DOE/ER-0694

FUSION ENERGY SCIENCES ADVISORY COMMITTEE

Advice and Recommendations to the U.S. Department of Energy

In Response to the Charge Letter of September 20, 1996

November 1996

U.S. Department of Energy
Office of Energy Research
Washington, DC 20585

Meeting of the Fusion Energy Sciences Advisory Committee

Gaithersburg, Maryland
September 24-25, 1996

U.S. Department of Energy
Office of Fusion Energy Sciences

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The Fusion Energy Sciences Advisory Committee (FESAC) met for the first time on September 24-25, 1996 in Gaithersburg, Maryland. The purpose of the meeting was to response to a charge letter from the Director of Energy Research (Appendix 1) requesting that the Committee suggest how the program FY 97 plan could be made consistent with a $232.5M appropriation. A straw-person distribution of funds was proposed by the Office of Fusion Energy Sciences (Appendix 2), and served as the starting point for the deliberations. The minutes of the FESAC deliberations is attached as Appendix 3. During the meeting, the Committee addressed a set of questions (Appendix 4) formulated to assist in addressing the FESAC charge. The letter of response from FESAC is included as Appendix 5.

Appendix 1. Charge Letter to the Fusion Energy Sciences Advisory Committee

Department of Energy
Washington, DC 20585

September 20, 1996

Dr. John Sheffield
Chair, Fusion Energy Sciences
Advisory Committee
Oak Ridge National Laboratory
Bethel Valley Road
Oak Ridge, Tennessee 37831

Dear Dr. Sheffield:

In January 1996, the Fusion Energy Advisory Committee (FEAC) provided recommendations to the Department of Energy on how to restructure the fusion program in the light of congressional guidance and budget realities. The Department endorsed these recommendations and prepared a strategic plan to implement them. The FEAC report containing the recommendations concluded that the goals of the restructured program could most effectively be accomplished at a funding level of $275 million per year, including the Federal government management costs.

The Department requested that Congress appropriate $255.6 million in Fiscal Year 1997 for the fusion energy sciences program exclusive of the Federal government management costs of about $8 million. This level of funding was judged sufficient to accomplish the goals of the FEAC recommended program.

On September 11, 1996, the Energy and Water Development Conference Committee settled on a Fiscal Year 1997 appropriation for the fusion energy sciences program of $232.5 million. Because this appropriation is $39.5 million less than the $275 million nominal funding level assumed in the strategic plan, I would like the Fusion Energy Sciences Advisory Committee to suggest how the program described in the strategic plan could be changed to make it consistent with the $232.5 million appropriation.

I would like to have your comments and suggestions in written form by the end of your meeting on September 25, 1996. Enclosed is a strawperson distribution of the available funds from which you should start your deliberations.

I look forward to meeting with you on this subject in late September.

Sincerely,

Martha A. Krebs
Director
Office of Energy Research

Appendix 2. OFES draft '97 budget.

Fusion Energy Sciences

($ in Millons)

New Category Elements	FY 1996 Fin Plan	FY 1997 Request	Conference w/gen red
Fusion Experimental Research	125.5	148.7	127.6
Tokamak Physics	*118.1*	*130.6*	*114.5*
Tokamak Fusion Test Reactor	51.3	54.0	46.6
DIII-D	38.8	46.0	43.3
Alcator C-Mod	9.9	13.0	13.0
International/Other	6.4	6.8	1.8
Experimental Plasma Research (Tok)	8.6	7.0	6.4
SBIR/STTR (science)	3.1	3.8	3.4
Alternative Concept Physics	*7.4*	*16.1*	*13.1*
NSTX	0.8	5.0	5.0
Experimental Plasma Research (Alt)	6.6	13.1	8.1
Fusion Theory*	18.6	18.0	16.8
Fusion Plasma Theory	18.6	18.0	16.8
Basic Plasma Science	0.2	4.0	3.0
Experimental Plasma Research (Basic)	0.2	0.0	0.0
Plasma Science	0.0	4.0	3.0
Total Fusion & Plasma Science	**144.3**	**170.7**	**147.4**
Fusion Engineering Research	75.1	75.9	62.0
ITER	54.4	55.0	54.5
Plasma Technologies	5.6	5.6	0.0
Fusion Technologies	3.3	3.5	0.0
Advanced Design (Sys Studies)	2.3	2.0	1.0
SBIR/STTR (technology)	1.7	1.8	1.6
Inertial Fusion Energy	7.8	8.0	4.9
Materials Research	7.9	9.0	4.9
Advanced Materials	7.9	9.0	4.9
Fusion Technologies	**83.0**	**84.9**	**66.9**
Total Fusion Energy Sciences	**227.3**	**255.6**	**214.3**
MFE Computing	7.7	0.0	7.5
Program Direction	8.7	0.0	8.3
Total Fusion Energy Sciences Program	**243.7**	**255.6**	**230.1**

*Includes $1.1 million dollars for HBCU's and FESAC support

September 23, 1996

Appendix 3

Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee
Gaithersburg, Maryland
September 24-25, 1996

Present:

Dr. J. Sheffield, ORNL (Chair)
Dr. I. B. Bernstein, Yale
Dr. R. J. Briggs, SAIC
Dr. J. D. Callen, University of Wisconsin
Dr. M. Cray, LANL
Mr. J. Davis, ANS/McDonnel Douglas Aerospace
Dr. R. D. Hazeltine, University of Texas
Dr. J. A. Johnson, Fla. A&M
Dr. C. F. Kennel, UCLA
Dr. J. D. Lindl, LLNL
Dr. E. S. Marmar, MIT
Dr. D. B. Montgomery, MIT
Dr. M. N. Rosenbluth, UCSD
Dr. S. Prager, University of Wisconsin
Dr. N. Sauthoff, IEEE / PPPL
Dr. T. T. Taylor, GA
Dr. N. A. Uckan, ORNL
Dr. S. J. Zweben, PPPL

Tuesday, September 24, 1996

Welcome and Opening Remarks

Dr. Martha Krebs opened the meeting by introducing the new chair and welcoming the new committee.

J. Sheffield also welcomed the members. Members introduced themselves and stated their institutional affiliations. Two "questions" were introduced for consideration throughout the session:

1) Is DOE's proposed FY 97 budget direction moving in the direction of the new strategy recommended by FESAC an January 1996?

2) To the extent you are concerned with the movement, what areas cause the most discomfort?

The agenda was presented and a revision was proposed to first hear public comments after hearing Dr. A. Davies discuss the proposed FY 97 allocation and finally to begin deliberations on a response letter. This revision was unanimously agreed to.

Program Update from DOE

Dr. Martha Krebs welcomed the Committee and mentioned that the reorganization of the fusion program has been a difficult adjustment, and that she wanted the direction of the program to reflect the advice of this Committee. She mentioned a potential reduction of Enenegy Research (ER) funding in $200M per year, for each of the next three years. With these levels of reductions, important programs, including fusion, would be hard to maintain at present levels. She said she was working hard to change this position and was optimistic it would change. Although no specific comments on the proposed fusion budget for the years beyond 1997 could presently be made, she expected that optimistically they will be flat. The deliberations on the FY 97 budget should be considered in this light. One potential source of relief in future years may be the removal of Program Direction and NERSC funding from the fusion budget, but she indicated that there is very little flexibility in the FY 97 budget regarding these matters. Finally it was noted that ER program management is one of the leanest organizations in DOE (315 staff in headquarters for a $2.5 billion budget) but that the Program Direction funds for fusion may be reduced in FY 98.

Discussion:

J. Callen suggested that some mechanism be identified for identifying where the budget is going for the next several years, to facilitate planning on a time horizon more than one year. M. Krebs replied that while A. Davies can give her sense of the budget direction, the outyear budget is not resolved now, and will not be available until November or December.

M. Rosenbluth reiterated the need for long range program planning and wondered whether there is a process being set up to determine the U.S. position on ITER's future, and the likely scenarios for the U.S. involvement. M. Krebs replied that the Secretary is firmly committed to ITER though the end of the EDA, but beyond that the ITER future is largely dependent on Japan's enthusiasm. If Japan takes leadership, the U.S. could consider some participation. There is presently no formal process in the U.S. for determining a role beyond that.

R. Briggs noted that fusion has fared below average and wondered if there was any advice towards stabilizing future funding. M. Krebs noted that while FY 97 fusion funding is down somewhat from FY 96, things could have been worse. Pressure on Congress is needed to maintain present funding levels. Other ER programs have been more protected from cuts by virtue of their "pure science" nature.

Fusion Energy Science Program Draft FY 97 Budget

Anne Davies presented the DOE response to the FEAC recommendations and the OFES proposed budget for 1997 (see Appendix 2). Regarding the response to the FEAC recommendations, the restructuring of the program means a broader approach with more emphasis on concept development and a reduction of work on conventional tokamaks, which is reflected in the proposed FY 97 budget distribution. The estimated FY 97 appropriation is $230.1 M, which is about $ 41M below the amount requested to fulfill FEAC recommendations. The $230M figure represents an increase over the House request, and also much of the restrictive House language has been removed. Some specific conference language remaining includes specifying that FY 97 is the last year of TFTR operation and that ITER will remain funded through FY 98. Regarding the proposed FY 97 budget, the primary cut is in fusion engineering research. Some general comments regarding the proposed budget are: 1) no close-out costs are included, and 2) an ER/OFES tax of $5M is required to support grants for Historically Black Colleges and Universities, etc. Regarding the major tokamak experiments it was noted that the proposed facility utilization is very low. Alternate concept funding increases, largely due to the NSTX increase. Theory and modeling funding decreases slightly (primarily that being supported by major tokamaks) with an emphasis towards maintaining core competency, but postpones code conversion to MPP machine architectures. N. Sauthoff requested carry over budget information in the tokamak area be made available, since it was claimed that FY97 budgets were effectively decreased. Basic Plasma Science has an increase. ITER funding is approximately constant but it was noted that in FY96, EDA credit was given to the base technology work, which is being eliminated in the proposed FY 97 budget - indicating a reduction in the amount of work contributed by the U.S.to ITER. The base technology R&D is eliminated with the expectation that any crucial elements will be picked up under the ITER umbrella. Material R&D is cut by about 40% - with the elimination of programs such as IFMIF and by reducing collaborations. IFE R&D is reduced about 40%, below the minimum level recommended by FEAC. Movement by OFES was noted towards addressing FEAC recommendations through actions including 1) a reorganization of and reduction in the size of the OFES staff (although it was claimed that their program direction cannot be reduced), 2) reconstitution of the FESAC and 3) following the Facility Program Advisory Committee's advice to get more users to the facilities. The structure of the new OFES organization was shown. A. Davies stated that she was particularly satisfied that all of the elements of the draft budget distribution were valuable. It was stressed that OFES sought FESAC comments on the strawman FY 97 budget.

Discussion

J. Sheffield reminded the Committeethat 1) it is being asked to suggest how the program described in the Strategic Plan for Fusion Energy Sciences could be changed to make it consistent with the $235M FY 97 Congressional appropriation, and 2) noted that for items which have specific congressional advice, FESAC should recommend what it felt was correct but that DOE has to negotiate changes with Congress.

J. Callen read a Sci-Com statement on endorsing OFES plans for initiating a basic plasma science and young faculty investigator program.

J. Lindl noted that the restructured budget protected NSTX, another tokamak, while cutting IFE 40%. He suggested that IFE is the major alternative to the tokamak, and in fact for magnetic confinement. While the target physics is being studied with Defense Programs (DP) funds, the technologies needed for IFE development need to be supported here. A. Davies responded that she viewed ST as an advanced tokamak, but FEAC said to put NSTX in with alternatives. She said that she viewed target physics as being similar to tokamak physics research, while heavy ion beam research is analogous to magnetic fusion technologies research. J. Lindl voiced his disagreement with the logic of this position and stated that he would like to have a more lengthy discussion following public comment. J. Lindl further stated that IFE is an approach to fusion with potentially unique strengths, and that cutting funding of IFE was inconsistent with a commitment do developing alternatives to the tokamak. J. Sheffield noted that one problem was that the previous FEAC was not asked to specify a fraction of the budget for IFE.

J. Johnson mentioned two points regarding the fusion energy strategic plan: 1) throughout the plan, the sense of urgency is not reflected, and 2) he is concerned about maintaining the human workforce development pipeline, namely in the universities, in training etc. M. Krebs acknowledged that there is no longer an urgency in developing fusion energy, but contended that there is a strong commitment to maintaining the necessary human resource development. J. Johnson suggested that giving up on a sense of urgency in the program may lead to weakness in future funding. A. Davies responded that he was correct about perceived urgency for fusion energy development. But there was a strong commitment to developing new people. If that was not clear, it would be made clearer.

J. Sheffield noted that the international programs now define the fusion energy development time-scale, and wondered if the restructured program was positioned to capitalize on these programs.

S. Harkness worried about the direction of the restructured program, in that it is difficult to defend a plasma science program at around $200 M/yr. A sense of urgency needs to be maintained. He added that without excitement and enthusiasm, the budget will spiral downward. If we loose the focus, we will loose the program.

M. Rosenbluth voiced concern about the proposed cut in the theory budget. Theory is a strength of the U.S.program. Strong efforts on theory and modeling is one way to maintain U.S.leadership in the fusion program as minimal expense. He voiced a concern that senior and more experienced leadership in the office was being replaced by more junior and less experienced. He questioned the direction of reducing efforts towards code conversion.

R. Briggs questioned what the TFTR shutdown costs will be. In particular, will a tax be imposed on the rest of the program to pay for this? A. Davies replied that the original shutdown plan was for FY 98 and that it had never been planned for decommissioning. A review was needed in FY 97 to make sure the planned safe-shutdown could be completed in FY 97. She also noted that the TFTR budget in the proposed FY 97 budget was already a reduction relative to FY 96.

N. Uckan expressed puzzlement at the comments on a lack of mission. The energy mission is now in ITER, and the question is whether the U.S. participates after the EDA. Also she observed that each year the same mistake is made in assuming that the next year's funding situation will be more favorable. In reality it is likely that anything eliminated in this year's budget will not be restored in the out years. Finally she noted that ITER is not the only driver for technology development, as advanced tokamak operation is also dependent on base technology developments. A. Davies replied that is why the technology programs will have to be continued through ITER. N. Uckan answered that it is not enough to rely on ITER and A. Davies replied that if needed, some components may need to be purchased from abroad. A. Davies also commented on the decision process evolving for evaluating whether to proceed with ITER. In July agreement was received to start informal explorations with the partners, in the hopes that by next summer we will be able to decide whether to enter formal negotiations on an agreement for future ITER activities.
J. Sheffield commented that the FESAC Committee will be requested to review the ITER Detailed Design Report in its next charge.

S. Prager questioned whether the FY 97 budget is a good reflection of the fusion restructuring plan. He noted that TFTR funds may disappear next year, and some effort should be made to relabel these funds to reflect the planning exercises that are actual occurring. He favored ITER supporting the technology work, but desired explicit wording to this effect. A. Davies replied that regarding the TFTR and PPPL prospects, that NSTX funding is increasing. Anne said she viewed NSTX as a major new effort at PPPL.
S. Prager reiterated that relabeling a small fraction of TFTR funding would appear as a large amount of money with respect to the $ 5M slated for NSTX.

M. Cray asked how the levels for NERSC and program direction fund levels were determined. A. Davies replied that the program management costs are at a minimum and were specified by E.R. The NERSC levels are the same as the previous year. M. Cray related lessons learned from painful major program restructuring at LANL: Planning should be for more than one year, one needs to know where one is going, and there is a need to maintain youth in the workforce. She questioned what the long term strategy for fusion is. M. Cray stressed that we should know were we are going to be in the year 2000 and specifically asked Anne if she did not see an urgency in moving into the restructuring. A. Davies replied that the fusion plan was following the FEAC recommended restructuring, and flat budgets were expected for the next 5 years. Anne stressed that funding for the future is in conflict with making the best use of the roll of TFTR operation. She agreed that it is important to maintain youth, but the program is not planned at this

level of detail. J. Sheffield mentioned that the FEAC restructuring plan does not reflect what the 5 year expectations are, and that this is an important consideration.

C. Kennel made some observations regarding the lack of a clear goal for fusion. In an analogy to a NASA program for flight to Mars, a need to reduce cost of an expensive mission resulted in adoption of successful cost effective smaller probes. In this light he suggested a vigorous program for alternates.

J. Callen made the points that 1) the international fusion program is setting the dates for the fusion timetable, 2) theory is useful for extracting useful knowledge from experiments, 3) the budget needs to have a stronger emphasis on the program restructuring and 4) expressed concern for the proposed decrease in the enabling technology budget.

N. Sauthoff noted that there is too little emphasis on non-ITER international collaboration in the proposed budget. With decreasing U.S.budgets and increasing budgets in the rest of the world, we need to pay more attention to cooperating with the international programs. There seemed to be increasing opportunities such as the DIII-D/JET collaborations and asked what process was in place to identify similar opportunities. A. Davies mentioned bilateral meetings in Montreal to work out agreements. A. Davies noted that there was a whole rework of international collaborations and J. Sheffield requested that information on this subject be supplied.

J. Davis expressed a concern about the future for fusion graduate students if there was no long term vision, with the only possible reason being ITER. He worried that when TFTR shuts down Congress may remove the funds and that a logic to retain the TFTR funds needs to be developed. He was also concerned that a lot of technology, blanket, low activation materials (highlighted as important by Congress) were being abandoned.

S. Zweben asked if the ITER review process is folded into present budget considerations. He did not believe ITER was a viable reactor candidate, not that inertial fusion concepts were. So, doing basic science was essential.

E. Marmar commented that the issue of a schedule driven fusion program versus science has been answered by Congress; we have to give up the schedule aspect. Regarding attracting students to the program he noted that students go into a wide range of fields, not just fusion. He said there are many challenging problems.

R. Hazeltine reiterated that fusion students find good jobs, even if not necessarily in fusion. Students are attracted to broad fields such as fusion. He also felt that the reactor product schedule driven program did not work, and should not be re-emphasized.
A. Davies responded that the training of students in all plasma sciences is a goal of OFES.

B. Montgomery felt the program is too rigid and needed more flexibility. People are too constrained by DOE and local guidance. He suggested that part of the TFTR funds should be used for alternate studies.

Public Comment:

At this point John Sheffield began the public comment part of the agenda. Because of the large number of individuals requesting time to comment, each speaker was limited to five minutes.

R. Bangerter, LBL

The IFE program has suffered because it is caught between the DP and ER programs, and DOE needs a clear policy regarding the roles of DP and ER. By reducing the IFE budget, ER is loosing a valuable opportunity to benefit from DP He disagreed with the characterization (in the proposed 97 budget) that IFE is a technology program, in that a high percentage of the support is for non-neutral plasma physics. 10% goes into direct technology development such as improved ferromagnetic materials. Also the reduction in the proposed IFE budget is an effective reduction in alternate spending, resulting in a "business as usual" approach, which does not lead to a new direction. He commented that if you include NSTX as a tokamak, in FY 97 budget, Tokamaks are up, alternates are down -- not a restructured program.

Discussion:

J. Sheffield commented that this is the fusion energy program, not the magnetic confinement program, and also that fusion energy science does include technology programs.

S. Harkness asked if the IFE program is the only one supporting heavy ion beam drivers, and R. Bangerter replied yes.

E. Bloom, ORNL

The importance of materials development for any fusion device to be safe and attractive was stressed. Further, the fusion material requirements are unique and have long development times. Even if one had developed a confinement device, it would take more than 10 years to develop a new material regardless of budget. Material development was characterized as a scientific endeavor as challenging as plasma science. Regarding the large cuts from FY95 to FY97 (proposed), he noted that there is no other program to fund this work.

Discussion:

S. Prager asked what the spin-offs are, and examples were given for stainless steel developments for fossil fuel plants and for turbine blades.

R. Briggs wondered if any of the National Spallation Neutron Source programs would benefit from, or fund this work, and it was noted that the spallation target environment and materials are different from the fusion requirements.

N. Sauthoff asked about the extent of international material programs, and Bloom replied that the U.S.had smaller programs than Japan and the EC.

J. Johnson asked what leverage may be made from NSF material science programs, and Bloom replied that these programs provide some basic process understanding, but the fusion environment is unique, and is not being addressed elsewhere.

M. Rosenbluth asked what the present international commitments are, and it was noted that there are two ongoing long term projects with Japan, which made be broken on a 6 month notice.

N. Uckan asked how long the development time is for a material. Bloom referenced the 20 year time required to develop materials for the fast breeder reactor, and noted the fusion material requirements are more difficult.

J. Callen asked what fraction of the material budget involved students, and Bloom (Wiffen/ OFES) replied 5-10%.

D. Smith, ANL

Reinstatement of funds for blanket technology and advanced material development was urged. These programs are consistent with the new mission statement of the revised strategy which requires the development of environmentally benign and safe technologies. These efforts are independent of the confinement concept, and significant progress can be made with a modest budget. The requirements for higher power density confinement devices will be even tougher than for ITER. Continuation of this program is important so that the U.S. will be prepared to participate in this phase of ITER technology operations.

Discussion:

M. Rosenbluth asked why vanadium development is being eliminated, and Smith replied that it is the vanadium work being done at ANL which is proposed for elimination.

B. Montgomery asked if the materials being developed are applicable for ITER, and Smith replied that they could be used as test modules.

C. Kennel asked if there are intermediate benefits to material development, and the reply was yes - in a broad sense. It was noted that, in any case, to support small devices with their corresponding high heat loads, these materials need to be developed.

M. Cray asked what is the minimal level at the labs to maintain a critical mass in these programs, and Smith replied 15-20 people.

R. Briggs asked if the ANL program had any relationship/collaboration with the Spallation Neutron Source project, and Smith replied that some people had worked on the IPNS-U proposal.

M. Saltmarsh, ORNL

An argument to maintain the fusion technology programs was made, with reference to the previous FEAC recommendation that the materials and enabling technology should be protected. These are essential elements to the Fusion Energy Science program, and in the past have been the foundation of improved plasma performance (e.g. plasma heating enabling access to new confinement regimes, plasma facing components being a key to improved plasma performance, and pellet injection providing the first evidence of profile control). Also, technology capabilities contribute to experimental flexibility, and offer a powerful entree to international programs (e.g., providing pellet injectors for JET).

Discussion:

J. Johnson asked what program should be cut if not technology, and Saltmarsh replied that technology is required for growth in fusion plasma science. Only a short term benefit is gained by cutting technology.

N. Uckan asked if using the experimental tokamak and ITER programs as a vehicle for technology development was a viable alternative to an explicit technology program, and Saltmarsh replied no - there is a risk of loosing the basic capabilities for these technologies. If ITER is never constructed, and Congress eliminates ITER funding, with no base program the technology program would be completely lost.

I. Bernstein asked about the status of enabling technology programs abroad, and A. Davies replied that they are larger than those in the U.S.

J. Callen asked if there are close out costs associated with the elimination of the enabling technology programs, and Saltmarsh indicated yes, that this may impact other programs.

R. Tempkin, MIT

He argued against the cuts in the electron cyclotron technology development program at MIT and in industry. Termination of this work will eliminate an important element of the

U.S. program at DIII-D and a unique industrial capability. The U.S. has demonstrated world leadership in this field, which has important applications and spin-offs.

Discussion:

M. Rosenbluth asked whether the large tokamaks and ITER needed this technology, and A. Davies mentioned that ITER was consulted regarding the proposed elimination of this program.

J. Callen asked what the industrial/university breakdown of this budget was, and it was replied that there was significant industrial involvement.

S. Harkness commented that we need to work out the right thing to do.

M. Ulrickson, SNL, withdrew his request to speak, as others had made the points he was concerned with.

P. Rutherford

Speaking as an individual, Dr. Rutherford discussed the linkage between ITER and plasma fusion technologies. Previously ITER depended on the tokamak program, but now the tokamak program depends on ITER. Regarding the prospects for ITER to progress, Japan needs to see strong programmatic support from the other partners to continue ITER. Thus, the long term development of the tokamak concept needs a balance between the experiments and ITER, which is not reflected in the proposed budget (with ITER + enabling technologies taking a disproportionate cut). Unless ITER moves forward, there is no future for the U.S.tokamak program and the steady-state advanced tokamak.

Discussion:

M. Rosenbluth asked how this support for ITER fits into the restructured U.S. program, and Dr. Rutherford replied that the U.S. should do whatever it can to be a partner in the future of the ITER program.

T. James, U.S. ITER Home Team

Dr. James mentioned that C. Baker would have liked to be at the meeting, but could not make it. He stressed that the restructured strategy has identified burning plasma physics as one of three fundamental issues - one which ITER clearly addresses, and furthermore in an international collaboration. He stressed the commitment of the Japanese to the ITER program, and the importance of the U.S. fulfilling its commitment. He addressed the impact of the proposed budget cuts on the ITER planning for next year showing the proposed budget readjustments. The cuts which included termination of the ECH, remote

handling and vacuum vessel efforts, and severe cutbacks in the blanket, materials, and diagnostic efforts, and smaller cuts elsewhere.

Discussion:

S. Prager noted that the strategic plan for the restructured U.S.program says that if the U.S. budget is cut, the ITER role should be rethought. He asked what possibility there was to restore some of the plasma technologies.

R. Briggs voiced concern for the U.S. credibility as an international partner if we change our ITER funding, and questioned whether we need to consult the partners if we reduce the ITER funding. A. Davies replied that the Russians have had major revisions of their contributions, and that if the U.S. maintains a role acceptable to its partners, no renegotiating is needed. T. James noted that the proposed ITER FY 97 cut was disproportionate to its share of the budget.

S. Harkness asked how the proposed cuts will affect industrial participation for construction. James replied that the U.S. already has reduced industrial involvement, but hopes the situation improves, so that the U.S. could be a more equal partner.

E. Marmar stressed that ITER is more than just a technology development program and asked if the U.S. can be a reasonable partner without a viable base tokamak program. James replied that we do have a viable tokamak program.

N. Uckan asked what the U.S. role would be if we hoped to be an "equal" partner, and James replied about the 10% level (or 100 M$/yr.). A. Davies replied that she hopes to maintain ITER funding at about $50 M/yr., and try to find a role at this level.

J. Davis asked what the priorities are if additional funds can be found, and James replied in the technology area.

J. Callen questioned the basis for the magnitudes of some of the quoted ITER cuts, and James replied that these were relative to the amounts the U.S. had originally promised to its partners to spend, not relative to the FY 96 budget.

T. Taylor questioned whether there is an alternative to ITER for achieving a burning plasma, and whether any of the international partners were pursuing this. James replied that ITER is the only plan for a burning plasma for all the parties. A. Davies added that killing ITER would hurt the partners, too.

J. Johnson asked if the U.S. would become a customer for commercial tokamaks if we maintain present funding levels, and J. Sheffield noted that ITER is not a DEMO reactor, and such a device may in fact not follow the ITER concept. J. Sheffield emphasized that ITER is not a reactor, ITER is an experiment.

S. Dean, FPA

The proposed FY 97 budget was concluded to have too strong a bias towards the tokamak programs (i.e., experiments, ITER, NSTX and most of theory). He says tokamaks increased from FY 96 to FY 97 from 76% of the total to 81% of the total. On the other hand, the budget appears biased against IFE, technology, and systems studies resulting in a program that is out of balance. Dean proposed an alternate budget plans through FY 98 with the tokamak programs declining from the present 76% of the budget to 64%, alternates increasing from 6% to 18%, and the rest being redistributed to base plasma science and systems studies, and with technology being held constant. 10% of the budget was recommended for IFE, which, in his view, represents the primary alternative to the tokamak. He opposed arguments that technologies should only be accommodated within ITER. It would wipe out industrial participation. The tokamak program should be used to help bring the overall fusion program funding up. If it cannot, it must live with a reasonable fraction of the budget. Also, with respect to alternates, the more different they are from the tokamak, the more effort you should make at making room for them in the program.

Discussion:

A. Davies complimented S. Dean for his insightful comments.

E. Marmar questioned whether NSTX should be included as part of Dean's tokamak category, as in that sense any toroidal alternate could be classified as such.

J. Callen asked where the cuts should come from to cover Dean's proposed increase in alternates, and Dean replied that DOE would have to decide that, as it would be micromanaging to suggest any level of detail. Dean re-emphasized that the present budget proposal does not adequately reflect the program restructuring.

J. Sheffield asked Dean to indicate how a consensus to implement a plan such as his proposal might be reached at this meeting. Dean suggested a retreat with broad community involvement would be a better mechanism.

S. Zweben mentioned that the reason alternates (e.g., NSTX) tend to look like tokamaks is that they work best. He also said he understood how it made sense to buy into a fusion reactor financed mainly by Japan, but did not understand why we should buy into a project financed by our own defense department

J. Johnson questioned the statement that the proposed budget has too much emphasis on tokamaks, yet not enough on technology. He understood the part about IFE, but was not clear what was encompassed in technology. Dean replied that the IFE program is an example which has technology needs and is not a tokamak.

S. Prager mentioned that TFTR shutdown costs are also in S. Dean's tokamak cost category.

M. Haynes, G.A.

Mr. Haynes reflected his view of what people (a small group) on the "Hill" wanted. This included a discernibly new direction, more concept improvement, international collaboration (not necessarily ITER), and a strong new program at PPPL and university programs. The present strawman budget will not sell. In particular, there is not enough perceived change, and TFTR spending is too large, with the TFTR funds being ''ripe for picking'' in 98. The IFE program should not be cut, as it is popular on the hill and represents a major alternative to "the same old stuff".

Discussion:

J. Sheffield asked how what level of change is needed. Haynes did not give a specific amount, but said to make a clear new future for PPPL.

C. Kennel said that the comments were useful and suggested that the restructured program is close to what Congress wants already.

J. Davis questioned why Congress cut TPX if PPPL needs to be protected. Mr. Haynes responded that TPX was unaffordable.

T. Taylor asked what sort of non-ITER international collaboration might be acceptable to Congress, but Haynes was not sure.

E. Marmar noted that science was at the bottom of Haynes list, and Haynes replied that a pure science program would be a target for large cuts in Congress.

J. Callen asked what FESAC should do now, vs. later, and Haynes replied it should show a significant change of PPPL towards alternates now.

M. Rosenbluth expressed a concern for the suggestion on cutting ITER spending after the EDA, and Haynes replied because it is too big.

R. Briggs wondered why fusion science is held in such low esteem on the Hill. Haynes replied that it is regarded as being less pure than particle physics.

I. Bernstein asked how people on the Hill form their "low esteem" opinion of plasma science. Haynes replied that fusion has a history of feuding and talking to itself.

J. Johnson suggested that plasma physics needs a better selling job, as an applied science. S. Harkness asked if there are other ways to communicate to the Hill the importance of

fusion, besides as a potential energy source. Haynes suggested that the energy goal needs to be maintained as the primary mission.

R. Davidson, PPPL

Dr. Davidson outlined the PPPL perspective on the fusion program. The uniqueness of TFTR and its operation in a period of extraordinary success was stressed. The proposed budget would significantly impact its operation. He noted that last year's budget cuts were less severe for the technology programs, and stressed that PPPL is making a transition to new areas.

Discussion:

J. Sheffield proposed to hear all the PPPL talks before the Committeeasked questions, which was unanimously agreed to.

D. Meade, PPPL

Dr. Meade outlined the changes at PPPL due to recent budget cuts. He noted the large impact of budget cuts at PPPL, including a 50% reduction in staff levels since 1992, and a reduction in the TFTR operation from 33 weeks/yr. in 1995 to the proposed 10 weeks in FY 97, resulting in very little opportunity/flexibility. He noted that the FY97 U.S. fusion and the proposed PPPL fusion budget were roughly equal to those in FY94 when expressed in terms of FY97 dollars. Further, the present PPPL staff level is essentially the same as that in FY74 before TFTR. He also noted that the cut to tokamak physics budgets from FY95 to FY97 was 36%, slightly larger than the 34% cut to ITER and technology, therefore the budgets proposed by OFE for FY97 were about right for a science program.

R. Hawryluk, PPPL

Dr. Hawryluk reviewed the results of TFTR over the past year, and discussed the expectations for next year. The national and international contributions to the TFTR DT experiments were also noted. The important discoveries such as alpha driven TAE modes, control of transport barriers and alpha channeling were included as examples of significant fusion science progress in 1996. The present shutdown and installation of RF launchers was discussed. FY 97 operational plans hope to contribute towards advanced plasma science and using the advanced tokamak mode to study the burning plasma science.

R. Goldston, PPPL

Dr. Goldston discussed the PPPL plans for movement towards the aims of the restructure science program. He outlined the need to investigate high beta plasmas which are required for an attractive reactor. Two plans towards this end proposed for PPPL are the NSTX and a feedback stabilization experiment (FSX) using the PBX-M facility. The use of feedback

stabilization of global MHD modes is perceived as an issue also applicable to tokamaks and alternates. Continued concept development for design of another cost effective and innovative device - possibly an optimized stellarator - was also suggested.

Discussion:

E. Marmar expressed enthusiasm for the innovative ideas proposed by PPPL, but questioned why propose another stellarator with two large stellarators under construction. Goldston replied that for a reasonable cost a pulsed device could be built at PPPL that makes a more significant impact towards high beta.

J. Callen asked what is being put off by the restructuring. Hawryluk replied that TFTR had changed its priorities to address fusion science issues (e.g., ion Bernstein wave studies).

R. Briggs asked what the role of PPPL staff in ITER and other experimental collaborations is. Davidson replied that PPPL has ~ $3.3M in the design work of ITER and also has ongoing collaborations with JET, JT-60U, LHD, DIII-D and C-Mod.

J. Davis wondered if the proposed FSX device should come before NSTX, and Goldston replied no, but NSTX is configured to accommodate any FSX lessons learned.

M. Rosenbluth mentioned that PPPL has suffered because it did not retreat rapidly enough from a maximal program, and questioned the importance of the proposed TFTR work. He suggested consideration of shutting down TFTR immediately. He stated that the benefits from TFTR while real (e.g. IBW) were not compelling. Why not do the rest on PBX? Davidson replied that the balance is about right between TFTR and NSTX, and there are still exciting TFTR experiments that can be done.

S. Prager noted that the $46M slated for TFTR in FY97 is vulnerable to be removed by Congress. Can this money be itemized to highlight the restructuring towards new experiments? Davidson suggested the budget could be broken down accordingly.

J. Lindl wondered what TFTR work could not be done on JET, and D. Meade said the JET operation is delayed until December 1996 and will then run only four months of D-T experiments prior to 1999 with fewer alpha particle diagnostics than TFTR. D. Meade called for an assessment of the relative DT capabilities between JET and TFTR. The TFTR work concentrates on core plasmas, and that it is useful to double check results with two machines. R. Hawryluk said JET will have a limited program in 97 and not have an extensive DT program until 1999.

N. Uckan commented that PPPL proposed to lead the next phase of ITER and questioned if PPPL wholeheartedly supports ITER, how they would propose to lead ITER. R. Davidson mentioned that the Japanese would have the lead role, but PPPL would like to play a

strong role in leading U.S. participation. But with U.S. fusion budgets at $230 - 250 M/yr., the U.S. would be a junior partner at best.

J. Johnson asked how could PPPL be made "happy" to satisfy the "Hill". Davidson said 3 to 5 months of TFTR operation in FY 97 would be a good prescription.

T. Taylor asked what the plans are for FY 97 and 98 international collaborations. Davidson said the breakdown in collaboration spending is roughly 2/3 domestic, 1/3 international. He also mentioned a new collaboration between PPPL and Korea. Taylor asked if there were any considerations in providing hardware in international collaborations. In particular, he noted that JET was significantly under-powered, and the TFTR beams and some diagnostics, plus the PPPL expertise in DT plasmas could provide significant improvement in the JET capabilities, and an opportunity for TFTR scientists.

T. Simonen GA

Dr. Simonen stressed that the DIII-D is a flexible tokamak with many collaborations. A problem is that it needs an operating budget of $52M. The proposed DIII-D budget of ~ $44M will mean reductions in programs and loss of key staff. The operation time for FY 97 is estimated to be only 12-14 weeks, and the reductions in the technology budget will defer the divertor and ECH improvements, limiting future U.S. international roles.

Discussion:

Uckan asked how the proposed budget impacts GA's strategic plan, and T. Simonen replied that the upgrade of the ECH gyrotrons will be halted, and that they will have to live with the present pellet capabilities, but no comprehensive plan on dealing with the new budget exists.

Briggs asked what fraction of the DIII-D budget is for outside collaborations, and Simonen replied about $8M out of $42.5M.

E. Marmar asked how DIII-D should fit into the overall restructuring plan, and it was suggested that a 5 year plan needs to be articulated to address this.

J. Callen asked if the divertor upgrade work for ITER is impacted, and Simonen replied that all upgrades will be put off.

M. Porkalab, MIT

Dr. Porkolab reviewed Alcator C-Mod's successful initial period of operation. Record surface and volume power densities have been demonstrated without deleterious effects. This device is 1/2 to 1/3 the size of bigger tokamaks and as such extends the range of geometric parameters, while maintaining some dimension-less parameters. He noted that

the FEAC major facility review panel endorsed the proposed C-Mod upgrades, which will not be possible under the proposed budget. The proposed budget allows very limited flexibility.

Discussion:

Johnson questioned what was meant by C-Mod being called a national fusion facility, and several people responded that, although it is not a national lab, it has national importance, and involves many national collaborations.

Briggs asked how the budget is allocated to collaborators on C-Mod, and Pokolab replied that others submit collaboration proposals and with DOE guidance choices are made.

Sauthoff asked how MIT would split the FY 97 proposed level of $13M with collaborators, and the reply was that it is difficult to say at this time but that MIT would prefer all $13M to go to MIT.

Zweben asked what should be cut in order to give C-Mod what it needs to do all its proposed work. Pokolab replied that the previous FEAC guidance was that at a budget level below $250 M, TFTR should not be run, and ITER should be cut. Unless this advice is followed, the program is in paralysis.

J. Sheffield asked where C-Mod stands regarding the proposed divertor work for ITER. The reply was that funds are needed to complete installation of cryopumps and shaping coils, and this probably could not be done with the proposed budget.

H. Fleischmann, Cornell

Dr. Fleischmann presented a historical perspective on the present budget situation. He stressed that we do not have a good message to sell, and questioned the role of energy production as a vehicle to sell plasma science. The central problem with fusion reactor feasibility is cost. To address this problem reactor studies should be a driving force in the process - we need honest studies to survive.

Discussion:

Rosenbluth asked if a point of this is that we need to pursue alternates, and wondered

whether IFE should be considered as an alternate. Fleishman replied yes, but alternates need accompanying reactor studies.

S. Harkness agreed that fusion should be sold as a backup in case solar and fission power sources do not work out, and that systems studies are needed.

J. Callen asked if Fleishman had seen the alternates panel review, and suggested that systems studies are more suited to the better defined, better understood concepts.

K. Thomassen, LLNL

Dr. Thomassen started by emphasizing the need for a 5-year plan, and noted that we are selling the program to a skeptical customer. To help improve the product he stressed: 1) we need to improve the tokamak concept towards higher beta and steady-state, 2) we need to pursue alternate concepts in a science based program, and 3) theory and computation offer a big "bang-for-the-buck". He proposed creation of a national team to do concept evaluation of alternatives. This team would have a broader base that the usual system studies, including a strong physics competency. Results of this group could be used in development of a 5-year strategy for alternates.

Discussion:

Sheffield agreed that we need a product that is significantly better than present vision, but technology improvements are also needed to realize this. K. Thomassen suggested that there may be other possibilities.

J. Callen asked what Thomassen would propose to do now, and the reply was he wouldn't tell the program exactly what to do, but liked the direction outlined by S. Dean above.

J. Lindl resonated the idea that theory/computation should play an important role and asked what could be done. Thomassen replied that a national team should be formed to do physics and reactor studies.

J. Drake, U. of Md.

J. Drake discussed the relationship between Congress and the proposed budget. He reiterated that the FEAC restructuring is towards scientific knowledge and confinement innovations. This restructuring is supported by the scientific community and Congress. There is criticism from the House that the recommendations are not being followed closely enough, and are not reflected in the proposed budget.

Discussion:

J. Sheffield asked how far off the proposed budget distribution is from being acceptable to Congress. The reply was that modest increases should be included and that the budget should clearly reflect that PPPL will be a leader in this area.

E. Marmar asked what he thought about ITER and particularly the base technology. Drake replied that this was a tough problem and did not have answers.

M. Reiser, U. of Md.

M. Reiser read a statement expressing concern for the proposed cuts in the IFE budget. He emphasized the science content of the required intense beams and the role of the program in spawning collaborations between plasma and accelerator physicists. He suggested that it is more appropriate to categorize IFE as fusion science rather than as technology.

Discussion:

E. Marmar asked if fostering university work is a useful purpose for the program redirection, and Reiser replied yes, you need exciting prospects to attract students. He also mentioned that there remain requirements for technology improvements in IFE.

M. Mauel, Columbia U

M. Mauel outlined three goals of the strategic planning process that the fusion community need to fulfill to survive: 1) respond to Congress, 2) build a consensus, and 3) argue for a larger budget. The last item has not been successfully done. The proposed FY 97 budget gives the perception that restructuring is not occurring, which will undermine support. Increases need to be made in alternate spending and the post-TFTR role of PPPL in these new initiatives needs to be highlighted. He proposed that we should start with the very definitive "level funding" guidelines in the FEAC restructuring document and decrease from there.

Discussion:

J. Sheffield suggested the crux of the problem is the balance of getting on with new elements and using existing facilities. A. Davies replied that there was an attempt to protect the smaller programs in planning for FY 97.

S. Prager asked what is needed for the restructured plan to be fully recognized, and Mauel replied that the role of the major tokamaks must decline, in particular TFTR.

R. Briggs disagreed that science could only be done on smaller experiments meant a loss of science, and that what is needed is a cultural change to more fully utilize the major tokamaks as user facilities - all other fields of science have had to go through a process of learning how to do their science on a few big machines. Mauel replied that the major

tokamaks have historically benefited from experiments initially performed in smaller devices.

M. Rosenbluth asked how Mauel would move ahead given all the constraints. Maul replied that a physics program for the post-TFTR PPPL era needs to be started, and re-emphasized the need to shut down TFTR.

G. Logan, LLNL

Dr. Logan characterized attractive fusion power as a long term goal requiring advances in science and technology to realize a cost effective solution. A higher emphasis on lower cost fusion approaches was suggested and it was noted that this is an area in which the U.S. has unique skills.

Discussion

E. Marmar asked how ITER fits into the "lower cost approaches". Logan replied that if built, ITER will be constructed in Japan. University programs and enabling technologies are low cost ways in-which we can contribute. In any case, Logan stressed that we have to reduce the role of the major tokamaks.

D. Baldwin, G. A.

Dr. Baldwin suggested more support for the IFE program, indicating that it makes good sense to put 10% of the budget into something that doubles fusion's chance of success. He also raised questions as to what fusion science really means, and suggested that really understanding where the program should head to best reflect the restructuring needs an intense debate with broad community input. This is something that could not be done in the present two day meeting and would be better served in a retreat.

Discussion:

J. Sheffield welcomed suggestions as to what a community retreat could address.

J. Callen asked Baldwin what he suggested doing today and tomorrow, and Baldwin replied that TFTR funds should be used to identify future prospects.

Hazeltine commented that one first changes direction and later gets somewhere new.

This ended the public comment portion of the meeting.

General Discussion

A. Davies presented some additional comparisons of funding changes from FY 96 to the proposed FY 97 levels. Some trends were that, generally, the theory budget held up as the budget declined, an increase in university spending as a fraction of the total budget, large cuts in technology, and decreases in the three large tokamak programs (TFTR, DIII-D and C-Mod). Savings gained by not operating TFTR in FY 97 were estimated to be only ~ $3M, and no operation of C-Mod would save only ~ $0.5 M, if there were no reductions in personnel.

M. Rosenbluth noted that there must be people doing TFTR safe-shutdown that would not be let go until FY 98. What was the expected cost? D. Meade that at the $46M level for TFTR in FY 97 they would layoff 40-50 people (in FY 97). He added that they need to retain people to analyze data and prepare new programs and PPPL institutional plans call for no further staff reductions. Anne Davies noted that OFE had estimated a severance cost of $12M if all PPPL engineers and technicians were laid off. D. Meade concurred that this estimate was about right. D. Meade also indicated that TFTR would be mothballed until DOE-EM accepts responsibility for its removal. M. Rosenbluth asked what the staff planning was for the new programs Goldston outlined. R. Davidson replied that the total PPPL staff would be about constant. They had already cut staff by about a factor of 2 since 1992, and were close to a 1974 level.

J. Lindl questioned why there is only a 10% cost reduction for TFTR if it has no operation, suggesting this is not consistent with a strategic vision. A. Davies agreed that the programs have been reduced close to the point where they can't operate, and retaining the staff may not be justified.

S. Harkness suggested using TFTR staff for collaborations, and A. Davies replied that this is happening with Japan.

B. Montgomery suggested using TFTR staff to work on NSTX / FSX programs after TFTR operation in 97, and highlight this in the budget. A. Davies replied this may be possible, and R. Davidson suggested the only question is the schedule for completing TFTR operations.

M. Rosenbluth asked why NSTX is only at a $5M/yr. level, and A. Davies replied that it will increase to $20M/yr. when it begins operation.

At this point J. Sheffield asked each Committeemember to revisit the original two questions asked at the beginning of the meeting: 1) Is the budget breakdown proposed by DOE for the FY97 budget moving in the direction of the new strategy? 2) To the extent you are concerned with the movement, what areas cause the most discomfort?

J. Johnson: In general the budget is OK. Eliminating the enabling technology budget is justified, but IFE spending should be restored. Tokamak physics should include a specific line item for future PPPL direction to reflect the dynamic evolution. DIII-D and C-Mod

should be slowed down, there should be less spending for NSTX, and the ramp up for plasma science should be delayed.

E. Marmar: We need to show and do more on restructuring PPPL, and should move quickly - but avoid getting no results next year. He noted that C-Mod is taking cuts, and suggested that the ECH program be restored. Also the IFE program should not be cut. It sends the wrong message.

N. Sauthoff: He does not see major changes in the numbers, but does see a change in the structure. It is hard to redirect without knowing about FY 98. There is a desperate need for a plan. The most concern is on budget cuts for international collaboration (non-ITER) and modeling. Regarding restructuring of the budget, ITER and base technology should be merged, IFE should be moved from technology to alternates, and a cross cut of the budget by research topic (instead of by device) should also be presented to better reflect the shift in program emphasis.

S. Prager: The budget numbers are about right. But the program needs to be perceived as being restructured, and the TFTR funding should be expressed accordingly. He leans towards the kind of strategy suggested by S. Dean. Some funding should be shifted from ITER to base technology. Perhaps some money from the tokamak programs should be shifted to the IFE program, which should be listed as an alternate concept, rather than technology.

B. Montgomery: The fusion community needs to be persuaded to take responsibility for its future. He endorsed K. Thomassen's idea for creating a physics/systems-studies group to evaluate alternate concepts - by reassigning people from the tokamak programs.

I. Bernstein: Generally agreed with the budget, but supported B. Montgomery's idea of redirecting TFTR funds to the evaluation of alternate concepts at PPPL in the FY 97 budget.

J. Davis: The present budget does not reflect enough change in the direction of the suggested restructuring. The budget decline is likely to continue and we need to maximize collaborative international efforts. In this light, we need to maintain the ITER effort independently of the base program. He expressed concern about the elimination of the enabling technology programs, and the large cut in systems studies. Systems studies provide insight into where we are going and why.

R. Hazeltine: Generally agreed with the strawman numbers, but also agreed that the budget document should more clearly demonstrate the program redirection. He was particularly concerned about for the elimination of the modeling program, in confinement.

S. Zweben: He emphasized the importance of the TFTR program and the importance to the community of proposed burning plasma experiments with the possibility of controlling alpha heating profiles. He expressed enthusiasm for the NSTX project.

R. Briggs: Changes are needed in the budget. Unfortunately, we are reacting tactically, not strategically. The program needs to adopt a user facility mode of operation for the major experiments, similar to high energy physics detector collaborations. The international collaborations and commitments are important, and the ITER commitments should be honored. The IFE budget should also be protected from cuts because IFE represents a major opportunity and it is mainly a science program at this point. The

technology development should be scaled back, emphasizing generic long term programs and items needed to support the next experiments.

9/25/96

The meeting was reconvened at 8:30. All members in present on 9/24/96 were in attendance except Dr. C. Kennel. J. Sheffield reiterated the two primary questions of concern (see above) for the deliberations. A suggestion was made to distribute a list of questions to the Committeemembers, from which the responses could be used as the basis for the FESAC letter of response. This approach was agreed to. The polling of members on their thoughts on the proposed budget distribution continued.

J. Callen: Agreement was expressed with the comments from E. Marmar and S. Prager to the effect that the strawman budget numbers are generally OK, but the restructuring of the program needs to be reflected more strongly. Concern for the elimination of the modeling budget was expressed, and some technology funds should be made available - which are not earmarked through ITER.

J. Sheffield read C. Kennel's written comments suggesting that overall the budget does not support the claim that the program is restructured. Particular concerns are: a) There is no goal for the fusion program, b) there is no long term plan or vision for PPPL, c) there is no vehicle in place for post EDA ITER activities. A reduction in the TFTR operation was supported, with an aim of moving PPPL towards new programs.

S. Harkness: There is a need for major goals and milestones towards a long term (~ 5 year) plan. The budget direction could then be compared to the specified goals. The general proportioning of funds outlined by S. Dean was preferred over the strawman allotment. There is a concern on the focus on the D-T fuel cycle, and some support for alternate fuels (such as D-D) was suggested.

J. Lindl: The strawman budget does not appear to be moving towards restructuring. This is partly due to the way the budget is presented. A strategic review of the program is needed. Specific concerns were expressed for: 1) the cuts in computation and modeling, 2) the

material program needs to be broadened, 3) the IFE program should not be cut, and 4) support for K. Thomassen's concept for a systems/modeling team for alternate concept review.

T. Taylor: The budget does not reflect movement in the direction of the new strategy. There are no new initiatives or new strong international collaborations. A major concern is that he cannot identify many elements in the FY97 budget which will lead to a stronger fusion energy sciences program in FY98, 99, & beyond. He is concerned about the IFE, material programs and base technology programs. Also there is a concern that contrary to

the recommendations of the strategic planning document in the case of budget levels below $250 M/yr., the TFTR program is still maintained while other programs are cut.

M. Cray: The budget does not reflect sufficient change. There is too much support for the traditional tokamak programs. More IFE and alternate concept support is needed. PPPL should use a fraction of the TFTR budget to this end. The materials and technology programs are critically impaired, and should have constant budgets. Also theory and computation needs to be protected. To support these programs, $15M should be taken from the tokamak programs. The program is in a severely limited FEAC strategy case. Some paring of PPPL is necessary. We need to look at ITER and other tokamaks, and ask "what do we want to be when we grow up?" Also, international collaborations under the tokamak experimental programs should be labeled as such, to highlight these efforts. Efforts to make the budget better reflect the national collaborations also is needed. Finally, strong out-year planning is needed.

N. Uckan: The budget has a perception problem of too little change. There is a disproportionate split between tokamak physics and everything else. The disproportionate cuts in ITER/base technology, modeling/computation and international collaborations are bothersome. The base technology programs are applicable to any confinement concept, and also a valuable entree into international collaborations. There is a concern that the close-out costs of TFTR are not reflected. Sources of funds should be sought from the computer center and tokamak experiments.

M. Rosenbluth: Theory and computation are the biggest leverage items in low budgets. The computational field is blooming, and it is critical to support this area (by adding $2-3M to the proposed budget). He emphasized that fusion energy is the goal of this program and without our making progress toward that goal, support for the program will wither away. The future is tied to ITER and international collaborations, and therefore programs like JET/DIII-D collaboration should be pursued. Changing the budget labeling to better reflect the de-emphasis on tokamaks is recommended. The present support of alternates is OK. The plasma science program may need to be ramped up more slowly, and the IFE program should be supported at the FY 96 level. He urges PPPL to get on with more science oriented directions and more international programs.

J. Sheffield discussed the rules of conflict of interest and voting eligibility. In the case when voting on matters directly impacting their own institutional funding people should recuse themselves from voting. Also, if insufficient information is given, or people feel they are not independently knowledgeable, they should not vote. ITER was suggested to be interpreted as a broadly based program rather than a program with direct institutional impact. According to the draft rules on federal advisory committees, ex-officio members are allowed to comment on proposals, but not vote.

N. Sauthoff questioned the consistency of the draft federal advisory Committeeguidance and separate DOE rules regarding the issue of ex-officio voting. Also it was pointed out that strict

rule interpretation calls for members leaving the room during discussion of matters directly influencing their institutions.

A. Davies reminded members that the appointment letter request that members act for the benefit of the community as a whole without institutional bias.

N. Uckan asked how previous FEAC committees addressed this issue, and A. Davies replied as mentioned above regarding the letters of appointment statement.

J. Johnson mentioned that for example, in NSF deliberations, members do not need to recuse themselves if they are voting on reviews in the context of programs, as opposed to items with a direct impact. If A. Davies is comfortable with the present approach we should not worry.

J. Lindl asked whether IFE would be treated as a general program. He did not support a strict interpretation of the rules for recusing oneself.

J. Sheffield presented a list of questions to be answered by each Committeemember. The replies to these questions will help form a basis for a response letter. It was agreed by A. Davies and J. Sheffield to use the approach that members could vote on any question unless it had a direct impact on their funding. The wording of each question was deliberated until everyone was satisfied with them. A break was held to allow Committeemembers time to respond to the questionnaire.

Break

J. Sheffield noted that other committees allow ex-officio members to vote, while the DOE only has draft rules not allowing them to vote. Therefore it was agreed by A. Davies that the ex-officio members should be allowed to vote in this committee. The questions mentioned above were then distributed to the members, and are indicated in Appendix 4.

A draft letter of response from J. Sheffield was circulated to the members with request for comments. At this point Committeemembers began presentation of summarizing paragraphs on the public comments. Some Committeemembers had been requested to prepare these summaries on specific areas touched on during the public comments to be possibly used as an appendix to the response letter. T. Taylor presented a paragraph summarizing the ITER comments and J. Callen presented a summary of the major tokamak facility issues.

E. Marmar proposed that proposed that these summaries not be included in an appendix to M. Krebs, and the review of them be dropped. M. Rosenbluth seconded the motion, and the vote was unanimous to drop discussion of these summaries. The summaries would be given to J. Galambos instead for help in preparing the minutes.

Davies presented budgets for the major tokamak facilities delineating the cross collaboration (national and international) nature of these facilities. Substantial national laboratory and

university utilization of these facilities was evident for both FY 96 and FY 97. J. Callen mentioned that this is a useful way to present funding data.

Discussion of Questionnaire Voting/Response Letter

John Sheffield then presented a compilation of the results of voting on the questionnaire. These results are appended, and other specific comments from Committeemembers will be available from DOE- OFES. There was some discussion on how to incorporate the answer to question 18b (i.e., which specific programs should have budget cuts). M. Rosenbluth proposed not giving numerical summaries of this voting, as many votes had stipulating comments that would be impossible to tally. Rather, the entire set of comments would be made available. This motion passed 14-2. The draft letter of response previously circulated was then reviewed. With the aid of the voting responses the draft letter wording was deliberated until all members were satisfied. It was agreed, that anyone who left before the meeting is adjourned would accept editing for reason of clarity and accuracy.

Presentation to J. Decker

J. Sheffield reviewed the letter of response to the FESAC charge to J. Decker. J. Decker asked what level of detail the budget was gone into, and J. Sheffield replied that A. Davies had shown a summary of the proposed budget (see above), and additional levels of detail were presented by speakers. J. Decker wondered how comfortable the Committeemembers were with this level of detail, and E. Marmar and S. Prager expressed some concern.
A. Davies mentioned that the information was needed immediately, and there was no time to prepare or present a higher level of detail, and J. Decker agreed that this seemed reasonable. J. Decker expressed appreciation of the work done by the Committeeon a very difficult assignment, and said that the results were helpful and would be taken seriously. It was difficult however to imagine finding any financial relief. Regarding the retreat, this sounded helpful. The comments on the redirection of the future of PPPL were also appreciated and would be worked with.

J. Sheffield presented the new charges to the FESAC, for which a reply is requested by May 1997. The charges consist of two components. The first is to review the ITER EDA design report. To address this it was suggested creating sub-panels in the Jan./Feb. 1997 timescale. Input will also be requested from the U.S. ITER Home Team (a 1-pager on each issue) to assist this effort. The second charge involves addressing the role the U.S. should play in the post EDA ITER program.

The meeting was adjourned at this point.

John Galambos
Secretary to the FESAC
Oak Ridge National Laboratory

Appendix 4. Questions answered by Committeemembers.

Directions:

1. People who are at an institution which may benefit directly and predictably from a vote must recuse themselves from voting. Please write recuse by the question

2. If you feel that you were given insufficient information to answer a question, please write "insufficient information."

3. If you do not wish to vote, please write "abstain."

4. If you indicate a partial funding increase please indicate the general range (e.g. 10-20%, 20-30%, etc.)

5. Please write brief, clarifying comments if you feel it would help to explain your vote.

Questions:

1. The Committeereaffirms the importance of proceeding expeditiously to implement the restructured program defined by FEAC:

   yes no

   Please indicate what aspects give you concern.

2. Broadly speaking, the DOE budget strategy is responsive to the FEAC structured program proposals:

   yes no

   Please indicate what aspects give you concern.

3. The extent of the restructuring in the FY97 budget, as the program moves into FY98 and beyond and the extent of collaboration, needs to be made clearer in the way the budget is presented by DOE:

   yes no

   Please comment.

4. The PPPL, in conjunction with DOE, should redirect some of the effort within the budget labeled "TFTR" to emphasize more clearly the transition to its future program.

yes no

5. Is the Tokamak Physics budget at the current level

slightly too high?
roughly correct?
slightly too low?

Please comment on the general philosophy you feel is appropriate for this area.

6. Is the Alternative Concepts Physics budget at the current level

slightly too high?
roughly correct?
slightly too low?

Please comment on the general philosophy you feel is appropriate for this area.

7. Should IFE be placed in the Alternative Concepts category?

yes no

Please comment on the general philosophy you feel is appropriate for this area.

8. The IFE budget was reduced substantially, should funds be restored

fully?
partially?
not at all?

9. Is the Fusion Theory plus modeling budget at the current level

slightly too high?
roughly correct?
slightly too low?

Please comment on the general philosophy you feel is appropriate for this area.

10. Is the Basic Plasma Sciences budget

high?
correct?
low?

Please comment on the general philosophy you feel is appropriate for this area.

11. A) The Base Technology programs (those outside the ITER line in FY96) were eliminated. Should funding be restored separate from ITER adjustments?

Plasma technologies (magnetics, ECH, ICH, PFCs, Pellet Fueling)

fully
partially
not at all

Comment on which areas should have priority for funding increases.

Fusion technologies (Blankets, Tritium, Environment and Safety, Remote Handling, Containment Structures):

fully
partially
not at all

Comment on which areas should have priority for funding increases.

Please comment on the general philosophy you feel is appropriate for this area.

11B. Should the OFES make an effort to ensure that plasma technologies capabilities are retained within the experimental programs to the extent that they are not funded elsewhere?

yes no

12. Within the ITER budget, is the proposal of the ITER Home Team to restore the technology funding the correct approach?

yes no

If the answer is yes, are the proposals

high?
correct?
low?

13. Is the combined ITER plus related technologies strawman budget at the correct level

slightly too high?
roughly correct?
slightly too low?

Please comment on the general philosophy you feel is appropriate for this area.

14. The materials budget was cut substantially. Should funding be restored

fully?
partially?
not at all?

Comment on priority areas for supplements.

Please comment on the general philosophy you feel is appropriate for this area.

15. System studies were cut substantially. Should funding be restored

fully?
partially?
not at all?

Comment on the general philosophy you feel is appropriate for this area.

Comment on the proposal for emphasis on a broad, community-wide concept evaluation study?

16. Does the program take advantage adequately (systematically) of international collaboration beyond the effort in ITER?

yes no don't know

Please comment on the general philosophy you feel is appropriate for this area.

17. Should OFES organize a retreat to define better the vision, goals and evolution of the program elements in the longer term program, including an analysis of how the necessary skills can be retained?

yes no

Please identify key topics for discussion (e.g. Is the emphasis on the fusion goal adequately explained?).

18. If you recommended budget increments,

a. please indicate the priority in which they should be funded

Indicate where budget cuts would be appropriate or indicate that you believe OFES should handle the financial adjustments?

Appendix 5 Response letter to the Office of Energy Research Director

October 3, 1996

Dr. Martha A. Krebs, Director
Office of Energy Research
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Dr. Krebs:

The Fusion Energy Sciences Advisory Committee(FESAC) has addressed, in part, the charge in your letter to the Committee dated September 20, 1996. You asked the Committee to suggest how the program described in the Department's Strategic Plan (1996) for the Fusion Energy Sciences Program might be changed to make it consistent with the $232.5 million appropriation. The Department had requested that Congress appropriate $255.6 million in fiscal year 1997 for the Fusion Energy Sciences program, exclusive of the Federal Government management costs of about $8 million to accomplish the goals of the plan recommended by the Fusion Energy Advisory Committee (FEAC, as FESAC was named prior to August, 1996) [1].

The Department presented a provisional budget distribution at the meeting. Given the short time available to comment, we addressed, in part, the charge in terms of recommended changes to the provisional budget and its presentation.

In making these recommendations, the FESAC took into account the valuable input of the Department and of numerous members of the fusion community who gave presentations or provided written information. Enclosed is a list of the contributors.

The FESAC has a few general comments. All of the program elements shown in the provisional budget are important to the future of the program. The budget reduction from Fiscal Year 1996 to 1997 is very hard to handle. With some exceptions, as outlined below, FESAC generally agrees with the Office of Fusion Energy Sciences response to this difficult situation. Any help you can give to alleviate the budgetary problems would be very valuable in optimizing the new program.

The FESAC reaffirms, unanimously, the importance of proceeding expeditiously to implement the restructured program defined by FEAC. We believe, however, that the fusion community needs to do further work on refining the vision and long-term goals of the program, including a clearer explanation of the approach to the fusion energy goal and an implementation plan.

A majority of the Committee feels that the provisional budget is generally responsive to the restructuring recommended by FEAC. However, there are concerns in two areas: first, the budget gives the perception of less responsiveness than is the reality; second, some elements important to the future program need greater emphasis.

The perception issue should be addressed by structuring the budget entries to indicate, more clearly, the changes in direction. In the same way, the extent of national and international collaboration in the various program elements should be made more visible.

The FESAC recommends that the Princeton Plasma Physics Laboratory, in conjunction with the Department, should redirect some of the effort within the budget labeled "TFTR" to emphasize more clearly the transition to its future program. This can include new initiatives, as well as increased domestic and international collaborations.

The Committee generated for itself a list of 18 questions, to address the issue of the program balance as reflected in the provisional budget. Based on the answers to these questions, a majority of the Committee (as indicated) was in agreement on the following issues. For each of the questions, the vote of the 14 members and 3 ex-officio members present (excluding the Chair) is given:

- Is the Tokamak Physics budget at the current level:
  slightly too high (11); roughly correct (3); or slightly too low (2);
  [insufficient information (1)]?

- Is the Alternative Concepts Physics budget at the current level:
  slightly too high (2); roughly correct (7); slightly too low (8)?
  (Note: at the time the question was posed, the alternative concepts category did not include IFE.)

- Should IFE (Inertial Fusion Energy) be placed in the Alternative Concepts category?

  Yes (15); No (2).

- The IFE budget was reduced substantially. Should funds be restored:
  fully (4); partially (11); not at all (1); [insufficient information (1)]?

- Is the Fusion Theory plus Modeling budget at the current level:
  slightly too high (0); roughly correct (5); slightly too low (11); [insufficient information (1)]?

- Is the Basic Plasma Sciences budget :
  high (5); correct (12); or low (0)?

- The Base Technology programs (those outside the ITER line in FY96) were eliminated. Should funding be restored separate from ITER adjustments?

  - Plasma technologies (Magnetics, ECH, ICH, PFCs, Pellet Fueling): fully (0); partially (10); not at all (4); [insufficient information (3)].

  - Fusion technologies (Blankets, Tritium, Environment and Safety Remote Handling, Containment Structures):
    fully (0); partially (9); not at all (5); [insufficient information (3)].

- Should the OFES make an effort to ensure that plasma technologies capabilities are retained within the experimental programs to the extent that they are not funded elsewhere?
  Yes (13); No (2); abstain (1); [insufficient information (1)].

- Within the ITER budget, is the proposal of the DOE to restore the technology funding the correct approach?
  Yes (12); No (3); [insufficient information (1) or other (1)].

  - If the answer is yes, are the proposals:
    high (1); correct (7); low (2); or other (7)?

- The materials budget was cut substantially. Should funding be restored:
  fully (2); partially (10); not at all (4); [insufficient information (1)]?

- System Studies were cut substantially. Should funding be restored:
  fully (2); partially (7); not at all (5); [insufficient information (1) or abstain (2)]?

- Does the program take advantage adequately (systematically) of international collaboration beyond the effort in ITER?
  Yes (3); No (9); Don't know (5).

- Should OFES organize a retreat to better define the vision, goals and evolution of the program elements in the longer term program, including an analysis of how the necessary skills can be retained?
  Yes (16); No (0); Perhaps (1).

In summary, the Committee supported budget increments in the following areas (votes in parentheses):

IFE (13)
Base Technology (10)
Materials (9)
Modeling/Theory (8)

System Studies (5)
International collaboration (4)
Alternates (4)

Further details and comments are in the responses of the individual members on a few items that received limited support, and on reasons for the various choices.

No clear position of the Committee emerged for modifying the OFES budget proposal (as indicated) on the following issue:

- Is the combined ITER plus related technologies strawman budget at the correct level:
  slightly too high (3); roughly correct (5); slightly too low (5); too low (1); [insufficient information (3)]?

The FESAC recommends that to the extent possible the proposed budget increments should be met within your discretionary funding. To the extent that funds must be found within the program, the majority of the Committee recommends that budget adjustments should be handled by the Office of Fusion Energy Sciences and yourself, taking into account the sense that economies may be found in the tokamak experimental program [the Committee felt that this budget was slightly too high (11); roughly correct (3); slightly too low (2); insufficient information (1)]; and by allowing for the points of substantial agreement in the detailed comments made by the individual Committee members.

The FESAC recommends strongly that the Office of Fusion Energy Sciences should organize a retreat soon for members of the fusion community to define the goals of the longer term program and an implementation plan. In addition, a plan needs to be developed on how to sustain critical skills in the future program.

The FESAC is pleased at the extent of the Department's support for the program and hopes that its recommendations will help to optimize opportunities for the future success of Fusion Energy Sciences.

Sincerely,

John Sheffield, Chair
Fusion Energy Sciences Advisory Committee
on behalf of the members

[1] "A Restructured Fusion Energy Sciences Advisory Program," an Advisory Report Submitted to Dr. Martha A. Krebs, Director, Office of Energy Research, U.S. Department of Energy, by the Fusion Energy Advisory Committee, January 17, 1996.

Fusion Energy Sciences Advisory Committee:

Dr. John Sheffield, Chair
Dr. Ira B. Bernstein
Dr. Richard J. Briggs
Dr. James D. Callen
Dr. Robert W. Conn (not present)
Ms. Melissa Cray
Dr. Katharine B. Gebbie (not present)
Dr. Samuel D. Harkness
Dr. Richard D. Hazeltine
Dr. Joseph A. Johnson, III
Dr. Charles F. Kennel (present first day)
Dr. Michael L. Knotek (not present)
Dr. John D. Lindl
Dr. Earl S. Marmar
Dr. D. Bruce Montgomery
Dr. Marshall N. Rosenbluth
Dr. Tony S. Taylor
Dr. Nermin A. Uckan
Dr. Stewart J. Zweben

Ex-officio members:

Mr. John W. Davis
Dr. Stewart C. Prager
Dr. Ned Sauthoff

Enclosure

Public comment speakers:
R. Bangerter (LBNL)
E. Bloom (ORNL)
D. Smith (ANL)
M. Saltmarsh (ORNL)
R. Temkin (MIT)
M. Ulrickson (SNL) (agreed with previous comments)
P. Rutherford (ITER/TAC)
T. James (ITER/USHT)

S. Dean (FPA)
M. Haynes (GA)
R. Davidson (PPPL)
D. Meade (PPPL)
R. Hawryluk (PPPL)
R. Goldston (PPPL)
T. Simonen (GA)
M. Porkolab (MIT)
H. Fleischmann (Cornell U.)
K. Thomassen (LLNL)
J. Drake (U. Maryland)
M. Reiser (U. Maryland)
M. Mauel (Columbia U.)
G. Logan (LLNL)
D. Baldwin (GA)

Written comment contributors:
M. Abdou (UCLA)
T. Godlove (FM Technologies)
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J. Herndon (ORNL)
W. Jackson (HMJ Corp.)
A. Kritz (Lehigh U.)
R. Miller (UCSD)
P. Moroz (U. Wisconsin)
G. Navratil (Columbia U.)
W. Stacey (ISCUS)
A. Staprans (CPI)