



FUSION POWER ASSOCIATES

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CLINTON NAMES O'LEARY DOE HEAD

NEW DOE ADVISORY COMMITTEE FORMED WATKINS EXPRESSES DECLASSIFICATION HOPE ITER COUNCIL SETS GUIDELINES

NEW AFFILIATE: TOSHIBA CORP.

Toshiba Corporation has joined Fusion Power Associates as a corporate affiliate. Ken-ichi Kakizawa, senior manager, Fusion Technology Development Office will represent the company. He can be reached at 1-6, Uchisaiwaicho 1-chome, Chiyoda-ku, Tokyo 100, Japan; tel. 03-3597-2105; fax -2678. We welcome the participation of Toshiba Corp. in Fusion Power Associates.

O'LEARY NAMED ENERGY SECRETARY

On December 21, President-elect Bill Clinton named Hazel R. O'Leary Secretary-designate for the Department of Energy. O'Leary has been executive vice president for corporate affairs of Northern States Power Company, a large Minneapolis-based utility that operates three nuclear power plants. Northern States Power Company has been a sponsor of Fusion Power Associates, as a Corporate Affiliate, since 1980. In early December, O'Leary was named president of NSP Gas Company, a new unit of Northern States Power that serves about 350,000 natural gas customers.

During the Carter Administration, O'Leary was head of the Energy Regulatory Administration, while her late husband, John O'Leary, was undersecretary of the Department of Energy. At a press conference announcing her appointment, Clinton stated that he had only met her "a few

days ago," but that she was "ready to give new life to a department that has failed to meet the pressing national needs it was created to address." Vice president-elect Al Gore said that he had known and worked with O'Leary for many years. In her acceptance speech, O'Leary stressed the record of Northern States Power in the areas of conservation and the use of natural gas and renewable energy sources, specifically mentioning windmills.

O'Leary, 54, is a graduate of Fisk University in Nashville and has a law degree from Rutgers.

INERTIAL FUSION COMMITTEE FORMED

DOE has formed a new advisory committee, called the Inertial Confinement Fusion Advisory Committee (ICFAC), chaired by Dr. Venkatesh Narayanamurti, dean of the College of Engineering, University of California at Santa Barbara. Narayanamurti was previously with AT&T Bell Laboratories and a vice president at Sandia National Laboratories. The Committee met for the first time December 16-18 at DOE headquarters in Washington. Although advisory committees are required to meet in public by law, this committee is also allowed to exclude the public when it is reviewing classified information. DOE closed the meeting to the public after the first morning, which dealt with largely ceremonial topics.

As its first charge, the committee was placed in the middle of a scientific dispute between a scientist at the Naval Research Laboratory (Steve Bodner) and scientists at the Lawrence Livermore National Laboratory concerning the performance of classified inertial fusion targets. Bodner has claimed the "indirect drive" pellets will not produce the fusion yields predicted by Livermore because of "time dependent hohlraum asymmetries." In the light of this controversy, DOE charged the committee to "evaluate the benefit versus risk of proceeding with conceptual design of an indirect-drive, solid-state, laser-driven ignition facility" and asked for their response by December 31. At the end of the briefings, the committee polled the managers of the major ICF programs on what they thought the conclusion should be. The vote was 5-1 to proceed. Sentiment on the committee seems to suggest that they will reach a similar conclusion. The committee expects to make a letter report to DOE within a month. In the absence of any declassification action (see next article), it is not clear when, or whether, the committee's report will be made public.

Other members of the ICFAC include Solomon J. Buchsbaum, senior VP, AT&T Bell Laboratories, and Timothy Coffey, Director of Research, U.S. Naval Research Laboratory, as well as J. Richard Airey (SAIC), Betsy Ancker-Johnson (World Environmental Center), John Birely (U.S. Department of Defense), Robert Christy (CalTech), Ronald Davidson (Princeton), Anthony DeMaria (United Technologies), Donald Dudziak (North Carolina State U.), David Hammer (Cornell U.), Arthur Kermin (MIT), Steven Koonin (CalTech), Gerald Kulcinski (U. Wisconsin), Conrad Longmire (Mission Research Corp.), Bruce Miller (Titan Spectron Corp.), Marshall Rosenbluth (U. California at San Diego), William Simmons (Consultant), and Alvin W. Trivelpiece (Director of Oak Ridge National Laboratory).

The charter for the committee states that its purpose is to "provide advice and guidance to the Assistant Secretary for Defense Programs on both technical and management aspects of the inertial confinement fusion program."

The committee's next meeting is scheduled for March 8-10 at Sandia National Laboratories (SNL) in Albuquerque, at which time they will review issues associated with the light ion fusion effort there. The charge to the committee is to "evaluate the progress of the program against the SNL goals for reducing ion beam divergence, the scientific quality and significance of SNL target physics experiments and

associated diagnostics and, given the above evaluations against the accomplishments and needs of the overall ICF program, identify the appropriate strategy for the ICF light ion program, and determine whether the Particle Beam Fusion Accelerator II should be upgraded to higher energies."

The ICFAC is also charged, by the end of 1993, to review the krypton fluoride laser program and the ICF target physics program.

WATKINS "HOPES" FOR DECLASSIFICATION

Energy Secretary James Watkins kicked off the first meeting of the new Inertial Confinement Fusion Advisory Committee, telling them that the ICF program has "grown in importance" since a moratorium was imposed on nuclear testing as part of the FY 1993 appropriations bill. The ban is to become permanent in October 1996 and DOE weapons laboratories are scrambling to propose "above ground test facilities." The ICF community has proposed to build a "Laboratory Microfusion Facility" to meet some of the above ground missions of the weapons community. But DOE assistant secretary for Defense Programs Richard Claytor told the committee that he faced severe budget problems.

Responding to a reporter's question on when he was going to declassify inertial fusion (see our July newsletter), Watkins said, "I'm hopeful I will be able to act on this before I leave."

FPA president Steve Dean also wrote letters to Watkins on October 1 and November 30 urging Watkins to complete the declassification action before he leaves. Watkins has the personal authority to issue the declassification order unilaterally, but he has been deferring to an interagency review process that has been going on for two years! Reportedly the action is stalled by a request from a staff member of the National Security Council to re-review its previous approval of the action. Dean has received a response to his October 1 letter, signed by Hugo Pomrehn, the Under Secretary of Energy. Pomrehn states: "On April 1, 1992, Secretary Watkins was briefed on the proposed new policy and its accompanying ICF declassification. Subsequent to that briefing, the National Security Council (NSC) expressed renewed interest in this matter. As you can appreciate, DOE must assure that what is proposed is fully understood within the Government in order to avoid misconceptions. While the NSC request for

further review will take additional time to resolve, I agree that we should move quickly on this matter and we are committed to the earliest possible resolution of this matter."

Arthur Kermin, a member of ICFAC from MIT, commented: "It will be very embarrassing if we finally decide to declassify, and there's nothing left to declassify."

ITER COUNCIL SETS POLICIES

The ITER Council met in Moscow during the week of December 14 to review recommendations from its Special Working Groups (SWG) 1 & 2 (see our October newsletter) on establishing the working ground rules for the ITER project. SWG-1 addressed the detailed technical objectives and approaches for achieving the programmatic objectives of ITER. SWG-2 proposed guidelines for implementing the way task assignments should be made to the Home Teams. Reports of these activities will be made at Fusion Power Associates annual meeting, January 28-29 in San Diego. For registration information, contact Ruth Watkins at (301) 258-0545.

SEAB ENDORSES TPX

The Secretary of Energy Advisory Board (SEAB) Task Force on Energy Research Priorities, in a letter dated October 20 to Energy Secretary James Watkins stated: "Since the report of the Task Force, the U.S. magnetic fusion community and the DOE Fusion Energy Advisory Committee have developed plans for a device, variously called the Tokamak Physics Experiment (TPX) or the Steady-State Advanced Tokamak. The Task Force was briefed, at your request, on the current technical rationale and plans for this experimental device. We believe that this proposed project is of solid technical merit. It will strengthen both the U.S. fusion energy program and the ability of U.S. researchers and industry to contribute effectively to ITER. The Task Force also finds that the proposed Tokamak Physics Experiment is consistent with its previous recommendations to you on the fusion energy program. Thus, the Task Force endorses the Tokamak Physics Experiment and recommends its further development. In order to allow for timely completion of this work, the conclusion from previous meetings is reaffirmed: '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."

Based in part on the SEAB recommendations, the DOE Energy Systems Acquisition Advisory Board (ESAAB) approved the preparation for the Conceptual Design Report ("KD-O") and sent a request to OMB requesting the start of Title 1 design in FY 1994 ("KD-1A")

TPX IS A NATIONAL PROJECT

Although the TPX is to be built at the Princeton Plasma Physics Laboratory (see our October newsletter), it is to be managed as a national project. Keith Thomassen, from the Lawrence Livermore National Laboratory, has been named TPX program director. Rob Goldston, from PPPL, has been named chief scientist; Bruce Montgomery, from MIT, has been named senior engineer. John Schmidt, from PPPL, has been named project director; George "Hutch" Neilson, from Oak Ridge National Laboratory, has been named deputy project director and physics manager. Jim Sinnis, from PPPL, will be engineering manager. Bill Nevins, from LLNL, will be deputy physics manager. Stewart Prager, from the University of Wisconsin, chairs the TPX National Advisory Council, which has members from LLNL, UCLA, Fusion Power Associates, Columbia University, MIT, ORNL and LANL. Gerald Navratil, from Columbia University, chairs a Program Advisory Committee.

FPA SYMPOSIUM PROCEEDINGS PUBLISHED

The proceedings from Fusion Power Associates April 1992 annual meeting and symposium, "Future Opportunities in Fusion Power Development," have been published in the June 1992 issue of the Journal of Fusion Energy (Plenum Press). The issue includes the keynote address by John Nuckolls, director of LLNL; a paper by S. Dean, C. Baker, D. Cohn, D. Dautovich, W. Ellis, and W. Morison, "Pilot Plant: An Affordable Step Toward Fusion Power;" and an article by Alex Glass, "Opportunities for U.S. Industry in the ITER Project."

ITER U.S. INDUSTRY ADDITIONS

In addition to the industries selected to participate in U.S. ITER Home Team support activities, as announced in last month's newsletter, the DOE announced on December 16 the selection by Sandia National Laboratories of a team led by McDonnell Douglas for plasma facing components R&D. Other members of the team are Ebasco Services, General Atomics, Rockwell International, Westinghouse and the University of Illinois. The DOE also announced that Oak Ridge National Laboratory had selected the team of Pitt-Des Moines and Grumman Corp. for vacuum vessel R&D.

DOE estimates the value of the contracts to be \$10 million for plasma facing components and \$3 million for vacuum vessel work over the six years of the ITER Engineering Design Activity. However the exact amount depends on the share of these tasks assigned to the U.S. by the ITER Joint Central Team.

U.S. STELLARATOR RESTART

Following the recommendations of the DOE Fusion Energy Advisory Committee (FEAC) (see our October newsletter), the DOE has decided to restart the ATF torsatron/stellarator at Oak Ridge National Laboratory. At present ATF is disassembled in order to replace two helical field coil segments that were damaged in an arcing incident in May 1991. ATF will be reassembled in FY 1993 and experimental operations will begin in early FY 1994.

The ATF restart will make it possible for the U.S. to continue an active role in the world stellarator development program. In addition, ATF will continue the tokamak-stellarator complementary studies for the advancement of toroidal physics.

IN MEMORIAM: KOJI UO

Prof. Koji Uo of Kyoto University, Japan, died recently at the age of 67 after a two year illness. He was recognized around the world as a leader in the field of stellarator/torsatron research. He was known especially for his invention of heliotron configurations with high shear and large rotational transform. He worked at the Princeton Plasma Physics Laboratory in 1962-63, at Max Planck Institute 1964-65 and at Culham Laboratory 1965-66. He became full professor at Kyoto University in 1976 and retired in 1988. He received a prize from the Atomic Energy Society of Japan in 1982 for the construction of the

Heliotron E device and was awarded a silver medal with a purple ribbon by the Emperor in 1991 for outstanding contributions to plasma and fusion research.

His many friends around the world express sadness due to his passing.

MEETINGS

Jan. 28-29 - Fusion Power Associates Annual Meeting and Symposium. San Diego. Contact Ruth Watkins, FAX (301) 975-9869.

Feb. 21-25 - Sixth Transport Task Force Workshop. Newport, RI. Contact Dorothy Tate FAX (615) 576-7920.

March 10-11 - Fifteenth Annual Industrial Liaison Program Conference. UC-Berkeley. Contact ILP Office (510) 642-6611.

June 14-18 - Open Systems 93. Novosibirsk, Russia. Contact I.N. Golovin (Moscow) FAX 7-095-943-0073.

June 28-July 2 - Fourth Annual Scientific and Technical Conference of the Nuclear Society: Nuclear Energy and Human Safety. Nizhni Novgorod, Russia. Contact A.Y. Gagarinski (Moscow) FAX 7-095-196-2073.

July 12-16 - Cryogenic Engineering Conference. Albuquerque. Contact Jan Hull (LANL), FAX (505) 667-7558.

August 8-13 - Twenty-Eighth Intersociety Energy Conversion Engineering Conference. Atlanta. Contact Diane Ruddy FAX (202) 872-6128.

Sept. 20-24 - Seventh International Conference on Emerging Nuclear Energy Systems. Makuhari, Chiba, Japan. Contact Dr. T. Hiraoka (JAERI) FAX 81-292-82-6122.

Sept. 27-Oct. 1 - Sixth International Conference on Fusion Reactor Materials. Lake Maggiore, Italy. Contact Mrs. A. B. Meazza, FAX 39-332-785-730.

October 11-15 - Fifteenth IEEE Symposium on Fusion Engineering, Hyannis, MA. Contact A. M. Dawson (MIT) FAX (617) 253-0807.



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INERTIAL FUSION PANEL REPORTS WATKINS COPS OUT ON DECLASSIFICATION JAPAN FORMS ICF FORUM

ICF PANEL REPORTS

Following its first meeting December 16-18 (see our January newsletter), the newly-formed Inertial Confinement Fusion Advisory Committee (ICFAC) sent a letter report to DOE Assistant Secretary for Defense Programs Richard Claytor. The report, dated December 30 and signed by committee chairman V. Narayanamurti, states "I wish to report that the committee is very pleased with the progress achieved in the implementation of the 1990 NAS committee recommendations." (See our October 1990 newsletter for a summary of those recommendations.) Narayanamurti further states "We commend the progress of LLNL in meeting its first Technical Contract milestone and the ongoing development of an independent first rate simulation effort by LANL. We are particularly gratified to observe the great deal of cooperation exhibited by the weapons laboratories in developing a truly national ICF program. We would also like to compliment DOE in establishing a strong ICF headquarters office reporting directly to DASMA and would urge that a permanent director be appointed." (DOE personnel inertia has resulted in Marshall Sluyter serving as "acting" director for about the last two years.)

As described in our January newsletter, the ICFAC was asked to evaluate a dispute between a scientist at the Naval Research Laboratory (NRL) and scientists at the Lawrence Livermore National Laboratory regarding the adequacy of data on the performance of classified inertial fusion pellets. On this point, the ICFAC letter report states "In the judgement of ICFAC the issues raised by NRL, while challenging and not yet fully resolved, are being adequately addressed by the ongoing NOVA program and technical

contract as specified by the NAS report cited earlier. Scientists at LLNL, LANL, and the University of Rochester have conducted this program with mutual peer review as well as extensive review by Sandia."

The ICFAC went on to recommend that "DOE should now proceed with an effort to develop a conceptual design for a National Ignition Facility (NIF)." (DOE did authorize this shortly before the Clinton inauguration.) The ICFAC recommended that the NIF be "organized as a national effort with multi-laboratory participation in the design team." The goal of the NIF, they said, should be a "cost-effective 1-2 MJ, 500-700 TW advanced glass laser laboratory facility with the goal of demonstrating and studying the regime of ignition and modest gain." The ICFAC further states "While ignition physics is the most urgent goal, the committee firmly believes that the long range future of ICF will be best served by continuation of other driver programs (light ions, KrF, direct drive) which are likely to be better suited for LMF and/or energy applications."

DECLASSIFICATION LIMBO

Despite his December 16 statement "I am hopeful I will be able to act on this before I leave," Energy Secretary James Watkins left his post on January 20 without acting on the declassification of inertial confinement fusion. Watkins first promised the declassification action in a speech to the International Atomic Energy Agency fusion conference in September 1990 (see our October 1990 newsletter).

Several leading U.S. inertial confinement fusion scientists, speaking at Fusion Power Associates annual meeting

January 28-29 in San Diego, expressed doubts that the declassification action would ever see the light of day. Watkins appeared to have been outmaneuvered by bureaucrats at the National Security Council who had been opposed to the action in the first place. These bureaucrats used the age-old Washington ploy of asking for further time to review, a review that they were then "unable to complete" before Watkins left office. DOE's Office of Classification has agreed to the declassification action, however, and continues to prepare a new classification guide (see our July 1992 newsletter). Thus, some remain hopeful that the declassification will occur.

David Banner, head of the physics section, International Atomic Energy Agency in Vienna, Austria, speaking at FPA's annual meeting, stated the agency was engaged in coordinating activities among the nations working on ICF, including preparation of a book on inertial fusion. U.S. classification policy has been a major impediment to international collaboration in this field, he said.

ICF 5-YEAR PLAN AVAILABLE

The U.S. Department of Energy has issued a five-year plan for the development of inertial confinement fusion. This is the first time the department has issued an unclassified version of the plan. Copies may be requested from Marshall Sluyter, Office of Inertial Confinement Fusion, DP-28, USDOE, Washington, DC, 20585; fax (301)903-3888.

GIBBONS NAMED SCIENCE ADVISOR

On January 29, the Senate confirmed President Clinton's nomination of Dr. John H. (Jack) Gibbons to be his Science and Technology Advisor. Gibbons will direct the White House Office of Science and Technology Policy (OSTP). Gibbons has been director of the Congressional Office of Technology Assessment (OTA) for the past 13 years. Earlier he worked for 19 years at the Oak Ridge National Laboratory. His brother worked in the fusion program at Oak Ridge until his untimely accidental death in the early 1960's. Gibbons is a nuclear physicist by background and directed ORNL's environmental program for four years.

Gibbons was head of OTA when that agency prepared a report on fusion in 1987 entitled "Starpower: The U.S. and International Quest for Fusion Energy." In the foreword to that report, Gibbons notes that fusion offers "the hope of an energy technology with an essentially unlimited supply of fuel

and relatively attractive environmental impacts." In 1991, Gibbons published an article (co-authored by OTA staffer Peter Blair) on U.S. energy policy in the July 1991 issue of Physics Today. In that article, Gibbons writes "We need to make an explicit commitment to a transition to the post-fossil fuel age, as well as to an era of consistently advancing energy efficiency." The only comment on fusion in that article is the statement "Attempts to develop fusion power technology have so far been frustrating."

Gibbons has a reputation of being an unbiased mediator and observer of science and technology issues and is expected to be skillful at balancing the interests of the many competing science and technology interest groups.

BUSH BUDGET BOOSTS FUSION

As has happened to fusion before (Remember Jimmy Carter signing the Magnetic Fusion Energy Engineering Act of 1980 one week before losing the election?), fusion has gotten a pat on the back from the outgoing President. A White House news release issued shortly before January 20 tells the world what budget President Bush was planning to send to Congress for FY 1994. The Office of Fusion Energy was to receive a boost from its \$340 million FY 1993 level to a level of \$423 million in FY 1994. Included in the amount, the release stated, was \$60 million for "full funding of the International Thermonuclear Experimental Reactor engineering design," \$36 million for "initiation of a steady-state Tokamak Physics Experiment to provide the technical basis for greatly lowering the eventual cost of a fusion demonstration reactor," and \$25 million for "provision of new small-scale experiments to investigate the most promising fusion reactor concepts."

Shortly after January 20, the DOE received guidance from the Clinton Office of Management and Budget to prepare a new request based on a "flat budget."

FEAC REPORT AVAILABLE

The DOE's Fusion Energy Advisory Committee's report on "Strategy for the U.S. Magnetic Fusion Energy Research Program" (see our October 1992 newsletter) has been issued as a DOE report (DOE\ER-0572T). Fusion Power Associates has a limited number available upon request. Copies may also be requested from DOE (fax 301-903-2791) or from FEAC chairman Bob Conn at UCLA (fax 310-206-4832). The report provides advice on program priorities for

four different assumed future budget profiles. This and all previous FEAC reports will also be published in the next issue of the Journal of Fusion Energy (Plenum Press).

JAPAN FORMS ICF FUSION FORUM

"Based on the recent remarkable achievements in the ICF research," an Inertial Confinement Fusion Forum has been formed in Japan. Mr. Yasuo Hashimoto, management director, Kansai Electric Power Company, will serve as forum chairman. Mr. Eiichi Ohno, management director, Mitsubishi Electric Company, will serve as vice-chairman. The group states that "With steady progress on the technology of high power laser systems, ICF research should take a further step toward a project of energy development." A complete list of the forum members is available from Fusion Power Associates or from Mr. Kazuo A. Tanaka, Institute of Laser Engineering, Osaka University (fax 06-877-511).

REBUT URGES ITER CONSTRUCTION

ITER director Paul-Henri Rebut, in his keynote address to Fusion Power Associates' Annual Meeting and Symposium "Fusion: An International Venture," said that he was committed to an engineering design that would be no more expensive than that of the original conceptual design report, even though he was leaning toward a somewhat larger device. Savings were possible by simplifications in the original design, Rebut said. Rebut also said that he was committed to designing a machine that would operate safely and demonstrate fusion's safety and environmental potential.

As Rebut sees it, ITER would be designed with confinement adequate to reach "controlled ignition, based on established favorable modes of operation." The device would reach "controlled ignition and extended burn" for a flat top pulse of at least 1000 sec (about 15 minutes). Rebut said that the measure of success for the Engineering Design Activities (EDA) is that the machine actually be approved for construction. To this end, Rebut urged the four parties (U.S., Europe, Japan and Russia) to start the internal processes of identifying potential sites now and to lay the groundwork for a site selection process internationally. He recommended that each of the four parties propose one or more sites by July 1994 and that a site be picked by July 1996. Much of the engineering design is site specific and dependent on the regulatory and licensing guidelines of each



John Sheffield Elected ANS Fellow

country. Consequently, it is essential, according to Rebut, that site selection be made during the EDA.

SHEFFIELD ELECTED FELLOW

John Sheffield, director of the Fusion Energy Division at Oak Ridge National Laboratory, has been elected Fellow of the American Nuclear Society. John was recognized "for his exemplary leadership in the U.S. Magnetic Fusion Community and in the fusion program at Oak Ridge National Laboratory, for his leadership in quantifying the requirements of tokamak fusion reactors, and for his contributions to the physics and engineering of toroidal devices."

FUSION ADVISORY COMMITTEE MEETINGS

The DOE Office of Energy Research Fusion Energy Advisory Committee (FEAC) will meet in public session on March 4-5. The main topic will be a discussion of the report of FEAC Panel 6, which was asked by DOE (see our October 1992 newsletter) "to evaluate the Neutron Interactive Materials Program of the Office of Fusion Energy." DOE asked, "Given the budget constraints, is our program optimized to achieve these goals for DEMO, as well as to support the near-term ITER program?" The panel is chaired by Klaus Berkner of the Lawrence Berkeley Laboratory. FPA president Steve Dean is a member of the panel. The meeting is currently planned to be held in

Washington, DC. Contact Terry Davis at UCLA for further details, (310)206-4854.

The DOE Defense Programs Inertial Confinement Fusion Advisory Committee (ICFAC) will meet on March 8-10 at Sandia National Laboratories in Albuquerque, beginning on the afternoon of March 8. Only the first afternoon of the meeting is expected to be open to the public. The primary task of the panel at this meeting will be to "evaluate the progress of the program against the SNL goals for reducing ion beam divergence, the scientific quality and significance of SNL target physics experiments and associated diagnostics and, given the above evaluations against the accomplishments and needs of the overall ICF program, identify the appropriate strategy for the ICF light ion program, and determine whether the Particle Beam Fusion Accelerator II should be upgraded to higher energies." Contact Bob Jones in the DOE Office of Inertial Confinement Fusion, (301)903-4236, for details.

INNOVATIONS SOUGHT

Responding to recommendations of the Fusion Energy Advisory Committee (see our June 1992 newsletter), the DOE Office of Fusion Energy has set aside \$1 million this year "for funding to support innovations in tokamak improvements and new fusion confinement systems." DOE published a "program notice" in the Federal Register December 18, indicating that proposals had to be received by February 2. Fusion Power Associates asked that the date be extended to allow more time to publicize the competition, but DOE declined. Dr. Ronald Blanken is overseeing the evaluations within the Division of Advanced Physics and Technology.

FEAC recommended that "a small but structured and highly visible periodic competition be established to foster new concepts and ideas that, if verified, would make a significant improvement in the attractiveness of fusion reactors." They suggested that "Priority should be given to testing scientifically well-founded concepts at small-scale proof-of-principle levels."

ERRATUM

Our October 1992 newsletter listed Dr. Masaji Yoshikawa of Japan as a member of the ITER Council. In addition, we should note that Dr. Yoshikawa is the Co-chair of the Council.

DOE: VISITORS NIGHTMARE

Just when you thought things couldn't get worse, the government proves you wrong. The Department of Energy recently decided to no longer allow visitors to enter its Germantown headquarters through the south entrance. Fusion and most of the Office of Energy Research programs are located at the south end of DOE's very large Germantown building. It is a good 5 minutes walk through dog-legged corridors from the north entrance to the south, assuming you don't get lost. Furthermore, previous downhill bureaucratic hardening of the arteries at DOE resulted in a requirement that U.S. citizens without a secret clearance must be escorted within the building. This means that the Office of Fusion Energy must send secretaries or other staff on the 5-minute jaunt to the north end of the building to escort the visitors to the south end. If you are not a U.S. citizen, you may only be escorted by someone with a Q-clearance. However, in its wisdom a few years ago, DOE decided that most of its own employees (except in the defense programs) did not need Q-clearances; hence most staff in the Office of Fusion Energy are not "qualified" to escort non-U.S. citizens. The above actions, have created near chaos in the orderly affairs of the Office of Fusion Energy and given rise to a chorus of complaints from visiting scientists. The immediate cause of the south entrance closure was said to be a reduction in the budget of the Security Division. Meanwhile, incoming Energy Secretary Hazel O'Leary has announced that she wants the DOE buildings to become more "user friendly" and has commissioned a study. And the Office of Energy Research has offered to pay for the costs of reopening the south entrance until the study is completed. Of course, things could still be worse. During the Gulf War, DOE stopped all visitors out by the main highway and radioed the fusion office staff to come out of the building to pick up them up.

PEOPLE

John M. Greene of General Atomics has received the 1992 James Clerk Maxwell prize from the Division of Plasma Physics (DPP) of the American Physical Society (APS).

Wim Pieter Leemans of Lawrence Berkeley Laboratory has received the 1993 Simon Ramo award from the DPP of the APS.

David Anderson of Lawrence Livermore National Laboratory has been elected a Fellow of the American Physical Society.



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CLINTON BACKS FUSION ECONOMIC PLAN INCLUDES NEW TOKAMAK

CLINTON ECONOMIC PLAN

Speaking to a joint session of Congress February 17, President Bill Clinton outlined his plan to stimulate the U.S. economy and reduce the federal deficit. The overall package included a short-term \$30 billion stimulus package, a \$160 billion long-term investment package over 4 years, and a proposed tax increase formula.

Included in the \$160 billion, 4-year, long-range investment package was \$372 million for the construction of a next generation fusion device, the Tokamak Physics Experiment (TPX), to be built at the Princeton Plasma Physics Laboratory (see our October 1992, January 1993 and February 1993 newsletters). Clinton indicated that \$20 million would be requested in FY 1994 for initiating the project, whose total cost is expected to be about \$500 million.

In a handout to reporters following the President's address, the Department of Energy stated that the Department "has heard President Clinton's call to arms and is ready to take action to implement his economic stimulus package." The handout calls TPX "the next step in advanced fusion research" and said the project "continues U.S. leadership."

Clinton's announcement ended weeks of uncertainty in the fusion community on whether fusion would be cast with the "good guys" or the "bad guys." DOE also announced after Clinton's speech that they were reducing some programs as part of Clinton's "economic savings package" aimed at reducing the deficit. Included on DOE's FY 1994 hit list were reductions in Defense Programs (\$800 million), the Power Marketing Administration (\$300 million) and

uranium enrichment activities (\$260 million). The plan also called for "phase out" of the nuclear advanced reactor programs (\$200 million) and a slowdown of the Superconducting Super Collider. The latter action cuts the anticipated FY 1994 increase in the SSC budget, and will certainly result in a significant increase in its projected \$8.2 billion total cost. SSC sources indicate that DOE plans to limit growth of the SSC budget to 3% above inflation per year and that this will result in a four year slippage and \$2 billion increase in the project cost. Administration officials have indicated that the slippage will give them more time to solicit foreign contributions to the project. SSC advocacy groups have indicated that they will not lobby against the slowdown since they are fearful that fighting the Administration could result in a cancellation of the project.

EPRI RENEWS FUSION INTEREST

The Electric Power Research Institute (EPRI) has released the results of an internal study entitled "Report of the 1992 EPRI Fusion Panel" which completed its work last September. The study was performed by a panel of EPRI executives, chaired by Robert L. Hirsch (VP, EPRI Washington Office). Other members of the panel were Floyd Culler (president emeritus), Nari Hingorani (VP, Electrical Systems), John Taylor (VP, Nuclear Power), Thomas Schneider (executive scientist, Exploratory and Applied Research), and Dwain Spencer (VP, Commercialization and Business Development), all from EPRI headquarters in Palo Alto. Copies of the report are available from Fusion Power Associates.

The report states that "Fusion is one of only a few very long-term (multi-century) options for the central station

generation of electric power. As such, an informed awareness of the status of fusion development is important to the electric utilities and to EPRI."

The panel received briefings from advocates of over a dozen fusion concepts at a meeting July 6-8, 1992. The panel decided not to attempt to assess the physics credibility of the various concepts, but rather focussed on their engineering characteristics, assuming "favorable physics performance and adequate economics."

The panel developed a set of "operational considerations" that they said should be used to assess fusion concepts "from the point of view of their desirability to an electric utility." These were (1) complexity, (2) availability, (3) fuel choice and cycle, (4) energy balance, (5) safety, (6) waste, (7) siting, and (8) technical uncertainties. Each of these is discussed briefly in the report, although the panel decided not to rank the concepts that were presented to them.

The panel concluded that "the federal fusion research program represents an important national investment" and that "producing deuterium-tritium fusion power in the 10-20 megawatt-thermal range in the Princeton TFTR is an important program milestone and should continue to be a high priority." They stated that "program diversity beyond tokamaks is important," citing as reasons the facts that "commercialization is a long way off and this field is highly complex."

In "diversifying its fusion program" the panel recommended that "DOE should give special consideration" to the following: (1) "concepts and/or designs that may be less complex," (2) "power plant designs without tritium burning, because of the very serious materials problems associated with 14 MeV neutrons," (3) "use of certain low activation materials," (4) "high overall energy conversion efficiency, e.g., combined direct electrical and thermal conversion," (5) "the outage and waste disposal problems of changing out large volumes of fusion reactor core materials every few years," and (6) "the importance of effective ash removal from fusion plasmas."

The panel also recommended that "engineering thinking and the eventual needs of the marketplace should become a critical element in fusion program planning and decision-making."

DOE COMMENTS ON EPRI REPORT

Dr. N. Anne Davies, head of the DOE Office of Fusion Energy, sent a letter to EPRI thanking them for sending her a copy of the report. In that letter, Dr. Davies says, "I welcome EPRI's renewed interest in fusion, because I believe even a long-range energy program such as fusion can benefit from the knowledge and experience of today's utility industry." Dr. Davies states, "Although the Panel concluded they could not complete an evaluation of fusion concepts from a utility desirability standpoint, the Report nevertheless provides a very succinct set of considerations." Dr. Davies says, "It also is easy to read between the lines the Panel's desire for a fusion concept with more attractive features than the conventional D-T tokamak. This desire is shared by the U.S. fusion community and is reflected in the FEAC recommendation that the Department maintain some effort on concept improvement, regardless of the budget level."

Dr. Davies states, "I do take exception to the implication of the Panel's recommendation that engineering thinking and the eventual needs of the marketplace should become a critical element in fusion program planning and decision-making. I believe that kind of thinking already is a critical element. As you know, reactor implications have long been a consideration in reviewing any fusion proposal or program."

Dr. Davies continues, "However, there is another equally critical element to be considered that your Panel decided to take as a given, namely physics performance. My view is that it is neither wise nor practical to ignore either criteria; the issue is one of balance. To insure that our decision-making has the right balance, I would like very much to have the participation of utility-oriented engineers in our advisory and oversight groups, especially the steering committee for our reactor studies; in panels that review proposals for concept improvements; and on committees that review the operation of our experimental facilities. I hope the EPRI Fusion Working Group will be a resource for this kind of participation."

EPRI FORMS UTILITY WORKING GROUP

EPRI has formed a Fusion Working Group composed of utility executives which will hold its first meeting in Washington March 16-17. The group will be chaired by Jack Kaslow, executive director of EPRI's Northeast Region. Bob Hirsch, VP, EPRI Washington Office, will serve as executive

secretary to the group. Other members of the group are Merwin Brown (Pacific Gas & Electric), Jack McCann (Consolidated Edison), Dennis McCloud (TVA), Louis Peoples (Madison Gas & Electric), Art Peterson, Jr. (Niagara Mohawk Power), Bruce Snow (Rochester Gas & Electric), Wes Taylor (Texas Utilities Electric), and Erik Titland (Baltimore Gas & Electric). Steve Dean (Fusion Power Associates) and Jerry Kulcinski (University of Wisconsin) have been asked to give an overview of fusion to the group.

ELLIS ELECTED TO FPA BOARD

Dr. William R. Ellis, VP and Chief Scientist, Ebasco Services, has been elected to the Fusion Power Associates Board of Directors. He will replace Dr. Robert C. Iotti of Ebasco and serve the remaining portion of Dr. Iotti's term, which expires October 31, 1994. We welcome Dr. Ellis to our Board.

WATKINS URGED DECLASSIFICATION WHILE EXITING DOE

Five days before leaving office, former Secretary of Energy James Watkins signed a memo to his Assistant Secretary for Defense Programs telling him to "inquire or seek resolution of the declassification of NIF (inertial fusion National Ignition Facility) technology for possible participation by the U.S. in foreign governments' (inertial fusion) programs." Watkins also asked that the Assistant Secretary "investigate foreign funding participation (in the National Ignition Facility)."

As indicated in last month's newsletter, Watkins had the authority to declassify inertial fusion on his own authority before leaving but declined to do so.

DOE AUTHORIZES NIF DESIGN

As indicated in last month's newsletter, DOE has authorized the initiation of conceptual design of an inertial fusion National Ignition Facility. By approving the so-called "Key Decision Zero" (recognition of a mission need) on January 15, DOE authorized the expenditure of funds (\$12 million) for "only those Conceptual Design activities necessary to provide more cost, schedule and scope definition, alternatives and options, site evaluation study, and National Environmental Policy Act documentation process."

The next DOE milestone for the project is the so-called



William R. Ellis

"Key Decision One" (New Start). This decision requires that the project have completed a "manufacturing readiness strategy . . . defining the risks, cost, and funding requirements necessary to proceed with this activity." In addition the authorization states that "should a decision be made to request approval of KD-1 in FY 1994, KD-0 must be reaffirmed and any site selection decision shall be made by the Acquisition Executive."

As part of the approval of KD-0, DOE prepared a "Justification of Mission Need" document which defined "the military requirements, relationship with project milestones and the test ban in 1996, impacts on stockpile maintenance, weapons design data, activities to accomplish mission between the time of the test ban and completing of the project in 2001, and usefulness to the Energy Research program."

ICF 5-YEAR PLAN NOT AVAILABLE

At Fusion Power Associates annual meeting in January, DOE Office of Inertial Confinement Fusion acting director Marshall Sluyter announced that "for the first time" he had an unclassified version of his 5-year plan. In last month's newsletter, we suggested that interested parties request the plan from DOE. However, Marshall has advised us that he is not sending out copies of the document because "it is out of date" and because the existing document was "never approved by my superiors nor was public distribution authorized." He has indicated, however, that a new unclassified plan is being prepared and that he will send copies to interested parties once it has been approved by the Department and public release has been authorized.

FPA E-MAIL

Messages and documents can be sent to Fusion Power Associates at the following e-mail address:
72570.707@compuserve.com

We do not monitor this daily, so urgent messages should continue to be sent by fax: (301) 975-9869.

WISCONSIN RECEIVES DARPA EQUIPMENT

The Defense Advanced Research Projects Agency (DARPA) has announced that equipment used in a terminated DARPA-sponsored fusion project will be made available to the University of Wisconsin. Wisconsin has indicated that it will use the equipment to continue studies of the concept, called inertial electrostatic fusion. The concept involves the establishment of a spherically symmetric electrostatic potential well by a system of grids and oscillating injected electrons. Ions fall into the electrostatic well, gaining energy, and, ideally, fuse while passing through a dense central region. Persons interested in knowing more about the concept should contact Nick Krall (fax: 619-481-7827), Bob Bussard (fax: 703-330-7890), or Jerry Kulcinski (fax: 608-263-4499). If the concept works, it offers the potential of a relatively simple configuration for a fusion reactor.

OIL DEPENDENCE CONTINUES GROWTH

U.S. petroleum demand, which has been rising gradually since the end of the Gulf War, is projected to reach 17.5 million barrels per day in 1994, the highest annual level in almost 15 years, according to the Energy Information Administration (EIA). Of this, 7.9 million barrels per day, or 45%, are expected to be imported. In 1992, the U.S. imported 41% of its 17.1 million barrels per day of domestic consumption. The EIA also predicted in a February 10 press release that "a sharp decline in gas productive capacity is expected over the next 2 years (5.0 percent in 1993 and 3.4 percent in 1994).

PEOPLE

Al Opdenaker has been named executive assistant to Office of Fusion Energy associate director N. Anne Davies. Al will also continue to work with the ITER program directly.

Don Priester, having completed a one-year assignment as executive assistant to Dr. Davies, has joined the Confinement Systems Division in the Office of Fusion Energy.

William Happer, Jr. has been asked by the Clinton administration to stay on as DOE Director of Energy Research, at least for the next few months.

Al Narath, director of Sandia National Laboratories and *James Okeson*, general manager of EG&G Idaho, Inc., have been named as winners of DOE's Management Excellence Award for managers at DOE contractor-operated facilities. The award carries with it a \$20,000 stipend.

Doug Holland and *Steve Piet*, from the fusion safety program at EG&G Idaho, will join the ITER Joint Central Team.

MEETINGS

In addition to the meetings listed in our January newsletter, the following meetings are of interest to the fusion community.

March 28-31: 1993 International Sherwood Fusion Theory Conference. Newport, Rhode Island. Contact Anna Kotsopoulos, MIT, fax (617) 253-5805.

May 25-28: International Symposium on Heavy Ion Inertial Fusion. Frascati, Italy. Contact Maria Polidora, fax Italy/6/94005100.

July 19-21: Second Wisconsin Symposium on Helium-3 and Fusion Power. Madison, WI. Contact John Santarius, fax (608) 263-4499.

October 25-29: Eleventh International Workshop on Laser Interaction and Related Plasma Phenomena. Monterey, CA. Contact Chris Stalker, fax (217) 333-2906.

QUOTABLE

"Fusion energy holds great promise as an element of the Nation's long-term energy supply."

Hazel O'Leary, Secretary of Energy
Senate Energy and Natural Resources
Committee Hearing
January 19, 1993



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JAPANESE TOKAMAK SETS NEW RECORD

FEAC UPDATES STRATEGIC VIEWS KULCINSKI, TRIVELPIECE NAMED TO NATIONAL ACADEMY

NEW AFFILIATES

Noell, Inc., a consulting engineering firm, has become a Corporate Affiliate of Fusion Power Associates. George Ulrich, formerly with Everson Electric Co., will represent the company. He can be reached at Noell, Inc., 2411 Dulles Corner Park, Suite 410, Herndon, VA, 22071, (703)793-6500, FAX (703)793-3330.

Rockford Technology Associates, Inc., has become a Small Business Affiliate of Fusion Power Associates. Prof. George Miley (University of Illinois) will represent the company. He can be reached at 100 NEL, 103 South Goodwin, Urbana, IL, 61801, (217)333-3772, Fax (217)333-2906.

We welcome their participation in Fusion Power Associates.

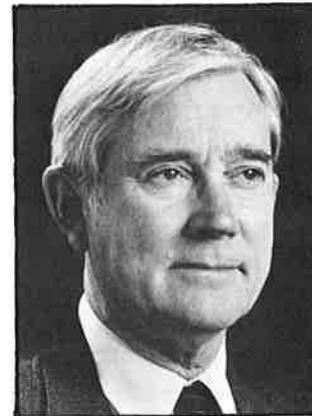
KULCINSKI, TRIVELPIECE NAMED TO ACADEMY OF ENGINEERING

Gerald L. Kulcinski and Alvin W. Trivelpiece have been named to the National Academy of Engineering. Kulcinski was cited for "contributions to the understanding of radiation damage to materials and for leadership in the design of fusion reactors and advanced fuels." Trivelpiece was cited for "technical contributions to magnetic fusion energy and for leadership in energy research and development."

Kulcinski is Grainger Professor of Nuclear Engineering and Director of the Fusion Technology Institute, University of



G. L. Kulcinski



A. W. Trivelpiece

Wisconsin. He is also Vice President, Research, Fusion Power Associates.

Trivelpiece is Director of Oak Ridge National Laboratory. He also was a founder of Fusion Power Associates in 1979 and a member of our first Board of Directors.

JT-60 SETS WORLD FUSION RECORD

Scientists at the Japan Atomic Energy Research Institute, working with JT-60, the world's largest tokamak fusion device, have announced the achievement of a new record for the fusion "triple product." The fusion triple product (product of plasma density, temperature and confinement time) is widely used as the primary indicator of progress for achieving the conditions required for an operating fusion power reactor.

According to a March 23 news release, a triple product of $1.1 \times 10^{21} \text{ m}^{-3}\text{keVs}$ was achieved. This compares to the previous record of 0.9×10^{21} achieved in the European JET device (See our November 1992 newsletter). The JT-60 results were achieved at a central ion temperature of 35 keV. The results followed the coating of the JT-60 vacuum vessel inner wall with boron, a technique known to decrease the presence of impurities in the plasma. The experiments also utilized increased heating power and optimized current profiles, resulting in H-mode confinement and high poloidal beta. A triple product only 4 times higher than that achieved in JT-60 and JET is required for an operating fusion power plant. In these experiments, the JT-60 scientists also tied the world record of DD neutron production rate of 5.6×10^{16} per sec previously achieved in TFTR. This production rate corresponds to 65 kW of DD fusion power. In upcoming experiments the JT-60 scientists plan to increase further the heating power and to sustain the plasma for a longer time.

The JT-60 team is carrying out a broad program of tokamak experiments, as evidenced by the eleven papers they presented at the 14th IAEA International Conference on Plasma Physics and Controlled Nuclear Fusion Research last October in Vienna.

FEAC UPDATES STRATEGIC VIEWS

Following its meeting on March 4-5, the DOE's Fusion Energy Advisory Committee wrote a letter, dated March 12, to DOE Director of Energy Research William Happer, as "an update of our views on the strategy for fusion energy development." The letter states that "the FEAC was pleased to find a commitment to design and construct both ITER and TPX in President Clinton's 'A Vision of Change for America'." The letter states "We believe both projects are essential to achieving our goal of building an attractive fusion demonstration reactor in the 2025 time frame."

The FEAC noted that, in its report of September 1992 on "Program Strategy for the U.S. Magnetic Fusion Energy Research," they had said that "The two highest priority recommendations, which remained invariant under the four budget cases considered, were the expeditious implementation of the DT program in TFTR, with completion in 1994, and vigorous participation in the ITER EDA leading to the construction of ITER." They state that "with regard to TFTR, we note excellent progress toward achieving its goal." They note that "tritium operation is

expected to begin in September of this year," and state that "the production of up to 10 MW of fusion power will mark an important milestone in the quest for fusion power."

The FEAC noted that the ITER design "is progressing well" and "recommends that the U.S. immediately prepare criteria for the earliest possible site selection and commitment to construction of ITER."

The FEAC stated that "other main program priorities identified in our September report are the Tokamak Physics Experiment (TPX) and the core program." They state, "We remain convinced that the TPX is the correct major next step for the U.S. national program." They also state, "We emphasize that other elements in addition to ITER and TPX are indispensable to achieving the goal of building an attractive fusion demonstration reactor in the 2025 timeframe. A vigorous core program is necessary to properly support the designs of ITER and TPX and to develop the science and technology that will be required to construct an attractive demonstration reactor."

They conclude, "Finally, we urge the Department to provide the program funding as identified in the Reference Budget of our September report. This will be consistent with the priority assigned to fusion in the President's "Vision of Change for America," which mandates moderate growth of the U.S. fusion program above inflation, and is in accord with the recommendation of the SEAB Task Force." Copies of the FEAC letter can be obtained from Fusion Power Associates.

CLINTON'S "VISION OF CHANGE FOR AMERICA"

The White House issued a document entitled "A Vision of Change for America" on February 17 to accompany President Clinton's economic address to a joint session of Congress on that date (See our March newsletter). The complete text of the fusion section of that document is as follows:

"Fusion offers the promise of abundant energy from readily available fuels with low environmental impact. The centerpiece of the research effort in magnetic fusion energy is a collaboration among the United States, the European Community, Japan, and Russia to build an International Thermonuclear Experimental Reactor (ITER). Design and

construction of ITER will be a multibillion dollar effort that would take two decades to complete. The United States must maintain a vital domestic research program to support our efforts on ITER. Yet, the U.S. has not commissioned a major new machine for fusion research since the early 1970's. This investment would fund moderate growth in the U.S. fusion energy program above inflation to allow construction of a new facility, the Tokamak Physics Experiment (TPX). Estimated additional spending between 1994 and 1997 is \$210 million in outlays; (\$90 million in 1997)."



Alan J. Wootton

WOOTTON NAMED TEXAS DIRECTOR

Professor Alan J. Wootton has been appointed Director of the Fusion Research Center at The University of Texas at Austin, effective January 16, 1993. He succeeds Dr. William E. Drummond who retired from the directorship to return to teaching and research as the Texas Atomic Energy Research Foundation Professor of Physics. Dr. Drummond, who held the position of Director since 1966, was instrumental in the establishment and growth of a strong fusion research program at the University.

Dr. Wootton has served as Associate Director of the Fusion Research Center and Head of the Texas Experimental Tokamak (TEXT) since his arrival at the University in 1985. Prior to his employment at the University, Dr. Wootton held positions as Experimental Physicist at Oak Ridge National

Laboratory, and Senior Scientific Officer at Culham Laboratory. Dr. Wootton received his B.S.C. and Ph.D. degrees in Physics from Royal Holloway College, London University, England.

The TEXT Tokamak is being upgraded (TEXT-U) to allow divertor operation and the addition of electron cyclotron heating. New diagnostics and external field perturbation capabilities are also being added. Anyone interested in experiments on TEXT-U should contact Dr. Wootton at (512)471-5780.



Drs. William Tang and Charles Karney

TANG, KARNEY PPPL THEORY HEADS

Dr. William Tang has been appointed Head and Dr. Charles Karney has been appointed Deputy Head of the Theory Division at Princeton Plasma Physics Laboratory. The two succeed Drs. Roscoe White and Liu Chen as Head and Deputy Head, respectively.

Tang is an internationally recognized specialist in the theory of microscopic plasma turbulence and transport and has pioneered important advances in the understanding of transport processes in tokamaks. He has also worked extensively on the interpretation of transport experiments carried out in TFTR and other tokamaks.

Karney is a widely recognized expert in computational physics, noninductive current drive, and nonlinear physics. At present, his research is directed at divertor physics and current drive with a focus on their application to ITER.

ERRATA

The FAX number for Mr. Kazuo Tanaka, secretary to the Inertial Confinement Fusion Forum of Japan, was incorrectly listed in our February newsletter. The correct FAX number is 06-877-4799. He will be happy to tell you about the new ICF Forum.

AAAS FELLOWS

The following fusion scientists have been named Fellows of the American Association for the Advancement of Science: *Damon Giovanielli* (Los Alamos), *Donald Grove* (Ebasco Services, retired from PPPL), *Charles Kennel* (UCLA), and *Nathan Rynn* (UC, Irvine). Congratulations one and all!

CQ REVIEWS FUSION

The Congressional Quarterly devoted the January 22, 1993 issue of its publication "The CQ Researcher" to a 20-page summary of fusion, written by Rod Griffin. Copies are available from Congressional Quarterly for \$7 by calling 1-800-432-2250. Fusion Power Associates has a limited number available for \$5. Here are some of the highlights.

"Experts say commercial fusion energy is still at least a half-century away . . . critics say it is time to abandon the fusion effort . . . but proponents argue that funding should be increased, not decreased . . . global collaboration on fusion research, they add, could set a precedent for other big science projects."

"In the 21st Century, fusion technology could profoundly change the future of the country and mankind," declares Eric Storm, a fusion expert at the Lawrence Livermore National Laboratory.

"The decade of the 1980's has seen enormous advances, . . . (we are) on the threshold of demonstrating its viability as a large scale source of energy," according to Robert W. Conn, a physicist at the University of California at Los Angeles and chairman of the Fusion Energy Advisory Committee at the Department of Energy.

"Breakthroughs usually come around budget time," says Robert Park, a University of Maryland physicist. "I'm not trying to disparage fusion power; research should continue. But it won't solve energy problems in our lifetime."

"It is hard to make an economically based argument for

fusion," says Lawrence Lidsky, a nuclear engineer at the Massachusetts Institute of Technology.

"Scientists have scarcely begun to work on the basic engineering problem of converting fusion energy to electricity," notes Ed Rodwell, manager of advanced nuclear systems at the Electric Power Research Institute.

"Congress has been unwilling to commit to expanding the budgets that will permit the next machine to be built," laments Stephen Dean, president of Fusion Power Associates. "You can't lay out an agenda without that commitment."

"Some people worry that we've committed to the tokamak too early," says Anne Davies, director of the DOE's fusion project. "But we have not had much choice. There just wasn't enough money to carry alternative projects and build a new tokamak."

IN MEMORIAM

The fusion community mourns the deaths of two of its most senior advisors and supporters: *Solomon J. Buchsbaum* and *Henry Seligman*.

Buchsbaum served on numerous fusion advisory panels dating back to the early 1960's. A physicist, with a doctorate from MIT, he worked at Bell Laboratories for 45 years, rising to senior executive positions, including a stint as head of the Sandia National Laboratories, which is managed by Bell Labs. He served on many government advisory boards over the years, including as chairman of the White House Science Council, and as chairman of the DOE Energy Research Advisory Board. He had recently agreed to serve on the new DOE Inertial Confinement Fusion Advisory Committee. He died at the age of 63 of multiple myeloma.

Henry Seligman, known to fusion scientists around the world as the man who presided over the International Atomic Energy Agency's biennial fusion conferences, including the one held last October, is dead at the age of 84. He joined the agency in Vienna when it was just beginning in the mid-1950's, leaving Harwell, where he was director of the isotope division. His impact on the IAEA over the years was profound. His dedication to the cause of fusion and the IAEA's role in fusion for the benefit of all mankind was unflinching.



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HAPPER LEAVING DOE

NASA SCIENTIST URGES FUSION PROPULSION HEAVY ION FUSION PROGRAM IN LIMBO

HAPPER LEAVING DOE

DOE Director of Energy Research William Happer, Jr. has announced plans to leave the Department of Energy around the end of May. Happer has held his current position since August 1991 and was asked by the Clinton Administration to stay on until a successor was named to the post, which is a Presidential appointment.

Clinton is expected to nominate Dr. Martha Krebs, an associate director of the Lawrence Berkeley Laboratory to replace Happer. Krebs was previously on the staff of the House Science and Technology Committee.

HEAVY ION FUSION PROGRAM IN DOUBT

The DOE's Fusion Energy Advisory Committee (FEAC) considered the plight of the Heavy Ion Inertial Confinement Fusion Energy program at its meeting April 15-16. At that meeting FEAC received the report of its "Panel 7" which was charged to consider "the nature and extent of an inertial fusion energy program" (See our October 1992 newsletter). Panel 7 was asked to provide programmatic advice for three possible budget cases: \$5M, \$10M, and \$15M per year. However, shortly before the FEAC meeting, DOE submitted its FY 1994 budget to Congress, requesting only \$4M for inertial fusion energy, a decrease from the FY 1993 level of \$7.7M. FEAC was thus presented with the dilemma that the DOE request level was already \$1M below the lowest case it was considering.

Panel 7 was chaired by Prof. Ronald C. Davidson of the Princeton Plasma Physics Laboratory; Dr. Barry Ripin of the U.S. Naval Research Laboratory was vice chairman. FPA president Steve Dean was also on the 18 member panel. The panel presented \$17M, \$10M, and \$5M cases.

The panel found that the "DOE has not established an inertial fusion energy program that resembles remotely the one envisioned by the (DOE) Fusion Policy Advisory Committee (in 1990)" (See our October 1990 newsletter). They noted that "Numerous reviews . . . have recommended heavy ion fusion as the most promising driver approach for inertial fusion energy," and that the "National Energy Policy Act (of 1992) directs the Secretary of Energy to conduct a fusion energy program to demonstrate the practicality of commercial energy production by 2010, including research and development of inertial confinement fusion energy and development of a heavy ion inertial confinement fusion experiment." The panel stated that "Without an accelerated effort in the heavy ion fusion program, particularly an accelerated ILSE (Induction Linac Systems Experiment) project with its related experimental goals, the Office of Fusion Energy will not be prepared to move forward with a full scale driver for inertial fusion energy until long after the demonstration of ignition." Only in the \$17M case, the panel stated, would sufficient funds be available to proceed with the (\$34M) ILSE project. "At this level," the panel said, "ILSE will be completed and operational within four

years." "ILSE will provide an integrated demonstration of induction linac technology and the beam physics required to provide the data base for scaling to a heavy ion driver."

In the \$10M case, the panel said, "It is not possible to complete the integrated demonstration project ILSE, although a significant set of large-scale accelerator experiments could be completed, thereby providing an increased understanding of key technical issues."

In the \$5M case, "the panel believes there is no credible program for the development of a heavy ion fusion energy option."

At its meeting on April 15-16, the Fusion Energy Advisory Committee accepted the report of Panel 7 and will transmit it to DOE with a covering letter endorsing the principal findings and recommendations of the panel. In addition, faced with the "fait accompli" of the \$4M budget submission, the FEAC will recommend that DOE reexamine its total budget with a view to embarking more realistically on a heavy ion inertial fusion energy program with ILSE as the centerpiece.

Panel 7 took pains to point out that heavy ions was not the only potential driver technology for inertial fusion energy applications. The panel report states, "The panel did not evaluate the relative status and prospects for inertial fusion energy as compared with magnetic fusion energy . . . nor did it reevaluate the relative merit of heavy ions as compared to other potential drivers, such as KrF (lasers), light ions, or diode-pumped lasers."

FUSION BUDGETS

President Clinton submitted his FY 1994 budget to Congress in early April. Within that budget, the President requested \$347.6 million for the Office of Fusion Energy (including \$4.0M for inertial fusion energy) and \$188.4 million for the Office of Inertial Confinement Fusion within the Defense Programs segment of DOE. The request compares to the FY 1993 levels of \$339.8 million for the Office of Fusion Energy (including \$7.7M for inertial fusion energy) and \$212.3M for the Office of Inertial Confinement Fusion.

Within the above requests, \$20 million is requested for design leading to construction of the Tokamak Physics Experiment and \$6M is set aside for the conceptual design of the "National Ignition Facility," a laser-pellet ignition

experiment within the Defense Programs activity (See our March newsletter).

NASA SCIENTIST LOOKS AT FUSION

NASA scientist Norman Schulze, on his own initiative, prepared and submitted a proposal within NASA to start a fusion energy program for application to NASA's future space missions. The proposal has been discussed at many levels within NASA up to the Administrator's office. It contains the rationale, planning, and tasks required to initiate a research and development program for fusion energy for space propulsion and power, with emphasis on propulsion. It is based on Schulze's NASA Technical Memorandum (TM 4297 and 4298, August 1991) entitled "Fusion Energy for Space Missions in the 21st Century" (See our July 1992 newsletter). The motivation is cost and safety advantages, as well as performance.

The proposal was subjected to wide peer review. It states that "highly efficient, high power space energy systems are essential to the future of space missions operating beyond the Earth," noting that "energy systems considered currently available to provide power for space missions are very limited." The proposal asserts that the development of propulsion systems "capable of velocity changes from 100 km/s to over 20,000 km/s will enable efficient human and robotic flights to all orbiting masses within the solar system--also, robotic missions to the stars." These requirements suggest the development of energy sources capable of "direct propulsion" ("the use of plasma energy directly for thrust without requiring other energy conversion systems") and "direct space power" ("the direct conversion of charged particles into electricity is used, thereby avoiding thermal conversion system losses"). The proposal says, "The total spectrum of alternative, potential energy sources is : chemical, nuclear fission (thermal and gas core), matter-antimatter, and perhaps a hypothesized strange matter stable regime. There are other energy derivatives such as metallic hydrogen and solar sails. But only fusion has the inherent desirable properties of feasibility, performance, safety, and cost features to make it attractive as the sole purveyor of large energy levels for space travel, i.e., energy in the gigawatt and perhaps even to the terawatt range."

For further information, contact Norman Schulze (202)358-0537 (days) or (703)818-2328.

JOHNSTON DRAFTS FUSION BILL; SCHEDULES HEARING MAY 6

Senator J. Bennett Johnston (D-LA), Chairman of the Senate Energy Committee, has submitted a bill (S-646) in Congress entitled "International Energy Act of 1993" and scheduled a hearing on the bill for May 6. The bill states that "the Department's magnetic fusion program shall be referred to as the ITER program and shall be carried out in cooperation with the international community." It "requires" that "In developing the ITER program, the Secretary shall . . . eliminate those components of the magnetic fusion energy program not contributing directly to development of ITER or to the development of a fusion demonstration reactor." The bill states that "In the event the Secretary terminates the ITER program, there is authorized to be appropriated to the Secretary \$50,000,000 for FY 1994" This compares to \$350,000,000 that would be authorized otherwise.

Reaction to the bill has been generally negative. FPA president Steve Dean (quoted in "Inside Energy," March 29) stated that "The fusion community wasn't consulted during preparation of the bill and wouldn't support it in its present form. Ninety percent of DOE's fusion effort is already directed toward ITER. It would be a mistake to cut off the other 10% of the programs because they could lead to an alternative reactor approach that ultimately proves better than the mainstream ITER design. There's nothing wrong with ITER being the flagship, but the non-ITER work isn't superfluous."

The fusion "Theory Coordinating Committee" (Richard Hazeltine, Allen Boozer, Ronald Cohen, Robert Dory, George Morales, Dieter Sigmar, and Roscoe White) wrote a letter, dated April 8, in which they state "We have misgivings, however, about language that appears in some parts of the bill. We are concerned that its emphasis on ITER, apparently to the exclusion other domestic fusion research activities, could unintentionally hamper the contribution of US scientists and engineers to the international fusion campaign." The language, they said, "could be viewed as discrediting the value of careful, innovative science -- language that makes the entire US research program appear subservient to ITER"

The University Fusion Association, a national organization of fusion researchers from every U.S. university active in

fusion research, sent a letter dated April 21 to Senator Johnston and signed by its president, Professor Stewart Prager of the University of Wisconsin, stating that the bill, "as we interpret it," would "severely retard progress in fusion." They state, "ITER is a major milestone in fusion research, but will likely not by itself provide sufficient information to proceed to a practical reactor . . . the time scale for fusion demands a strong and innovative research effort in addition to ITER." The letter states, "To put a halt to such research would eliminate the program which has given us the knowledge to build ITER . . . the non-ITER research is necessary to proceed beyond ITER. It is also needed to operate ITER most effectively and to fully utilize the results from ITER." The letter further states, "It is drastically premature to commit the fusion program to a well-defined reactor concept at this time. To do so is analogous to terminating aviation research at the Wright airplane or computer research at the first vacuum computer . . . to stop non-ITER research now would condemn us to a 2040 reactor based upon 1993 science." The letter concludes, "Often the planning of the fusion program is framed as a choice between two undesirable alternatives. The first is that we have an ITER-only program, based on the belief that our present view of a reactor will prevail decades into the future. The second is that we do not build ITER and abandon fusion energy, based on the belief that after all these years we still do not know how to build a reactor. This is a false choice, not in the best interests of the country."

The DOE is also reported to be unhappy with much of the language and tone of the bill.

The bill does, however, have a number of redeeming features. It states that the "Congress finds that (1) fusion energy has the potential to be a safe, environmentally attractive, secure and economically affordable source of energy; (2) the United States Department of Energy's magnetic fusion energy program has made significant progress toward realizing fusion as a viable source of energy; (3) other industrial nations have also invested in significant magnetic fusion energy programs; (4) an integrated program of international collaboration will be necessary for continued progress to demonstrate the scientific and technological feasibility of magnetic fusion energy; (5) there is international agreement to proceed with the engineering and design of the International Thermonuclear Experimental Reactor to prove the scientific

and technical feasibility of fusion energy and to lead to a demonstration reactor; (6) the United States should focus the Department of Energy's magnetic fusion energy program on the design, construction and operation of the International Thermonuclear Experimental Reactor; (7) the continuation of an aggressive fusion energy program requires the Department of Energy, industry, utilities, and the international fusion community to commit to the International Thermonuclear Experimental Reactor as soon as practicable; and (8) an effective U.S. fusion energy program requires substantial involvement by industry and utilities in the design, construction, and operation of fusion facilities.

Members of the magnetic fusion community are working with Senator Johnston and his staff to make improvements in the wording of the bill. (The bill ignores inertial fusion for energy applications.)

DOCUMENTS AVAILABLE

Fusion Power Associates' Fusion Facilities Directory (See our September 1992 newsletter) is in its second printing. Several corrections have been incorporated. The Directory gives phone/fax numbers for most fusion personnel in North America, as well as travel information to fusion facilities. The cost of this popular and useful 275-page Directory is only \$20 plus postage and handling. To place your order, contact Ruth Watkins (301)258-0545; fax (301)975-9869; e-mail 72570.707@compuserve

The University of Rochester Laboratory for Laser Energetics 1992 Annual Report is available from Prof. Robert L. McCrory (716)275-4973; fax (716)275-5960; e-mail RMCC@LLE.ROCHESTER.EDU

"Computing for Magnetic Fusion Energy Research An Updated Vision" (DOE/ER-0583T, February 24, 1993) is available from DOE. Contact Dr. David Crandall at (301)903-4596; fax 903-4716; e-mail DAVID.CRANDALL%ER@MAILGW.ER.DOE.GOV

VARIAN-LIVERMORE SIGN "CRADA"

Varian Associates, the world's leading producer of microwave tubes, has signed a two-year, \$3 million Cooperative Research and Development Agreement (CRADA) with the DOE's Lawrence Livermore National Laboratory to use computer codes, developed in the lab's

weapons program, to aid in the design of 1 MW continuous power gyrotrons with a frequency of 110 to 140 GHz. The codes were developed as part of the lab's free electron laser program. This is the first CRADA entered into by the lab's weapons program. Varian engineer Kevin Felch said that a new generation of microwave devices with even higher power and frequency could be developed in the future.

COAL PLANT FACTOID

Over the course of a 24-hour day, a 1,000-megawatt coal-fired power plant releases into the atmosphere over 30,000 tons of carbon dioxide, over 2000 tons of particulates, over 600 tons of nitrogen oxides, and over 50 tons of sulphur dioxide. In normal operation, a coal-fired plant releases more than 10 times more radioactivity than a comparable-size nuclear power plant, because the coal itself contains radioactive products of uranium and thorium decay, and these products are released in gaseous form when the coal is burned.

To operate a 1,000-megawatt coal-fired plant for one year requires the mining and transportation of over 2 million tons of coal. (A similar-size fusion power plant would require about one-half ton of deuterium.)

APS FELLOWS

The American Physical Society has awarded the following fusion scientists the rank of Fellow: R.J. Fonck, J. Grun, L.L. Lao, W.W. Lee, R.A. London, P. Liewer, P.J. Morrison, Y. Nishida, M. Ono, P.F. Ottinger, J.M. Soures, R.J. Temkin, J.W. VanDam. Congratulations one and all.

PEOPLE

Christopher J. Hamilton has been named head of General Atomic's Fusion Group Business Development activities, replacing *Ms. Jay Creutz*. His responsibilities will include being the contact for all GA ITER and reactor study work. He can be reached at (619)455-3364; fax (619)455-2494.

J.W. Anderson has been named head of PPPL's Facilities Engineering Division, replacing *Harry Howard* who is retiring. He will be responsible for integrating the activities of the Project Engineering, Maintenance Engineering and Maintenance Operations branches.



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LIGHT ION FUSION ENDORSED CONGRESS HOLDS FUSION HEARINGS

NEW AFFILIATES

Chicago Bridge & Iron Company has become an institutional affiliate of Fusion Power Associates. Don H. Coers, Business Development Manager, will represent the company. He can be reached at 800 Jorie Blvd., Oak Brook, IL, 60521-2268; (708)572-7275; Fax (708)572-7103.

Princeton University Plasma Physics Laboratory has become an institutional affiliate of Fusion Power Associates. Dale M. Meade, deputy director, will represent the laboratory. He can be reached at P.O. Box 451, Princeton, NJ, 08543; (609)243-3301; Fax (609)243-2749.

We welcome their participation in the activities of Fusion Power Associates.

LIGHT ION FUSION ENDORSED

The DOE's Inertial Confinement Fusion Advisory Committee (ICFAC), in a letter dated April 13 to DOE acting assistant secretary for defense programs Everett Berkner, states that they are "pleased with the progress Sandia has made in the light ion program" and that they "consider light ions as a potential cost-effective route to a Laboratory Microfusion Facility (LMF) and energy, and as a possible backup for ignition." The ICFAC report is based on the committee's March 8-10 meeting at Sandia National Laboratories in Albuquerque.

The report represents a major victory for light ion fusion program director Don Cook, who has struggled for the past three years to turn around the negative image of light ion fusion prospects, in the wake of the 1990 inertial fusion



Donald L. Cook

review report from the National Academy of Sciences (see our March and October 1990 newsletters). The ICFAC noted that the National Academy of Sciences panel had "established a challenging set of milestones for the Sandia light ion program. Some have been met and some have not; nonetheless, overall progress since 1990 has been very good."

A key accomplishment of the Sandia program has been the improvement in focusing both proton and lithium ion beams (see our November 1992 newsletter). At the time of the 1990 review, Sandia had produced lithium ion beams with a beam divergence of approximately 40 milliradians and a beam intensity of approximately 0.25 TW/cm^2 . This has been improved to a beam divergence of slightly below 20

milliradians and a beam intensity of slightly more than 2 TW/cm². As a result, the Sandia scientists said, "These intensities have enabled us to begin lithium-driven target experiments on PBFA II which are producing temperatures that are likewise consistent with lithium beam intensities more than 2 TW/cm²." A goal for the PBFA II facility is to operate with lithium beams with divergence of 14 milliradians and intensity of 10 TW/cm². Approximately 120 TW/cm² would be required for ignition. A part of this increase would be obtained by raising the energy in the beam from the present value of 10 MeV to 30 MeV. Don Cook, leader of the Sandia effort, estimates that he would like to improve the beam divergence to 14 milliradians on PBFA II, to about 6 milliradians for the LMF, and to about 4 milliradians for a fusion power reactor.

In its report, the ICFAC also stated, "Based on the information we received at both the December and March meetings of ICFAC, we once again urge the DOE to proceed with implementing the previously suggested declassification of appropriate elements of the ICF program. This is an important issue which needs to be resolved rapidly. Declassification would enable us to take better advantage of international cooperation in laser, light ion, and heavy ion fusion."

Copies of the ICFAC letter are available from Fusion Power Associates. Copies of the unclassified minutes of ICFAC meetings are available from Marshall Sluyter, acting director, DOE Office of Inertial Confinement Fusion, Fax (301)903-3888.

HOUSE HEARING

Representative Marilyn Lloyd, chairperson of the House Science, Space and Technology Committee's Subcommittee on Energy Research and Production, held a hearing on the DOE Office of Fusion Energy program on May 5. Witnesses included fusion office director N. Anne Davies, Harold Forsen (Bechtel), Paul-Henri Rebut (ITER director), Charles Baker (ORNL & ITER Home Team Leader), Ronald Davidson (PPPL), Klaus Berkner (LBL), Bogdan Maglich (Advanced Physics Corporation), Edmund Storms (Los Alamos), and Randall Mills (HydroCatalysis Power Corp., Lancaster, PA).

Mrs. Lloyd stated, "Columbus reached our shores just 500 years ago. In much less time than that, fossil fuels, which provide for most of today's energy needs, for all practical

purposes, will be exhausted. Fusion promises us a virtually unlimited supply of potentially clean energy." Rep. Harris Fawell (R-IL) noted that the magnetic fusion program had recently been criticized by former fusion director Robert L. Hirsch, vice president, Washington Office of the Electric Power Research Institute. In a statement to the DOE's Fusion Energy Advisory Committee March 5, Hirsch stated, "DT tokamak and laser-fusion reactors as currently envisaged will be extremely complex, highly radioactive, likely to be highly regulated, and costly." Hirsch recommended that the program "get off the DT fuel cycle" and "scale up alternate R&D concepts as fast as possible." Fawell stated that "when someone of Dr. Hirsch's knowledge, background and stature makes such observations, I believe they deserve serious consideration, and I expect today's witnesses to address them."

Davies presented the DOE's FY 1994 budget request of \$347.6 million. She stated that "The development of fusion as an energy source could contribute to the energy security of the United States, provide economic growth potential, and make us a supplier of energy technologies to other countries." She noted that fusion was endorsed both in the Energy Policy Act of 1992 and in President Clinton's "Vision of Change for America" (see our December 1992 and January 1993 newsletters) and that President Clinton had called the International Thermonuclear Experimental Reactor (ITER) "the centerpiece of the research effort in magnetic fusion energy" She also noted that "other major activities are required in order to make fusion a practical energy option," specifically mentioning the Tokamak Physics Experiment (TPX) and the development of low activation materials.

Forsen stated that "the program needs to have some funds available to support alternate and/or improved approaches to the tokamak configuration as a power reactor." However, he stated, "I worry very much about not getting on with the DT-fueled tokamaks at the expense of too much second guessing of what might be cheaper, smaller or fueled with more exotic, remote fuels." He concluded, "To say today that any fusion power plant is or is not acceptable is to anticipate a future that will be very different than it is today."

Berkner urged the committee to support the development of heavy ion inertial fusion, including the construction of the Induction Linac Systems Experiment (ILSE), as an energy option (see our May newsletter). "The diversity created by

developing two approaches (magnetic and inertial) greatly increases the probability that fusion will become an economically and environmentally attractive energy source," he said.

Maglich called both magnetic and inertial confinement fusion "Cold War technologies" that "fail to take account of environmental and economic considerations, of major new scientific discoveries and inventions, and of new thinking of the new generation of scientists who do not have to defend old programs." He described his concept, known as the "Self-Collider" (Phys. Rev. Lettr., January 18 and March 22, 1993). He said, "Unlike conventional fusion, it is based on nonradioactive fuel, helium-3. Because it would produce insignificant neutron radiation ("aneutronic"), it cannot breed or proliferate nuclear weapons and produces 1000 times lower radioactive waste than conventional fusion." He said that "our research consortium is now only 3 years away from proving once and for all that a nonradioactive-fuel, nonproliferating, aneutronic fusion energy reactor is feasible." Commenting on the current plan to build a large tokamak as an international venture, he said, "If an important universal power generator cannot be developed in one country like the United States, it cannot be developed at all."

Edmund Storms, a retired Los Alamos National Laboratory scientist, stated that a "careful and extensive examination of available information as well as personal research has convinced me and many other scientists that this phenomenon (cold fusion) is real and, I believe, may have important consequences to the U.S." He stated, "I am not speaking for the Los Alamos National Laboratory on this subject because policy in this area has not yet been formulated. The Laboratory does not want me to pre-empt this process."

SENATE HEARING

Senator J. Bennett Johnston, chairman of the Senate Energy and Natural Resources Committee, held a hearing on May 6 to discuss his recently-introduced fusion bill (see our May newsletter). Witnesses were Jim Decker (deputy director, DOE Office of Energy Research), Paul-Henri Rebut (ITER director), Robert Hirsch (EPRI), David Overskei (General Atomics), and Joe Gavin (former president, Grumman Aerospace Corp.).

Johnston stated, "Over the last four decades we have spent

almost \$10 billion exploring ways to produce electricity from magnetic fusion. Many different approaches have been studied. The decades and billions of dollars of research have narrowed the magnetic fusion energy path to one approach -- ITER . . . We are at a point that our magnetic fusion program must be focused entirely on ITER. The days of unfocused fusion research are over . . . But I also believe that we should not continue to spend substantial amounts of money studying the engineering problems associated with fusion if we cannot reach an agreement with the international community to develop ITER or if we decide ITER will not lead to a fusion demonstration reactor . . . While some level of basic research in fusion would still be appropriate in the absence of ITER, it would not be appropriate to continue the level of effort of today . . . We are at a critical juncture for the magnetic fusion program. The fusion community has sounded the rallying cry to design and build ITER. This bill answers that cry by committing the U.S. magnetic fusion program to ITER."

Senator Bill Bradley (D-NJ), who attended only a portion of the hearing, stated, "I support the Chairman's interest in giving the Department of Energy the authority to negotiate ITER agreements and I believe that this country should put forward an ITER site. Having said that, I want to take a minute to focus on the American fusion program, because I believe it is important not to lose sight of our homegrown talents and expertise. As we move ahead with the ITER project and toward the demonstration reactor, we need to move ahead from a position of strength. American contributions to ITER will only be as strong as the underlying U.S. program. If it's worth investing in ITER -- and I believe it is -- it's worth investing in a solid domestic program." He noted that "In 1970, the most fusion power that could be produced in experiments was one-hundredth watt. In 1991, the Joint European Torus (JET) achieved an output of almost 2 million watts." He concluded, "This is a successful program. These projects work as designed. The goals are met. Unfortunately, since the early 1980's, there has been a steady erosion of financial support."

Decker stated that the DOE considered the bill as "a constructive step in furthering the development of magnetic fusion for civilian purposes. However, we have some important modifications to suggest to the Committee and appreciate this opportunity to comment on the bill." Decker stated, "We need to recognize that any research and development program, especially a long-term one such as

fusion, should maintain a modest level of activity devoted to innovation . . . I am not proposing that we do any development-level work on alternates." Decker noted that Johnston's bill "contains a provision that if the ITER program is terminated, the Department may continue to carry out fusion energy research, but only at the level of \$50 million per year." He stated, "While I fully expect the ITER program to be successful, if for some reason we cannot go forward, I am concerned that such a precipitous reduction in the program would be unmanageable and not in the long-term interests of keeping fusion energy research as a viable activity. I am also concerned that such a provision could, in effect, give other nations a type of "veto" power over the U.S. fusion program, and substantially reduce our negotiating position on ITER and other related program elements."

Rebut noted that "the annual cost to develop a fusion reactor would amount to approximately 0.1% of the electric power costs incurred annually by countries of the OECD. This is a small investment for the capability to produce electricity necessary to sustain the long-term development of the world economy . . . As ITER Director, I am committed to seeing ITER built . . . But, for me, the real goal is not any one specific device, however important, but the establishment of fusion as a major source of energy. ITER should therefore be seen as the leading element of a balanced Fusion Reactor Development Program. To that end, ITER must be built but, at the same time, there should be a complementary program . . ."

Hirsch stated, "I appear before you today to urge further study before the United States commits to an International Thermonuclear Experimental Reactor . . . We must develop fusion power units that are more attractive than fission reactors and other baseload power options. If not, there will be little incentive for utilities to utilize this technology . . . The problem is that the best DT tokamak designs appear to be less attractive than the Advanced Light Water fission reactor." Citing projected high cost, radioactive waste, and complexity, he said, "Despite my conviction that fusion has great potential, I believe that a DT tokamak fusion reactor that follows the current path of development will be quite unpromising as compared to the advanced light water reactor. That being the case, a multibillion dollar investment in ITER may not be prudent . . . Fortunately there are a number of other, more favorable fusion fuel cycles to choose from . . . It would thus appear reasonable and prudent to consider reorienting the U.S. thinking on fusion and

targeting our research on those potentially more attractive systems." He recommended establishing "a user community of utility experts and managers to evaluate the arguments for and against the DT tokamak approach to fusion."

Overskei stated that the "bill appropriately focuses the DOE to develop a plan for future U.S. participation in the International Thermonuclear Experimental Reactor, to effectively utilize the existing U.S. fusion resources, and to develop new resources and technologies to make fusion energy a reality." He said, "I strongly endorse your legislation which directs the Department of Energy to identify a proposed ITER site in the U.S. and a plan for reaching an international siting agreement of the ITER project by 1995 . . . However, ITER alone will not provide all the answers or the technology that we envision in a fusion power electricity generating demonstration reactor . . . In parallel with continued concept improvement, through science and experimentation, the DOE should place more emphasis absolutely and relatively on the development of fusion reactor technologies with particular emphasis on low activation materials." He also said, "We need to evolve from the present 20% industrial and 80% national laboratory and university participation to a point in the near future where industry plays a dominant role in the program with R&D support from the university and national laboratory systems as needed." Overskei stated that he "disagreed with the proposed involvement of the utility industry . . . U.S. utilities have no relevant expertise in the development of fusion energy and generally have little expertise in the development and engineering of large-scale energy sources."

Gavin stated, "I believe it is essential to press on now; we need to regain a competitive position . . . There is a clearly expressed concern about the ability of the United States to maintain a long term commitment. This is a real concern for the design phase of ITER and could be a critical factor in reaching an agreement for construction and siting. This committee can help in this matter . . . We should support this (ITER) effort vigorously . . . My position is simply that we need to develop the fusion option soon as insurance against a future critical need." He called Hirsch's proposal to establish a committee of utility experts to judge the commercial viability of the DT tokamak like asking the railroad barons in 1933 to judge the reasonableness of the Ford tri-motor aircraft as a development step towards commercial transatlantic flight.



FUSION POWER ASSOCIATES

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CLINTON VISITS FUSION SITE

FPA SYMPOSIUM SET OCTOBER 5-7

FORSEN NAMED ANS FELLOW

CLINTON VISITS LOS ALAMOS

President Bill Clinton visited Los Alamos National Laboratory (LANL) on May 21 with U.S. Senators Bingaman and Domenici, Congressmen Bill Richardson and Steve Schiff, Energy Secretary Hazel O'Leary, and New Mexico Governor Bruce King. While there he visited the site of the Compact Torus Experiment (CTX), one of several magnetic fusion experiments at Los Alamos that were terminated by DOE several years ago when program managers decided to narrow the U.S. magnetic fusion program to the pursuit of the tokamak concept. The CTX spheromak equipment and diagnostics are now located in the building where another fusion experiment, the ZTH reversed field pinch, was three-quarters completed when DOE canceled it. The fusion equipment is now being used to improve plasma source ion-implantation technology as part of the lab's largest Cooperative Research and Development Agreement (CRADA), a \$13 million joint venture with General Motors and the University of Wisconsin. The technique was invented by Prof. John Conrad, a fusion-bred scientist from the University of Wisconsin. The LANL experiment is led by Don Rej, who spent 10 years working on field reversed magnetic fusion concepts.

The technique allows the manufacture of low friction material surfaces that are harder and more resistant to wear and corrosion. Upon learning of the technique, Clinton remarked, "With this we could dramatically lower costs and increase output for American manufacturing in a huge array of areas." Rej said that the technique can be applied to



President Bill Clinton peers into the CTX vacuum tank at LANL as Blake Wood (arms crossed) and Don Rej look on. In the foreground: Energy Secretary O'Leary.

such products as machine tools, ball bearings, and other automotive components. After inspecting a prosthetic joint treated by the process, Clinton said, "That's a big deal for all the people who are getting these hip replacements now with dread in their hearts because in a few years they will have to go back and do it all over again." The plasma source technique offers advantages over traditional ion-implant techniques, including increased speed of formation, reduced cost, greatly reduced waste, and the ability to treat all surfaces of large objects simultaneously.

For information on the technique, contact Don Rej, (505)665-1883; fax 667-1754.

FPA SYMPOSIUM OCT 5-7

Fusion Power Associates Annual Meeting and Symposium will be held October 5-7 in Oak Ridge, TN. The theme of the meeting will be "Near-Term Applications of Fusion and Plasma Technologies." The symposium will treat numerous "spin-off" benefits from decades of fusion research and development, including plasma materials processing, medical imaging, control systems and x-ray lithography. Technology transfer, CRADA, and small business opportunities will be discussed. The meetings on October 5 and 6 will take place in the Pollard Auditorium, next to the Garden Plaza Hotel, in Oak Ridge. On the morning of October 7, there will be a briefing and tour of the Fusion Energy program in the ORNL Y-12 plant. More details on the meeting will be mailed out in the near future.

FEAC ISSUES MATERIALS REPORT

The DOE's Fusion Energy Advisory Committee (FEAC) sent a report to then Director of Energy Research William Happer on May 20 providing a requested (See our October 1992 newsletter) evaluation of the Neutron Interactive Materials Program of the Office of Fusion Energy. (Happer left office on June 1; a replacement has not yet been nominated by President Clinton; Dr. James Decker is Acting Director.) FEAC's letter report (available from Fusion Power Associates) is based on a study by its "Panel 6" chaired by Klaus Berkner of the Lawrence Berkeley Laboratory. FPA president Steve Dean was a member of the Panel.

FEAC notes that "testing in fission reactors is a vital component of fusion materials development" and laments that "There is concern about the continued availability of such reactors. One fast reactor (FFTF) is no longer operating, and the availability of the sole remaining reactor (EBR-II) is not assured." A key recommendation is that "the U.S. seek an international commitment for the design and construction of a high-fluence fusion neutron source facility with the aim of having initial operation shortly after the year 2000." The report states, "The Panel and FEAC conclude that the accelerator-based D-Li system is the preferred approach for this function."

The FEAC concludes that the current level of funding for the development of structural materials for fusion applications (about \$10 million per year) is "inadequate to ensure the availability of such materials on the time scale

consistent with the operation of an attractive fusion demonstration reactor beginning around 2025." They urge that the level of effort grow "to about twice the current level by 1996-97." The FEAC recommended that "the base program focus on the development of low/reduced activation structural materials, with relatively smaller but still important efforts on neutron irradiation issues related to ceramic insulators, material coatings, and plasma-facing components." They cautioned "that it is important that the longer term base materials program be protected against diversion of funds towards near-term, non DEMO-relevant materials development."

The FEAC noted "that both the ITER and TPX projects are considering seriously the use of low/reduced activation materials in appropriate components. We strongly endorse these efforts both for the impetus they will provide and for the benefits that will be gained from large-scale practical experience with such materials in actual fusion machines."

NEW MIT TOKAMAK OPERATES

Alcator C-Mod, a new high field tokamak device at MIT, obtained its first plasma discharges in mid May. Ian Hutchinson, director of the project, said "After only about 150 shots of full physics operation this year, we had learned enough about the field tuning and programming to obtain a sustained current ramp-up to 300,000 amperes. This is a substantial validation of the important concept of tokamak construction using massive, toroidally continuous conducting materials." Alcator C-Mod operation was identified by DOE's Fusion Energy Advisory Committee (See our October 1992 newsletter) as one of the top priorities within the magnetic fusion program.

The purpose of the Alcator C-Mod program is to address a range of critical issues confronting the development of the tokamak as a viable fusion reactor concept. These issues include power and particle handling (divertor testing), control, plasma confinement, and radio-frequency heating and current drive. For further information contact Ian Hutchinson, (617)253-8760; fax 253-0627.

TRITIUM ARRIVES AT PPPL

After 19 years of preparation for deuterium-tritium experiments in the Tokamak Fusion Test Reactor (TFTR), and nearly two years of intensive effort, the first shipment of tritium (200 Curies or 0.02 gram) arrived at the Princeton

Plasma Physics Laboratory on April 29. The tritium will be used to test the tritium handling and delivery equipment, in preparation for the first DT experiments scheduled to begin this Fall. TFTR scientists expect to have a maximum of 50,000 Curies on site during FY 1994, leading up to the production of 10-20 Megawatts of fusion power, which will be a new World's record. This relatively small amount of tritium compares to the millions of Curies routinely handled at the DOE weapons laboratories and is illustrative of the extreme fuel energy efficiency of fusion power systems.

FORSEN NAMED ANS FELLOW

Dr. Harold K. Forsen, senior vice president, Bechtel National Inc., has been named a Fellow of the American Nuclear Society. At an awards luncheon June 22 at the ANS annual meeting in San Diego, Forsen was cited for his pioneering development of fusion engineering at the University of Wisconsin; establishment of the laser isotope separation effort at Exxon Nuclear Corporation; management of successful R&D efforts at Bechtel on both nuclear and non-nuclear technologies; and service on numerous government advisory committees. Forsen is a former member and chairman of Fusion Power Associates Board of Directors.

INERTIAL FUSION BOOK PUBLISHED

A comprehensive reference book entitled "Nuclear Fusion by Inertial Confinement" has been published by CRC Press (Boca Raton, Ann Arbor, London, Tokyo). The 725-page comprehensive treatise is edited by Guillermo Velarde, Yigal Ronen, and Jose Martinez. Forty-five leading scientists from around the World contributed chapters covering topics ranging from physics and diagnostics to technology and reactor design. It is a highly-recommended addition to every technical person's reference collection.

ENERGY TRUST FUND PAPER PUBLISHED

Tau Beta Pi, the national engineering honor society, has published a paper by S. Locke Bogart and Richard P. Hora of General Dynamics entitled "Funding Advanced Electric Energy System Demonstrations" in the Spring 1993 issue of their journal "The Bent." The paper describes in detail the operation of an "amortizing fund" to provide a "stable funding environment" for research and development on advanced technologies. The fund would be "established from a small investment fee, such as one mill per kilowatt-hour on the purchase of electricity," paid by consumers.



ANS Fellow Harold Forsen

The paper expands on a concept originally proposed by FPA president Steve Dean in a luncheon address to the American Nuclear Society on March 6, 1985 and later incorporated as an implementing feature of Fusion Power Associates' Accelerated Fusion Power Development Plan (See our February 1990 newsletter and J. Fusion Energy, June 1991).

The Bogart/Hora paper describes the operation of several existing trust funds ranging from the Highway Trust Fund and the Nuclear Waste Fund to Retirement Trust Funds and Life Insurance Annuities. It describes a number of potential beneficiary technologies ranging from superconducting energy storage to fusion, fission and renewable energy. And it proposes organizational structures for implementing the fund. Reprints can be requested from Locke Bogart, (619)547-8014; fax 547-8329.

LANL LETS INDUSTRY CONTRACTS

Los Alamos National Laboratory has announced the signing of contracts worth \$2.6 million with six industries to help design a particle accelerator and associated systems to produce tritium. The industries are Bechtel Corp., Grumman Aerospace Corp., Babcock and Wilcox, Maxwell Balboa, Merrick and Co., and General Atomics. "Working with these companies will enhance the engineering credibility of the accelerator production of tritium concept and demonstrate the Laboratory's ability to work successfully with the private sector," said John Ireland, who

heads the Los Alamos project. "We wanted industry on board from the beginning because of the expertise in the private sector and our desire to transfer the accelerator technology from the national laboratories. We also believe that having industry on board will help speed up development and construction if the DOE chooses accelerators as the preferred technology for future tritium production," he said. DOE is scheduled to decide on the construction of the facility in 1994.

NEWS FROM CANADA

The Ontario Hydro Canadian Fusion Fuels Project (CFFTP) designed, built, and is installing a tritium purification system for the Tokamak Fusion Test Reactor (TFTR), under contract to the Princeton Plasma Physics Laboratory. The system will be used for detritiating TFTR's plasma chamber exhaust gases during experimental operation, scheduled to begin in the Fall.

The Tokamak de Varennes (TdeV) returned to service in early February after a four-month refit and maintenance shutdown. During the shutdown, cryogenic divertor pumps and a compact toriod fueller were installed. The tokamak has been successfully operated, providing the first known demonstration of cryopumping of helium through a plasma divertor.

Experimental data on the behavior of deuterium in beryllium at high concentrations (up to 20%) and high temperatures has been obtained at the Université du Québec. Indications are that deuterium migration is significantly more rapid than inferred from published data. Beryllium is a possible coating material for plasma facing components. Contact Danielle Kéroack, Fax (514)449-8702.

MEETINGS

12-16 JUL - Cryogenic Engineering Conference. Albuquerque, NM. Contact Jan Hall (505)667-6574; Fax - 7558

19-21 JUL - Second Wisconsin Symposium on Helium-3 and Fusion Power. Madison, WI. Contact John Santarius (608)263-1694; Fax -4499; e-mail jfs@he3.neep.wisc.edu

16-20 AUG - Plasma Fluctuations and Transport Summer School. Madison, WI. Contact Barbara Griffith (608)263-8142; Fax 262-6707

22-24 SEP - Fifth European Fusion Theory Conference. Madrid, Spain. Contact Carlos Alejaldre 34-1-346-6419; fax - 6124

27 SEP - 1 OCT - Sixth International Conference on Fusion Reactor Materials. Lake Maggiore, Italy. Contact Mrs. A.B. Meazza (Ispra) 39-332-789988; Fax -785730

5-7 OCT - Fusion Power Associates Annual Meeting and Symposium, "Near-Term Applications of Fusion and Plasma Technologies." Oak Ridge, TN. Contact Ruth Watkins (301)258-0545; Fax 975-9869; e-mail 72570.707@compuserve

11-15 OCT - IEEE Fifteenth Symposium on Fusion Engineering. Hyannis, MA. Contact Ned Sauthoff (609)243-3207

25-29 OCT - Eleventh International Workshop on Laser Interaction and Related Phenomena. Monterey, CA. Contact Ms. Chris Stalker (217)333-3772; Fax -2906; e-mail miley@uiucvmd.bitnet

PEOPLE

Donald M. Kerr has joined Science Applications International Corporation as executive vice president and member of the Board of Directors. He was formerly president of EG&G, Inc., and also a former director of Los Alamos National Laboratory.

QUOTABLES

"If you are looking for perfect safety you will do well to sit on a fence and watch the birds; but if you really wish to learn, you must mount a machine and become acquainted with its tricks by actual trial."

Wilbur Wright, 1899

"What has happened in the past half-century is the bureaucratization of aviation. Knighthood is replaced by the bourgeoisie; glory by profit; victory by safety. The prose of Saint-Exupery is replaced by that of the National Transportation Safety Board."

Flying Magazine, March 1993, p.93



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LASER FUSION BREAKTHROUGHS GERMINATE AT LLNL MAGNETIC FUSION INNOVATIONS FUNDED BY DOE

LIVERMORE SEEKS BREAKTHROUGHS

Responding in part to a call for fusion concept breakthroughs from Lawrence Livermore National Laboratory director John Nuckolls (See our October 1992 newsletter) and funded in part using a Director's Initiative from the Laboratory Directed Research and Development Program, managed by John Holzrichter, a team of laser fusion scientists under the direction of John Woodworth have developed a high-risk concept called the "Fast Ignitor," which could reduce the size of laser required for inertial confinement fusion by a large factor. Physicist Max Tabak is responsible for the overall design of the fast ignitor system. Bill Krueer and Jim Hammer have made important contributions to the concept. Other LLNL scientists on the project team include Chris Darrow, Jim Dunn, Mike Glinesky, Dan Klem, Steve Lane, Mike Perry, Rick Stewart, Scott Wilks, and Bruce Young.

The concept utilizes the new technology of ultra-high intensity (up to 10^{21} Watts/cm²), short-pulse (less than 10 picosecond) lasers to symmetrically heat a small portion of the fuel to ignition conditions before it can disassemble. The concept separates the usual target implosion into two stages: the familiar compression stage to assemble the fuel to high density, followed by the very rapid ignition stage using the new laser technology. Lasers up to 10^{19} W/cm² are available now and recent developments in "chirped" pulse amplification support the possibility of kilojoule-class lasers with irradiances up to 10^{23} W/cm². (See our July 1987 newsletter for a report on the demonstration of achieving 10^{18} W/cm² in an amplified and focussed chirped laser pulse at the University of Rochester.) While several

drivers (e.g., lasers, heavy ions or light ions) are candidates for the compression stage, only the chargeless bosons from a laser permit the enormous power fluxes that are required for the success of the fast ignitor concept.

The fast ignitor, if and when fully demonstrated, would permit fusion ignition and high gain with a large reduction in driver energy, compared with the energy currently thought to be necessary. Success of the fast ignitor concept could thus have a significant impact on the size, cost, and development schedule of future inertial fusion power plants and other facilities. For example, adding the fast ignitor to the DOE's mission-approved National Ignition Facility (NIF) could convert it directly to the high-yield Laboratory Microfusion Facility, which is the end-goal of the DOE's Defense Inertial Confinement Fusion program.

Major issues involve the coupling of the high intensity laser's energy through the coronal plasma surrounding the imploded pellet and into the high-density fuel. The laser intensities which the scheme requires produce relativistic plasmas which to date have not been extensively studied. Research on the scientific basis of the fast ignitor has been going on at LLNL for about two years and is expected to continue during the construction of the NIF. Development over the next three years will concentrate on "chirping" a beamline on the Nova laser and propagating the shortened, intensified pulse into the ten-beam target chamber. This program should provide a sufficient scientific basis and proof-of-principle demonstration of the fast ignitor concept.

DIODE-PUMPED LASER PROGRESS

In two papers about to be published, Lawrence Livermore National Laboratory scientists will report major advances in diode-pumped laser development and the implications for inertial fusion energy power plants. The progress complements nicely the fast ignitor concept and gives a major boost to the credibility of fusion power plants based on diode-pumped lasers.

One paper (Stephen A. Payne, Charles D. Orth and William F. Krupke, "Diode-Pumped YB-FAP Solid-State Laser Driver for Inertial Fusion Energy Power Plant") notes "5 major advances that have occurred: (1) the demonstrated efficiency (0.6) and extrapolated costs (less than ten cents per watt) of laser diode pump sources . . . (2) continuously-annealed, heated fused silica . . . as a conceptual solution for the final optic (which encounters the neutron yield), (3) acceptably low thermally-induced optical aberrations . . . from the gas-cooled slab geometry, (4) a novel laser gain medium . . . has been identified, and (5) large aperture regenerative amplifier architecture is now being realized for the Beamlet laser at LLNL."

The second landmark paper (L.D. DeLoach, et al., J. Opt. Soc. Am. B, to be published) describes the new laser gain medium having favorable extraction and pumping parameters (Yb:Sr₅(PO₄)₃F or Yb:S-FAP) mentioned in (4) above. For further information, contact Steve Payne at LLNL (510)423-0570; fax -6212.

LOGAN SUGGESTS INNOVATIVE LASER FUSION REACTOR DESIGN

Livermore scientist B. Grant Logan has developed an innovative inertial confinement fusion reactor design using an advanced Rankine cycle and magnetohydrodynamic (MHD) energy conversion of lithium-bearing working fluid mixtures. His designs include plants optimized for electricity production and others optimized for producing synthetic fuels. Plasma is exhausted from the fusion chamber in the form of a jet and passed through the MHD generator. According to Logan, "by coupling nuclear energy directly into a working plasma, the MHD conversion can potentially exceed 10 MWe/ton total balance of plant mass power density, 30 times that of a steam balance of plant and 100 times higher than previous, lower temperature MHD systems." The concept requires development of low cost target blanket shells for plasma production, and advanced

target gains, such as the Fast Ignitor. For further information contact Grant at (510)422-9816; fax 423-6212.

INNOVATIONS AWARDS ANNOUNCED

The DOE Office of Fusion Energy has announced that they will fund three proposals from fifteen that were reviewed in response to DOE's request for proposals for "Innovations in Tokamak Improvements and New Confinement Systems." (See our February newsletter.) According to the DOE announcement, "These programs contribute to the technical breadth of the fusion energy program and could lead to reactor concepts offering advantages in size and simplicity over tokamak reactors." A total of \$1.2 million in each of fiscal years 1993, 1994, and 1995 will be made available to these three programs. According to DOE, "This initiative was taken in part as a result of recommendations made to the Department of Energy by the Fusion Energy Advisory Committee which recommended that a non-tokamak fusion concept program, at some level, should be supported as a matter of policy." (See our June 1992 newsletter.)

The winning proposals are (1) "Thermonuclear Fusion in a Staged Z-Pinch," Dr. Frank Wessel, University of California at Irvine; (2) "Ion Rings for Magnetic Fusion," Prof. Ravi Sudan, Cornell University; and (3) Penning Trap Systems for Producing Fusion Plasma," Dr. Dan Barnes, Los Alamos National Laboratory.

The staged Z-Pinch experiments, to be conducted at the University of California at Irvine, build on prior successes of multi-shell implosions demonstrated at UCI, the Ecole Polytechnique, and the Kurchatov Institute, showing that implosions onto a gas target or small fiber retain their axially-uniform character until peak current transfer, thereby avoiding the most dangerous instabilities characteristic of earlier Z-pinches and demonstrating enhanced energy transfer. By driving large (megampere) currents through the fiber on fast (100 ns) time scales, high density and temperature plasmas result. The Irvine work seeks to study such methods to heat, compress and sustain the process by storing and delivering additional energy to the fiber from a surrounding gas or plasma.

The ion ring experiments, to be conducted at Cornell University, are aimed at demonstrating the production of a fully field-reversed large orbit ion ring, the magnetic compression of the ring, and studies of the lifetime of the ring. Such rings could provide a closed magnetic field plasma

confinement configuration in a linear containing vessel. In earlier work at Cornell, ion rings with self fields up to 5-10% of the applied field were generated. Fully-reversed field configurations were produced by electron rings. The planned work will focus on the design and construction of a new experiment having a 1 MeV, 700 kA, 160 ns proton beam.

The Penning Trap experiments, to be conducted at the Los Alamos National Laboratory, build on previous demonstrations of excellent confinement of single particles in non-neutral plasmas in Penning-type "traps." In the planned work, low energy, low canonical momentum particles will be injected into a spherical Penning trap. These particles are accelerated inward to the order of 100 keV by the effective spherical parabolic vacuum potential well produced by an applied electromagnetic field, without using grids internal to the system. The approach is related to other self-collider concepts using non-Maxwellian plasmas and high energy beams. (See our June 1992 and February 1993 newsletters.) The Los Alamos experiment will have a spherical radius of a few millimeters. The goal of the program is to demonstrate the expected degree of spherical convergence, combined with theoretical analysis to determine the efficacy of this approach for fusion plasma production and confinement.

HARKNESS, POST NAMED ANS FELLOWS

The American Nuclear Society has named Samuel D. Harkness (Westinghouse) and Douglass E. Post, Jr. (PPPL) as Fellows of the Society. Harkness was cited "for important contributions to the improvement of fission and fusion nuclear systems through advances in materials performance and understanding. Post was cited "for individual and leadership contributions to the modeling of tokamak transport and effect of impurities; for leadership in the physics design work for the International Tokamak Reactor (INTOR) and International Thermonuclear Experimental Reactor (ITER) projects; and for substantial contributions to fusion activities in the Society."

ANDERSON NAMED LANL FELLOW

Jim Anderson has been named Laboratory Fellow at the Los Alamos National Laboratory (LANL). Fellowship appointment is made by the Laboratory Directory and is considered a "top honor" at Los Alamos. Jim was group leader of the Tritium Science and Technology Group at

LANL and is currently on assignment at the Tokamak Fusion Test Reactor at Princeton Plasma Physics Laboratory. He had previously received a Distinguished Performance Award from the laboratory for outstanding leadership of the multiorganizational team that designed and constructed the Tritium Systems Test Assembly (TSTA) at Los Alamos.

FEAC REPORTS PUBLISHED

The December 1992 issue of the Journal of Fusion Energy contains all the reports of the DOE Fusion Energy Advisory Committee (FEAC) as sent to DOE through the end of 1992, including the reports of FEAC panels 1 through 5, the FEAC letter reports to DOE and the DOE responses to those reports. The issue also contains the report of the 1992 EPRI Fusion Panel and the report commissioned by DOE on fusion industrial policy, prepared by Bennett Miller (See our April 1992 newsletter). It also contains the paper by Dick Hora and Locke Bogart of General Dynamics on an amortizing fund approach to funding energy technologies (See last month's newsletter).

COLD FUSION: DOWN BUT NOT OUT

A 700-page book containing the proceedings of the 1992 Third International Conference on Cold Fusion has been published by Universal Academy Press (Tokyo); fax 81-3-3813-5932. The book, edited by former Oak Ridge scientist Hideo Ikegami of the National Institute for Fusion Science, Nagoya, is titled "Frontiers of Cold Fusion." There were 386 registered participants from 18 countries, 229 of whom were residents of Japan. In the Preface, Ikegami states, "At the Conference, the video produced by Drs. Fleishmann and Pons allowed us to see that a controllable excess heat generator was already in hand." He also states, "Positive heat results were also presented on several light water experiments, which may be closely related to the mechanisms of excess heat generation that we see in heavy water experiments." But, according to Ikegami, "There is still no evidence to prove that the heat produced is nuclear in origin."

Fleishman and Pons have recently published a new paper in the May 3 issue of Physics Letters A (Vol. 176, p. 1). According to the June 14 issue of Chemical and Engineering News, Michael McKubre of Stanford Research Institute (whose cold fusion work is supported by the Electric Power Research Institute) stated that the recent paper increased

his own "confidence and belief" that the Fleismann-Pons data "can be trusted quantitatively. C&E News also quotes Prof. John Huizenga of the University of Rochester as saying there is "nothing really new" in the paper and quotes Dr. Allen Bard of the University of Texas at Austin as saying, "I think it is going to take more than a paper like this to convince the scientific community that there's reality in this effect."

The Fourth International Conference on Cold Fusion will take place December 6-9 at the Hyatt Regency in Maui, Hawaii, sponsored by EPRI. Contact S. Crouch-Baker, SRI International, 333 Ravenswood AV., Menlo Park, CA 94025.

WHITE HOUSE FACTOIDS

According to William White, recently confirmed as Deputy Secretary at the Department of Energy, the DOE is "exploring opportunities to reintroduce solar energy systems" at the White House. President Carter had solar panels installed at the White House after he took office in 1977, but they were removed by President Reagan. Also, according to the July issue of MIT Technology Review, you can send an e-mail message to President Clinton via internet. His e-mail address is 75300.3115@compuserve.com

QUOTABLES

"My view is (the Superconducting Supercollider, SSC) has been managed very gently, and that means inappropriately."

- Hazel O'Leary, Secretary of Energy

"(SSC) ranks among the worst projects we have seen in terms of contract mismanagement and failed government oversight."

- Rep. John Dingell

"The SSC is not the cause of the federal deficit."

- Sen. J. Bennett Johnston

MEETINGS

SEP 13-17 - Fifth IAEA Technical Committee Meeting and Workshop on Fusion Reactor Design and Technology. UCLA. Contact Terry Davies (UCLA), fax (310)206-4832.

SEP 20-24 - Seventh International Conference on Emerging Nuclear Energy Systems. Makuhari, Chiba, Japan. Contact T. Hiroaka (JAERI), fax 81-292-82-6122.

SEP 22-24 -Fifth European Fusion Theory Conference. Madrid, Spain. Contact Carlos Alejaldre, fax 34-1-346-6124.

SEP 27 - OCT 1 - Sixth International Conference on Fusion Reactor Materials. Lake Maggiore, Italy. Contact Mrs. A.B. Meazza (ISPRA), fax 39-332-785730.

OCT 3-6 - International Nuclear Congress and Exhibition. Toronto. Contact Sylvie Caron, fax (416)979-8356.

OCT 3-8 - Ninth Interdisciplinary Laser Science Conference. Toronto. Contact Optical Soc. of America, fax (202)416-6100.

OCT 4-8 - European Conference on Applied Superconductivity. Gottingen, Germany. Contact Mrs. Ulrike Weber. fax 49-6171-52554.

OCT 5-7 - Fusion Power Associates Annual Meeting and Symposium, "Near-Term Applications of Fusion and Plasma Technologies." Oak Ridge, TN. Contact Ruth Watkins, fax (301)975-9869.

OCT 11-15 - IEEE Fifteenth Symposium on Fusion Engineering. Hyannis, MA. Contact Albe Dawson (MIT), fax (617)253-0807.

OCT 18-22 - Basic Tritium Safe Handling Course. Chalk River, Ontario. Contact Maryann Zito, fax (416)823-8020.

OCT 19-22 - Annual Gaseous Electronics Conference. Montreal. Contact Michel Moison, e-mail: moison@ere.umontreal.ca

OCT 25-29 - Eleventh International Workshop on Laser Interaction and Related Phenomena. Monterey, CA. Contact Mrs. Chris Stalker, fax (217)233-3772.

NOV 1-5 - Annual Meeting of APS Division of Plasma Physics. St. Louis. Contact Saralyn Stewart (U. Texas), fax (512)471-6715.

NOV 14-19 - Winter Meeting of American Nuclear Society. San Francisco. Contact Patricia Pollack (ANS), tel (708)579-8252.



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JT-60 EXTENDS CURRENT DRIVE RECORD ROBERTS, ADLER RECEIVE PRESIDENTIAL CITATIONS

NEW AFFILIATE

Pitt-Des Moines, Inc. has become an institutional affiliate of Fusion Power Associates. Robert H. Swinderman will represent the company. He can be reached at 3400 Grand AV, Pittsburgh, PA, 15225; tel. (412) 331-3000; fax -7751. We welcome the participation of Pitt-Des Moines in Fusion Power Associates.

Fusion Power Associates currently has 14 full voting members, 18 non-voting institutional affiliates, and 13 non-voting small business affiliates, for a total of 45 institutional participants. We thank all of them for their continued support.

JAPAN SETS NEW RECORD

The JT-60, one of the world's largest tokamaks, has set a new world record for driving plasma current by radiofrequency waves: 3.6 million amperes. That is nearly twice the old record, set by JT-60 and JET in 1992. It is also approximately equal to the plasma current specified for ITER (the International Thermonuclear Experimental Reactor) in its Conceptual Design Report. The result, sustained for about a second, helps to establish the physics basis for designing a steady-state fusion reactor. Without such a technology, the tokamak would be limited to long-pulse operation.

The JT-60 result was obtained using a newly developed antenna to launch "lower hybrid" waves at powers up to 8.3 million watts, which is the highest power ever used in a current drive experiment. No deleterious effects were observed on the divertor plates or vacuum vessel wall from the high energy electrons produced.

The results were obtained for plasma densities of about 10^{13} cm^{-3} . Reactors will operate at about 10 times higher densities. The JT-60 group is also investigating current drive techniques using negative ion neutral beams and "bootstrap" current.

JT-60 is located at the Japan Atomic Energy Research Institute (JAERI), Naka Research Center. For further information, contact Dr. H. Ninomiya; fax 81-292-70-7419. Our thanks to Dr. H. Kishimoto, Director, Department of Fusion Plasma Research at JAERI for advising us of this important result.

U. S. FUSION BUDGETS

The U. S. House of Representatives has passed the DOE FY 1994 appropriations bill; the Senate is expected to pass its version in late September. (The government fiscal year begins October 1). The House bill provides the amounts requested by President Clinton for both magnetic and inertial fusion: \$347.6 million for magnetic and \$188.4 million for inertial.

The magnetic fusion amount, which is \$7.9M more than FY 1993, includes \$20 million to begin detailed design of a new tokamak (TPX) at the Princeton Plasma Physics Laboratory. Full construction authorization for the \$500 million facility is expected to be requested in the FY 1995 budget, due next January.

In its report on the bill, the House Appropriations Committee expressed strong support for the ITER project, calling it "a model of successful partnerships of large scientific projects."

for design and fabrication of the plasma facing components and vacuum vessel. A solicitation is also expected soon from the Lawrence Livermore National Laboratory, which has been assigned responsibility by PPPL for the design and fabrication of the superconducting magnets. In addition, contractors will be sought later this year for construction management and systems integration support.

HYDRO-QUEBEC FUSION ANNUAL REPORT AVAILABLE

The 1992 annual report from the Centre Canadien de Fusion Magnétique is available from Richard Bolton, director general, CCFM (fax 514-652-8625). CCFM is a joint enterprise of Hydro-Québec, Atomic Energy of Canada Limited, and Institut National de la Recherche Scientifique. The report describes work on divertor, edge plasma and plasma biasing studies; impurity transport, sources and control; plasma-wall interaction and materials studies; transport and equilibrium of the main plasma; and radiofrequency plasma current drive and heating. The report features the operation of the tokamak, "TdeV." The annual budget of CCFM is approximately \$14 million.

QUOTABLES

"The problem was that, by and large, the advice dispensed by professionals was based not on lives they had led, but rather on books they had read. This advice, therefore, while intellectually appealing, was all but devoid of common sense."

John K. Rosemond
Hemispheres Magazine
January 1993, p. 75

"The physicists - or the technicians and engineers of their various institutions - then designed every piece of equipment, every software program, every electronic device for the detector. Unlike the space program and the military, which ask industry to provide the product, the physicists, even with \$20 million to play with, could not afford to leave the planning to anyone but themselves."

Gary Taubes
Nobel Dreams
(Random House, 1986, p. 47)

ITER NEWS

The ITER Council has asked ITER director Paul-Henri Rebut to "streamline the design so as to confirm for the next Council meeting (scheduled for late September in San Diego) its ability to satisfy simultaneously the three conditions on cost, technical objectives and safety margins defined by the Council." The Council asked that the "outline design" be assessed by the Technical Advisory Committee at its meeting September 9-11 in Japan. The Council agreed to the participation of Canada in the ITER project through the European Community and established guidelines for other countries which may wish to participate. It is expected that Canada will second about 5 professionals to the ITER Joint Central Team (JCT). The total number of professionals to be seconded to the JCT by all the parties is 150.

Each of the four parties (European Community, Japan, Russia, and the United States) have arranged for industry participation in manufacturing feasibility studies of the superconducting magnets. Eight industries are currently involved. The Council approved the procurement of about 26 tons of superconducting strand as part of the R&D program, to be used in the production of model coils and for the purpose of establishing reliable and proven industrial sources for superconducting strand for the full scale magnets. The full scale coils are expected to require approximately 1300 tons of strand. All four parties are producing test strand. The Council also approved the establishment of Model Coil Test Facilities to be located at KfK in Karlsruhe, Germany and at the Japan Atomic Energy Research Institute in Naka, Japan. The KfK site uses the existing TOSKA facility and is essentially complete; the JAERI facility is in the final stages of construction.

The ITER Garching Co-Center, headed by Ron Parker, has prepared draft statements of work for forty different "tasks" which will eventually be given to one or more of the four parties for R&D credits. The tasks cover R&D and design work, primarily in the areas of divertor and associated materials (eight tasks), and the first-wall/blanket/shield and associated structural materials (29 tasks). In addition, there are tasks in the radiofrequency heating and current drive area, and one task in diagnostics. The proposed tasks vary from short-term assessments, taking a few months, to multi-year development programs.



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FPA 1993 AWARDS ANNOUNCED

LEADERSHIP

DONALD L. COOK
JOHN SHEFFIELD

DISTINGUISHED CAREER

ROBERT A. GROSS
MURRAY W. ROSENTHAL

EXCELLENCE IN ENGINEERING

JOHN D. GALAMBOS
SCOTT W. HANEY

NEW AFFILIATE

The University of Texas Fusion Research Center has become an institutional affiliate of Fusion Power Associates. Alan J. Wootton, director, will represent the Center. He can be reached at (512)471-5780; fax - 8865. We welcome their participation in Fusion Power Associates.

PRINCETON READIES TRITIUM TESTS

Experiments using tritium to produce fusion reactions are scheduled to begin this month in the Tokamak Fusion Test Reactor at the Princeton Plasma Physics Laboratory. These experiments will mark the first use of tritium as a fuel to produce significant amounts of fusion energy in a U.S. tokamak confinement experiment. Princeton scientists expect to produce 5-10 Megawatts of fusion power during some of the experiments, which will continue for approximately a year.

The primary physics issue to be investigated is whether the

confinement of a deuterium-tritium plasma differs from that of the pure deuterium plasmas that have been used in experiments to date. The planned experiments will be about five times the power density and three times the power of the deuterium-tritium experiments performed in the European JET experiments in late 1991 (See our December 1991 newsletter). In those experiments a peak fusion power of almost 2 Megawatts was produced.

ICF DECLASSIFICATION IMMINENT

The National Security Council has withdrawn its objections to the declassification of major portions of the DOE's inertial confinement fusion (ICF) program (see our February 1993 newsletter). Sources indicate that DOE will soon issue new classification guidelines permitting U.S. scientists to describe their experiments in more detail.

ICF STUDIES AVAILABLE

DOE has approved the publication of two industry-led

studies of inertial confinement fusion reactors completed last year (see our July 1992 newsletter). The two studies (both dated March 1992) were led by McDonnell Douglas Missile Systems Company and W. J. Schafer Associates respectively. Copies of the McDonnell Douglas Study (MDC 92E0008) may be requested from John Davis (FAX 314-234-4506). Copies of the Schafer Associates study (WJSA-92-01) may be requested from Mike Monsler (FAX 510-447-0544). Both studies treat the design of two conceptual ICF reactors; one driven by a heavy ion beam and one driven by a krypton fluoride laser. Critical development issues are identified. Ebasco Services, KMS Fusion, Ontario Hydro Canadian Fusion Fuels Technology Project, Spar Aerospace, TRW and UCLA were members of the McDonnell Douglas team. Bechtel, General Atomics, Textron and the University of Wisconsin were part of the Schafer Associates team.

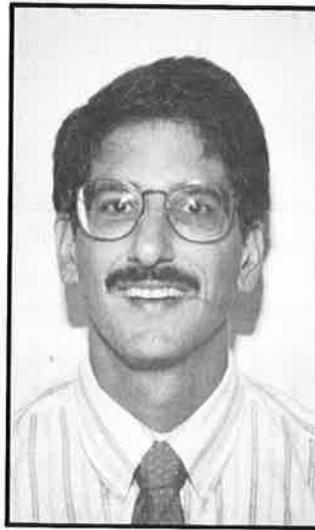
CFFTP ANNUAL REPORT AVAILABLE

The 1992/93 annual report (Fiscal Year ending March 31, 1993) of the Canadian Fusion Fuels Technology Project (CFFTP) is available from Don Dautovich, Program Manager of CFFTP (fax 416-823-8020). CFFTP's funding partners are the Canadian Federal Government, the Ontario Provincial Government and Ontario Hydro. CFFTP also sells goods and services to clients around the world. Its annual budget is approximately \$14 million.

The report describes CFFTP's many activities, including support for ITER, programs to involve Canadian industries and universities, support for U.S. and European laboratories, and tritium handling training courses.

IN MEMORIAM: DONALD W. KERST

Fusion pioneer and accelerator expert Don Kerst died of cancer August 19 in Madison, Wisconsin, at the age of 81. He is best known in fusion circles for his work with magnetic octopole systems at General Atomics and later as a professor of physics at the University of Wisconsin. He also invented, in 1940, the Betatron, which has been used in cancer therapy and as a fundamental nuclear research tool throughout the world. He was a member of the U.S. National Academy of Sciences and a recipient of Fusion Power Associates first Distinguished Career Awards in 1987. He is survived by his wife, two children and several grandchildren. Regrets can be sent to Mrs. Kerst at 425 Date Palm Road, Vero Beach, FL 32963.



John D. Galambos



Scott W. Haney

EXCELLENCE IN FUSION ENGINEERING

Fusion Power Associates Excellence in Fusion Engineering Awards for 1993 are being presented to John D. Galambos of Oak Ridge National Laboratory and to Scott W. Haney of the Lawrence Livermore National Laboratory.

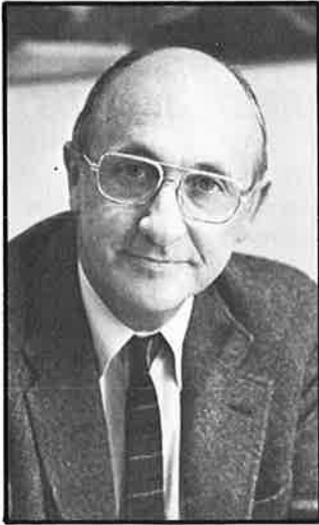
Galambos is recognized for his "contributions to the development and applications of the TETRA systems code, which has played a major role in the conceptual design of ITER and other possible fusion devices such as CIT, TPX and PILOT."

Haney is recognized for his "educational record, outstanding thesis, and contributions to computational physics," including his "contributions and leadership to the development of the SuperCode, which is now in wide use for fusion tokamak device design."

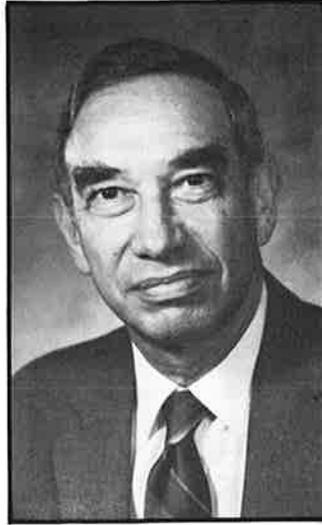
Fusion Power Associates Excellence in Fusion Engineering Awards were established in 1987 in memory of MIT Professor David J. Rose to recognize individuals in the early part of their careers who have shown outstanding technical accomplishment and leadership potential in the field of fusion engineering.

PEOPLE

Neville Luhmann has been named chairman of the University of California's Department of Applied Science, Davis/Livermore Campus. He was formerly a professor at UCLA.



Robert A. Gross



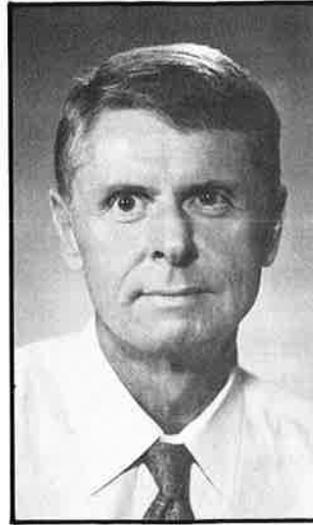
Murray W. Rosenthal

DISTINGUISHED CAREER AWARDS

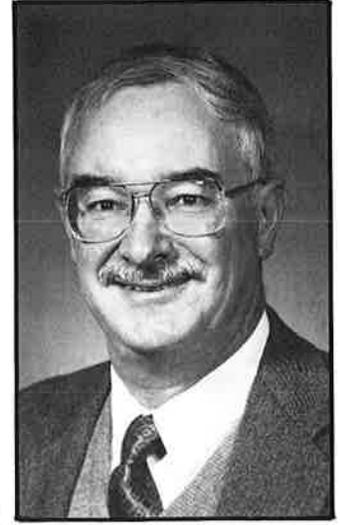
The Fusion Power Associates Board of Directors has announced the selection of Robert A. Gross and Murray W. Rosenthal to receive its 1993 Distinguished Career Awards. These awards were established in 1987 to recognize individuals who have made distinguished, lifelong career contributions that directly or indirectly have benefitted fusion.

Bob Gross founded the Columbia University Plasma Physics Laboratory thirty years ago and over the years supervised 25 doctoral theses. In 1981 he was appointed Dean of Engineering. He has made many original contributions to fusion science, authored a textbook on fusion, and served on numerous advisory committees. In presenting this award, the FPA Board recognizes his "distinguished career as a researcher, educator, author, administrator, and valued advisor to students, government and industry."

Murray Rosenthal is deputy director of Oak Ridge National Laboratory and is a member of the U.S. National Academy of Engineering. He has made many important technical contributions to the development of nuclear technologies. During the late 1970's and early 1980's, he provided critical leadership to the fusion programs at Oak Ridge as Associate Director for Advanced Energy Systems. The FPA Board recognizes his "distinguished career as a researcher, manager, administrator, and valued advisor to the nuclear community in general and to the fusion community in particular."



Donald L. Cook



John Sheffield

LEADERSHIP AWARDS

Fusion Power Associates Leadership Awards for 1993 are presented to Donald L. Cook of Sandia National Laboratories and to John Sheffield of Oak Ridge National Laboratory. These awards were established in 1980 to recognize individuals who have shown outstanding leadership qualities in accelerating the development of fusion.

Don Cook is director of pulsed power programs, including the light ion inertial confinement fusion program at Sandia. The FPA Board presents its Leadership Award to Don in recognition of his "successful, dedicated effort to demonstrate the potential of light ion fusion for both military and civilian applications," and for his "tireless technical and management efforts to provide credibility to this line of development under extreme pressure and in the face of widespread skepticism."

John Sheffield is director of the Fusion Energy Division at the Oak Ridge National Laboratory. The FPA Board presents its Leadership Award to John "to recognize your many and continuing efforts to focus the fusion program towards its ultimate goal of fusion power." and cites his "important physics contributions, systems analysis of fusion reactors, and leadership of community assessments." The Board notes that John has "consistently provided technically-based challenges to ongoing fusion activities over the years."

FUSION POWER ASSOCIATES AWARD PROGRAMS

LEADERSHIP AWARDS

Leadership Awards are presented by the Fusion Power Associates Board of Directors to those individuals who have shown outstanding leadership qualities in accelerating the development of fusion. Recipients are:

1980	S. J. Buchsbaum R. L. Hirsch M. McCormack P. Tsongas
1981	E. E. Kintner
1982	H. P. Furth J. H. Nuckolls
1983	J. L. Emmett T. K. Fowler
1984	T. Ohkawa G. Yonas
1985	E. P. Velikhov C. Yamanaka
1986	R. C. Davidson
1987	M. N. Rosenbluth
1988	J. F. Clarke
1989	P-H. Rebut
1990	B. B. Kadomtsev
1991	B. Coppi E. Storm
1992	R. W. Conn G. L. Kulcinski
1993	D. L. Cook J. Sheffield

DISTINGUISHED CAREER AWARDS

Distinguished Career Awards are presented to those individuals who have made distinguished lifelong career contributions that directly or indirectly have benefitted fusion. Recipients are:

1987	M. B. Gottlieb D. Kerst R. F. Post L. Spitzer, Jr.	1991	H. K. Forsen J. W. Landis R. L. Sproull H. G. Stever
1988	K. Husimi D. Palumbo R. S. Pease	1992	R. Bickerton A. Bishop V. Glukhikh S. Mori
1989	F. H. Coensgen D. J. Grove F. L. Ribe	1993	R. A. Gross M. W. Rosenthal
1990	N. G. Basov T. Sekiguchi		

EXCELLENCE IN ENGINEERING AWARDS

1987	Steven J. Piet
1988	Michael A. Ulrichson
1989	David Ehst Y-K. Martin Peng
1990	Wayne Reiersen
1991	John Santarius
1992	Oleg Filatov Steven Zinkle
1993	John D. Galambos Scott W. Haney

SPECIAL AWARDS

1980	J. R. Beyster, Jr.
1981	E. A. Frieman
1987	A. W. Trivelpiece
1990	G. S. Clemens
1990	J. Killeen



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FUSION SCIENTIST WINS NOBEL PRIZE RUSSELL HULSE CITED FOR ASTROPHYSICS DISCOVERY

PRINCETON SCIENTISTS WIN NOBEL

Princeton University scientists Joseph Taylor and Russell Hulse have been awarded the 1993 Nobel Prize in Physics for their 1974 discovery of a binary pulsar, and their subsequent measurements on it to verify predictions of Einstein's general theory of relativity. Taylor is a Professor of Physics at Princeton and Hulse is a fusion scientist at the Princeton Plasma Physics Laboratory.

Hulse discovered the binary pulsar while he was a graduate student at the University of Massachusetts, using the 300-meter radiotelescope at Arecibo, Puerto Rico. Taylor was Hulse's thesis advisor at the time. Measurements made since the discovery have shown that the orbit of the pulsars around each other is decaying slightly and that the two dying stars are rotating faster and faster around each other into an increasingly tight orbit. These measurements enabled a verification of a prediction of Einstein's 1916 general theory of relativity to an accuracy of better than 0.5 percent. Pulsar timing afforded the first, and thus far only, experimental evidence for the existence of gravitational waves predicted by Einstein.

Hulse received his Ph.D. in 1975 and then worked as a postdoctoral fellow at the National Radio Astronomy Observatory in Charlottesville, VA until 1977 when he joined the U.S. fusion energy program as a scientist at the Princeton Plasma Physics Laboratory. His work in magnetic fusion research includes the development of computer codes modeling atomic processes and the transport of impurity ions in fusion plasmas. In connection with this impurity transport modeling work, he developed the format for an atomic physics database for fusion applications for the



Nobel Laureate Russell Hulse

International Atomic Energy Agency (IAEA). His tokamak modeling work has most recently focused on investigations of electron particle transport in gas-puff and pellet-fueled plasmas.

Dr. Hulse is also currently involved in a Cooperative Research and Development Agreement (CRADA) with industry on advanced computer modeling environments. This work is based on his experience with tokamak transport modeling and has the objective of developing new approaches to computer modeling in order to make computer models more flexible and easier to use for diverse applications in research, industry, and education.

His fusion colleagues around the world congratulate Dr. Hulse on his Nobel Prize and thank him for choosing to make his career in fusion.

BUDGET UPDATE

The Congress has passed the FY 1994 DOE appropriations bill, which provides the full fusion funding requested by the President: \$347.6 million for the Office of Fusion Energy and \$188.4 million for the Office of Inertial Confinement Fusion. In a non-binding conference report accompanying the bill, the House-Senate conferees "directed" the DOE to spend \$2 million "to begin the evaluation and selection of a U.S. host site for ITER," and to increase by \$500,000 the \$4 million DOE had proposed to spend within the Office of Fusion Energy for energy applications of inertial confinement fusion. These funds were to be obtained by an unspecified redistribution of the total effort. The bill does not provide formal approval of the proposed new Tokamak Physics Experiment (TPX) at Princeton Plasma Physics Laboratory, although it does provide the full \$20 million requested for engineering design. The conferees intend to address full authorization of TPX as part of the FY 1995 budget cycle. However, the report states "It is the intent of the conferees for the TPX project to proceed with design activity including industrial participation in the engineering design and R&D. The Department should utilize standard, phased, industrial contracts for these activities with options for construction that would permit continuity and would allow the project, if it should be approved in the future, to be completed in the most efficient and cost-effective manner."

The conferees also "strongly urge the Department to maintain a viable inertial fusion energy program and move forward with a timely decision on the Inertial Linac Systems Experiment that would allow, if a favorable decision is rendered, construction to begin in fiscal year 1995."

O'LEARY ENDORSES FUSION EFFORT

In a letter dated September 22 to Senator J. Bennett Johnston, Energy Secretary Hazel O'Leary urged the Senator to support both the International Thermonuclear Experimental Reactor (ITER) project and a strong national U.S. fusion program centered around the Tokamak Physics Experiment (TPX). The Senator had indicated previously (see our June 1993 newsletter) his belief that the U.S. fusion program should focus its efforts entirely on ITER and, in the budget process, he has sought to delay a commitment to construct the TPX until an international commitment has been obtained to construct ITER.

In her letter, O'Leary states that an "international agreement to begin construction (of ITER) will take considerable time even with the best intentions of all participants. The Tokamak Physics Experiment, on the other hand, is ready to move forward (now)." The Secretary states that "The Department of Energy regards the International Thermonuclear Experimental Reactor as setting a standard of excellence for carrying out a collaborative international scientific endeavor, and we appreciate your interest and support." However, the Secretary notes, "The Tokamak Physics Experiment constitutes a forward-looking step for the United States fusion program and addresses issues in improved tokamak design and pulse length that go beyond the International Thermonuclear Experimental Reactor mission. It represents an experimental focus for the United States fusion program at the beginning of the next century when existing experiments will have been fully exploited."

Copies of Secretary O'Leary's letter are available from Fusion Power Associates.

EBASCO-LED TEAM WINS ITER SUPPORT CONTRACT

The DOE has announced the selection of an industry team led by Ebasco Services, Inc. to provide support to the design of the International Thermonuclear Experimental Reactor (ITER) and also to support the U.S. national effort in the design of a fusion electric power demonstration plant. Members of the team include Chicago Bridge & Iron, General Atomics, General Dynamics, Grumman Aerospace, McDonnell Douglas Aerospace, Rockwell International Rocketdyne Division, SAIC, Stone & Webster Engineering Company, TRW, and Westinghouse Electric Corporation. All members of the team are participants in Fusion Power Associates.

The contract will be let and administered by the Lawrence Livermore National Laboratory. The work is designed to provide a fast response to needs of the ITER Joint Central Team for design support and to provide industry with experience and participation in the development of fusion energy systems. For further information, contact Dr. William R. Ellis, VP and Chief Scientist, Ebasco Services, Inc., FAX (212)839-3528.

FPA ELECTS OFFICERS

Fusion Power Associates members have elected Dr. William R. Ellis (Ebasco Services) as chairman of the FPA Board of Directors for a two year term commencing November 1; Dr. Don Dautovich, manager of the Ontario Hydro Canadian Fusion Fuels Technology Project was elected Vice Chairman. Also elected to two year terms as officers were Dr. Stephen O. Dean (president), Ms. Ruth Ann Watkins (VP, Administration and Finance and Secretary/Treasurer) and Prof. Gerald L. Kulcinski (VP, Research). Reelected to additional 3 year terms as members of the Board of Directors were William Grossmann (SAIC), John W. Landis (Stone & Webster), Richard P. Hora (General Dynamics), and David O. Overskei (General Atomics).

CONN DESIGNATED DEAN AT UCSD

Richard Atkinson, Chancellor of the University of California, has announced his intention to appoint Prof. Robert W. Conn to become dean of the School of Engineering at the University of California, San Diego (UCSD). Conn is currently director of the Institute of Plasma and Fusion Research at UCLA and has been chairman of DOE's Fusion Energy Advisory Committee (FEAC). He is also widely known for his leadership of a series of advanced fusion power plant designs called ARIES. In announcing the appointment, Atkinson said "The appointment of Dr. Robert Conn as dean of the School of Engineering marks the beginning of a new stage in the development of the School. Dr. Conn is an exceptionally distinguished engineer and institutional leader. I cannot think of a more qualified or more innovative person to lead the School of Engineering into the next century."

Conn first gained prominence in the fusion program as professor of nuclear engineering at the University of Wisconsin in the early 1970's. He served as the director of the Plasma-Fusion Technology Program there from 1974-1980, when he joined the UCLA faculty. He is a Fellow of the American Nuclear Society and the American Physical Society and was elected to the National Academy of Engineering in 1987. He received the DOE Ernest O. Lawrence Memorial Award in 1984 and Fusion Power Associates Leadership Award in 1992. Recently, he was also appointed as member of the ITER Technical Advisory Committee.



Robert W. Conn



Michael D. Williams

WILLIAMS RECEIVES IEEE AWARD

Michael D. Williams, Head of the Engineering Department at the Princeton University Plasma Physics Laboratory, was presented the Fusion Technology Award of the Institute for Electrical and Electronic Engineers (IEEE) at their recent Symposium on Fusion Engineering in Cape Cod, MA. Laboratory director Ron Davidson said, "The award aptly recognizes Mike's distinguished leadership in the design and successful operation of neutral beam heating systems on the Poloidal Divertor Experiment and the Tokamak Fusion Test Reactor at Princeton. The neutral beam systems have enabled us to attain world record plasma temperatures and are essential to the achievement of record fusion power levels from TFTR during the coming year. In addition, as Head of the PPPL Engineering Department, Mike has done an outstanding job managing the preparation of TFTR facilities for these historic experiments."

INERTIAL FUSION COMMITTEE REPORTS

The DOE's Inertial Confinement Fusion Advisory Committee (ICFAC) has issued a letter report dated September 27 stating that "The Committee strongly reaffirms its conviction of the importance of the Inertial Confinement Fusion program for defense purposes." They state "We believe there is no other part of the (DOE's) Weapons Research, Development and Testing (program) which shares all of the key attributes necessary for the future: i.e., exciting science, maintaining competent people, weapons physics and effects testing, and dual-use energy applications."

The Committee states that "The national interest requires that we proceed promptly but prudently toward the demonstration of ignition/burn via a National Ignition Facility." The Committee complimented the Naval Research Laboratory and Los Alamos National Laboratory krypton fluoride laser program, as being of "high quality of both the scientific effort and the technology development." They said "We expect excellent scientific work will be done when NIKE (the NRL krypton fluoride laser) becomes available for flat target physics in late FY 1994."

Copies of the 3-page letter report are available from Fusion Power Associates.

ICF DECLASSIFICATION SET

The Department of Energy has set November 9 as the date it will announce declassification of major aspects of the Inertial Confinement Fusion program (see our October 1993 newsletter). In a letter to FPA president Steve Dean dated September 22, DOE director of the Office of Intelligence and National Security John Keliher stated that he had "signed letters providing the declassification proposals to the current (Nonproliferation Interagency Working Group) members. We recently received their concurrence for the proposed declassifications." Keliher indicated in his letter that "As soon as the Secretary is briefed on the status of this issue and her approval obtained, we will proceed with the declassifications." Keliher's letter was in response to a letter FPA president Steve Dean sent to Secretary O'Leary dated September 2, in which he asked the Secretary to "advise those of us in the fusion community whether or not this (ICF declassification) issue is still pending in the Department and, if so, when can we expect a resolution?"

PEOPLE

Alex Glass (LLNL Associate Director for Programs), *Jim Davis* (LLNL Associate Director for Lasers), and *Phil Coyle* (Principal LLNL Associate Director) have taken advantage of LLNL's early retirement program.

Mike Campbell (LLNL Deputy Associate Director for Inertial Confinement Fusion) has been named acting LLNL Associate Director for Lasers.

Ralph Moir of LLNL has been elected chairman of the American Nuclear Society Fusion Energy Division. *Ron Miller* of LANL has been elected vice chair/chair-elect.

Robert Borchers of LLNL has accepted the post of director of the Division of Advanced Scientific Computing at the National Science Foundation in Washington, DC.

Victor Reis has been confirmed by the Senate as DOE Assistant Secretary for Defense Programs; he was previously director of defense research and engineering for DOD at the Pentagon.

Daniel Dreyfus has been confirmed by the Senate as DOE Director for the Office of Civilian Radioactive Waste Management; he was previously VP at the Gas Research Institute and was a member of the DOE Fusion Energy Advisory Committee.

Wil Gauster of Sandia National Laboratories has been awarded the DOE Distinguished Associate Award "in recognition of outstanding contributions to the nation's fusion energy program, particularly in the areas of fusion plasma materials interactions and high heat flux components, and continuing efforts to further international collaborations in fusion." He is currently on assignment in Garching, Germany, serving as deputy director of the ITER Co-Center there.

Mike Monsler has stepped down from his position as General Manager of the San Francisco Operation of W.J. Schafer Associates; he will continue to work half-time at Schafer on the technical aspects of inertial confinement fusion. *Dr. Keith Shillito* has been appointed Acting General Manager.

WIND ENERGY FACTOID

The Altamont Pass, near Livermore CA, is the site of 7300 wind turbines placed on over 80 acres of land. An estimated 500 birds of prey were killed by the turbines over a two year period, including 78 federally-protected golden eagles. There are only about 1000 golden eagles in the Western States. Source: The Independent (CA newspaper), September 15, 1993.

QUOTABLE

"To produce enough electricity to keep Yonkers going for a year, a light water nuclear reactor would make, as a by-product, just about enough plutonium to obliterate Yonkers."

John McPhee, in
The Curve of the Binding Energy
Noonday Press

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6 MILLION WATTS OF FUSION POWER PRINCETON TOKAMAK SETS NEW WORLD RECORD

On Thursday night, December 9, at 11:08 PM EST, scientists at the Princeton Plasma Physics Laboratory produced 3 million watts of fusion power in the first of several experiments. On Friday the power level was increased to over 6 million watts, exceeding the previous record of 1.7 million watts, produced in the Joint European Torus (see our December 1991 newsletter).

The experiment marked the first time that a 50-50 mixture of deuterium and tritium, the two heavy isotopes of hydrogen, had been raised to temperatures exceeding those on the Sun, releasing energy at a prodigious rate: millions of times more energy per pound than burning coal. This feat was accomplished in the Tokamak Fusion Test Reactor (TFTR), which is operated for the U.S. Department of Energy by Princeton University's Plasma Physics Laboratory. The accomplishment marked the achievement of the primary mission of TFTR, which was authorized by Congress in 1976 and began operation in 1982 (see back page for 1974 Atomic Energy Commission memo recording decision to build TFTR).

The fusion power in TFTR was generated during a pulse lasting about 1 second. This is about 3 times the fusion power generated in late 1991 in the Joint European Torus (JET), in which only 10% tritium was added to a deuterium plasma. The recent experiments reached peak temperatures of about 350 million degrees Celcius (30 keV) with peak densities of about $7.5 \times 10^{13} \text{ cm}^{-3}$. The energy confinement time was 180 ms. The input neutral beam power was about 29 MW.

TFTR had previously achieved record temperatures in deuterium plasmas of 400 million degrees Celcius, about 25 times hotter than the surface of the Sun. In those experiments, 65 thousand watts of fusion power had been produced. In these latest experiments, the fusion power level increased over a hundredfold as expected.

A series of experiments are planned during the next year on TFTR to study the properties of this unique plasma. Scientists predict that self-heating of the plasma, due to the slowing down of fast helium particles produced by the fusion reactions, is likely to be observed for the first time.

Dr. Stephen O. Dean, president of Fusion Power Associates, congratulated the scientists at Princeton on their accomplishment, saying that their tests "are an essential validation of physics necessary for the development of fusion power reactors of the future." Dr. Dean was responsible for preparing the "decision paper" that led to the approval of TFTR by the Atomic Energy Commission in 1974.



UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

JUL 15 1974

To Those Listed

PROGRAM DECISION PAPER ON TOKAMAK FUSION TEST REACTOR

The Fusion Power Coordinating Committee (FPCC) met at AEC Headquarters July 9-11, 1974 to consider proposals and related reports on a DT-burning tokamak Fusion Test Reactor (TFTR).

Reports were distributed in advance of the meeting from Princeton/Westinghouse, ORNL, General Atomic, the University of Wisconsin, Naval Research Laboratory, and Lawrence Livermore Laboratory. Summaries were presented and discussion ensued during July 9 and 10 among the over 80 attendees.

On July 11, the FPCC met in executive session to consider the following issue:

"Should the Division of Controlled Thermonuclear Research request authorization in the FY 1976 budget for the design, construction, and operation of a Tokamak Fusion Test Reactor?"

The FPCC members unanimously endorsed the attached Program Decision Paper for the Tokamak Fusion Test Reactor. Their recommendation is worded as follows:

"It is recommended that the Division of Controlled Thermonuclear Research request FY 1976 authorization for the design, construction, and operation of a Tokamak Fusion Test Reactor employing neutral beam injection, for deuterium-tritium fusion experiments at reactor level conditions. The TFTR, if successful, will be a major national achievement and will constitute a logical step toward a commercial fusion power capability."

The Director, Division of Controlled Thermonuclear Research, has accepted the FPCC recommendation without modification and expresses his appreciation to all those who worked so hard over the past many months to analyze all the issues involved.

Stephen O. Dean
Stephen O. Dean
Assistant Director for
Confinement Systems
Division of Controlled
Thermonuclear Research

CTR:ADCS
Enclosure: SODean:rw
Program Decision Paper

7/15/74



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DOE DECLASSIFIES INERTIAL FUSION MARTHA KREBS CONFIRMED AS DOE RESEARCH CHIEF

NEW MEMBER

B&W Nuclear Technologies (BWNT) has joined Fusion Power Associates as a full voting member. Edward R. Kane, vice president and chief scientist, Nuclear Engineering, will represent the company. He can be reached at P.O. Box 10935, Lynchburg, VA, 24506-0935; tel (804)385-3600; fax (804)385-3736.

BWNT is a Framatome company that offers a broad range of technologically advanced products and services to nuclear utilities, government and industry. BWNT evolved from the Nuclear Power Division of the Babcock & Wilcox Company, which built the nation's first privately-financed nuclear power station and installed the pressurized water reactor for the first nuclear-powered merchant ship, the NS Savannah.

We welcome the participation of B&W Nuclear Technologies in Fusion Power Associates.

MARTHA KREBS CONFIRMED

Dr. Martha Krebs has been confirmed by the Senate and sworn in as Director, Office of Energy Research, U.S. Department of Energy. The Office of Fusion Energy reports to Dr. Krebs; Dr. N. Anne Davies is Associate Director for Fusion Energy, Office of Energy Research.

Dr. Krebs comes to DOE from her post as associate director for planning and development at the University of California's Lawrence Berkeley Laboratory, a post she has held since 1983. Previously she was staff director of the Subcommittee on Energy Development and Applications of the House Committee on Science and Technology, U.S. Congress. Dr. Krebs holds a Ph.D. in physics from the



DOE Director of Energy Research Dr. Martha Krebs

Catholic University of America, where she specialized in the field of statistical mechanics.

During the past few months, since the President announced his intention to nominate her, Dr. Krebs has met with many senior scientists in the national fusion program and others, including Fusion Power Associates president Steve Dean, seeking their perspectives on the current status and issues in fusion research.

We wish Dr. Krebs success her new post and pledge to assist her as needed.

RENEWABLE ENERGY GROUPS COVET FUSION'S BUDGET

A group called the Energy Efficiency Education Project (1333 H St. NW, Suite 700, Washington, DC 20005-4707; 202-682-1270), claiming to represent over 80 environmental and citizen action groups, held a press conference November 16 calling for the shifting of \$1 billion in the DOE budget out of fusion, fission and fossil energy research and into "more cost-effective and environmentally sound energy-efficiency and renewable energy programs." Rep. Philip R. Sharp (D-IN) and chair of the House Subcommittee on Energy and Power, appeared at the press conference and announced he would offer a resolution in the House of Representatives endorsing the concept. (Sharp subsequently introduced the resolution, H. Con. Res. 188). Sharp said "For too long, cost-effective efficiency and renewable energy initiatives have taken a funding back seat, while other energy options have received most of the attention."

Groups listed as supporting the proposals included the National Resources Defense Council, the National Association of State Energy Officials, the Sierra Club, the Solar Energy Industries Association, the Union of Concerned Scientists, the American Biofuels Association, the American Public Power Association, the American Wind Energy Association, Friends of the Earth, Midwest (WI) Renewable Energy Association, United Methodists Board of Church and Society, as well as Wisconsin Secretary of State Doug LaFollette.

The group issued a document entitled "Sustainable Energy Budget for the U.S. Department of Energy, Fiscal Year 1995." It was similar to a plan proposed by the same group last year, which was considered and rejected by the Clinton Transition Team. However, congressional sentiment towards long-range research has deteriorated during the past year, especially in the House, and thus this plan is likely to draw considerable attention next Spring during the budget hearings process.

The plan calls for increased funding for energy efficiency (\$500 M) and renewable energy (\$320 M) and decreases in fusion (\$300 M), fission (\$700 M), and fossil energy (\$480 M). On fusion, the proposal states "After nearly a half century of taxpayer funded research, fusion power has not produced any energy." It states that "Deuterium-tritium fusion energy would still create some radioactive waste

(though less than fission reactors), and there is little hope that it will be affordable." It notes that "fusion receives more DOE research funding per year than solar, wind and bioenergy sources combined."

The report further states that "Critics of the U.S. fusion program, including MIT professor Lawrence Lidsky, argue that the program should be significantly scaled back and redirected." It claims that "The Electric Power Research Institute has indicated that it does not believe DOE's fusion energy program has any prospect of producing a practical electricity source."

The group calls for reducing the magnetic fusion energy budget from its current level of \$348 M to a level of \$50 M. It cites a bill passed in the Senate this year (See our September newsletter) which contains the statement "In the event the Secretary (of Energy) terminates the (ITER) program, there is authorized to be appropriated to the Secretary \$50 M for 1994, \$50 M for 1995 and \$50 M for 1996 for activities relating to magnetic fusion energy." This bill, sponsored by Sen J. Bennett Johnston (D-LA), seeks to get a firm commitment from the Clinton Administration to proceed with site selection and construction of the International Thermonuclear Experimental Reactor (ITER), as a joint project of the U.S., Europe, Japan, and Russia. The bill actually authorizes a fusion budget of \$425 M for 1995.

The renewable energy group's report calls for "transforming the fusion program to basic R&D on cleaner, alternative fusion processes, such as the helium-3 and deuterium reaction which does not produce dangerous neutrons and cannot be used to breed or proliferate nuclear weapon fuel."

During the confirmation hearings for Martha Krebs before the Senate Energy Committee, which Johnston chairs, Johnston, a staunch nuclear fission power advocate, warned Krebs to avoid what he called "cheerleader research" conducted during the Carter administration on some renewable energy technologies. Johnston cited President Carter's placing a solar water heater on the roof of the White House as "not serious science," and said he objects to geothermal energy as "too expensive." Johnston also called, during the hearing, for President Clinton to get "personally involved" in the negotiations with other countries to get a commitment to construct ITER. He said "If you are not going to build ITER, you might as well forget the hundreds

of millions of dollars that you will spend otherwise on fusion energy."

DOE DECLASSIFIES SOME INERTIAL FUSION DATA

Finally completing a declassification review that took over three years (see our October 1990, July 1992, January 1993, and November 1993 newsletters), the DOE announced on December 7 that it was declassifying most aspects of the design of the small fusion fuel pellets that are used in conjunction with high power laser and ion beams to study inertial confinement fusion. The U.S. has previously refused to publicly disclose the dimensions and other detailed physical characteristics of the pellets used in the research, although in most cases it has published the results of the experiments. Japanese researchers have published the details of their pellet designs for years, but U.S. researchers have not been allowed to discuss this aspect of the research with scientists from other countries (or with U.S. scientists not holding special DOE clearances).

DOE did not declassify any aspects of a series of inertial confinement fusion pellet irradiation experiments which it conducted during the 1980's using radiation from underground nuclear test explosions. (See our April 1988 newsletter and New York Times front page story by William Broad, March 21, 1988). It also did not declassify the LASNEX computer code, used by U.S. scientists to design experiments and to compare experimental data with theory.

A DOE spokesperson called the inertial fusion declassification process "the most contentious and resource-consuming classification issue since the program began in the 1960's." It is widely known that DOE classification officials have been willing for years to relax restrictions on inertial fusion pellet design, but that officials in the nuclear weapons non-proliferation office at the State Department have resisted declassification. For the past year, declassification has been bottlenecked by a staffer at the National Security Council (See our January 1993 newsletter).

Scientists at the DOE laboratories are elated by the declassification actions, since the past restrictive policy has resulted in many awkward experiences at international conferences and a tempering of the scientific stimuli that comes from open exchange of scientific data and ideas.

There have also been several instances where DOE has forbidden U.S. scientists from attending international conferences.

At the December 7 press conference, DOE claimed that until now 70% of inertial fusion research was classified and that now only 20% remains classified because it is "related to weapons research." FPA president Steve Dean called the 70% number a "gross exaggeration" and the amount of declassification an "overestimate."

Commenting on the DOE security clearance system during a recent speech in Bethesda, MD, sponsored by the Public Employees for Environmental Responsibility, Energy Secretary Hazel O'Leary said "Those terrible cards that hang around people's necks reflect a secrecy hierarchy and a system of first, second and third class citizenship." She pledged to change the system, saying "I am committed to providing openness."

1994 MEETINGS

March 14-16 International Sherwood Fusion Theory Conference. Dallas, TX. Contact Saralyn Stewart, fax (512)471-6715.

April 6-8 Seventh Boulder International RF Workshop. Topic: RF Current Drive and Profile Control for Advanced Tokamaks. Boulder, CO. Contact Lodestar Research Corporation, fax (303)449-3865; e-mail dasd@csn.org

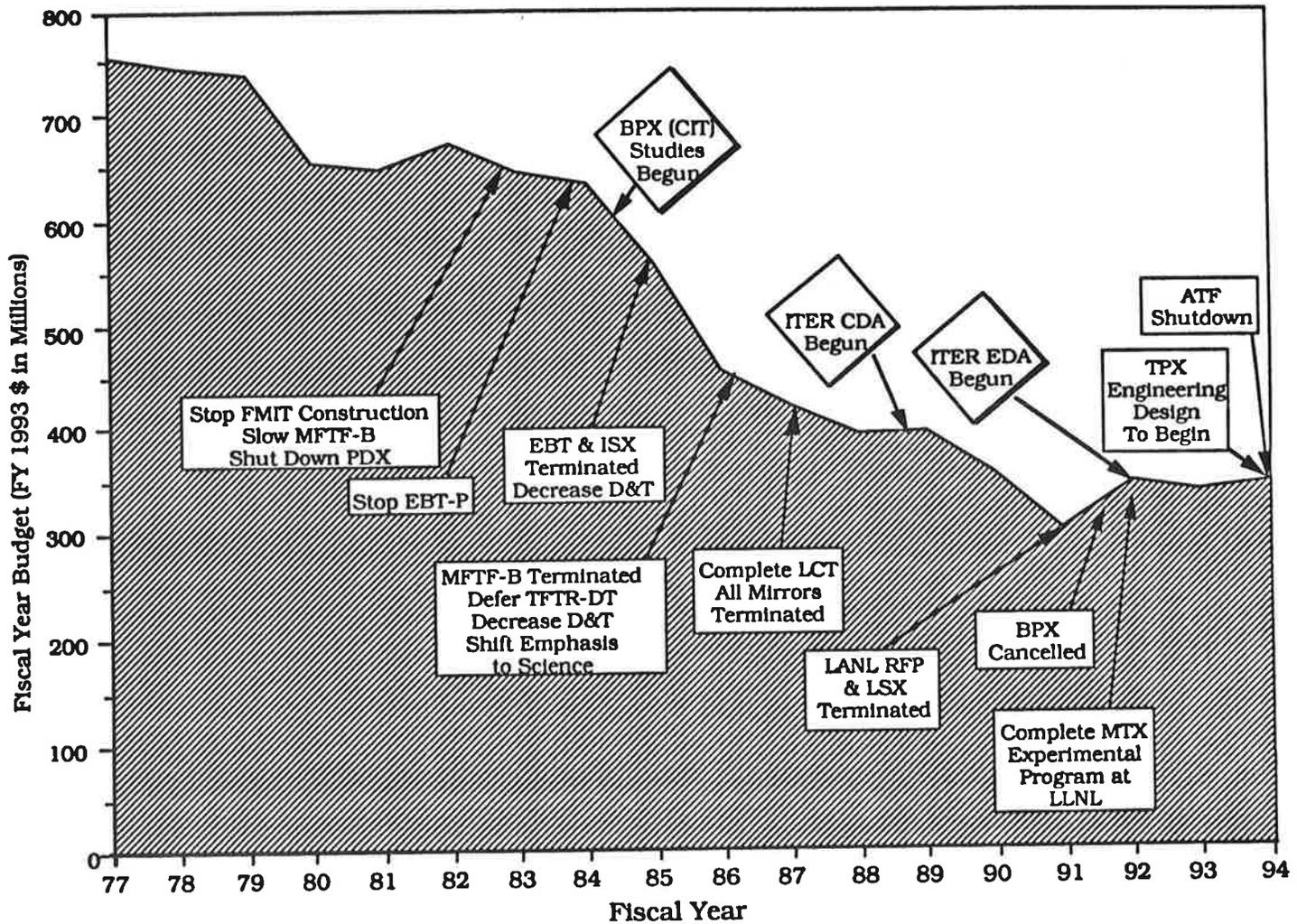
June 5-8 Canadian Nuclear Society Annual Conference. Montreal, CA. Contact Mr. H.M. Huynh, Hydro-Quebec, fax (514)344-1538.

June 19-23 Eleventh Topical Meeting on the Technology of Fusion Energy (American Nuclear Society). New Orleans. Contact John Gilligan, fax (919) 515-5115 or Wayne Houlberg, fax (615)576-7926.

June 20-24 Tenth International Conference on High Power Particle Beams. San Diego. Contact Amanda Ness, fax (619)576-7659.

June 27-Jul 1 Third International Symposium on Fusion Nuclear Technology. UCLA, Los Angeles. Contact Mark Tillack fax (310)825-2599; e-mail MST@fusion.ucla.edu

U.S. Magnetic Fusion Budget History



BUDGET UPDATE

Although the Congress has passed the DOE FY 1994 budget (see our November newsletter), the President subsequently sent a "recision request" to Congress, asking them to rescind about \$2 billion earmarked for specific programs government-wide. Clinton did not ask that any money be rescinded from the fusion program. The House, in taking action on the request, however, chose instead to rescind \$2.6 billion government-wide, including a 3% cut in energy R&D programs, including fusion. The Senate will not take up the measure until January.

During debate on the measure, an amendment was offered by Reps. Tim Penny (D-MN) and John Kasich (R-OH) which would have made massive cuts in federal spending totalling \$100 billion over 5 years. If passed, the amendment would have reduced the magnetic fusion program to half its

current level over the next 5 years. The Clinton Administration argued strongly against the amendment. Although the amendment failed, over 200 representatives voted for it, causing Rep. Penny to declare a moral victory and vow to return to the fight another day.

A history of the fusion budget since 1977 (shown in inflation-adjusted 1993 dollars) is shown in the figure. (Source: DOE Office of Fusion Energy)

QUOTABLE

"Scientists are of different types. Some follow rules and techniques that exist. Some have imagination, larger perspectives."

Stanislaus Ulam, quoted in
The Curve of the Binding Energy
 John McPhee, Noonday Press (1974)