDICAL SOCIETY ADOPTS FUSION POLICY

At the December 1990 meeting of the American Medical Association House of Delegates, the AMA adopted the report and recommendations of its Council on Scientific Affairs endorsing "a prolonged commitment and the appropriate funding" for the development of fusion. This is the culmination of a year-long study of a similar resolution given preliminary approval by the AMA delegates last year (see our July 1990 newsletter). The latest action makes the endorsement of fusion the official policy of the AMA. The AMA is in the process of notifying individual doctors and regional medical associations of the action. A copy of the complete 39 page report is available from Dr. Theodore Douge, AMA, 535 Dearborn St. Chicago, IL, 60610, (312)464-4538. An executive summary is available from Fusion Power Associates.

The resolution reads as follows: "The AMA urges Congress, the Administration, energy companies, and organized public interest groups to press for the establishment of a national strategy for energy research and production that includes appropriate consideration, support and development of fusion technology. The strategy should include a prolonged commitment and the appropriate funding to accomplish this mission in the most reasonable period of time."

GENERAL ATOMICS, SCHAFER ASSOCIATES WIN ICF AWARD

The U.S. Department of Energy (DOE) has awarded a contract for $15.7 million to General Atomics of San Diego, CA, to provide Inertial Confinement Fusion (ICF) target component fabrication and technology development support to DOE for the U.S. laboratories engaged in ICF experimental activities. General Atomics will be supported on this project by two principal subcontractors: W. J. Schafer Associates, Inc. of Chelmsford, MA, and Polymer Systems, Inc. in Livermore, CA. The responsibilities assigned to General Atomics had been under contract to KMS Fusion of Ann Arbor, MI, since 1972.

OMB NIXES CIT CONSTRUCTION

The Office of Management and Budget has turned down DOE's request for line item authorization of the Compact Ignition Tokamak (CIT) in the forthcoming FY 1992 Presidential Budget request, while allowing some growth in fusion funding. Design-only authorization of $30 million is expected for the CIT device, which DOE intends to rename as the "Burning Plasma Experiment." The action represents a setback for Energy Secretary James Watkins who reportedly has said that "CIT is absolutely essential" to fusion progress. DOE hopes to get construction authorization in FY 1993, however. CIT construction funding had been approved previously by OMB in the FY 1990 Presidential budget, but Watkins rescinded that request on June 15, 1989 (see our July 1989 newsletter) pending formulation of a "new" fusion policy. Watkins received the report of his "blue ribbon" Fusion Policy Advisory Committee in September 1990 but has not yet announced his new fusion policy.

QUOTABLES

"It's an easy way out to blame Congress, but the truth is these guys (fusion scientists) never met a machine they didn't like or didn't want to make bigger."

House Appropriations Committee Staffer "who spoke on condition of anonymity"
Quoted by Lawrence Spohn
Albuquerque Tribune, Dec. 25, 1990.

February 1990

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

SOVIETS DESIGN FUSION PILOT PLANT

REP. GEORGE BROWN ENDORSES FUSION

KADOMTSEV DESIGNS PILOT PLANT

In a letter dated December 13, 1990 to FPA president Steve Dean transmitting two preprints, Academician Boris Kadomtsev writes, "I have recently prepared two papers for publication in the "Comments on Plasma Physics" magazine. These papers may be interesting for you because they were stimulated by the Moscow discussions with you." The title of Kadomtsev's first paper is "Tokamak for Net Electricity Production"; the second paper provides more physics calculations to back up the first paper.

In his paper, Kadomtsev derives the parameters of a primitive tokamak reactor optimized to make electricity, stating that the current tokamak "data base is sufficient for the design of an experimental fusion tokamak reactor." He notes that the ITER device design is "uniformly loaded from the viewpoint of physics and technology", having as its main goal "to provide the scientific and engineering data for the DEMO-reactor design", a device that would follow ITER. As such, Kadomtsev notes, "ITER has been optimized as the only step towards DEMO."

"However," he states, "some other strategies are possible in our rapidly-changing world, e.g. we can imagine smaller machines aimed at faster progress along some specific directions. Respectively, for each of such facilities only one of the goals could be chosen as a first priority, others should be shifted to the second and the third priority background." Kadomtsev continues, "Let us discuss now, as an example, the machine, the first priority of which is the net electricity production. In other words, such a fusion device can be considered as a fusion power plant prototype. The very goal by itself - electricity production - is rather complicated. Therefore, all other engineering characteristics of such a fusion machine should be maximally simplified. In other words, the second priority aspects shouldn't pretend to be directly used in DEMO."

The above philosophy is one that has been advocated in a previous Fusion Power Associates study, "An Accelerated Fusion Power Development Plan" authored by Stephen O. Dean (FPA), Daniel R. Cohn (MIT), Charles C. Baker (ANL and ORNL) and Susan D. Kinkead (FPA). The study was prepared for the Agency for the Advancement of Fusion Power (see our July 1990 newsletter). The results were summarized at FPA's annual meeting in September 1990 and will be published in a forthcoming issue of the Journal of Fusion Energy. Copies of both Kadomtsev's papers and the FPA study are available from Fusion Power Associates.

In advocating an accelerated fusion power development initiative, the FPA study states, "The goal of the Initiative is to construct and operate a fusion pilot plant that generates electricity in order to demonstrate, on the soonest practicable timescale, the viability of fusion as a practical energy source." The FPA study suggests a goal of operating

the pilot plant within 15 years of a commitment to proceed and states, "Because the plan is ambitious and based on symbiotic advances in both physics and technology on a tight time schedule, it entails considerable technical risk. The Initiative controls this risk by requiring an intense up-front period (7-8 years) of project-specific R&D and plant design." The report identifies several "general desired characteristics" for the pilot plant: (1) Minimal capital cost and minimum thermal power, (2) Net electrical power production of about 100 MW, (3) Operation at high availabilities (>50%) for prolonged periods, (4) A high (>10) ratio of fusion power generated to electrical power input, and (5) Use of reduced-activation materials consistent with project schedule.

In Kadomtsev's paper, he states "In order the tokamak reactor would be able to produce power, it is necessary to reduce to a minimum its own power consumption." He then outlines the parameters of a pilot plant that would produce about 250 Mw of thermal power and 40-50 Mw of electricity, with the reactor itself consuming about half of the electric power. Among the technical characteristics of the plant are the following: (1) "It is desirable not to use non-inductive current drive, since it is an extra power consumption," (2) "It is desirable to have large aspect ratio (a value of 9 is selected) . . . in order to realize a long burn pulse with minimal power," (3) "With a low fusion power it seems not reasonable to breed tritium," (4) "It is desirable to use the simplest method of plasma heating to ignition, e.g., gyrotrons or CARM's masers based on cyclotron auto-resonance." Other characteristics of the plant are: maximum magnetic field of 16T, plasma current of 3 MA, and beta of 0.5%.

Kadomtsev asks in his paper whether this line of thinking is worthwhile since "this goal (the pilot plant) can be realized due to rejection of other fusion technologies which will be necessary for the DEMO-reactor." He concludes that the physics data base required for the pilot plant "can be used as a basis for the subsequent proceeding to more promising tokamak reactor concepts. More precisely, we can argue the use of D-He3 as a fuel with the least amount of radioactive wastes, the development of schemes for direct synchrotron radiation conversion into electricity, more acceptable solutions to the problem of plasma-wall interaction, the possibilities of current drive by synchrotron radiation in combination with the bootstrap effect etc. Thus (the pilot plant) could show not only an opportunity to obtain electricity from fusion power but to initiate ways to some promising fusion technologies." He concludes, "The present data base for tokamaks with improved plasma confinement (better as compared with the L-mode) allows one to imagine the tokamak reactor concept for net electricity production."

BROWN SPEAKS AT ITER MEETING

Rep. George E. Brown (D-CA), the new chairman of the House Committee on Space, Science and Technology, spoke to a gathering of about 100 industry representatives at a January 15 meeting in Palo Alto on planning for the next phase of the ITER project (see our December newsletter). Brown noted the dangers of our continued dependence on fossil fuels and that "since 1979, civilian energy R&D programs have seen more than half their constant dollar budget disappear. . . . In essence, we have systematically canceled the possibility of transition to other energy sources. Its a little bit like standing on a sinking ship and shooting holes in your life boat." Fusion, he said, "represented the beacon of promise for our far-term energy future."

Brown said that "the Federal budget is under extreme stress." He said "Undoubtedly, the $50 million funding cut in magnetic confinement for 1991 was a setback. Although a portion of this cut may be restored, I do believe that with a budget reduction of this proportion, it is important to include the affected community in the decisions to reorder program priorities for accommodating the cut." "Faced with the Federal budget constraints and a decade of energy program neglect, we must be both realistic and steadfast in our support for fusion research," Brown said, adding "That means preserving our commitment to the fusion program by moving beyond the Federal Government as the sole patriarch. That means taking advantage of our opportunities for international collaboration and for government/industry collaboration."

Brown urged industry to take an active interest in the ITER project, saying "ITER presents government and industry a real-life opportunity for partnership. . . . A stated objective of the ITER project is to transfer all technology developed during the Engineering Design Activity to industry. It seems to me that this arrangement speaks strongly to partnership potential."

Copies of Rep. Brown's speech are available from Fusion Power Associates.

GLOBAL WARMING TREND CONTINUES

According to an article in the January 18 issue of SCIENCE, 1990 was "the hottest year on record," based on all three major measures of global temperatures. Global temperature was 0.45 degrees Centigrade above normal. (The normal is the average temperature during the period 1951-1980.) "That's a whopping increase considering that the entire global warming of the past 100 years is thought to be only 0.4 degrees," says the article's author, Richard A. Kerr. Temperatures in the U.S. were even higher, more than 1 degree C. According to Kerr, "The temperature records of 1990 occurred without a contribution from El Niño, the surge of warm water that periodically appears in the equatorial Pacific and helps to raise global temperatures." Kerr quotes climate expert James Hansen as saying "Because an El Niño is expected (this Year) it's likely we're going to get still higher levels."

ELLIS AND GILLELAND GO TO INDUSTRY

Dr. William R. Ellis, Associate Director of the U.S. Naval Research Laboratory and former Director of the Magnetic Mirror Systems Division at DOE has accepted a position as Chief Scientist and Vice President, Advanced Systems, at Ebasco Services, Inc in New York City.

Dr. John R. Gilleland, U.S. ITER Program Manager at LLNL and formerly Vice President for Fusion at General Atomics, has accepted a position as Vice President for Special Programs at Bechtel Corp. in San Francisco.

We wish both our friends good luck in their new positions.

EDITORIAL, THE BOSTON GLOBE

The following editorial appeared in the January 2 issue of the Boston Globe:

"Among the long-term solutions to the world's energy problems, none is quite as enticing as fusion power -- an elusive objective that will demand enormous scientific and technological effort to succeed. At a time when others are accelerating their commitments, Congress has unwisely decided to curtail funds for the American program -- a move that amounts to shortsighted miserliness.

"Controlled fusion would harness energy derived from the fusing of isotopes of hydrogen, an essentially limitless source of power. Doing so requires the creation of extremely hot plasmas, in excess of 100 million degrees Celsius, in a reactor capable of capturing heat produced by continuous fusion of hydrogen. This process represents the taming of intense bursts of energy in the explosion of a hydrogen bomb, on a far smaller scale, or the mimicking of fusion in the sun or other stars.

"Scientists continue experimenting with devices to create and control the hydrogen plasma, moving gradually closer to the point at which more power can be extracted from the process that goes into its operation. A $50 million cut in the current budget has forced mothballing of one promising development, the advanced toroidal facility at Oak Ridge, Tenn., that might have supplied answers to plasma management.

"Realists like those cited in a review of fusion efforts in the magazine *Science* point out that fusion power lies some decades in the future. They also point out that Europeans, who have merged many of their efforts and who also are cooperating with their Soviet counterparts, are pressing ahead even faster, even though the rewards cannot be immediate.

"The long-term benefits, if the process succeeds, are enormous. Fusion power could eliminate dependence on fossil fuels that are sometimes subject to political disruption, as in the case of the Persian Gulf right now. It could sharply reduce injection of carbon dioxide into the atmosphere, ending the threat of climatic shifts because of global warming. Although other sources -- notably solar power -- may play a role, fusion would provide an energy supply anywhere on the planet, not subject to vagaries of weather or season.

"America certainly belongs in the vanguard of fusion research and can only benefit from maximizing its own program and increasing cooperation with other countries' efforts. The stakes are far more than national, and future generations will applaud this one for pressing ahead toward fusion power."

Thanks to MIT's Ron Parker for passing this editorial along to us.

RESEARCH UP; MAGNETIC FUSION, SDI DOWN IN FY 1991

According to a survey published in the December 1990 issue of *Physics Today* and reprinted below, magnetic fusion and the strategic defense initiative were the only government research programs that received less money in FY 1991 than they received in FY 1990.

Bottom lines: Research budgets* in fiscal 1991

	FY 90 estimate	FY 91 request	FY 91 enacted	Percentage gain (loss)
	(millions of dollars)			
National Science Foundation	2083.6	2383.0	2316.1	11.1
Research and related activities	1592.4	1809.2	1694.2	6.4
Science education**	220.5	273.3	322.4	46.2
Research facilities modernization	20.0	20.0	20.5	2.5
Department of Energy				
General science and research	1093.3	1273.7	1148.7	5.1
Superconducting Super Collider	217.0	317.9	242.9	11.9
Magnetic fusion	331.0	325.3	275.3	(−16.8)
Inertial fusion	169.2	166.8	175.0	3.4
Biological and environmental research	308.7	338.8	396.4	28.4
Basic energy sciences	582.5	648.7	716.3	23.0
Department of Commerce				
National Institute of Standards & Technology	161.8	198.4	215.3	33.1
Oceanic and atmospheric research	172.8	199.5	207.0	19.8
NASA				
Research and development	5227.8	7074.0	6023.6	15.2
Physics and astronomy	861.4	985.0	1014.0	17.7
Planetary exploration	391.7	485.2	452.2	15.4
Earth sciences and applications	439.3	661.5	674.5	53.5
Space Station Freedom program	1749.6	2451.0	1900.0	8.6
Department of Defense				
Army research sciences	172.6	179.5	175.5	1.6
Navy research sciences	341.6	374.4	371.4	8.7
Air Force research sciences	182.2	193.2	195.2	7.1
University research initiatives	96.0	98.7	174.2	81.5
Strategic Defense Initiative	3819.1	4663.3	2890.0	(−24.3)
Defense Advanced Research Projects Agency	1227.0	1078.0	1400.0	14.1

* Detailed breakouts of line items are not yet available.
** Adjusted for restructuring into the NSF Education and Human Resources Directorate.

QUOTABLES

"The willingness to risk failure is an essential component of most successful initiatives. The unwillingness to face the risks of failure - or an excessive zeal to avoid all risks - is, in the end, an acceptance of mediocrity and an abdication of leadership."

Harold T. Shapiro
President, Princeton University, in
SCIENCE, November 2, 1990

"The price of self-destiny is never cheap, and in certain situations it is unthinkable. But to achieve the marvelous, it is precisely the unthinkable that must be thought."

Tom Robbins, in
Jitterbug Perfume
Bantam Books, 1984

March 1991

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

SENATORS JOHNSTON AND WALLOP PROPOSE ENERGY TRUST FUND

FPA ANNUAL MEETING DATES, JUNE 25-26 AT PPPL

ENERGY TRUST FUND

A Bill (S.341) "to reduce the Nation's dependence on imported oil, to provide for the energy security of the Nation and for other purposes" was introduced February 5 by Sen. J. Bennett Johnston, Chairman of the Senate Energy Committee and Sen. Malcolm Wallop, the ranking minority member. Among other things, the Bill contains a subtitle (Title II, subtitle F) which deals with the disposition of revenues received by the United States from the leasing of Federal lands for oil and gas exploration. The Bill states "Revenues distributed to the United States pursuant to subsection 9601(b) shall be deposited into a special account in the Treasury which shall be known as the Energy Security Fund. Revenues may be expended from the Energy Security Fund solely as provided in this section." The Bill instructs the Secretary of Energy to prepare a list of "energy-related projects or programs to enhance this nation's energy security and reduce dependence on imported oil." The Bill states "Unless the list is subsequently modified by law, the Secretary of the Treasury is authorized and directed, without further appropriation . . . to make funds from the Energy Security Fund directly available to the Secretary of Energy to be used to fund those projects or programs on the list in an amount and in the manner and sequence provided therein."

Setting up such an "off-budget" trust, to fund energy R&D, is a concept that Fusion Power Associates has been advocating to anyone who would listen for the past two years. Such a funding mechanism is absolutely essential if the moneys needed to develop new energy sources is ever to be found. There are many possible mechanisms that could be used to provide income to the fund other than the mechanism suggested by the Johnston/Wallop Bill. For example, "a mill per kilowatt hour" on electricity or a surcharge of fossil fuel use could be used instead of, or in addition to, the royalty source. Congress will undoubtedly debate the details, but let us hope that the trust fund idea will finally catch on.

FPA TO MEET JUNE 25-26

Fusion Power Associates will hold its annual meeting and symposium on June 25-26 at the Princeton Plasma Physics Laboratory in Princeton, NJ. The theme of the symposium will be "Fusion Facilities Planning for the 1990's." Topics to be covered will include plans for new facilities capabilities such as tritium experiments in TFTR, the Burning Plasma Experiment (BPX), the International Thermonuclear Experimental Reactor (ITER), the NOVA laser upgrade, the OMEGA laser upgrade, the NIKE Krypton-Fluoride laser project, and proposed supporting facilities such as a Steady State Tokamak, neutron sources for materials testing, and divertor testing facilities. Other program options, such as

upgraded or new light and heavy ion fusion facilities will be discussed. Systems and design studies of future facilities such as the Laboratory Microfusion Facility, pilot plant/demonstration reactors and commercial magnetic and inertial fusion reactors will also be on the agenda.

The detailed technical agenda for the meeting is still being developed. Persons with suggestions for talks should contact Steve Dean at FPA. For further information on registration, contact Ruth Watkins at FPA, (301) 258-0545.

FUSION IN THE NATIONAL ENERGY STRATEGY

Fusion figures prominently in the long-awaited National Energy Strategy document released by Energy Secretary James D. Watkins on February 20. Fusion is a separate chapter in the "Securing Future Energy Supplies" section, on equal footing with Oil, Natural Gas, Coal, Nuclear Power, and Renewable Energy. This is a major accomplishment for fusion advocates since fusion has been relegated to a paragraph buried in a section on speculative possibilities in past government energy planning documents. In the Table of Contents, the subchapter headings in the Fusion chapter are: "Credible Energy Source," "Cost-Effective Program," and "A Safe, Environmentally Sound Energy Source."

The report states "The National Energy Strategy recognizes that fusion energy offers the potential to provide an inexhaustible supply of electricity with little, if any, environmental impacts; and it is setting long-term goals for developing fusion as a technically credible energy resource." The document provides discussion of both magnetic and inertial fusion, with planning chart schedules, saying "The Department of Energy will continue to pursue safe and environmentally sound approaches to fusion energy, pursuing both the magnetic confinement and the inertial confinement concepts for the foreseeable future." It discusses international collaboration and the ultimate promise of advanced (D-He3) fuels. It states that "actions will be undertaken to encourage substantial involvement of U.S. industry in fusion energy development . . . not only for the hardware phases of the program, but also in the planning, research and development, and analytical phases." The fusion strategy generally follows the recommendations of the Fusion Policy Advisory Committee (see our October 1990 newsletter). In the Executive Summary, the report states "For the longer term, the National Energy Strategy looks to fusion energy as an important source of electricity-generating capacity."

FY 1992 FUSION BUDGET REQUEST

In early February, the President sent to Congress his budget requests for FY 1992. The request contained $337.1 million for fusion energy (including $9.0 for inertial fusion energy) and $182.5 million for inertial confinement fusion (in Defense Programs). These numbers represent a $7.5 million increase over this year for the Defense ICF program and a $1.4 million increase for inertial fusion energy. Inertial fusion energy is a new category within the Office of Fusion Energy for FY 1992, following the recommendations of the Fusion Policy Advisory Committee (see our October 1990 newsletter). A large portion ($6M) in FY 1991 of this activity, for heavy ion accelerator development, was funded in the Basic Energy Sciences portion of the DOE budget. The increase for the magnetic fusion program is $40.1 million. DOE has been successful in reprogramming back into magnetic fusion $25 million of the $50 million that Congress cut in FY 1991. The reprogramming request (see our January newsletter) was approved by the relevant committees of Congress in late February.

Of the $40 million increase in magnetic fusion, approximately $30 million is earmarked "for R&D, prototype fabrication, and design for the BPX (Burning Plasma Experiment, formerly designated CIT or Compact Ignition Tokamak), preparations of the TFTR device for deuterium-tritium experiments in late 1993, and experimental physics support for BPX/ITER." The rest of the increase is aimed at "those tasks that require the longest lead time and are most critical to the success of ITER."

The small increase is Defense ICF is basically cost of living. Priority efforts identified in the budget document are "completing development of Precision NOVA and initiating development of an advanced beamlet for the NOVA laser . . . development of the NIKE laser . . . upgrade of the OMEGA laser . . . experiments on Hermes III and PBFA II . . . and activities toward advanced glass laser development." The request document states "Funding (is) no longer included for further development of the AURORA KrF laser at LANL due to higher priority inertial fusion requirements. Los Alamos will, in accordance with

recommendations of the National Academy of Sciences report, increase experiments at other facilities."

WATKINS COMMENTS ON BUDGET

At a press conference releasing the Department of Energy's FY 1992 budget request, energy secretary James Watkins made the following statement in his prepared remarks:
"I just want to say how disappointed I was to see Congress take $50 million out in the dark of night, without debate, without discussion and put it into pork projects. It was a tragedy at this particular time because we had just had the Fusion advisory panel, a very fine group, some of the best minds in the world on this subject, come together and with the agreement of the National Academy saying this is the time we should (inaudible) out of research and development with a 2025 demonstration project in fusion energy. So we got an opportunity here to meld the defense side, called ICF, and the magnetic fusion program in a new way that is exciting, research competition going on with milestones laid out to the demonstration project, when the $50 million disappeared. What this did was force us into reprogramming $25 million in '91. We couldn't find $50 million and we've had to restructure other programs and drop at Oak Ridge, Los Alamos, and elsewhere very important ancillary research programs that should have gone on in parallel to give us more capability out there to maneuver in different directions as the unknown of research unfolds. And we're unable to do that, and that's a tragedy. We simply can't allow that to happen again this year. I believe it's time to focus on an end product for fusion, and our participation in ITER is such an important element in our program now that we have to factor ITER into everything we are doing with our Tokamak at Princeton and all the other programs in plasma physics. It is a very important year for fusion, and it's going to have to be one that's collaborative with other nations of the world and therefore ITER becomes a very important program. ITER is a stepping stone to a demonstration reactor. It would come on line somewhere around 2005 and give us the kind of information we need for a baseline reactor design for fusion energy by the year 2025. So we now have a stripped back fusion program, bare bones, barely hanging in there, moving with ITER in the international community and with the best we can do without work here in the U.S. We're now shifting to international support for giving us the kind of upgrades we need of the plasma physics lab at Princeton to do what we would have done had we had the full funding last year out of Congress."

GLASS NAMED U.S. ITER LEADER

On February 8, Dr. N. Anne Davies announced the appointment of Dr. Alexander Glass of LLNL to be "Home Team Leader of the U.S. International Thermonuclear Experimental Reactor (ITER) effort." In a letter to LLNL director John Nuckolls, Davies also stated that LLNL had been selected to "provide the institutional support for the Home Team Project Office." The Home Team is to be the U.S. interface to the central design team which will be located at a site yet to be agreed upon by the international ITER participants. The U.S. has proposed San Diego as the U.S. candidate site for the central design team.

By naming Glass to head the Home Team and also proposing a U.S. site for the central design team, the U.S. is signalling its intent to enter into an international agreement to begin the next phase of the ITER collaboration, commonly known as the Engineering Design Activities (EDA). The U.S. hopes that an agreement will be signed by mid-year by the "four parties" (U.S., European Community, Japan and USSR). The EDA will consist of a 5-6 year effort composed of both design, and technology development and prototyping, hopefully leading to construction of the ITER. The U.S. National Energy Strategy, just released, envisages operation of ITER in 2005.

In her letter appointing Glass, Davies states "In order to avoid any appearance of a conflict of interest, the Home Team Project Office must be independent of the fusion program research effort at LLNL." She also states "The U.S. Home Team must be organized as a national project utilizing the best people available. To provide this breadth, we consider that the deputy positions in the Home Team Project Office should be filled by senior experts from other national laboratories and from industry."

KfK HOSTS FUSION TECHNOLOGY MEETING

Following up on a very successful first symposium in Tokyo in 1988, the Second International Symposium on Fusion Nuclear Technology will be held at the Karlsruhe Congress and Exhibition Centre in Karlsruhe, FRG, June 2-7 of this year. Topics to be covered include first wall technology, high heat flux components, blanket technology fuel cycle and

and tritium processing, repair and maintenance, remote handling, nuclear systems design and analysis, and safety considerations and waste management. Proceedings will be published in the journal "Fusion Engineering and Design." Dr. J. E. Vetter, KfK, is program chairman; Prof. Mohamed Abdou of UCLA is program vice-chairman. Other program vice chairmen are: Prof K. Miya, University of Tokyo, and Dr. G.E. Shatalov, Kurchatov Institute.

KMS CONTRACT ACTION ON HOLD

The Department of Energy's action to award a contract to General Atomics and its subcontractors (see our January newsletter) for work previously performed by KMS Fusion has been stopped pending resolution of a protest filed by KMS. The General Atomics team was issued a "stop work" order by DOE shortly after they had been told to proceed. KMS has alleged that officials on DOE's source evaluation board were biased in their handling of the proposal reviews. The dispute is currently being investigated by the General Accounting Office.

PEOPLE

John Lindl and ***Mike Campbell*** have been named principal Deputy Program Leaders at LLNL, reporting to ICF Program Leader and Deputy Associate Director ***Erik Storm***.

Dieter Sigmar has been named Deputy Director and ***Miklos Porkolab*** has been named Associate Director for Plasma Research of the MIT Plasma Fusion Center, reporting to Director ***Ron Parker***.

Radford Byerly, Jr., a physicist from the University of Colorado, has been named staff director for the House Science, Space, and Technology Committee by committee chairman ***George Brown***.

MEETINGS

March 13 - Public Hearing on the U.S. Fusion Program, House Science, Space and Technology Committee, Rayburn House Office Building, Washington, D. C. Contact Bob Liimatainen (202) 225-8056.

March 18-21 - Fourth Transport Task Force Workshop. Austin. Contact Jim Callen FAX (608) 262-6707.

April 15-19 - IAEA Technical Committee Meeting on Drivers for Inertial Confinement Fusion. Osaka, Japan. Contact Ms. H. Kyogoku FAX 06-877-4799.

April 22-24 - Sherwood Theory Conference. Seattle.Contact Loren Steinhauer, Spectra Technology, 2755 Northup Way, Bellevue, WA, 98004.

May 27-31 - Eighth International Workshop on Stellarators. Crimea, USSR. Contact V. Tereskin FAX 057-235-2664.

June 2-7 - Second International Symposium of Fusion Nuclear Technology. Karlsruhe, FRG. Contact Mohamed Abdou (213) 206-0501 or J. E. Vetter, FRG, FAX (07247) 825460.

June 3-5 - Eighteenth IEEE International Conference on Plasma Science. Williamsburg, VA. Contact Linda Sugiyama FAX (617) 258-7864.

June 11-14 - Cryogenic Engineering Conference. Tom Bevill Center, Huntsville, AL. Contact Mary Beth Magathan FAX (205) 895-6760.

June 16-21 - Sixth International Conference on Emerging Nuclear Energy Systems. Monterey. Contact Carl Henning FAX (415)423-2395

June 17-19 - Fourth European Fusion Theory Conference. Aspenes, Goteborg, Sweden. Contact Jan Weiland FAX 4631-164513.

June 23-28 - Twelfth International Magnet Technology Conference. Leningrad. Contact B.N. Zhukov FAX 812 463 9812.

June 25-26 - Fusion Power Associates Annual Meeting and Symposium "Fusion Facilities Planning for the 1990's." Contact Ruth Watkins (301) 258-0545.

QUOTABLES

"The only way to avoid criticism is to do nothing."

Theodore Hesburgh
C-Span Interview
February 10, 1991

APRIL 1991

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

THE WONDERFUL WORLD OF THE LOW COST HOT PLASMA

NEW AFFILIATE

Fluor Daniel, Inc., a major architect-engineering firm, has joined Fusion Power Associates as an Affiliate. Mr. Barry McElmurry will represent the company. He can be reached at Fluor Daniel, Inc., 3333 Michelson Drive, Irvine, CA 92730, (714) 975-5950. We welcome their participation in Fusion Power Associates.

LOW COST HOT PLASMAS

It is generally believed that big budgets and big machines are required to study high temperature plasmas. But not everyone has gotten the message. There are probably a couple of dozen fusion scientists, out of thousands, around the world who insist on doing the seemingly impossible, namely building and operating low cost equipment to study high temperature plasmas. In this issue we feature a few such efforts. You might expect that government money managers would leap at the chance to support such bargains. Actually, quite the reverse is true. Scientists interested in low cost approaches struggle to stay alive, competing for dollars that are "in the noise level" of many of the larger programs. We regret we do not have space in this newsletter to cover them all. A good technical summary of many of the smaller concepts is contained in the June 1989 issue of the Journal of Fusion Energy, a special issue entitled "On Creating Compact, High Power-Density Fusion Plasmas."

THE COMPACT TORUS

In the prestigious journal Physical Review Letters earlier this year (Phys. Rev. Lett. **66**,165 (1991)), LLNL physicists A.W. Molvik, J.L. Eddleman, J.H. Hammer, C.W. Hartman, and H.S. McLean report the formation and subsequent 2-fold radial compression of a stable, symmetric compact torus (CT) plasma ring. Similar small scale experiments, sometimes referred to as "spheromaks", have also been conducted at the Princeton Plasma Physics Laboratory (M. Yamada et al., in Plasma Physics and Controlled Fusion Research, Proc. 12th IAEA Int. Conf., Nice, 1988) and at Los Alamos National Laboratory (T.R. Jarboe et al., Phys. Fluids B **2**,1342 (1990)). The following paragraphs, entitled "Fusion Applications of Compact Torus Accelerators," was written by Art Molvik of LLNL.

Compact Torus (CT) accelerators are opening new vistas for fueling and current drive of tokamaks and for high-energy and high-power-density applications to inertial fusion. A CT is a magnetically confined toroidal plasma that doesn't require magnetic field coils. Currents flowing in the plasma and nearby conductors produce the fields, which move with the CT. It is a robust structure that can be accelerated to high velocities and directed kinetic energies, then focused to small size using conducting cones. These properties make CT accelerators useful for power compression applications where the power is put in at a modest level over a long period of time (many microsec., μs), then taken out at a much higher level over a much shorter period (nanosec., ns).

RACE, the plasma Ring ACcelerator Experiment, at LLNL forms the CT with a magnetized coaxial gun that injects the CT into a coaxial rail-gun accelerator. The CT has been accelerated in straight electrodes to velocities as high as 3000 km/s, and focused by a factor of 3 in radius with an efficiency greater than 30% for conversion of electrical

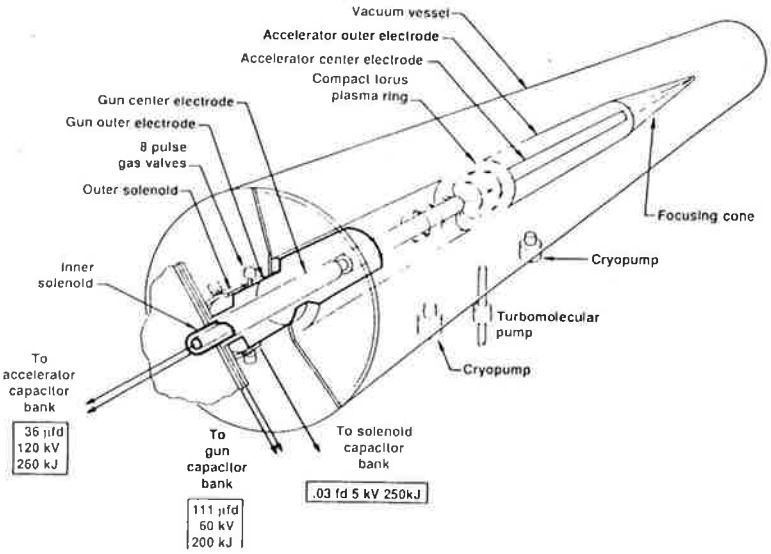
energy to kinetic energy. The most recent experiments (Phys. Rev. Lett. 66,175 (1991)) used magnetic forces to compress the CT a factor of 2 in radius in conical electrodes, before accelerating the CT. The compressed CT had magnetic fields as high as 2 Tesla, densities > 10^{22}particles/m^3 and velocities of 600 km/sec. These parameters are about what are needed for tokamak reactor fueling.

CT injection into tokamaks could provide the peaked density profiles found to give improved confinement in TFTR supershots; whereas other core fueling techniques appear to be impractical in reactor scale plasmas. At the same time, the CT would contribute part, or all, of the current drive needed. Experiments on tokamaks are needed to determine the requirements for a compact torus to penetrate to the core, and to determine the effects of CT injection on tokamak operation. These issues are being addressed by several groups: a joint Cal. Tech. - Univ. of Wisc. experiment to inject CTs into the Phaedrus-T tokamak this year, a Canadian Fusion Fuels Technology project to inject CTs into the Tokamak de Varennes in late 1992, and a Univ. of Calif. Davis project to study CT propagation across a magnetic field.

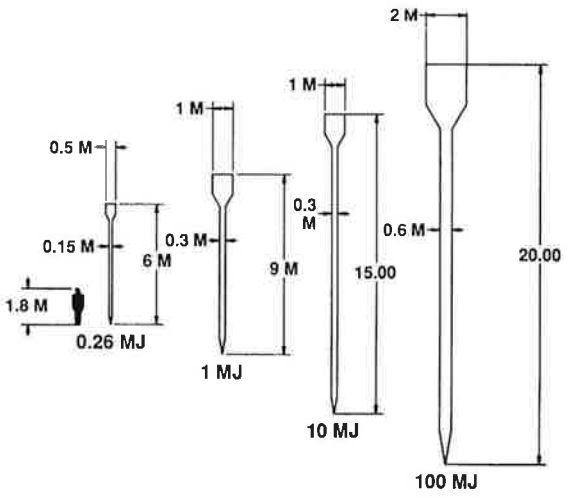
Higher power density CT accelerators have other potential fusion applications as drivers for inertial fusion (ICF) and for magnetically insulated inertial fusion (MICF). For ICF, the required power densities of 10^{14}Watts/cm^2 to 10^{15}Watts/cm^2, are predicted to be achievable at CT energies of 10-30 megajoules. Relatively slow 100 megajoule capacitor banks costing only \$0.30/joule can be used. The CT couples its energy to a large indirect-drive target with a gain of about 50 to produce 1 gigajoule per pulse. This large energy will destroy the end of the focusing cone on each shot, but fortunately also reduces the rep-rate to about 1 Hz, which is compatible with replacing the final focusing cone each shot.

In MICF, the CT itself contains the deuterium-tritium fusion fuel which will be compressed to about 1% of the density of an ICF target, injected into a "cannonball," and shock heated to fusion temperatures. The magnetic field provides thermal insulation between the $\beta > 1$ burning plasma and the wall until the "cannonball" blows up. MICF requires 100 megajoule range CT energies. With suitable techniques to refuel the CT, MICF is predicted by Grant Logan of LLNL to achieve gains of the order of 100, i.e., multi-gigajoule yields. He has also suggested the intriguing possibility of direct MHD power generation from the DT neutron energy deposited in the "cannonball" wall.

Such high-power density applications provide motivation for the RACE experiment at LLNL and the MARAUDER experiment at Kirtland Air Force Base. The proof-of-principle experiments this year at LLNL are predicted to achieve densities of a few x 10^{11}watts/cm^2, with a CT energy of up to 100 kilojoules. Experiments, just beginning at Kirtland, have the potential for accelerating CTs to several Megajoules of kinetic energy using the Shiva Star facility. For further information, contact Art Molvik at (415) 422-9817.



SCHEMATIC OF RACE



SCALING OF RACE TO 100 MJ

THE FIELD REVERSED CONCEPT

The Field Reversed Concept (FRC) is another version of the Compact Torus, using only poloidal fields for confinement. FRC's are unique in that the plasma pressure, to an even greater extent than the plasma current, defines the configuration. This leads to a naturally high plasma beta, which is a distinguishing feature of the concept. FRC's have been pursued at several sites in the U.S. in the past, including LANL and LLNL. Completely stable FRC's have been produced in small experiments, and very favorable confinement scaling has been observed. If the present scaling continued to apply at larger sizes, very small fusion reactors could be envisaged. A new device, the LSX, to test size scaling came into operation at Spectra Technology last September (see our September 1990 newsletter). However it was one of the victims of the DOE decision to terminate non-tokamak concepts following the Congressional budget cuts last Fall (see our December 1990 newsletter). A budget of only $3-5 million per year is necessary to carry out these experiments. For further information, contact Alan Hoffman at Spectra Technology, (206)827-0460.

THE SPHERICAL TORUS

The spherical torus is a tokamak of very low aspect ratio (ratio of major radius to the minor radius of the torus). Ratios of 1.2 to 2 are typical, compared to 3 or more for a conventional tokamak. The result is a tokamak of very small size, approximating a sphere. Calculations by their principal advocate, Y-K. Martin Peng of ORNL (Y-K. M. Peng and D.J. Strickler, Nucl. Fusion, **26**,769 (1986)) indicate they should be capable of sustaining high beta at low magnetic field, thus potentially leading to high power density at low cost. Although projections for spherical torus performance are so far theoretical, they are based on extensions of the existing tokamak experimental database. Experiments are underway in the U.S., in the U.K. and in Brazil. An experiment is also being built in the USSR. These experiments are all less than half a meter in major radius. Conceptualizations of low cost spherical torus facilities for tokamak divertor testing and for blanket testing have recently been developed. For further information, contact Martin Peng at ORNL, (615) 576-5449.

THE DENSE Z-PINCH

An altogether different alternative concept is the Dense Z-Pinch under development at the Naval Research Laboratory (NRL) and Los Alamos National Laboratory (LANL). The z-pinch is an inherently simple and compact system in which a large current both heats and confines a linear plasma column. The objective is to achieve densities in the range of 10^{20} - 10^{22}ions/cc and confinement times on the order of a few hundred nsec. Thus the z-pinch falls midway between conventional magnetic confinement and ICF. While this was one of the earliest fusion concepts to be tried, the z-pinch was abandoned long ago because it was thought to be proven incorrigibly unstable by both experiment and theory. However both NRL and LANL have recently demonstrated that if the pinch is formed from a very thin (100 micron diameter) fiber of frozen deuterium, and the current is driven rapidly by a modern high-voltage pulse generator, then it is stable for far longer than expected. In fact the NRL experiments show the pinch remains stable as long as the current is rising, up to the full 640 kA capability of the generator. These unexpected results led to a re-examination of the earlier MHD theory of the z-pinch stability theory. Research at Imperial College, London, as well as NRL has found that stable regimes of the pinch can indeed be predicted, if more realistic conditions are incorporated and modern numerical techniques are employed. The new theory and experiments have been sufficiently encouraging that NRL has built a new generator to increase the current through the pinch to 1.7 MA. If stability is maintained up to this level, then a pinch formed in D-T would release more energy than required to form it - in other words, it would achieve "breakeven."

NRL has performed some conceptual designs of a fusion reactor based on a repetitively pulsed z-pinch (40-60 Hz). This would be very different from a conventional fusion reactor design, such as a tokamak, because it would require no external superconducting coils and no complicated auxiliary heating systems. The system would be about the same size as a Pressurized Water Fission Reactor and would produce about 100 MWe. These units could be deployed either singly for small power stations or coupled together for larger plants. One advantage of this concept is that there is no need to build an entire reactor system to test it; the basic physics can be established on a single pulse for a relatively modest cost (under $3M). The subsequent reactor development would then be a matter of engineering a repetitive system.

For further information, contact John Sethian, Naval Research Laboratory (202) 767-2705.

CONGRESSIONAL HEARINGS

FPA president Steve Dean testified March 13 at a hearing of the Subcommittee on Energy, chaired by Rep. Marilyn Lloyd, of the House Committee on Science, Space and Technology. In his testimony he praised the positioning of fusion in the DOE's National Energy Strategy (NES) report, saying "In my reading of the NES document, fusion is used to 'anchor' the report in the future, as fossil fuels 'anchor' the report in the present." He called for the inclusion of a fusion "title" in any energy policy legislation that might emerge from Congress and endorsed the idea of establishment of a trust fund to finance energy R&D (see our March newsletter). Copies of Dr. Dean's testimony are available from Fusion Power Associates. Other witnesses at the hearing were James Decker (DOE), Ronald C. Davidson (PPPL), Ronald R. Parker (MIT), Roger O. Bangerter (LBL), David O. Overskei (GA), Harold K. Forsen (Bechtel), and Alexander J. Glass (LLNL). Dr. Dean and others are also scheduled to testify at a hearing of the Subcommittee on Energy and Water Development, chaired by Rep. Tom Bevill, of the House Committee on Appropriations on the morning of April 9. Hearings are also expected in the Senate at a later date.

STEADY-STATE TOKAMAK REPORT ISSUED

A statement of the mission and program goals for a new steady-state tokamak facility has been prepared, following the Steady-State Tokamak Workshop held in San Diego last November. The statement was prepared by an ad hoc committee consisting of Peter Politzer (GA), Bill Nevins (LLNL), Paul Rutherford (PPPL) and Ken Wilson (SNL, Livermore). In a covering letter issuing the statement, Peter Politzer states "We believe that the critical elements of the program for a steady-state tokamak facility are the demonstration of steady-state operation with regard to both plasma-surface interactions and internal plasma processes, the development and demonstration of the capability for continuous heat and particle removal, the implementation of efficient noninductive current drive, and the demonstration of steady-state methods for control and optimization of plasma properties." Copies of the complete 3 page statement can be obtained from Peter Politzer, (619) 455-2260. Politzer will describe the steady-state tokamak at FPA's annual meeting and symposium, June 25-26 at PPPL.

NOVA UPGRADE SUMMARY

Lawrence Livermore National Laboratory has prepare a 22 page concise summary (UCRL-LR-106736, March 1991) of the proposed Nova Upgrade laser project. Nova Upgrade is a $375 million (actual year dollars) laser to be built in the present Nova building at LLNL. For less than twice the cost of the current Nova, Nova Upgrade will deliver almost 50 times more energy to the target. The Nova Upgrade has been endorsed by the National Academy of Sciences and the Fusion Policy Advisory Committee as the next major facility for the inertial confinement fusion program in the U.S. (see our October 1990 newsletter). According to present theory, the Nova Upgrade will have the capability to ignite DT fusion in a small capsule yielding 2-10 times more energy out from fusion than was put into the capsule by the laser. The Nova Upgrade is planned as a construction item for the FY 1994 Federal budget, with completion in FY 1998.

The ability to get so much more laser energy in a space smaller than the current Nova building is the result of advances in laser architecture. Nova Upgrade uses multiple passes of the laser beam through a single amplifier, thus extracting more energy from the amplifier than is possible in today's single pass versions. Nova Upgrade thus provides the inertial fusion community with a possible fast-track, low cost route both to demonstrate capsule ignition and to provide data for the design of future high gain inertial fusion test reactors.

Information on the Nova Upgrade will be presented at FPA's annual meeting and symposium. Copies of the summary can be requested from Erik Storm at LLNL, (415) 422-0400.

ROCHESTER ISSUES ANNUAL REPORT

The University of Rochester Laboratory for Laser Energetics (LLE) has issued its 1990 Annual Report. In a letter accompanying the issuance of the report, LLE director Bob McCrory notes the endorsement of the U. of R. OMEGA laser upgrade by the recent National Academy of Sciences review committee on inertial fusion (see our October 1990 newsletter). John Soures of LLE will describe the OMEGA Upgrade at FPA's annual meeting and symposium. For copies of the LLE annual report, contact Bob McCrory's office at (716) 275-4973.

MAY 1991

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

DAVIES NAMED U.S. FUSION DIRECTOR

WATKINS VISITS PRINCETON LAB

DAVIES HEADS FUSION OFFICE

Dr. N. Anne Davies has been named Associate Director for Fusion Energy, Office of Energy Research, USDOE, effective April 14, 1991. The announcement was made by Dr. James F. Decker, Acting Director, Office of Energy Research. Dr. Davies has been serving as acting head of the U.S. fusion program since the departure of Dr. John F. Clarke in January 1989.

Dr. Davies received her Ph.D. from Yale University, worked in the tokamak program at the University of Texas, and joined the fusion office at the U.S. Atomic Energy Commission in the mid 1970's. Over the years she has risen to ever more responsible positions, serving as chief of the Tokamak Systems Branch, director of the Toroidal Systems Division, deputy director and then acting director of the Office of Fusion Energy.

Dr. N. Anne Davies

She has served the fusion community during the past two years under the most trying circumstances, as we have documented in our newsletters. During this period, the Secretary of Energy pulled our major next-generation fusion experiment construction authorization from the budget (see our July 1989 newsletter) and ordered a two-month policy review that took more than a year (see our July 1989 and October 1990 newsletters). And the Congress levied a vicious budget cut on the program (see our December 1990 newsletter), which resulted in the loss of all the non-tokamak magnetic fusion concept improvement programs. During this period also, however, fences were mended and the accomplishments of the program began to be recognized. The policy review committee endorsed the program, the Secretary of Energy addressed the IAEA's international fusion conference in positive terms and featured fusion in the National Energy Strategy, including recognition of the civilian energy potential of inertial confinement fusion. And modest budget recovery was contained in the President's FY 1992 budget submissions to Congress.

Anne has been working hard for all of us throughout this period. We are looking forward to working with her during the still difficult, but hopefully more positive, period ahead.

NEW AFFILIATES

After a difficult period, which we attribute to the government's negative attitude towards the development of new energy sources, applications for participation in the activities of Fusion Power Associates seem to be on the rise again (or is this just the famous "S" curve phenomenon?). We have no complaints if this trend continues. In fairness to the government, which we often blame for our troubles, renewed industrial interest in fusion undoubtedly stems from the recent positive rhetoric on fusion emanating from the Department of Energy. In any case, we are pleased to announce the recent addition of the following companies to our ranks.

The **Ralph M. Parsons Company**, a major architect-engineering and construction company has become an Affiliate of Fusion Power Associates. Richard J. Begley, Vice-President and Manager of Business Development and Systems Division, will represent the company. He is located at 100 West Walnut Street, Pasadena, CA, 91124, and can be reached at (818) 440-2439, FAX (818) 440-2630.

Conax Buffalo Corporation, an active participant in the nuclear industry for over 20 years with world-wide sales, has become an FPA Small Business Affiliate. Geoffrey M. Rhodes, Vice-President, Research and Development, will represent the company. He is located at 2300 Walden Avenue, Buffalo, New York, 14225, and can be reached at (716) 684-4500, FAX (716) 684-7433.

Everson Electric Company has become an FPA Small Business Affiliate. Everson manufactures motors, magnet coils and magnets for a variety of applications. George J. Urich, Marketing Manager, will represent the company. His address is P.O. Box 2688, Lehigh Valley, PA, 18001, and he can be reached at (215) 266-2832, FAX (215) 264-1040.

We welcome their participation and appreciate their support.

ENERGY SECRETARY VISITS PRINCETON

Although he has been at the helm for over two years, James D. Watkins, Admiral, U.S. Navy (retired), Secretary of Energy, had never seen the largest U.S. fusion experiment, the Tokamak Fusion Test Reactor (TFTR), nor had he visited the largest U.S. fusion laboratory, the Princeton Plasma Physics Laboratory, located 217 miles up Interstate 95 from his office. He corrected this oversight on May 2. He visited the Franklin Elementary School in Trenton NJ where he presented awards to the winners of Trenton School District's recent science fair competition and addressed the students. Afterwards, he motored up to Princeton where he toured the TFTR, addressed the laboratory's employees and congratulated them on surviving his "tiger team" review. He also praised the lab for its partnership with the Trenton School District, whereby the lab arranges classroom visits by PPPL staff and provides other learning experiences for teachers and students.

According to the May 3 edition of the Princeton Packet, Watkins urged PPPL employees "to get vocal" and to put the "excitement back into fusion." The paper reported that Watkins urged the scientists to lobby for support at the national, state, and local levels. "Let the people know you don't want that (the lack of funding by Congress) to jeopardize our only hope. . . . We have to look at budget projections from 1993 and beyond . . . to make sure we don't mortgage the future of this country based on year-in and year-out budgetary concerns," Watkins reportedly said. Watkins also urged more involvement of the private sector, saying "We have to become serious about the linkage between science and commercialization."

LIVERMORE ESTABLISHES NEW LASER LINK TO INDUSTRY

Lawrence Livermore National Laboratory (LLNL) Associate Director for Lasers Jim Davis recently announced the formation of a new center called the Center for Applications of Laser and Electro-Optic Technologies (CALEOT) "as a means of implementing a policy which strongly encourages collaborative partnerships between industry, academia and the federal government's research laboratories." The Center will be directed by Ralph Jacobs, a laser physicist who recently rejoined the lab after a decade in the private sector. The Center intends to "interact with responsible agencies, industries and individuals to develop support for joint ventures." According to Davis, "In today's highly competitive world market, it's a win-win situation for all who participate." Ralph Jacobs can be reached at (415) 294-4545.

ISAAC ASIMOV SPEAKS OUT

In the March 18, 1991, issue of ***TIME***, in an article entitled *"The next Frontiers for Science: Space exploration? Genetic research? The environment? A hard choice must be made,"* author and biochemist Isaac Asimov writes "We are living in an age where many scientists are thinking big. There is the supercollider, a new unprecedentedly powerful particle accelerator which may give us an answer at last to the final details of the structure of the universe, its beginning, and its end. There is the genome project, which will attempt to pinpoint every last gene in the human cells and learn just exactly how the chemistry of human life (and of inborn disease) is organized. There is the space station, which will attempt, at last, to allow us to organize the exploitation of near space by human beings.

"All these things, and others of the sort, are highly dramatic and will be, at least potentially, highly useful. All are also highly expensive, something of great importance in a shrinking economy. Worse yet, all are, at the moment, highly irrelevant.

"What is relevant is that we are destroying our planet. . . . Since there can be nothing on Earth, simply nothing, that is more important than saving the planet, our coming priorities must be to reverse these destructive tendencies. And America must lead." He advocates research on population control, detoxifying toxic products produced by industrial plants, finding substitutes for non-recyclable packaging, substitutes for chemicals that destroy the ozone layer, finding methods of saving our forests and of saving threatened species. He goes on to say "We must find alternate sources of energy, long-lasting and non-polluting. We must continue the search for nuclear fusion, in the hope that it will be a far richer and safer source than nuclear fission. We must develop wind-power, wave-power, the use of Earth's internal heat and, most of all, the direct use of solar power. All these things are highly practical, but cost more money than oil and coal, so the challenge is to make them cheaper. (The fact that we can destroy our planet so cheaply, by the way, does not mean we ought to destroy it.)" He concludes, "If there is any spare effort left over from these absolute necessities of scientific advance, we can put them into other projects--otherwise not. I regret this, for I am emotionally on the side of the big projects, all of them, but necessity is a hard task-master, and necessity is now in the saddle and holds the whip." Our thanks to Frank Chen of UCLA for calling this article to our attention.

LASER MEETING PLANNED

The 10th International Workshop on Laser Interaction and Related Plasma Phenomena will take place November 11-15, 1991, at the Naval Postgraduate School in Monterey, California. Presentations and discussions of selected key topics regarding powerful lasers and charged-particle beams and their interactions with plasmas up to and including extreme intensities and short (x-ray) wavelengths will be continued in the 10th meeting of this traditional series. The format will follow that of the previous workshops and will include: latest research results, extensive reviews of key areas, discussion of critical views,plus speculation about future directions. A 1-day tour of ICF facilities at the Lawrence Livermore National Laboratory is also planned. The timing of this workshop was planned to allow interested persons to combine attendance with the APS Plasma Physics Division Meeting which occurs the prior week in Tampa, FL.

The selection of regular presentations will be based on prior submission of 500-word abstracts. However, late abstracts of extreme urgency may also be considered for a post-deadline session. The scope of the workshop can be seen from examination of past proceedings (1971-1989) published in monographs by Plenum Press, New York.

The committee for the 10th Workshop include: Prof. Heinrich Hora and Prof. George H. Miley, co-directors, Prof. Fred Schwirzke, local organizer. The advisory board includes: N. G. Basov, R. Dautray, S. Eliezer, A. Guenther, M. H. Key, P. Mulser, S. Singer, G. Velarde, and C. Yamanaka. Abstracts are due June 1, 1991. For further information contact Prof. George H. Miley, Fusion Studies Laboratory, University of Illinois, 103 South Goodwin Avenue, Urbana, IL, 61801, USA, (217) 333-3772.

PEOPLE

Rulon Linford has been named program director of nuclear systems, a newly created post at the Los Alamos National Laboratory. Rulon will oversee the magnetic fusion energy program, civilian energy aspects of inertial fusion, and a new effort to develop a program in accelerator transmutation of

radioactive waste. Laboratory associate director ***John Whetten*** also announced that two subprogram managers will report to Linford. ***Dick Siemon*** will be program manager for fusion energy, which will include magnetic and inertial fusion energy programs and ***Ed Arthur*** will be program manager for the accelerator transmutation program.

General Atomic's crack fusion lobbyist ***Kathryne M. Bruner*** has married ***Richard K. Thorpe.*** Best wishes, Mrs. Thorpe.

NAME CHANGE

Spectra Technology, Inc. of Bellevue Washington, has changed its name to STI Optronics, Inc.. The name was changed to comply with the terms of the sale of Spectra Technology by Spectra Physics, Inc. to Amoco Technology Company, which took place on September 30, 1989. STI Optronics, Inc. is a member of Fusion Power Associates and its president, Bob Center, is a member of our Board of Directors.

FUTURE IAEA CONFERENCE SITES

The IAEA Conference on Plasma Physics and Controlled Nuclear Fusion will be held in Bavaria, FRG, in 1992; in the USSR in 1994; and in Montreal, Canada in 1996.

MEETINGS

June 2-7 - Second International Symposium on Fusion Nuclear Technology. Karlsruhe, FRG. Contact Mohamed Abdou (213) 206-0501 or J. E. Vetter, FRG, FAX (07247) 825460.

June 3-5 - Eighteenth IEEE International Conference on Plasma Science. Williamsburg, VA. Contact Linda Sugiyama FAX (617) 258-7864.

June 3-7 - 18th European Conference on Controlled Fusion and Plasma Physics. Berlin. Contact in Berlin 372-203-77-470, FAX 372-200-45-36.

June 11-14 - Cryogenic Engineering Conference. Tom Bevill Center, Huntsville, AL. Contact Mary Beth Magathan FAX (205) 895-6760.

June 16-21 - Sixth International Conference on Emerging Nuclear Energy Systems. Monterey. Contact Carl Henning FAX (415)423-2395

June 17-19 - IEEE Pulsed Power Conference. San Diego. Contact R. White, Maxwell Laboratories, 8888 Balboa Ave., San Diego, CA, 92123.

June 17-20 - APS Topical Conference on Shock Compression of Condensed Matter. Williamsburg, VA. Contact APS.

June 17-19 - Fourth European Fusion Theory Conference. Aspenes, Goteborg, Sweden. Contact Jan Weiland FAX 4631-164513.

June 23-28 - Twelfth International Magnet Technology Conference. Leningrad. Contact B.N. Zhukov FAX 812 463 9812.

June 25-26 - Fusion Power Associates Annual Meeting and Symposium "Fusion Facilities Planning for the 1990's." Contact Ruth Watkins (301) 258-0545.

August 4-9 - 26th Annual Intersociety Energy Conversion Engineering Conference (IECEC). Boston. Contact ANS (708) 352-6611.

September 29-October 4 - Fourth Topical Meeting on Tritium Technology in Fission, Fusion and Isotopic Applications. Albuquerque. Contact Susie Salazar, FAX (505) 667-7558.

September 30-October 3 - 14th IEEE Symposium on Fusion Engineering. San Diego. Contact Marion Stav (619) 455-2493, FAX (619) 455-2494.

QUOTABLES

"A determination to do fusion ought to be the first thing that comes out of the Monday morning quarterbacking on the Middle East."

Edwin E. Kintner
GPU Nuclear
September 28, 1990

"Washington is ruled by one principle: There is no money."

Paul Gilman
Aide to Sen. Pete Domenici
Quoted in LANL Newsbulletin
February 22, 1991

EXECUTIVE NEWSLETTER

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

BALDWIN RETURNS TO LIVERMORE

MEADE NAMED PRINCETON DEPUTY DIRECTOR

HAPPER NOMINATED TO ENERGY POST

BALDWIN NAMED MAGNETIC FUSION CHIEF AT LLNL

David E. Baldwin has been named Associate Director for Magnetic Fusion Energy at the Lawrence Livermore National Laboratory. He expects to take up his duties at LLNL in mid July. Dave is currently director of the Institute for Fusion Studies at the University of Texas at Austin. Prior to coming to Texas three years ago, Dave was deputy associate director for Magnetic Fusion Energy at LLNL. He received his Ph.D. from MIT in 1962 and first joined the magnetic fusion program at LLNL in 1970. From 1962 to 1970 he held positions at Stanford University, Culham Laboratory and Yale University. He is a Fellow of the American Physical Society and has served on numerous advisory committees. Among his recent activities, he was vice chairman of the Magnetic Fusion Advisory Committee, and he chaired the U.S. national review of the ITER conceptual design activity.

The ITER U.S. Home Team will be headed by Alexander Glass as a separate activity at LLNL (see our March newsletter). As LLNL associate director for programs, Alex will report directly to LLNL director John Nuckolls. Glass has been directing the magnetic fusion energy program at LLNL, but the two posts have been separated at LLNL at DOE's request.

David E. Baldwin

Dale M. Meade

MEADE NAMED DEPUTY DIRECTOR AS PRINCETON REORGANIZES

Ronald C. Davidson, director of the Princeton Plasma Physics Laboratory has announced a reorganization, including the naming of Dale M. Meade as deputy director. Meade had been head of the TFTR Project. Other significant appointments include the appointment of Ned Sauthoff as head of the Physics Department, Richard Hawryluk as head of the TFTR Project, Rob Goldston as

head of the Laboratory Research Council, Steve Jardin as deputy head of the Physics Department, Doug Post as head of Modelling and ITER Physics within the Physics Department and Paul Rutherford as Associate Director for Research. John DeLooper has been named Associate Director for Environment, Safety, Health and Quality Assurance.

WHITE HOUSE NOMINATES WILL HAPPER AS DOE DIRECTOR OF ENERGY RESEARCH

President Bush has sent to the Senate for confirmation the nomination of Princeton University professor William Happer, Jr. to become DOE Director of Energy Research. Happer, 51, is an atomic physicist who has been at Princeton since 1980. He is best known in fusion circles for his roles as chairman of a 1986 Academy of Sciences panel to review the DOE's inertial confinement fusion program and as a member of last year's Academy panel which updated the 1986 review.

Happer received his Ph.D. from Princeton University in 1964 and was at the Columbia University Radiation Laboratory from 1964 to 1980, serving as its director beginning in 1970. He has been a member of the JASON'S, a prestigious government advisory group, becoming its chairman in 1987. He is a trustee of the MITRE Corporation and a Fellow of the American Physical Society.

HEAVY ION FUSION STATUS

R. Bock of the GSI, Darmstadt, Germany has issued a report (GSI-91-13,February 1991) entitled "Status and Perspectives of Heavy Ion Inertial Fusion." The report, "dedicated to the memory of Denis Keefe," is based on an invited talk given in July 1990. The report summarizes the status of the two primary accelerator candidates for heavy ion fusion: the rf linac with storage rings being developed at GSI and the induction linac being developed at LBL. The report also describes the HIBALL reactor design study carried out by KFK, the University of Wisconsin and Fusion Power Associates. The report states that the primary uncertainties for the accelerator for heavy ion fusion are "the growth rate of longitudinal instabilities in storage rings, the final focusing and the final bunching." Various proposed European collaborations for heavy ion fusion development are described. The report concludes, "Recently Fusion Committees in the U.S. have recommended to relax classification in this field which, if realized, would greatly improve the international collaboration." Copies of the report may be requested from R. Bock, GSI, Planckstr. 1, Postfach 11 05 52, D-1600 Darmstadt 11, Germany.

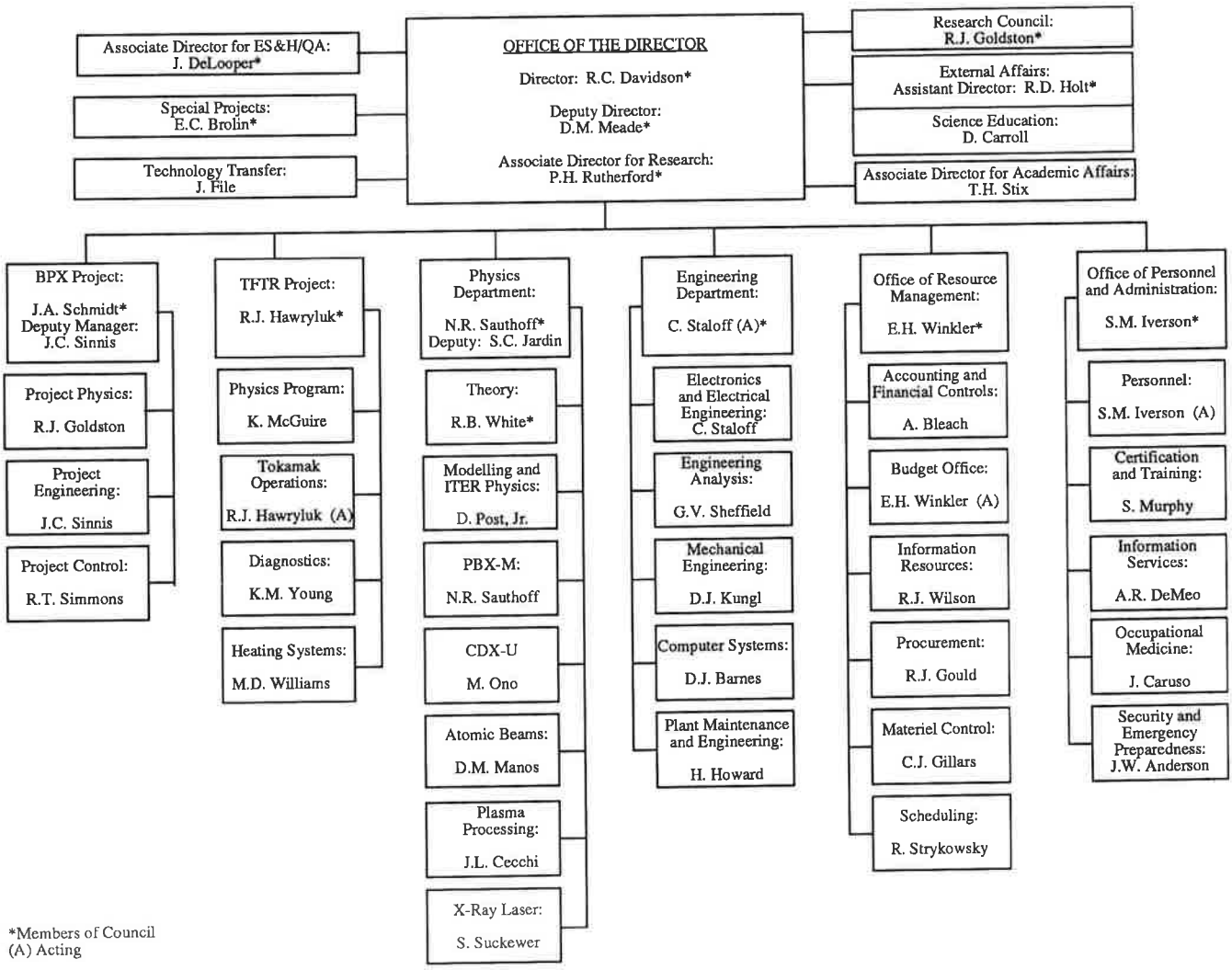
HOUSE PASSES FUSION APPROPRIATION

The House of Representatives has passed the FY 1992 appropriations bill containing fusion funding. Action on a similar bill is pending in the Senate. The House measure contains $12 million above the President's request for defense inertial confinement fusion, bringing the total for next year to $194.8 million. This year's ICF budget is $175.0 million. The House action also provides $337.1 million for civilian fusion energy, compared to this year's total of $289.6 million. The action earmarks $20.2 million within the ICF total for the Omega Upgrade at the University of Rochester and $8 million within the civilian program for inertial fusion energy.

SENATE ENERGY COMMITTEE ENDORSES FUSION DEVELOPMENT

The Senate Energy Committee added a fusion section to its energy policy bill, S-341, (see our March newsletter) and sent the bill to the full Senate for action. The fusion endorsement amendment was offered by New Jersey senator Bill Bradley on the final day of markup. Fusion Power Associates and Princeton University officials had been working with congressional staff on the amendment for several months. The fusion section of the bill directs the Secretary of Energy within 180 days of the bill's enactment to prepare a comprehensive management plan for a fusion research, development, and demonstration program that would lead to a commercial demonstration of fusion as a source of electricity after the year 2010. The section also calls upon the Secretary to evaluate the need for new or expanded international agreements in the field and to determine appropriate roles for academia and industry in the fusion development program.

The Secretary of Energy issued a press release praising the committee for its work in passing the bill, saying "I would like to commend and congratulate Senator Johnston and Senator Wallop for their leadership in producing a comprehensive and balanced energy bill, a monumental achievement by the Committee." The bill is intended to codify many aspects of the National Energy Strategy and also contains a trust fund concept to fund R&D programs, as reported in our March newsletter.



NEW PRINCETON ORGANIZATION

NEW JOURNAL TO FEATURE SOVIET T-15

In its second issue, the new journal "Plasma Devices and Operations" will feature the new Soviet superconducting tokamak T-15 which is now in operation at Moscow's Kurchatov Institute. In its first issue the journal contains an article by H. Ninomiya et al. on the Japanese JT-60 Upgrade, an article by V.A. Chuyanov on "Routes to Controlled Fusion on the Basis of Tokamaks" and several other interesting papers. For subscription information and to request a complimentary copy, contact Ms. Lorraine Rogers, Gordon and Breach Science Publishers, c/o STBS, PO Box 90, Reading, RG1 8JL, UK., FAX 44-734-568211. Information can also be obtained in the U.S. by calling 1-800-545-8398 and in Japan from Yohan Western Publications, 3-14-9, Okubo, Shinjuku-ku, Tokyo 169.

Academician V.A. Glukikh is Editor in Chief and A.N. Popov is Managing Editor. Both are at the D.V. Efremov Institute in Leningrad.

DOE FORMING PERMANENT FUSION ADVISORY COMMITTEE

The Department of Energy has approved the formation of a new fusion advisory committee to replace the old Magnetic Fusion Advisory Committee (MFAC). The new committee will be known as the Fusion Energy Advisory Committee (FEAC). The FEAC is expected to consist of 17 members; the names of the members have not yet been announced. Members are expected to serve two year terms and they will meet about 5 times a year to provide advice as requested by DOE. It is expected that the FEAC will function in a

manner similar its predecessor, the MFAC, by delegating review functions to ad hoc technical panels. All meetings of the FEAC will be announced in the Federal Register and be open to the public.

STELLARATOR SUMMARY PREPARED

Jim Lyon of ORNL has prepared a report reviewing recent stellarator results in the USA, USSR, and Japan. Lyon concludes that "key optimization issues . . . are being addressed at relevant parameters on complementary experiments," and that "stellarators with significant shear are maturing as a confinement concept." He states "However, higher power is needed for more relevant physics and optimization studies." For further information, contact Jim Lyon at (615) 574-1179.

PLASMA TRANSPORT SUMMER SCHOOL

The University of Wisconsin will conduct a summer school on "Plasma Turbulence and Transport" August 19-23 in Madison, Wisconsin. The class size will be limited to 30. The objective is "to teach a primarily experimental group of plasma physicists the key elements of plasma turbulence and transport, and provide an introduction to the current literature in these areas." For application information, contact Prof. J.D. Callen FAX (608) 262-6707.

CONGRATULATIONS

- - To Prof John P. Holdren of the University of California at Berkeley on his election to the National Academy of Sciences.

QUOTABLE

"Moreover the (fusion) fraternity must speak with one voice . . . . That voice must say that controlled fusion energy is imperative and that the way to have a reactor is to build one, now. The Wright brothers started their research with an airplane that they intended to fly, not one that would theoretically fly were wings and fuel added. Without a bold attitude fusion will remain a mirage, always out of reach, forever only twenty years away."

Robin Herman, in
FUSION: The Search for Endless Energy
Cambridge University Press, 1990

MEMBERS

ASEA Brown Boveri, Inc.
Bechtel National, Inc.
Ebasco Services
General Atomics
Grumman Aerospace Corp.
McDonnell Douglas Missile Systems Co.
Ontario Hydro
W.J. Schafer Associates, Inc.
SAIC
Stone and Webster Engineering Corp.
STI Optronics, Inc.
Varian Associates

AFFILIATES

Baltimore Gas and Electric Co.
EG&G Idaho, Inc.
Fluor Daniel, Inc.
Fusion Technology Institute, University of Wisconsin
Hoya Optics, Inc.
Hydro-Quebec
Martin Marietta Energy Systems, Inc.
Maxwell Laboratories, Inc.
Northern States Power Co.
Ralph M. Parsons, Co.
Spar Aerospace, Ltd.
United Engineers and Constructors, Inc.
Universal Voltronics Corp.
University of Rochester
Uranium Pechiney
Westinghouse Electric Corp.

SMALL BUSINESS AFFILIATES

Batzer Vacuun Technology Associates, Inc.
Conax Buffalo Corp.
Creare, Inc.
Directed Technologies, Inc.
Doty Scientific, Inc.
Everson Electric Co.
IGC Advanced Superconductors, Inc.
InterScience, Inc.
Krall Associates
Lodestar Research Corp.
General Leasing and Management Co.
Stern Laboratories, Inc.
Thermacore, Inc.

EXECUTIVE NEWSLETTER

JULY 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

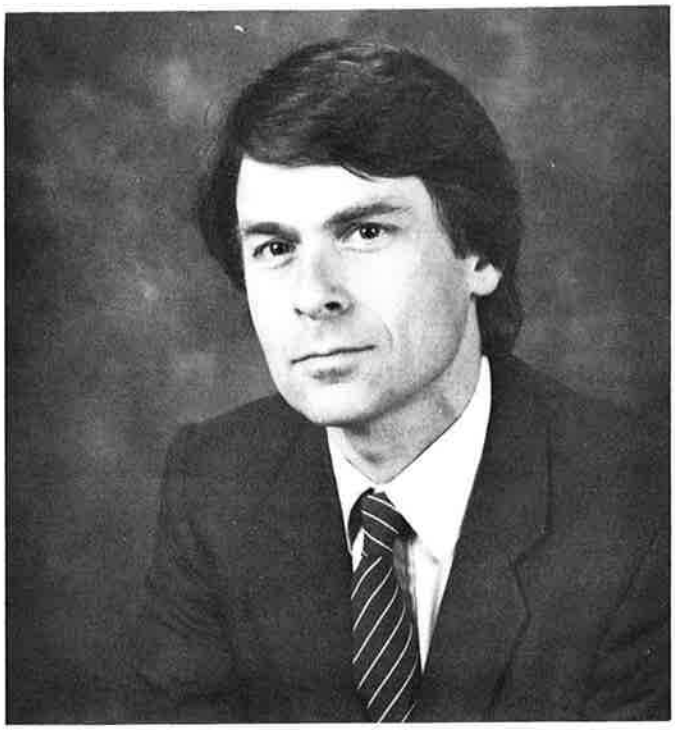
(301) 258-0545

GA FINDS BETTER TOKAMAK REGIMES

FPA ANNOUNCES AWARDS

STORM RECEIVES LEADERSHIP AWARD

Erik Storm, deputy associate director of ICF and ICF program leader at the Lawrence Livermore National Laboratory, received Fusion Power Associates Leadership Award at the FPA annual meeting and symposium June 25. In presenting the award on behalf of the FPA board of directors, FPA president Steve Dean noted Storm has consistently pointed out directions which could lead to the more rapid development of inertial confinement fusion and presented a constant challenge to "business as usual" attitudes. The award, established in 1980, is to recognize individuals who have shown outstanding leadership qualities in attempting to accelerate the development of fusion. The award certificate cites Storm for "providing technical guidance, a broad vision and enthusiasm to both the national and international inertial confinement fusion efforts, as well as effectively communicating the excitement of fusion to the public." FPA leadership awards have been presented in previous years to S.J. Buchsbaum, R.L. Hirsch, M. McCormack, P. Tsongas, E.E. Kintner, H.P. Furth, J.H. Nuckolls, J.L. Emmett, T.K. Fowler, T. Ohkawa, G. Yonas, E.P. Velikhov, C. Yamanaka, R.C. Davidson, M.N. Rosenbluth, J.F. Clarke, P-H. Rebut, and B.B. Kadomtsev.



Erik Storm

GA FINDS NEW REGIMES

Scientists at General Atomics, using the DIII-D tokamak, have discovered operating conditions in which the energy of the plasma is contained for almost twice as long as the best results obtained previously anywhere in the world. In a press release issued June 14, GA called the result a "major advance in fusion energy research." For many years tokamaks had been plagued by what scientists called "low mode scaling", meaning that extrapolations led to very large and expensive devices. A few years ago many tokamaks began operating in a new mode, called the "high mode", in which the energy was confined typically for about twice as long as in low mode. The new GA result, which they have

named the VH or "very high" mode, is typically 1.8 times the usual high mode. According to a paper by Tom Simonen at the June 7 European Physical Society meeting, "The plasma temperatures and densities are higher than in H-mode discharges with similar auxiliary heating and have lower radiated power." A more peaked current profile is believed to be instrumental in creating the improved conditions, which were achieved after a thin coating of boron was applied to the plasma facing surfaces in the device. Under VH-mode conditions, new record high values have been achieved for the DIII-D tokamak parameters electron temperature (6 keV) and the density/confinement time/ temperature product (1.3×10^{14} cm^{-3} s keV).

In separate experiments, reported by Simonen at Fusion Power Associates annual meeting and symposium at Princeton on June 25, operation of the DIII-D tokamak under conditions of high plasma pressure in the central plasma core was achieved. Core conditions corresponding to the so-called "second stability" regime were achieved with plasma betas of 42%. (Beta is the ratio of plasma pressure to magnetic field pressure.) The conditions were maintained transiently; GA scientists will work to extend the period of this mode to longer times.

The above two results hold promise that tokamak confinement scaling is improving in a direction that may lead to significantly smaller and less expensive tokamak reactors and test facilities in the future. For further information, contact Tom Simonen at (619) 455-3522.

FORSEN RECEIVES DISTINGUISHED CAREER AWARD

Harold K. Forsen, senior and executive vice-president of Bechtel National, Inc. and a member of the National Academy of Engineering, received FPA's distinguished career award at the annual meeting. In presenting the award, Steve Dean noted that Forsen established the very successful and productive fusion engineering group at the University of Wisconsin in the mid-1960's, established a laser isotope separation activity at Exxon Nuclear in the 1970's, and risen to ever more responsible positions at Bechtel during the 1980's. In addition, Dean cited Forsen's service on the DOE's Magnetic Fusion Advisory Committee, the National Academy of Science's committee on fusion in national energy policy, DOE's Fusion Policy Advisory Committee and Fusion Power Associates' board of directors.

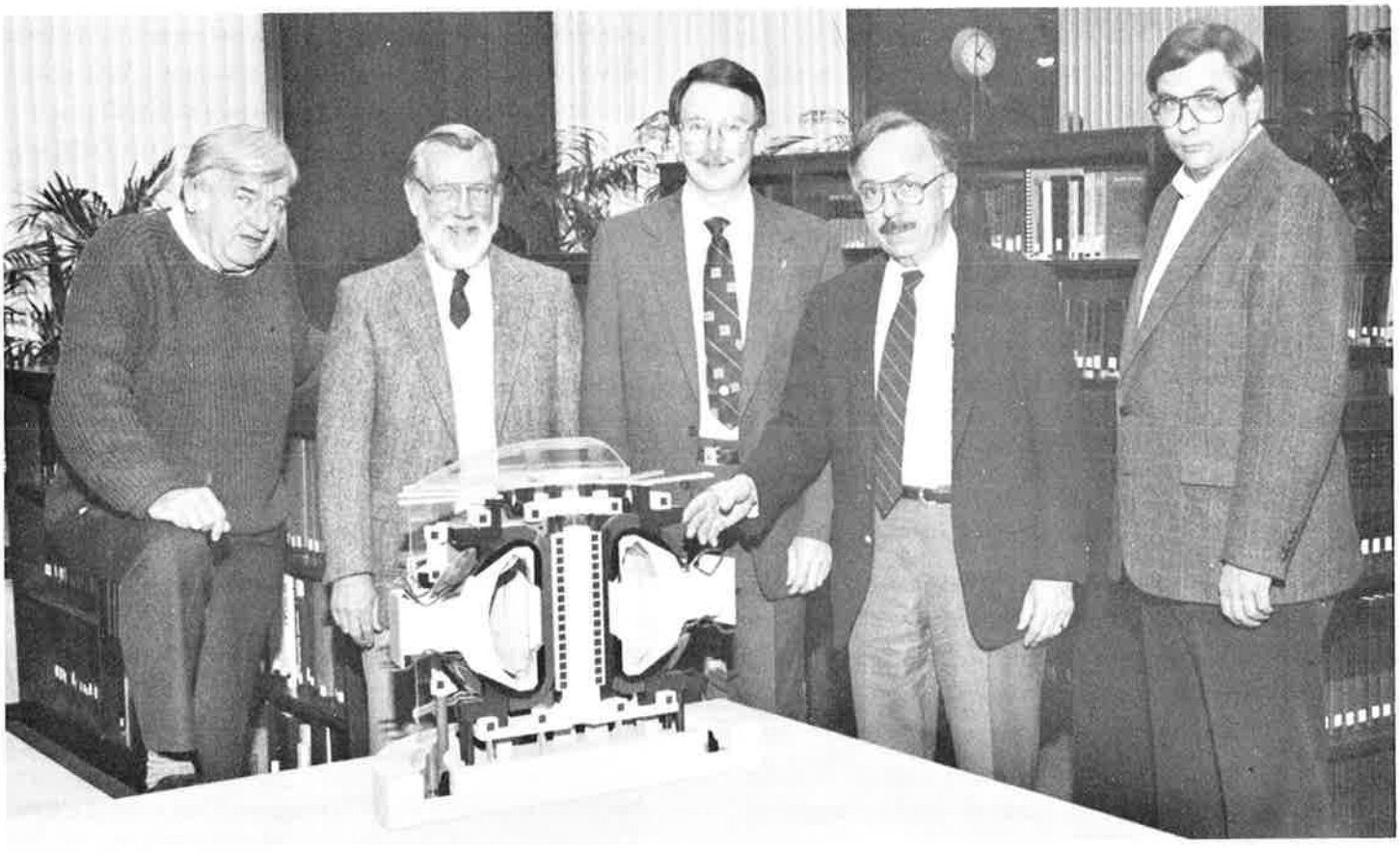
Harold K. Forsen

John F. Santarius

FPA's distinguished career awards were established in 1987 to recognize individuals who have made distinguished lifelong career contributions to the underlying sciences and technologies upon which fusion power development depends. Awards have been presented in previous years to M.B. Gottlieb, D. Kerst, R.F. Post, L. Spitzer, Jr., K. Husimi, D. Palumbo, R.S. Pease, F. Coensgen, D. Grove, F. Ribe, N.G. Basov, and T. Sekiguchi.

SANTARIUS RECEIVES FUSION ENGINEERING AWARD

John F. Santarius of the University of Wisconsin received FPA's Excellence in Fusion Engineering award at the FPA annual meeting. The award was established in 1987 in memory of Prof. David J. Rose, to recognize individuals in the early part of their careers who have shown outstanding technical accomplishment and also leadership potential in the field of fusion engineering. In presenting the award, Steve Dean quoted excerpts from several letters received in support of Santarius' candidacy: "John initiated the suggestion that the moon is a potential source of He3 and, together with Wittenberg and Kulcinski, dug out the data from the Apollo lunar landing program which substantiated that suggestion ... John is also an entertaining speaker who presents his ideas clearly and in a stimulating manner ... His productivity and the extent of his curiosity have led him to apply his analytic skill to a number of the urgent and puzzling contemporary problems in fusion power development." FPA excellence in engineering awards have been presented in previous years to Steven J. Piet, Michael A. Ulrickson, David Ehst, Y-K. Martin Peng, and Wayne Reierson.



U.S. ITER MANAGEMENT TEAM

US ITER MANAGEMENT TEAM NAMED

A multi-laboratory team has been named to manage U.S. efforts on the International Thermonuclear Experimental Reactor (ITER) project during a six-year engineering design activity (EDA). Alexander J. Glass of Lawrence Livermore National Laboratory is Leader of the U.S. Home Team for the project. Working with him are Charles C. Baker of Oak Ridge National Laboratory as Technology Manager, James N. Doggett of LLNL as Engineering Manager, and Douglass E. Post of Princeton Plasma Physics Laboratory as Physics Manager. Charles A. Flanagan of ORNL is Project Coordinator, and Forrest V. Kahle of LLNL is Resource Manager. The U.S. Home Team project office will be housed at LLNL.

The ITER project is an international collaboration among the United States, The European Community, Japan, and the Soviet Union to design a fusion engineering test reactor. The four ITER parties will share equally the $1 billion cost of the engineering design activity. Of the total EDA cost, about one-fourth will be for design work, and three-quarters is designated for engineering research and development and for developing and testing scalable models.

A unified multi-national team will perform design integration and overall project management. The site for the central design work has not yet been determined. A meeting of the four ITER parties is scheduled in Washington July 8-9.

The Home Teams of the four parties will perform specific design tasks and will also perform the research and development of critical technologies, including the construction and testing of the component models. Glass said these tasks will be apportioned equally among the four ITER parties. To perform its assigned tasks, the U.S. Home Team will draw upon national laboratories, university programs, and industries across the nation. Glass pointed out that collaboration with industry is especially crucial to the success of the project.

"The ITER project is committed to having the component models built by industry," said Glass. "The goal is to prepare an industrial base for bidding on the eventual construction of ITER. We plan to team with industry and transfer the necessary technology so that industry will be able to manufacture the final components."

WATKINS VISITS EBASCO

Energy Secretary James D. Watkins visited Ebasco's World Trade Center headquarters in May, receiving a general presentation on the company, with emphasis on the company's government business, from Ebasco chairman and CEO Rich Albosta. Ebasco senior vice president (and chairman of FPA's board) Bob Iotti participated in the briefing. Ebasco was prime contractor for the Tokamak Fusion Test Reactor and is under contract to Princeton for the vacuum vessel system for the Burning Plasma Experiment.

YOUNGER HEADS LANL ICF PROGRAM

Stephen Younger has been named head of the inertial confinement fusion program at the Los Alamos National Laboratory, succeeding David Cartwright. Younger was formerly deputy group leader in inertial fusion and plasma theory. He was also recently elected a fellow of the American Physical Society. In that action the APS cited Younger for "the development and application of improved techniques for the theoretical study of radiative transitions and electron-impact ionization of highly charged ions."

ANS FUSION DIVISION ELECTS OFFICERS

Don Dudziak has been elected vice-chairman/chairman elect of the ANS Fusion Energy Division. He will automatically succeed chairman Greg Moses next year. M. Yousry Gohar was elected secretary/treasurer. New members elected to the executive committee are: John W. Davis, Wayne A. Houlberg, and Dale L. Smith.

NEW LLNL ICF QUARTERLY

LLNL has issued volume 1, number 1 of a new quarterly entitled Inertial Confinement Fusion Quarterly Report, covering the period October-December 1990. The issue discusses aspects of microsphere technology, laser-plasma interaction physics, heavy ion beam propagation and beam smoothing on the Nova laser. For information on receiving this and future issues, write LLNL, Laser Programs Document Services, P.O. Box 5508, Livermore CA 94551-9989.

DOE ICF OFFICE UPGRADE

Following up on a recommendation of last year's Fusion Policy Advisory Committee (see our August 1990 newsletter) the DOE has upgraded the status of the inertial fusion program from being a division to being an office. The program manager, Marshall Sluyter, now reports to one level higher in the DOE management structure. This action reverses the downgrading action taken in mid-1987 (see our September 1987 newsletter) at a time when the DOE was actively trying to snuff out the identity of the ICF program and merge it with their generic weapons R&D activities.

HENNING MOVES TO ICF PROGRAM

Carl D. Henning, long-time magnetic fusion magnet and systems engineer at LLNL, has moved to the LLNL inertial confinement fusion program as deputy program leader for laser science and technology, in charge of engineering for the Nova Upgrade, Beamlet and other laser projects. He will report to program leader Mike Campbell. In recent years, Carl was active in the ITER project and, prior to that, led the design of the most recent U.S. magnetic fusion engineering test reactor design called TIBER. He also was responsible for the magnet systems for MFTF. We look forward to working with Carl in his new capacity.

Just prior to joining the ICF program, Carl headed a team of Livermore engineers who proposed new ideas for capping the Kuwaiti oil well fires. Of 1300 ideas from around the world reviewed at a special meeting in London, the LLNL concept was the only one selected by the Kuwait Petroleum Company for field testing in Kuwait. LLNL is now building a prototype of the 10 ft. diameter, 30 ft. high steel cylinder that would be dropped over the well by a crane. The cylinder has a vent on top for flaring gases and baffles inside to redirect falling oil into existing troughs around the wells. The fire is quickly extinguished inside the cylinder due to oxygen exhaustion.

THANKS

We thank the following individuals for making contributions to our Engineering Prize Fund since Jan. 1, 1991:

Daniel R. Cohn	**Ralph Moir**	**E. Press, M.D.**
Julian L. Dunlap	**Bruce Montgomery**	**J. R. Roth**
Kenneth Fowler	**Masanori Murakami**	**Kenneth Schultz**
Gregory Haas	**John G. Murray**	**Nicholas Sclufer**
Anne Jones	**Raymond Murray**	**John Sheffield**
Donald Kerst	**Farrokh Najmabadi**	**Thomas Simonen**
John Killeen	**Martin Peng**	**Donald Steiner**
John P. Larson	**Chun-Mou Peng**	**Alvin Trivelpiece**
Ronald L. Miller	**Steven J. Piet**	**Pace VanDevender**

EXECUTIVE NEWSLETTER

AUGUST 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

ITER PROGRAM MOVES AHEAD

NUCKOLLS, TRIVELPIECE URGE FUSION SPEEDUP
CONN HEADS NEW FUSION PANEL
DOUBLET DOUBLES AGAIN

NEW PARTICIPANTS

Babcock and Wilcox, a major engineering and reactor manufacturing company based in Lynchburg, Virginia, has become a corporate member of Fusion Power Associates. The company's representative to FPA will be Floyd N. Anderson, Manager, Marketing. He can be reached at P.O. Box 11435, Lynchburg, VA 24506-1435, tel. (804) 522-6800, FAX (804) 522-6800.

The General Electric Company has become a corporate affiliate of Fusion Power Associates. Dr. Walter L. Robb, senior vice-president, Corporate Research and Development Center, will be the company's representative to FPA. He can be reached at P.O. Box 8, Schenectady, NY 12301, tel. (518) 387-7000, FAX (518) 387-5324.

We welcome the participation of B&W and GE in Fusion Power Associates.

NEW FUSION ADVISORY COMMITTEE

Energy Secretary James D. Watkins sent letters July 16 to eighteen individuals, including FPA president Steve Dean, asking them to serve on a new Fusion Energy Advisory Committee (FEAC). The new committee succeeds the old Magnetic Fusion Advisory Committee (MFAC) which passed out of existence a couple of years ago. Bob Conn, director of the UCLA Institute of Plasma and Fusion Research, will

FEAC Chairman Robert W. Conn

chair the new committee. According to Watkins, the committee "will provide advice and recommendations on technical issues and other matters relating to the US Fusion Energy program." The FEAC membership includes inertial fusion scientists Klaus Berkner of LBL, Bob McCrory of the University of Rochester and Barry Ripin of NRL, an indication of DOE's recognition of inertial fusion as a potential energy source. Other persons invited to serve initial 2 year terms on the committee are Dave Baldwin (LLNL), Floyd Culler (EPRI), Ron Davidson (MIT), Dan Dreyfuss (Gas Research Institute), John Holdren

(UC-Berkeley), Rulon Linford (LANL), Norman Ness (U. of Delaware), Dave Overskei (GA), Ron Parker (MIT), Marshall Rosenbluth (UC-San Diego), John Sheffield (ORNL), Peter Staudhammer (TRW), and Harold Weitzner (NYU). Norman Ness, a person unfamiliar to most fusion scientists, is a geophysicist (MIT, 1959), president of the University of Delaware's Bartol Research Institute and Executive VP of the Franklin Institute.

According to the written charter for the FEAC, it will report to the Director, Office of Energy Research, USDOE, with primary support being provided by the Office of Fusion Energy. It is expected to meet about 5 times per year. Meetings will be announced in the Federal Register and will be open to the public.

DOUBLET DOUBLES AGAIN

Scientists at General Atomics, who just recently (see our last month's newsletter) found a new, improved plasma confinement regime in their DIII-D tokamak, have doubled the temperature in that regime from 60 to 130 million degrees. The result was achieved without loss of the high density-confinement time product of 2×10^{13} cm^{-3} s and without adding any additional neutral beam power to the 12.6 MW used previously, by simply changing the startup procedure so as to access the "hot ion regime" earlier in the discharge. The new operating regimes have also been at or near the maximum normalized beta limit predicted by the first stability theory.

ITER PROGRESS

Negotiators from the United States, the Soviet Union, Japan and the European Communities have reached agreement on terms of cooperation for the engineering design of the International Thermonuclear Experimental Reactor (ITER). If this agreement is approved by the four parties involved, the engineering design activity will extend for six years and result in completion of a design from which the test reactor can be built.

The design itself will be conducted by a multinational team located in three co-centers: San Diego, California; Garching Germany; and Naka, Japan. The director, who will come from the European Communities, will reside at the San Diego co-center, where the design integration will take place. In what *Science* magazine (July 19, 1991) calls a "scheme resembling musical chairs," the European co-center will be headed by an ITER deputy Director from the U.S., and the Japanese co-center will be headed by an ITER deputy director from Europe, while an ITER deputy from the USSR will reside in San Diego. The Japanese will provide a "principle deputy" in San Diego as well as chair a management advisory committee. The U.S. will chair a technical advisory committee.

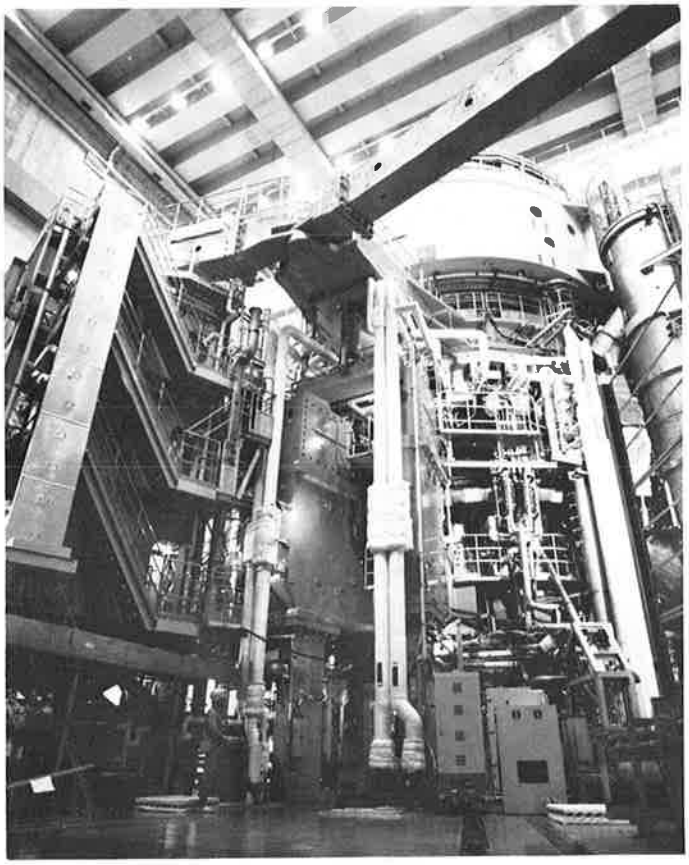
The project will be overseen by a council of the parties, the ITER Council, chaired by the Soviet Union and co-chaired by Japan. The ITER Council will be headquartered in Moscow.

The negotiating team consisted of P. Facella (EC), H. Ishida (Japan) B. Nikipelov (USSR) and J. Decker (US). The agreement, if ratified by the parties involved, will mark the beginning of the second step in a program of cooperation initiated by President Reagan and then-General Secretary Gorbachev of the Soviet Union in their 1985 summit meeting in Geneva, and actively supported by the Bush administration. The first step, the conceptual design, was successfully concluded in December 1990, under the auspices of the International Atomic Energy Agency.

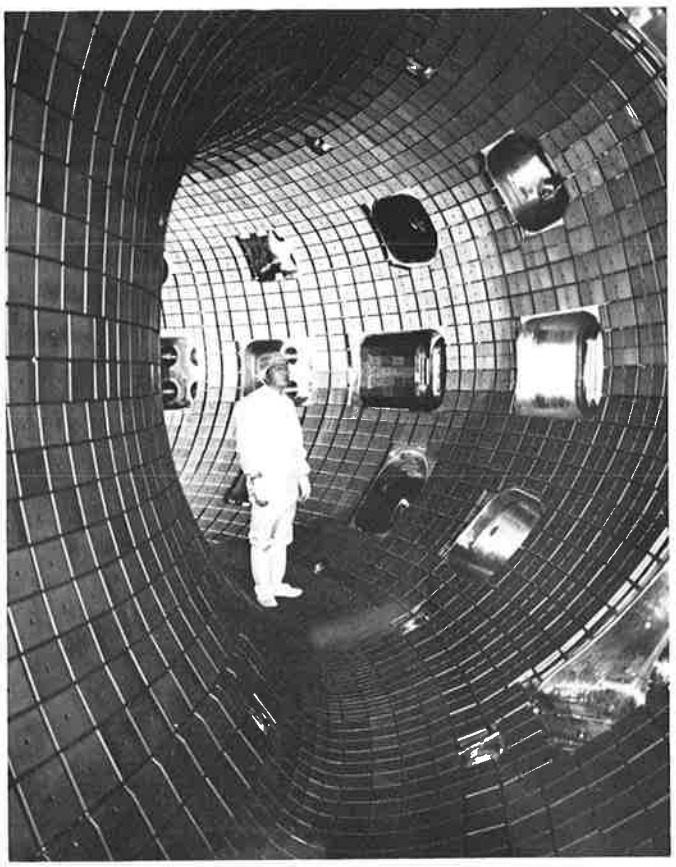
The agreement will now be submitted to domestic authorities for approval. It is hoped that the agreement will be formally ratified before the end of the year and that selection and assignment of personnel to work on the project will be accomplished early in 1992.

Dr. James F. Decker of the Department of Energy, who led the U.S. negotiating team said: "The agreement reached by the four parties is equitable, and is an important step forward in the development of fusion energy. It is also a significant milestone in the development of international cooperation in big science. Such agreements help us to make the most effective use of our scarce financial resources, and our equally scarce scientific and technical talents."

Chuck Flanagan, coordinator of the ITER "U.S. Home Team" has begun to issue an informal information newsletter called "U.S. ITER News." To receive a copy of the first and future issues, contact Chuck on (615) 576-5480. ITER information can also be requested from the U.S. Home Team office at LLNL, FAX (415) 423-4145.



Japanese JT-60U Tokamak



Inside View of JT-60U Vacuum Vessel

JT-60 UPGRADE ON THE AIR

The Japanese large tokamak JT-60 is back in business after a 1.5 year machine shutdown for upgrading. The modified machine, JT-60U, has the following capabilities: plasma current of 6 MA, plasma volume of 100 m^3, plasma elongation of up to 1.8 with single null divertor, and aspect ratio of 3-4. Deuterium has been introduced as the working gas and beam species. Neutral beam power can be increased up to 40 MW at a beam energy of 120 keV. Radio-frequency systems of 6 MW ICRF and 24 MW LHRF are available for plasma heating and current drive.

The modification was completed in March. Deuterium experiments with beam injection began in July. Major objectives of JT-60U research are (1) the confinement study of tokamak plasmas in the reactor core regime, (2) fuel-particle and impurities control and heat exhaust at high heating power, (3) non-inductive current drive with 500 keV negative NBI, bootstrap current and LH wave, and (4) fusion-produced particle physics including D-^{3}He alphas produced by 500 keV deuterium beam injection. The research program on these topics will allow JT-60U to to play an essential role for the further progress in fusion research toward the next step project such as ITER.

Our thanks to H. Kishimoto, deputy director of the Naka Fusion Research Establishment, for this information.

NUCKOLLS, TRIVELPIECE URGE FUSION SPEEDUP

As part of the growing congressional interest in passing national energy policy legislation (see our March and June newsletters), Rep. Marilyn Lloyd has been holding a series of hearings aimed at developing a bill in the House of Representatives. At hearings on July 11, LLNL director John Nuckolls and ORNL director Alvin Trivelpiece urged an acceleration of the US fusion effort as a part of their recommendations on a national energy policy.

Nuckolls said that "fusion has progressed to the threshold of net energy production," and that "technical success seems assured." "Fusion may also have a high economic potential," he said.

Noting that the DOE's National Energy Strategy document "calls for the development of the first demonstration fusion power plant by the year 2025, and the introduction of commercial fusion power by about 2040," Nuckolls said "Unfortunately, this would be too late to be relevant to the greenhouse challenge." "(The) stretched out development plan would also provide no economic benefit to the U.S. until mid-21st century, increase the total fusion energy development costs, and insure an inferior position for U.S. fusion industry in the giant global energy market."

Nuckoll's noted that "A detailed Accelerated Fusion Power Development Initiative has been prepared by Dr. Stephen Dean, et al." (Editor's note: "et al." equals Drs. C. Baker of ORNL and D. Cohn of MIT and Ms. Susan Kinkead of FPA.) Nuckolls states "The total costs of this accelerated initiative are smaller than those of the (DOE National Energy Strategy) because the time scales are shorter. If this initiative were successful, the payoff to the U.S. and the world would be substantially increased. I strongly recommend support of an accelerated fusion development program focused on realizing fusion's highest economic potential." To achieve that economic potential, Nuckolls urged an effort to reduce the projected capital costs of fusion reactors. "For both MFE and ICF, funding limitations have reduced the number of approaches being explored including those advanced approaches which have high economic potential." He listed a number of technical areas where cost reductions could be sought, saying "Realization of these advances would reduce fusion capital costs up to two fold and make the cost of fusion energy substantially cheaper than that of fossil energy."

Trivelpiece stated "The current situation of not building any electrical power plants of any kind is untenable. In the next 40 or 50 years, we will have to replace nearly our entire electrical power generating system just because it will have worn out. Because there is such a long lead time before a new facility becomes operational, we must act now to establish a basis for identifying the new technologies needed for electrical power generating facilities. . . .While alternatives to fossil fuels are not yet ready for massive substitution, R&D prospects are brightening for a number of much improved nonfossil technologies, ranging from passively safe nuclear power reactors to less expensive photovoltaics." He noted that a 1989 ORNL study concluded that an additional $1 billion per year "is essential if this nation is to provide long-term options for coping with the greenhouse effect and reducing dependence on fossil fuels," and said "This increase in funding for civilian energy research should be considered in comparison with the more than $400 billion U.S. citizens spend on energy every year." In a table "providing a breakdown for this additional expenditure," Trivelpiece lists an additional $100-200 million per year for fusion research.

Les Waganer (McDonnell Douglas), Dave Harris (LANL), Mike Monsler (Schafer Associates), and John Woodworth (LLNL) at FPA Annual Meeting

ANNUAL MEETING

At Fusion Power Associates annual meeting June 25-26 over one hundred attendees heard Grumman Corp. chairman and CEO Renso Caporali, in his keynote address, say that, in spite of a growing national energy crisis, "somehow we have not been able to follow the plan laid out in the Magnetic Fusion Energy Engineering Act of 1980 -- a plan that called for a Demonstration Reactor by the turn of the century." He said, "The Nation grew impatient with the fusion community's inability to produce anything but more research. While groups within the fusion community argued and lectured and fought for turf, the money went away." He noted that "The war with Iraq is fresh in our Nation's memory, and there's a respectable amount of money for fusion in the National budget. But we have to do something with it. We have to produce something, or that money will go away." He urged the DOE to "encourage the development of a U.S. fusion industry -- and fund industry in the near term for its fusion development work. . . . get industry involved right from the beginning in international ventures -- including those centered in the U.S. -- so that it has a say in planning and in deciding which technologies are of interest to our country." Copies of Caporali's address are available from Fusion Power Associates.

EXECUTIVE NEWSLETTER

SEPTEMBER 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

HAPPER CONFIRMED TO ENERGY POST

GILMAN JOINS WATKINS STAFF
FUSION TORCH REVISITED

HAPPER AT THE HELM

The nomination of Princeton University professor William Happer to be DOE Director of the Office of Energy Research (see our June newsletter) received confirmation by the Senate on August 2. He was sworn in August 6 by energy secretary James D. Watkins, who announced that Happer would also serve as his Science and Technology Advisor. As Director of the Office of Energy Research, Happer has line responsibility for the management of DOE's $3 billion research program, including fusion and high energy physics. As Science and Technology Advisor, Happer will provide advice to the Secretary on the DOE's research and development programs (including defense), education and training activities and on the management of its laboratories. There will be three deputy science advisors, one for defense programs, one for civilian R&D, and one for civilian labs. In an announcement, Watkins also stated that Happer would "help facilitate the transfer of technology from our laboratories to industry." To assist him on that matter, Happer will have a "director of technology utilization."

In a letter dated July 22 to Fusion Power Associates president Steve Dean, Happer thanked FPA for our support of his nomination and said, "I look forward to discussing with you strategies for mastering magnetic fusion in the most incisive and expeditious way, subject to the budget constraints we are likely to face."

William Happer

PAUL GILMAN JOINS DOE

Dr. Paul J. Gilman, administrative assistant to Sen. Pete Domenici (R-NM) will join the Department of Energy around September 1 as an executive assistant to energy secretary James Watkins. Gilman holds a Ph.D. from Johns Hopkins University in the field of ecology and evolutionary biology. He joined the office of Sen. Domenici in 1978 as a AAAS Congressional Science Fellow and has served with the Senator since that time, including a stint (1981-1985) on the

staff of the Senate Subcommittee on Energy Research and Development. He is intimately familiar with fusion affairs and addressed the American Physical Society Division of Plasma Physics in November 1989 at a special evening session organized by FPA president Steve Dean. The session was entitled "Plasma Physics, Public Policy, and the Future of Fusion." Gilman's remarks were published by the APS in Physics and Society, January 1990.

THE FUSION TORCH

In a paper presented during the June 16-21, 1991, International Conference on Emerging Nuclear Energy Systems (ICENES'91), physicists Ben Eastlund and Bill Gough updated their classic 1968 report on the "fusion torch" (Bull. Am. Phys. Soc. 11, 13, p.1564, 1968 and USAEC Report WASH-1132, May 15, 1969). The basic concept is to use energies in a fusion grade plasma to reduce waste or other materials back to their basic elemental form and thereby "close the cycle from use to re-use." If this process should turn out to be practical, i.e., economic, then at least two major societal problems are solved: availability of resources and waste disposal, including radioactive waste. In their current paper, Eastlund and Gough apply their analysis to the deactivation of radioactive waste and to the safe destruction of chemical and biological weapons.

According to Eastlund and Gough, it is not necessary that fusion reactions are actually occurring in the plasma, i.e., it is sufficient that the plasma be "fusion grade" in its temperature and density. Hydrogen and helium plasmas are analyzed for this purpose. They conclude that the technology to produce the required fusion grade plasmas "is available today." They cite information on the ionization of pellet fueling in today's tokamaks as providing the data required for evaluating the fusion torch concept.

Although Eastlund and Gough conclude that the economics still does not permit "general waste recycling" at the present time, they do assert that the technology "is ideal for certain high cost, environmentally hazardous recycling tasks," the two mentioned above, and analyzed in the paper, being examples.

Persons who wish to receive reprints of the paper should contact either Bernard J. Eastlund (6615 Chancellor Dr., Spring, TX 77373, phone 713-376-0955) or William C. Gough (442 Knoll Dr., Los Altos, CA 94024, 415-941-7462).

TRUST FUND IDEA GAINS GROUND

The idea of establishing a federal trust fund to finance the development of new energy sources is gaining ground. The idea was originally proposed in a luncheon speech March 6, 1985 to a meeting of the American Nuclear Society by FPA president Steve Dean. In that address, entitled "What Will It Take To Accelerate the Fusion Program?," Dean stated that continued scientific progress and an attractive fusion power plant design were two necessary, but not sufficient, conditions for an accelerated fusion program. The third, he said, was that "there has to be in the country a level of total R&D on energy technology that is commensurate with the energy problem that the country's going to face down the road." He said, "So what I am proposing is that we can get this third condition, that energy R&D is carried out on a sufficient level, if we fund it in a different way -- through a tax on energy use, a mill-per-kilowatt-hour on electricity, or a dollar on a barrel of imported oil." The idea was transmitted to the DOE and the White House energy staff during the preparation of the National Energy Strategy and also to congressional staff during the past few years.

Evidence of receptivity to this idea first surfaced in the currently-pending energy policy legislation in the Senate (see our March 1991 newsletter). Now it is reported (Inside Energy , August 12, 1991) that House energy and power subcommittee chairman Philip Sharp (D-IN) has asked "members of his panel to review a proposal that would raise as much as $1.4 billion a year for renewable energy r&d programs through a half- to 1.5 mill-per-kilowatt-hour fee on electricity."

The trust fund idea has been recently described in greater and more specific detail by S. Locke Bogart of General Dynamics Corporation. In a paper entitled "Amortizing Fund Financing of Applied Research, Development and Demonstration for Advanced Electrical Energy Production and Distribution Systems," Bogart argues for a direct linkage between the application (new electric generating technologies) and the source of funds (a set-aside from the sale of electricity). Bogart's paper has been distributed by Richard P. Hora, Division Vice President and Energy Business Area Manager at General Dynamics Space Systems Division. He has asked the recipients of his letter to "thoughtfully review the concepts presented in the White Paper and provide comments and recommendations back to me." If you are interested in receiving a copy of the paper, contact S. Locke Bogart, (619)496-7790, FAX (619)496-7676.

PPPL DIRECTORS ASSEMBLE

During its 40 year history, the Princeton Plasma Physics Laboratory has had but 4 directors. They were all at the same place at the same time for the first time recently and the accompanying historic photograph was the result. We wish them all continued good health, happiness and success. Princeton is planning a celebration in late October to commemorate its 40 years of fusion research. At rear are (left) Lyman Spitzer, Jr., founder of Project Matterhorn, (later PPPL) and Director from 1951 through 1960, and Melvin B. Gottlieb, Director from 1961 through 1980. In front are (left) Harold Furth, Director 1981 through 1990, and current Director Ronald C. Davidson.

GIBBONS, BLAIR SUGGEST ENERGY POLICY

Congressional Office of Technology Assessment (OTA) director John H. Gibbons and OTA energy and materials manager Peter Blair describe their view of a vital national energy policy in the July 1991 issue of Physics Today. Their bottom line: "We need to make an explicit commitment to a transition to the post-fossil-fuel age as well as to an era of constantly advancing energy efficiency." Referring to DOE's year and a half excercise to produce a National Energy Strategy (see our March newsletter), the authors note "It turns out that this is the ninth time a President has sought a thoroughgoing national energy program."

Commenting on recent events in the Middle East, the authors state "If we didn't know it already, the Persian Gulf war reminded us how dependent most of the world is on oil from abroad. As the latest Middle East crisis recedes, we may be beguiled again into a false sense of complacency about energy." They note the "largely abandoned" efforts of the 1970's to "push R&D in energy conservation and alternative sources." "A sensible, comprehensive energy policy certainly must be responsive to sudden changes of events, but it must also be grounded in a long-term strategy," they say.

They note that the U.S. presently consumes about 17 million barrels of oil per day, about 25% of world consumption and that our oil imports have risen from 33% of total consumption to about 45% today. Electricity production is largely based on fossil fuel consumption, primarily coal(55%). The U.S. presently produces about 1 billion tons of coal annually and is a net coal exporter. Nuclear power presently generates about 20% of U.S. electricity.

The authors urge that the U.S. commit to a goal of "a sustained improvement in efficiency of 20% per decade for the next two decades," combined with a commitment to a transition to the non-fossil fuel era by aiming for "an average reduction in carbon intensity of energy use of at least 10% per decade." "The U.S. needs to constrain its growing propensity for importing oil and emitting CO2."

ELECTRIC UTILITIES PLAN TO BURN COAL

According to a July 19 release by DOE's Energy Information Administration, "The electric power industry is expected to increase its share of total U.S, coal consumption form 86% in 1990 to 90% in 2010 as U.S. coal production incrcreases from 1 to 1.5 billion tons annually. Dr. Calvin A. Kent, EIA Administrator, said he "sees no exodus from coal by electricity producers due to the Clean Air Act Amendments of 1990 over the next 20 years and, in fact, expects (coal's) share of electric power generation (including independent power producers) to be the same as in 1990, at 53 percent."

PEOPLE

Bob Borchers has been named Assistant for University Relations to LLNL director ***John Nuckolls***. Borchers has been Associate Director for Computations.

John Birely has vacated his post as Associate Director for Nuclear Weapons Technology at Los Alamos National Laboratory in order to return to research in the LANL Center for National Security Studies. He has been succeeded by ***John Immele***. The LANL inertial confinement fusion program, headed by ***Steve Younger***, will report to Immele.

Rear Admiral W. Gerald Ellis has been named Deputy Assistant Secretary for Military Application, USDOE, reporting to Assistant Secretary for Defense Programs ***Richard A. Claytor***. Office of Inertial Fusion head ***Marshall Sluyter*** will report to Ellis.

Fusion engineers ***Jack Joyce***, ***Dave Mullaney*** and ***Bill Newman*** have retired at the Princeton Plasma Physics Laboratory. We thank them for their years of pioneering work on fusion.

MEETINGS

September 29-October 4 - Fourth Topical Meeting on Tritium Technology in Fission, Fusion and Isotopic Applications. Albuquerque, NM. Contact Susie Salazar, FAX (505)667-7558.

September 30-October 3 - 14th IEEE Symposium on Fusion Engineering. San Diego, CA. Contact Beulah Koz (619)455-2191.

October 28-November 1 - CFFTP Tritium Safe Handling Basic Course. Toronto. Contact Course Coordinator Fax (416)823-9644.

November 4-8 - APS Division of Plasma Physics Annual Meeting. Tampa, FL. Contact APS (212)661-9404.

November 11-15 - 10th International Workshop on Laser Interaction and Related Phenomena. Monterey, CA. Contact George Miley (217)333-3772.

EXECUTIVE NEWSLETTER

OCTOBER 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

WATKINS FLATLINES ENERGY BUDGET

- ABANDONS U.S. FUSION FLAGSHIP
- FOCUSES ON INTERNATIONAL COST-SHARING

DOE BUDGET CRISIS

When university professor Will Happer arrived in Washington to become DOE Director of Energy Research on August 6 (see our September newsletter), he found himself in the final stages of DOE's preparation of their 1993 budget submission to the Office of Management and Budget (OMB). He also soon discovered that his superiors would permit him no growth for the programs under his jurisdiction, with the exception of the Superconducting Supercollider (SSC). Worse still, he was told he could expect no growth for at least 5 years in those programs, not even for inflation. He also found that he had a number of physics accelerators and other projects under construction that required additional future year increases for their completion and other projects in various stages of approval that could now not be afforded under the flat budget constraint. Included in the latter list was the fusion Burning Plasma Experiment (BPX), a $1.4 billion project that had been endorsed by DOE's Fusion Policy Advisory Committee (FPAC) and was a key element in the department's published National Energy Strategy (see our October 1990 and March 1991 newsletters).

In response to this crisis, Happer sought and received permission to delay submitting to OMB the budget proposals for the affected programs until mid-October and announced in the September 4 Federal Register the formation of an advisory committee entitled "Task Force of the Secretary of Energy Advisory Board (SEAB) on Energy Research Priorities." The group met at DOE on September 19-20, displacing a previously scheduled meeting of the newly-formed Fusion Energy Advisory Committee (see our August newsletter), which meeting was rescheduled for September 24-25. The Task Force is chaired by nobel laureate Charles Townes of the University of California at Berkeley. Two fusion scientists are on the 15 member Task Force: Marshall Rosenbluth of the University of California at San Diego and David Baldwin of the Lawrence Livermore National Laboratory.

TASK FORCE MEETING

The Task Force opened its meeting September 19 with a presentation by Energy Secretary Watkins on how important it was to set priorities in these tough fiscal times. Then, Thomas Everhart, president of the California Institute of Technology and chairman of the full SEAB, spoke to the group by telephone hookup, suggesting criteria for setting priorities. The first criteria, he said, should be "value to society per dollar invested." The Task Force reviewed a large number of projects in high energy and nuclear physics, including the "B-Factory" at SLAC, the "Main Ring Injector" at Fermilab, the "AGS" and "RHIC" at Brookhaven, the "CEBAF" in Norfolk, the "Advance Photon Source" at Argonne and the "Advanced Neutron Source" at Oak Ridge. They also considered the BPX and were given an informational presentation on the SSC.

The letter report of the committee, though due immediately, had not surfaced at press time one week later, but the general response at the meeting appeared to be to force the advisory committees of each of the individual subfields to restructure their own priorities.

When fusion was discussed, Task Force member Marshall Rosenbluth offered the opinion that "Present budgetary constraints preclude the funding of BPX. The U.S. should participate in ITER, giving first priority to assuring that its long pulse burning physics objectives are met as early as possible." He also said "The fusion program over the next 5 years needs substantial increases to remain a viable participant in the international fusion energy program." As the meeting was drawing to a close, Task Force member David Baldwin sought and received endorsement of a proposal to defer a final judgement on fusion priorities to the new Fusion Energy Advisory Committee (FEAC) in the same spirit as was being done in the other areas.

FEAC MEETING

When the FEAC met on September 24, the report from the previous week's Task Force was still in draft and had not yet even been seen by many of the Task Force members, including Baldwin and Rosenbluth. Nevertheless the DOE presented a "Charge to the Fusion Energy Advisory Committee" that included the statement "The Task Force recommended that the DOE not proceed with BPX, but rather focus on ITER as the key next step after the Tokamak Fusion Test Reactor (TFTR) and the Joint European Torus in developing the physics of burning plasmas, along the lines currently being proposed by the European Community. The Task Force also recommended that the U.S. fusion energy program continue to grow modestly (even in an ER budget that is declining in constant dollars) and suggested that a more diverse program that included a less costly follow-on device to TFTR in the United States would be more effective in the long run." (In his comments the previous week at the Task Force meeting, Rosenbluth had also said "A large new facility (1/2 - 1/3 of BPX) emphasizing advanced tokamak physics is needed as a post-TFTR, pre-ITER focus for the US program.") Challenged on whether indeed these were recommendations from the Task Force, DOE officials stated that this is what was being proposed in a draft they were preparing for the Task Force members to review, but they thought that this fairly represented the views of the group. Later, at lunch, Dr. Happer stated that he felt that the statement on BPX referred to the BPX as "originally scoped and scheduled" and would not necessarily apply if FEAC wanted to propose a reduced scope or slower schedule BPX that fit his budget constraints.

During the first day of the meeting Princeton presented several reduced scope and slower paced versions of a BPX facility. However the consensus of the FEAC was that these could not be accommodated within the budget constraints provided by DOE. FEAC was asked to consider two budget cases, one in which the fusion program would receive cost-of-living and one with 5% real growth over cost-of-living. Cost-of-living was assumed as 4%. One member of FEAC described the Princeton proposals as "putting the camel's nose under the tent."

Energy Secretary Watkins was apparently well-briefed on the first day's discussions, which included opinions that DOE needed to find additional funds to do projects like BPX if they were serious about developing new central station power plant technologies, such as fusion, as described in the National Energy Strategy. The next morning Secretary Watkins addressed the group and impressed upon them that he felt he had absolutely no flexibility in his ($18 billion) budget to provide any additional funds, that he would not be receptive to any suggestions of "putting the camel's nose under the tent," and that he felt the ITER project would become the model of how all big science projects would have to be funded as joint international projects in the future.

At press time, the letter report of the FEAC had not yet been prepared. Based on the verbal report to Dr. Happer at the end of the meeting, it would appear that FEAC will accept the elimination of BPX from the U.S. fusion program and assist in finding alternatives. FEAC did, however, point out their opinion that BPX would be the preferred course if a "10-15%" growth above inflation for the next 5 years could be found. A subpanel was established to address the technical content of the fusion program absent BPX. It is to report in March 1992. Another subpanel was established to review the US position on ITER design in the absence of BPX. It will report in January.

COPPI GIVEN LEADERSHIP AWARD

Fusion Power Associates presented its Leadership Award on September 24 to Prof. Bruno Coppi of the Massachusetts Institute of Technology. The awards were initiated in 1980 by the Fusion Power Associates Board of Directors to recognize those individuals who have shown outstanding leadership qualities in accelerating the development of fusion. Prof. Coppi's award states "Over many years you have provided technical insight that has influenced the design of fusion reactors and led the fusion community towards more cost-effective systems and experiments."

In presenting the award, FPA president Steve Dean noted that Prof. Coppi initiated the very successful Alcator series of high density, high field tokamaks, provided the technical basis for initiating the Rigatron private sector venture, has been instrumental in interesting the Italian government in the Ignitor project, and has been a leading figure in the theory of tokamaks and the analysis of the potential for advanced fusion fuels.

Bruno Coppi

LANDIS, SPROULL, STEVER RECEIVE FPA DISTINGUISHED CAREER AWARDS

Fusion Power Associates presented its Distinguished Career Awards on September 18 to John W. Landis, Robert L. Sproull, and H. Guyford Stever. The awards were established in 1987 to recognize individuals who have made distinguished, lifelong career contributions to the underlying sciences and technologies upon which fusion power development depends.

In presenting the award to John Landis, FPA president Steve Dean cited Landis' service as president of Gulf General Atomic, as senior vice president of Stone and Webster Engineering Corp., as president of the American Nuclear Society, as a member of numerous advisory committees, including the National Academy Committee on Future Engineering Needs of Magnetic Fusion, the Magnetic Fusion Advisory Committee, the House of Representatives Fusion Advisory Committee, the DOE Energy Research Advisory Board, the DOE Fusion Policy Advisory Committee, the DOE Secretary of Energy Advisory Board and as a member and chairman of Fusion Power Associates Board of Directors.

John W. Landis, Robert L. Sproull and H. Guyford Stever

In presenting the award to Robert Sproull, Dean cited his contributions to education, his service as the director of the Advanced Research Projects Agency, his encouragement of inertial fusion research at the University of Rochester while president of that institution from 1970-1984, his service on the National Academy of Sciences Committee to review inertial confinement fusion and on the DOE Fusion Policy Advisory Committee.

In presenting the award to Guy Stever, Dean noted his contributions to aerospace science and technology at MIT and as advisor to the Defense Department, his service as president of Carnegie Mellon University from 1965-1972, as director of the National Science Foundation and as Science Advisor to President Ford, and his recent service as chairman of the DOE Fusion Policy Advisory Committee.

PRINCETON PLANS CELEBRATION

The Princeton Plasma Physics Laboratory invites all friends of fusion to join them in a program to celebrate the 40th Anniversary of the Laboratory on either or both days, October 31 and November 1. On October 31 there will be an all day symposium on the "past, present and future" of PPPL. Featured speakers will include Don Grove, Roy Bickerton, Rob Goldston, Paul Reardon, Bruce Montgomery, Harold Eubank, Ira Bernstein, Allen Boozer, Barry Ripin, and many others. On November 1 the theme will be "The place of fusion in the world's energy program." Featured speakers will include Paul Rebut, Atsuo Iiyoshi, Boris Kadomtsev, John Clarke, Bas Pease, Dale Meade and Ron Davidson. There will be a banquet on the evening of October 31 in honor of Lyman Spitzer. The banquet speaker will be Carl Sagan. Persons wishing to attend should contact Rush Holt at (609)243-2104, FAX (609)243-2749 as soon as possible.

PRINCETON LOOKS ON BRIGHT SIDE

In a memorandum to "all laboratory staff" dated September 26, PPPL director Ron Davidson reported that "under the conditions presented by Admiral Watkins the fusion program would have to reasess its plans for future new facilities." "In the months ahead," Davidson said, "the Department of Energy will seek proposals for a major post-TFTR fusion experiment that will cost perhaps one-third as much asBPX. Such a facility could be a long-pulse advanced tokamak like the device currently under study at PPPL." Davidson noted that, in his comments to FEAC, Admiral Watkins called fusion "one of the great hopes for mankind." Watkins, Davidson said, "expressed his support for a strong fusion program." "If BPX is not built, PPPL is in a strong position to undertake a major post-TFTR experiment," Davidson said.

FPAC/NES FUSION STRATEGY FADES

The year-long effort by the Department of Energy's Fusion Policy Advisory Committee (see our October 1990 newsletter and DOE report DOE/S-0081), which was accepted by Energy Secretary James D. Watkins and incorporated into the DOE's National Energy Strategy is fading from the minds of policy makers. Key elements of the fusion policy are being abandoned or postponed.

The FPAC recommended "that the U.S. take an even-handed approach in strengthening its national and international efforts, by participating as an equal partner in the International Thermonuclear Experimental Reactor (ITER) Engineering Design Activity (EDA) and by authorizing the construction of the U.S. Burning Plasma Facility in the FY 1992 budget." The DOE did not propose construction of the Burning Plasma Experiment (BPX) in the FY 1992 budget and, based on the meetings described above, apparently will abandon the BPX initiative due to budget constraints. In their comments on constrained budgets, the FPAC said, "We conclude that even under a constrained budget the U.S. should take an even-handed approach to strengthening its national and international efforts in magnetic fusion research, that is, the U.S. should both conduct its own burning plasma experiment and also play a prominent role in the international engineering test reactor." Furthermore, the FPAC said they would meet the requirements of constrained budgets by "stretching out the completion schedule for the burning plasma facility." Such a delay, they said, "would be unfortunate, but since the complex ITER process is itself likely to involve some stretchout and delay, we do not feel that this results in a qualitative change in the role of the burning plasma experiment in the U.S. and world programs."

During the recent meetings, however, DOE took the view that the ITER schedule was fixed and must be maintained.

QUOTABLE

"Now is not the time to pull the plug; now is not the time to grab defeat from the jaws of victory . . . . Now is the time to go for it."

James D. Watkins, Admiral, USN (Retired)
Secretary of Energy
Speech at Princeton Plasma Physics Lab.
May 2, 1991

EXECUTIVE NEWSLETTER

NOVEMBER 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

U.S. FUSION COMMUNITY REGROUPS
GRIEM WINS MAXWELL PRIZE
PILOT PLANT STUDY PROGRESS

NEW PARTICIPANTS

General Dynamics/Space Systems Division has joined Fusion Power Associates as a full voting member. Richard P. Hora, Division Vice President/Energy Business Area Manager, will represent the company. He can be reached at P.O. Box 85990, San Diego, CA 92186-5990, MZ DC-8260; phone (619) 496-7060; FAX (619) 496-7676.

Spectrum Engineering Corporation, Ltd. has joined Fusion Power Associates as a Small Business Affiliate. Dr. Jack W. Richman will represent the company. He can be reached at P.O. Box 687, Peterborough, Ontario, Canada K9J 6Z8; phone (705) 743-7520; FAX (705) 743-9878.

Wardrop Engineering, Inc. has joined Fusion Power Associates as a Small Business Affiliate. Ernie Card will represent the company. He can be reached at 6725 Airport Road, Suite 600, Mississauga, Ontario, Canada L4V 1V2; phone (416) 673-3788; FAX (416) 673-8007.

GRIEM WINS MAXWELL PRIZE

Hans R. Griem, Professor of Physics at the University of Maryland, has been awarded the 1991 James Clerk Maxwell Prize given by the Division of Plasma Physics of the American Physical Society. The prize, established in 1975 by Maxwell Laboratories, Inc., San Diego, is awarded annually to recognize outstanding contributions to the field of plasma physics. Griem's citation recognizes "his numerous contributions to experimental plasma physics and spectroscopy, particularly in the area of improved diagnostic methods for high-temperature plasmas." It also notes that "his books on plasma spectroscopy and spectral line broadening in plasmas have become standard references in the field." He has been at the University of Maryland since 1957, where he has supervised about 35 Ph.D. theses. He was the director of the University of Maryland Laboratory for Plasma Research from 1980-1987. Our most sincere congratulations to Prof. Griem on the receipt of this award, which is richly deserved.

Hans R. Griem

FUSION COMMUNITY REGROUPS

Faced with the DOE decision to forego construction the $1.4 billion Burning Plasma Experiment (See our October newsletter.) members of the U.S. fusion community are working with the DOE Office of Fusion Energy to restructure the U.S. magnetic fusion program strategy. A series of intense workshops and meetings are being scheduled.

A meeting of program leaders was held in San Diego October 16-17 to discuss the overall problem and to lay plans for dealing with it. This was followed up by a hastily-called technical workshop at MIT on October 25.

0

The focus of the "new strategy" is to define a major tokamak facility in the $300-400 million range. The device would be designed to take maximum advantage of facilities currently existing at the Princeton Plasma Physics Laboratory (probably to be built in the current TFTR test cell) but to be managed as a truly national project from concept through operation. Although PPPL director Ron Davidson will be charged with overseeing the concept selection process, he is to set up a "national task force" with a non-PPPL chairman to oversee the process. The challenge to the community is to ensure that the design addresses physics issues that are essential to fusion power development and which cannot be adequately addressed in current facilities.

During the technical workshop at MIT, a range of issues were discussed, including copper vs. superconducting coils, aspect ratio, long pulse/steady state, second stability, current drive, divertors, and relationship to current facilities, ITER, and future reactors. For information on future workshops, contact Dr. Curtis W. Bolton, DOE Office of Fusion Energy, (301) 353-4914.

SEAB TASK FORCE REPORTS

The Secretary of Energy Advisory Board (SEAB) Task Force on Energy Research Priorities (See our October newsletter.) issued its letter report to Energy Secretary James Watkins but left the door open for revisions based on public comment through October 31. The following is the full text of their recommendations on magnetic fusion:

"The Task Force believes that funding for the magnetic fusion program must increase at a modest rate (e.g., 5 percent real growth per year) even at the expense of other programs. This recommendation follows from the opportunity to participate in the International Thermonuclear Experimental Reactor (ITER), as well as a recognition that no major fusion facilities have been authorized since 1976 and many programs have been canceled, so that the domestic program is in danger of no longer being able to fulfill its scientific and educational mission.

"Such a modestly growing program is incompatible with authorization of the Burning Plasma Experiment (BPX) especially since the estimated cost of BPX has risen.

"The primary vehicle for studying the crucial physics of burning plasmas, then, must be the international ITER program, although valuable preliminary data will come from the Joint European Torus (JET) and the Tokamak Fusion Test Reactor (TFTR). A vision of ITER as the next major physics step, to be followed by a second engineering phase, has been advanced by the European ITER group. We believe the United States should support this vision and move expeditiously towards international cooperation and an international construction decision.

"Concept exploration should begin to define a new experiment in the $500 million class for the purpose of scientific study of tokamak improvements (e.g., second stability, steady state, bootstrap current) that could suggest new operating modes for ITER and permit the design of more reactor-desirable follow-ons to ITER. Such a scientific focus is required to ensure that the domestic program remains vital and able to attract the best young talent. Some increase in budget is also required for optimum use of existing facilities.

"In the long run, as fusion becomes primarily a development project -- perhaps with the second phase of ITER -- consideration could be given to spinning off the fusion program from the Office of Energy Research."

FPA MEETINGS PROCEEDINGS PUBLISHED

The proceedings of Fusion Power Associates annual meeting of June 1989, entitled "Fusion Energy and the Environment," have been published in the March 1991 issue of the Journal of Fusion Energy (Plenum Press). The proceedings of our September 1990 annual meeting, entitled "Energy for a New Age", have been published in the June 1991 issue of the same journal.

Richard D. Hazeltine

HAZELTINE HEADS TEXAS INSTITUTE

Dr. Richard D. Hazeltine has been named director of the Institute for Fusion Studies at the University of Texas at Austin. He replaces Dr. David E. Baldwin who returned to the Lawrence Livermore National Laboratory recently to become the associate director for magnetic fusion. The Institute has an annual budget of approximately $3 million. It has a staff of about 60 people, including 17 faculty members and research scientists, 7 postdoctoral fellows, 25 graduate students and 10 support staff members. It also officially hosts the annual U.S.-Japan fusion theory exchange program, as well as participating in regular exchange scientist visits with other laboratories in the U.S. and abroad. Dr. Hazeltine served as assistant director of the Institute during 1982-86 and as acting director in 1987-88.

PILOT PLANT STUDY PROGRESS

In 1989, Fusion Power Associates prepared a study for the Agency for the Advancement of Fusion Power entitled "An Accelerated Fusion Power Development Plan" (See our July 1990 newsletter.) The results were summarized at our annual meeting in September 1990 and were published in the Journal of Fusion Energy (June 1991). The key element of the accelerated plan was the operation of a fusion "pilot plant" at an early date. Based on his attendance at our annual meeting and subsequent discussions with FPA president Steve Dean in Moscow, Academician Boris Kadomtsev prepared a design for a such a plant (See our February 1991 newsletter.) which has recently been published in an issue of "Comments on Plasma Physics." In April of this year an informal working group consisting of Fusion Power Associates (Steve Dean), Ebasco Services (Bill Ellis), MIT (Dan Cohn), ORNL (Charles Baker) and Ontario Hydro CFFTP (Don Dautovich) was formed to pursue a range of pilot plant issues and designs. The group has held five meetings since April and will meet again in mid November.

The mission of the pilot plant is to demonstrate energy production from fusion, in a power plant configuration, at the lowest practicable capital cost, and at the earliest possible time. The plant is aimed at providing operational experience with a fusion power system, including the production and extraction of high grade heat, control of the plant, and fuel handling. Experience gained in designing, constructing and operating the plant will allow electric utilities and power plant manufacturers to assess maintenance, safety, licensing, environmental, and waste management aspects of fusion power systems. The plant will be designed to have high availability for extended run periods; it would be shut down after a few full-power years. Low capital cost and small thermal power are being used as primary design guidelines, thereby differentiating the pilot plant from other facilities in the traditional plans, such as ITER and DEMO.

In order to achieve small size, it is essential that the physics assumptions for the design be more optimistic than those currently in use for designs such as ITER. The group is therefore exploring a range of departures from the traditional designs, including higher magnetic field, higher beta, higher and lower aspect ratio, and better energy confinement. Also with the aim at lowering capital cost, the group is exploring the elimination of technologies not required for the basic mission, e.g., tritium breeding blankets. The pilot plant study thus assumes that other facilities, such as ITER, will be maintained in the international portfolio.

Arrival at a satisfactory design point is not assured; however the group is encouraged thus far at having found a number a interesting options and these are being further analyzed. The time frame envisaged for the pilot plant is 15-20 years earlier than the 2025 DEMO operating date published in the U.S. National Energy Strategy.

KAWABE PUBLISHES BOOK

Prof. Takaya Kawabe, University of Tsukuba, and co-author Eiji Mikado, science journalist with the daily newspaper "Asahi Shimbun", have published a book on fusion for the layperson. The 137 page, soft cover book, written in Japanese, is entitled "Energy in the 21st Century - Plasma and Fusion." Prof. Kawabe says "The objective of this book is public acceptance of the plasma and fusion. This is very important, and so far not many researchers are aware of this. We describe what is plasma so that ordinary people can get the idea about it. We also describe the broad implication of plasma technology and fusion technology, including space explorations and semiconductors. We finally describe the philosophy to push fusion." The book can be purchased for 1,100 Yen from IWANAMI-SHOTEN Publishers, Co. Ltd., 1-5-5 Hitotsubashi, Chiyodaku, Tokyo, 10102 JAPAN; fax (81) 3-3262-0820.

FEAC REPORTS

The DOE Fusion Energy Advisory Committee (FEAC) (See our October newsletter.) sent its report to Director of Energy Research William Happer on October 7. Copies are available from Fusion Power Associates. FEAC told Happer "First, we wish to reaffirm that the preferred fusion program strategy and time table are those outlined in the National Energy Strategy and given in the report of the Fusion Policy Advisory Committee." (See our August 1990 and March 1991 newsletters.) "Removing BPX from the fusion program produces a significant gap in the current DOE program plan," they said, adding "Immediate attention must be focussed on reformulating this plan." They urged that funds currently earmarked for BPX "should be used to strengthen already weakened programs and to plan the initiatives to fill the gap between the end of TFTR and the start of operation of an ITER." They stated that, as a result of the elimination of BPX, "an extension of the physics phase of ITER of at least 2 years could easily be envisioned, and more time could be required if unforeseen problems develop."

CANADIAN INDUSTRIES MEET

On October 24, FPA president Steve Dean gave an invited talk on "The Status of Global Fusion" to a 100-person seminar for Canadian industries sponsored by the Canadian Nuclear Association and the Canadian Nuclear Society. He also participated in a panel discussion on "Strategies to Enhance Industry Involvement in Fusion." Other featured speakers included Dave Jackson, director of the Canadian national fusion program, Don Dautovich, program manager of the Ontario Hydro Canadian Fusion Fuels Technology Project, and Richard Bolton, director general of the Hydro Quebec Centre Canadien de Fusion Magnetique.

PEOPLE

Rodolfo Carrera left the University of Texas to join Valley Research Corporation, 8868 Research Blvd. CCO-103, Austin, TX, 78758; phone (512) 453-0310; FAX (512) 467-9403.

Akira Hasegawa has left Bell Labs to become a professor in the Department of Communication Engineering, Osaka University, Suita, Osaka, 565, Japan; phone (81) 6-877-5111; FAX (81) 6-875-0506.

Robert L. Hirsch has left ARCO to join the Electric Power Research Institute (EPRI) as head of their Washington DC office.

H. Guyford Stever is a recipient of the 1991 National Medal of Science, presented by President George Bush at the White House on September 16.

Yoshi Matsuda, a plasma physicist in the LLNL Magnetic Fusion Energy program, died in early October as a result of an accidental fall. A trust fund to assist with his children's education has been established. Checks payable to the "Yoshi Matsuda Fund" can be sent to the Bank of Livermore, c/o Mrs. Patricia Rochin, 2125 Second St., Livermore, CA, 94550.

QUOTABLES

"The Secretary (of Energy) shall initiate design activities on a Fusion Engineering Device, using the best available confinement concept, to ensure operation of such a device at the earliest practicable time, but not later than the year 1990."

Magnetic Fusion Energy
Engineering Act of 1980
Public Law 96-386

"Fusion could be to space travel what the fission reactor was to the submarine."

Prof. Gerald L. Kulcinski
University of Wisconsin
At FPA Annual Meeting, June 1991

EXECUTIVE NEWSLETTER

DECEMBER 1991

FUSION POWER ASSOCIATES

2 PROFESSIONAL DRIVE, SUITE 248 • GAITHERSBURG, MARYLAND 20879

(301) 258-0545

JET GENERATES MEGAWATT OF FUSION POWER

US PLANS 20 MW IN 1993
DOE DROPPED THE BALL IN LATE 1988

FUSION POWER IN JET

Scientists operating the Joint European Torus (JET) announced that on November 9 they beam-injected tritium fuel into a hot deuterium plasma, releasing two million joules of fusion energy over a two second period, with peak instantaneous power of about 1.7 Megawatts. It was the first time tritium (which enhances the fusion reaction rate of pure deuterium almost a hundredfold) was used in a tokamak fusion device, and it was the largest manmade release of fusion energy with the exception of the hydrogen bomb. About 15 MW of heating power was used in the two shot run. JET director Paul-Henri Rebut described the result by saying "This is the first time that a significant amount of power has been obtained from controlled fusion reactions. It is clearly a major step forward in the development of fusion as a new source of energy."

Ron Davidson, director of the Princeton Plasma Physics Laboratory, said "This is an historic event for fusion." FPA president Steve Dean, quoted in the November 11 New York Times and the November 12 USA Today, stated "The JET work marks the beginning of the actual use of fusion fuel. This marks the beginning of the transition from research to reality." JET associate director Alan Gibson, quoted in the November 20 Christian Science Monitor, said "At last we have succeeded. It is a real milestone."

U.S. PLANS HIGHER POWER RUNS IN 1993 AFTER 2 YEAR DOE-INDUCED DELAY

Scientists in the U.S. praised their European colleagues for being first to introduce tritium fuel into their tokamak reactor, thus winning a friendly competition that began back in the mid-1970's when JET and TFTR began construction. JET and TFTR were the first magnetic fusion devices designed to handle the mildly-radioactive tritium fuel, and their construction was seen as recognition of the readiness of fusion research to begin the transition to the more goal-oriented mission of developing a new energy source. The two devices began operation using deuterium-only fuel in the early 1980's and, since that time, have been systematically improving performance and preparing for tritium operation. Both machines have been operating at near "breakeven" conditions for about two years. (Breakeven is defined as having plasma conditions of temperature, density and confinement time such that the use of tritium would result in as much fusion power being produced as was used to create the high temperature conditions.)

For most of the 1980's it was presumed that the U.S. TFTR scientists were on a track to be the first to introduce tritium in their machine. Indeed, plans were well along to produce 20 Megawatts of fusion power at near breakeven conditions by March 1991 in TFTR when, late in 1988 (See our January 1989 newsletter.), the U.S.

Department of Energy ordered Princeton to stop all work on the tritium systems. This abrupt action took the fusion community by surprise and resulted in the layoff of 160 industry personnel from the project on one day's notice. It also began an acrimonious period of confrontation between fusion scientists and congresspersons on the one hand and top level DOE officials on the other, as chronicled in our newsletters during 1989. The low point in this process occurred on June 15, 1989 when Energy Secretary James Watkins sent a letter to Congress rescinding a request for construction of the Compact Ignition Tokamak (CIT), a device that was designed to produce 200 Megawatts of fusion power by the mid-1990's.

After a lengthy review process, lasting over a year, the DOE reversed its opposition to performing the tritium tests in TFTR and, in late 1990, ordered the project reinstated. Tests at the 10-20 Megawatt level are now scheduled in TFTR for mid to late 1993. DOE also reversed its opposition to the construction of the CIT (since renamed BPX) and, in February 1991, indicated in the National Energy Strategy its intention to operate the 200 MW fusion device by the year 2000. However, just two months ago (See our October newsletter.), DOE decided not to pursue BPX construction, citing budget problems. FPA's Dean referred to this action as DOE's "on-again, off-again fusion strategy."

The 1993 20 MW tests in TFTR appear "safe" for the moment, a fact that prompted FPA president Steve Dean to remark in the November 12 Philadelphia Inquirer, "The Americans will catch up, but we won't hold the lead for long." The latter remark refers to the fact that JET plans to return to tritium shots at the 40 MW level in 1995-96. For the moment at least, JET scientists are basking in glory. JET director Paul-Henri Rebut, quoted in the November 20 Christian Science Monitor, says "It (the JET results) confirms Europe's leading position in fusion research. We are ahead of our main rivals in the U.S., the Princeton Plasma Physics Laboratory."

INTERNATIONAL PARTIES ENDORSE ITER

Representatives from the U.S., European Community, Japan and USSR met November 13 and 14 in Moscow to put the final touches on a draft agreement to proceed with Engineering Design Activities (EDA) for the International Thermonuclear Experimental Reactor (ITER).

The four delegations that attended the meeting were headed by Dr. James F. Decker, Deputy Director, Office of Energy Research, Department of Energy for the US, Professor Paolo Fasella, Director-General for Science, Research and Development for the EC, Mr. Hiroto Ishida, Director-General of the Atomic Energy Bureau of the Science and Technology Agency of Japan and Dr. Boris V. Nikipelov, Acting Minister of MAPI for the USSR.

The meeting was opened with expressions of congratulations to the JET Project, headed by Dr. Paul-Henri Rebut, and to the EC for the recent fusion power experiments reported widely in the press. The four delegations were pleased to hear from all sides statements with expressions of willingness to conclude the negotiation while continuing further preparatory work for the start of the EDA.

After a final review of the draft text of the Agreement, the negotiators initialled the texts of the Agreement and Protocol 1 signifying acceptance on an ad referendum basis for formal review by their authorities. The delegations also reached understandings on the locations of the work sites of the Joint Central Team (JCT) and on the likely nominees for key personnel positions in the EDA.

The negotiators confirmed their earlier understandings that the JCT will be located in San Diego, Garching and Naka. Further, the negotiators indicated that the likely nominees for the positions were the following:

Council Chair - E. P. Velikhov (USSR)
Council Co-chair and Chair of the Management Advisory Committee - M. Yoshikawa (Japan)
Director - P.-H. Rebut (EC) and
Chair of the Technical Advisory Committee - P. Rutherford (US)

The four delegations agreed to submit to their authorities the initialled text and understandings with a view to concluding as soon as possible the Agreement and Protocol 1. U.S. participants indicated their hope that this could be done before the end of January.

The ITER EDA Agreement envisions that the ITER EDA will be conducted under the auspices of the IAEA, as was the recently completed Conceptual Design Activity for ITER.

FPA ELECTS DIRECTORS, OFFICERS

Floyd Anderson (Babcock & Wilcox), John Gilleland (Bechtel), Chester Lob (Varian Associates), and Richard

Hora (General Dynamics), have been elected as new members of the Fusion Power Associates Board of Directors. Also re-elected to additional 3-year terms were Robert Botwin (Grumman Corp.), Stephen O. Dean (FPA), Donald P. Dautovich (Ontario Hydro/CFFTP), John Davis (McDonnell Douglas), Robert C Iotti (EBASCO), and Michael Monsler (Schafer Associates). They join the following persons whose terms expire at a later date: Charles C. Baker (ORNL), Ronald C. Davidson (PPPL), William Grossmann (SAIC), Alexander J. Glass (LLNL), John W. Landis (Stone and Webster Engineering Corp.), David O. Overskei (General Atomics), and J. Pace VanDevender (SNL).

The Board has elected the following officers: John Davis (Chairman), Michael Monsler (Vice Chairman), Stephen O. Dean (President and CEO), Ruth A. Watkins (Secretary/Treasurer and Vice President, Administration and Finance), and Gerald L. Kulcinski (Vice President, Research.

SANDIA GROUP HITS TARGETS WITH PROTON BEAM

Sandia National Laboratory has successfully carried out the first major target experiments on the Particle Beam Fusion Accelerator (PBFA-II), the world's most powerful particle beam accelerator. The series of experiments conducted in August and September included the first experiments aimed at heating and imploding inertial confinement fusion (ICF) ignition-size targets.

The experimental series included foam targets for diagnosing target heating and spherical targets for diagnosing hydrodynamic response. Sophisticated diagnostic instrumentation was used to obtain target data. "The quality of data was just superb," said Donald Cook, manager of Sandia's Fusion Research Department. "The target experiments show we are on the right track."

A National Academy of Sciences review of the status of ICF research and development in September 1990 called on Sandia to emphasize both improved ion-beam focusing and "well-designed and well-diagnosed target physics experiments" at increasing power concentrations.

"We've done for the first time well-integrated, well-diagnosed target experiments, "real" target experiments, and they were successful," said principal experimenter Gordon Chandler.

Sandia researchers hope to improve focusing and increase PBFA-II ion beam intensity over the next year to achieve beam intensities of 10 terawatts (10 trillion watts) per square centimeter. If this goal can be reached, the accelerator will be in a good position for the next National Academy of Sciences review of the ICF program in the summer of 1992, said Cook. That review will determine whether beam focusing issues have been resolved and whether PBFA should be upgraded to higher energies to permit it to achieve fusion ignition.

Electrical pulses from PBFA-II's 36 accelerator modules are converted by a diode in the center of the machine into a radially collapsing ion beam which impinges on the fusion target. The quarter-inch hydrogen targets used in this summer's experiments are almost the same size as the 6 mm lithium targets which will be used in ignition experiments. Hydrogen ions are easier to focus, but deposit less energy to the target than the more massive lithium ions.

Two types of targets were used in the summer experiments. Cylindrical targets were filled with an extremely low-density hydrocarbon foam that provides a medium that can be heated evenly throughout. This foam eventually will be used to distribute energy evenly around a fusion-fuel capsule. As the foam is heated by the ion beam, it gives off x-ray energy. During the summer experiments, spatial distributions and x-rays intensities were successfully recorded.

Spherical targets consisting of a 6 mm shell made of 0.1 mm thick plastic containing deuterium were heated by the proton beam directly on all sides, resulting in a target implosion and resulting fuel compression. This was the first time deuterium targets had been used on PBFA-II. For ignition experiments, tritium will be added to the deuterium capsules. Collapse of the deuterium targets was recorded by x-ray imaging diagnostic instruments.

HOGAN PROPOSES ICF PILOT PLANT

In a paper presented at the IEEE fusion engineering conference in September, LLNL scientist Bill Hogan described concepts for "Small Inertial Fusion Energy Demonstration Reactors." The concepts fit the spirit of smaller fusion reactors, both magnetic and inertial, that FPA has dubbed "pilot plants" (See our November newsletter and

Journal of Fusion Energy, June 1991).

Through systems analysis Hogan finds that, if he sacrifices the gain achieved per pellet implosion, he can design reactors with smaller driver energy requirements and correspondingly lower output, e.g. 1-100 MWe. While traditionally this has been thought of as "going in the wrong direction" for competitive cost of electricity, it has the advantage that the capital cost of the plant is reduced, which makes the cost of getting development experience lower. The cost of fusion development has become a major obstacle to progress towards commercial applications.

Hogan describes pilot plants requiring only 0.5-2 MJ of driver energy, comparable to the energy of the proposed next step test device at LLNL, the Nova Upgrade. "The scenario explored here is a relatively low-cost development program for fusion energy, which encourages technology transfer to industry at an early stage," says Hogan. Copies of his paper may be requested by calling his office at (510)422-1344.

JT-60 UPGRADE UPDATE

The Japanese large tokamak JT-60 is back in business since this April, after a 1.5 year machine shutdown for upgrading (See our August 1991 newsletter). JT-60 has, so far, 2 months of hydrogen operation, about 1 month of conditioning operation of tokamak and NB system for hydrogen to deuterium changeover, and 2 months of deuterium operation. During this latter operation period, 4 MA discharges with the duration of 15 sec have been achieved. The maximum stored energy reached 5.1 MJ with 200 MW NB injection.

The D-D neutron yield has been maximized in high ion temperature mode: 1.3×10^{16}n/s was achieved for 1.1 MA low density target discharge. The central ion and electron temperatures are 20 keV and 6-7 keV, respectively. Study of energetic particle physics has been made for the NB injected ion loss due to the toroidal field ripple. The large volume plasma has 2% ripple at the edge. The spatial distribution of heat flux onto the wall was measured with a toroidal and poloidal array of 40 thermocouples for the first time. The heat flux, which is approximately 10% of the heating power, increases with increasing the total NB power deposition. The heat distribution shows a good agreement with that evaluated by orbit-following Monte-Carlo (OFMC) calculations.

Further information can be obtained from Dr. Masayuki Nagami, Naka Fusion Research Establishment, Naka-Machi, Naka-Gun, Ibaraki-ken, Japan TEL 0292-95-3111 ext 3320; FAX 0292-95-3364. Our thanks to Dr. Sanae Tamura, Director, Department of Fusion Plasma Research, Naka for providing this information.

PEOPLE

Energy Secretary James Watkins has scheduled a three day "retreat" in Leesburg, VA on December 16-18 with the directors of the major DOE laboratories. They will discuss a wide range of technical, administrative and policy issues. PPPL director Ron Davidson will be among the attendees.

Tim Coffey, director of the U.S. Naval Research Laboratory, has received the "Delmar S. Fahrney Medal for Leadership in Science and Technology" from the Franklin Institute. Tim was cited for his "research in atmospheric physics and related plasmas" and for his "distinguished management of the Naval Research Laboratory."

Mike Roberts, Director, International Programs Staff, Office of Fusion Energy, DOE, has received the DOE's Meritorious Service Award which is DOE's "second highest award granted for achievements which substantially contribute to the accomplishment of the mission or major programs of the Department of Energy." Mike is cited "in recognition of his achievements in promoting international collaboration in magnetic fusion and, in particular, his major contributions to the Department's successful efforts on the International Thermonuclear Experimental Reactor."

QUOTABLES

"I am not going softly into the night while the whole base program rots away."

> Burton Richter, Director
> Stanford Linear Accelerator Laboratory
> quoted in SCIENCE, 8 November, 1991

"In order to build something, you need a lot of people; in order to destroy it, you need only a few."

> Unknown