

Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee

November 14 & 15, 2000
Bethesda Ramada Hotel, Washington, D.C.

Committee Members Present:

Richard D. Hazeltine (Chair)—University of Texas at Austin
Charles C. Baker—University of California, San Diego
Vincent S. Chan—General Atomics
Jill P. Dahlburg—Naval Research Laboratory
Jeffrey P. Freidberg—Massachusetts Institute of Technology
John D. Lindl—Lawrence Livermore National Laboratory
Kathryn McCarthy—Idaho National Engineering and Environmental Laboratory
William McCurdy—Lawrence Berkeley National Laboratory
George J. Morales—University of California, Los Angeles
Gerald A. Navratil—Columbia University
Cynthia K. Phillips—Princeton Plasma Physics Laboratory
Marshall N. Rosenbluth—General Atomics
John Sheffield—Oak Ridge National Laboratory

Committee Member Absent:

Joseph A. Johnson, III—Florida A&M University

Ex-Officio Members Present:

Allen Boozer (Division of Plasma Physics, American Physical Society)—Columbia University
Kathryn McCarthy (American Nuclear Society)—Idaho National Engineering and Environmental Laboratory
Ned R. Sauthoff (Institute of Electrical and Electronics Engineers)—Princeton Plasma Physics Laboratory

Designated Federal Officer Present:

N. Anne Davies (Associate Director, Office of Fusion Energy Sciences)—U.S. Department of Energy

Others Present:

James W. Van Dam (FESAC Secretary)—University of Texas at Austin
Names of guests who were present at the meeting are listed in Appendix A at the end of these minutes.

Tuesday, November 14, 2000

1. Call to Order and Welcome of New Members

The meeting was called to order by the new chair, Richard Hazeltine, at 9:00 a.m. on Tuesday, November 14, 2000. He asked each of the FESAC members—including the incoming members, Vincent Chan (GA), Kathryn McCarthy (INEEL), William McCurdy (LBNL), and George Morales (UCLA)—to introduce themselves.

The chair noted that the agenda had been slightly revised from that posted on the FESAC web page. Copies of the revised agenda were distributed.

2. Remarks by Dresselhaus

The chair introduced Dr. Mildred S. Dresselhaus, director of the Office of Science, U.S. Department of Energy.

Dr. Dresselhaus presented remarks concerning the activities, goals, organization, and funding of the Office of Science. The funding for Fusion Energy Science, High Energy Physics, and Nuclear Physics remained flat compared to last year. Since the inflation rate is about 4%, going from FY 2000 to FY 2001 fusion would need to lose about 80 people (from a total of 1,100) unless other drastic action is taken—such as reducing planned facility

operations, deferring small enhancements to facilities, and reducing travel and consumables. Compared to other Office of Science programs, the amount of fusion funding going to universities is about average, although there is opportunity for having more students. She commented that major fusion facilities are under-utilized (by about 50%, compared to approved experiments), and that she would like to work to correct this situation.

In terms of the worldwide fusion effort, the US was 20% (\$350M) in 1995, but is currently about 16% (\$244M). Major new fusion facilities and upgrades have been built abroad.

She commented that the key finding in the recent review by the National Research Council is that fusion does excellent science. She summarized the key NRC recommendations as (1) organizing the program around fusion science issues (instead of how to develop a concept into a reactor), (2) connecting with other scientific disciplines, and (3) partnering with NSF. She wants FESAC to give the Office of Science an assessment of whether the NRC report is on target.

She gave three new charges to FESAC: a Burning Plasma Physics charge, a Theory and Modeling charge, and a Program Strategic Questions charge.

She described the Office of Science's FY 2001 budget highlights: viz., Spallation Neutron Source, High Performance Computing for Science in the 21st Century, Scientific User Facilities Upgrades & Increased Utilization, Nanoscale Science Engineering, and Life Sciences (Understanding the Microbial Cell & Microbial Genomes and Biomedical Engineering). She noted that fusion is not represented in this list of initiatives.

Dr. Dresselhaus left the meeting at 10:05 a.m.

3. Briefing on Ethics and Conflict of Interest

The chair introduced Ms. Gloria Sulton, an attorney in the USDOE General Counsel's Office. She distributed handouts entitled "Advisory Committee Management Program." Ms. Sulton gave advice on ethical issues related to conflict of interest matters and gifts from outside sources in their appointments as advisory committee members.

She commented that advisory committee members should not appear to represent or speak for the advisory committee. It is all right for an advisory committee member to say that he/she is a member of FESAC, but he/she must speak as an individual. She also noted that advisory committee members should freely participate in discussions of general policy guidance for the Department, but cautioned members to refrain from participating in matters that could result in a direct and substantial effect on their employer/employment. Such participation may be viewed as lobbying for the benefit of such non-governmental interests and have the effect of tainting the validity of the advisory committee's final recommendations. Although its members represent various institutions, an advisory committee should be a collegial body that advises for the general good of the national program.

4. Recess and Reconvene

The chair recessed the meeting at 10:15 a.m. for a break and reconvened it at 10:30 a.m.

5. FY 2001 Budget

Anne Davies discussed activities of the US Fusion Energy Sciences Program, in particular, the FY 2001 budget (compared to the FY 2000 budget) and plans for the FY 2002 budget. In FY 2001 there is \$5.1M in "new" money, compared to the FY 2001 congressional request. She described how this money was allocated within the program.

She noted that the National Nuclear Security Agency and the DOE Office of Science are cooperating on inertial fusion energy. Monthly meetings are held to discuss planning, budgets, and program coordination. The IFE program continues to depend on the ICF program for high energy density physics information for target design. In FY 2001, Congress provided \$25M in the NNSA budget for high-average-power laser research. OFES and NNSA will cooperate on inertial fusion science including high-average-power laser development.

In response to a question about whether some part of the NNSA \$25M will go outside the defense labs, she answered that about half of it will go to NRL for krypton fluoride laser work, with another significant fraction to LLNL, also for lasers.

She noted that the Advanced Computing money in the OFES budget is part of the \$70M initiative that Dr. Dresselhaus described, for which the soliciting of proposals will begin soon.

6. Dahlburg Begins Attendance

FESAC member Jill Dahlburg began to attend the meeting at approximately 11:00 a.m.

7. Presentation of DOE Distinguished Associate Award

Anne Davies presented a DOE Distinguished Associate Award signed by the Secretary of Energy to Dr. Everett Bloom of Oak Ridge National Laboratory for his pivotal role in leading the USDOE program in fusion materials research.

8. Briefing on Outreach and Communications Activities in the Office of Science

The chair introduced Mr. Rick Borchelt, a member of the DOE Office of Science's Office of Planning and Analysis, who presented a briefing about outreach and communications activities in the Office of Science.

He described a program called "Research Roadmap for the Communication of Science and Technology in the 21st Century." This effort was initially chartered by the NASA/George C. Marshall Space Flight Center. Its 3-year charter began in 1998. It has two focuses: (1) set a research agenda for S&T communication, and (2) identify and articulate "best practices" in the public communication of S&T from (mostly US) research institutions.

He reported a number of findings that have been learned from a study of the best practice of scientific communication.

9. Briefing on a New Approach to the Annual Budget Narrative

The chair introduced Mr. Bill Valdez, Director of the Office of Science's Office of Planning and Analysis. Mr. Valdez presented a talk entitled "Strategic Management Systems: Performance Measures and GPRA."

He described the elements of strategic management system framework: viz., Planning; Budget Formulation; Budget Execution; and Program Evaluation. GPRA (the Government Performance Review Act, now a law) is an import from private industry. GPRA works quite well for certain programs (e.g., Social Security), fairly well for others (e.g., technology), but not so well for science programs (due to their high degree of failure, unpredictable results, and large amount of serendipity). GPRA depends on being able to predict the results.

The Office of Science is responding to GPRA with the following: (1) A 3-year benchmarking study of management practices of publicly funded science organization. (2) SPIRE—a deep analysis data-mining tool for portfolio analysis. (3) Innovative evaluation techniques—case studies, international benchmarking, quantitative measures. (4) A foresighting study of international science trends.

10. Recess and Reconvene

The chair recessed the meeting at 12:10 p.m. for lunch. He reconvened the meeting at 1:30 p.m.

11. Status of Integrated Program Planning Activities Report and Brochure

Charles Baker, chair of the Integrated Program Planning Activities (IPPA) Working Group, described the status of the working group's activities.

He briefly reviewed the major changes that had been made to the IPPA main report since the July FESAC meeting:

- Listed key scientific questions (Appendix III) in Section 2.0; revised IFE questions.
- Scientific questions added to MFE Goal 1, Section 3.1.
- Burning plasma issue in context of international programs and ITER.
- Revised Section 3.3.3 on Burning Plasma
- Some specific improvements in sections on ST, RFP, stellarator (and added sub-section on ET)
- References to NIF and relationship to IRE decision
- Addition of references to IFE pulsed power/Z-pinches in Section 3.5.
- References to LMJ removed.

He reported that the IPPA Working Group had decided to also write a "short version" brochure. Contributors were Dave Baldwin, Steven Dean, Jeffrey Freidberg, Richard Hazeltine, Mark Haynes, William Kinsella, Karen Kline (editor, LLNL), Grant Logan, and Ned Sauthoff. This is meant to be a booklet (about 18 pages). It is not done yet. He invited FESAC members to send him comments later. The contents of the short-version brochure are: (1) Introduction; (2) Approaches to Fusion; (3) Why Pursue Fusion Energy Science; (4) Fusion Energy Science Program—(a) Mission, Policy Goal, Program Goals, (b) Basic Science, IFE, Integrated Worldwide Program,

Interconnection Theory/Experiment/Technology; (5) Achieving the Goal—The Path Forward (Scientific Understanding, Innovative Experiments, Advanced Technology); (6) Measuring Progress in Fusion Science.

In response to comments from FESAC members about the short-version booklet, Baker agreed to include mention of the excitement of the opportunity to work with scientists all over the world and of the contributions to low-temperature plasma physics (e.g., etching, plasma lamp).

12. Discussion of Burning Plasma Physics Charge

The chair presented the new FESAC charge from the director of the Office of Science concerning burning plasma physics (text of the charge in Appendix B of these minutes). The charge letter requests a response by July 2001. The chair led a discussion of this charge.

In response to a question whether this charge also includes IFE and Magnetized Target Fusion, Anne Davies responded that it does not include IFE, but it may include MTF.

The chair announced that he has asked Jeff Freidberg to chair a panel to address this charge. The chair asked FESAC members to send names of suggested panel members to Freidberg and himself.

In response to a question about the time scale for responding to this charge, Hazeltine replied that an informal progress report from the panel is desired by the time of the next FESAC meeting, which will probably be held in February 2001.

Jerry Navratil described the UFA-sponsored Workshop on Burning Plasma Science that will be held December 11-13, 2000, at the University of Texas at Austin. He distributed copies of the announcement and showed a number of pages from the workshop's web site <w3fusion.ph.utexas.edu/bpsworkshop>. The workshop will focus on addressing five questions. Breakout sessions will be held in four topical areas: (1) Energetic alpha particle physics; (2) Self-heating, transport, and confinement at reactor scale; (3) Macro-stability in a self-heated burning plasma; and (4) Relation of burning plasma science to other fields. A report summarizing the range of views and degree of consensus reached will be prepared at the end of the workshop.

13. Discussion of Program Strategic Questions Charge

The chair presented the new FESAC charge from the director of the Office of Science concerning strategic questions for the fusion program (text of the charge in Appendix C of these minutes). These questions are organized into three categories: (#1) Priorities and balance within the program; (#2) FESAC reaction to the draft NRC report; and (#3) Comparison of the US fusion program with world programs. The charge letter requests a response by mid-December 2000.

The chair requested that each FESAC member be prepared to briefly give his/her own response to question #2 of this charge tomorrow morning, after hearing the NRC Report briefing scheduled for tomorrow.

The chair then asked FESAC members individually to respond to the questions in categories #1 and #3 of this charge.

McCurdy said that the IPPA document looks more like a catalog, rather than a guide for how to direct the program. He had no comment on #3.

Navratil said, concerning #1, that the Knoxville report had a rationale for a 5-year plan, and IPPA is trying to flesh things out. Since we didn't get the budget requested, we are already behind the 5-year plan. The plan was predicated on certain budget levels, but these are now lagging the plan.

Dahlburg said, concerning #1, that there was a good strategy at Knoxville. She is still comfortable with that strategy and the fallback options. Concerning #3, she commented that this is more of an issue for confined fusion, than for inertial fusion.

Chan said, concerning #1, that a parallel roadmap is needed that maps out scientific issues. The community roadmap is based on machines and concepts. Concerning #3, he asked whether this would be a competitive or a collaborative comparison. Both should be done.

Freidberg said that his responses to the respective questions in category #1 are yes, yes, and yes. He said that he thinks that IPPA does not provide a guide. His responses to the respective questions in category #3 are no, no, and no. The US is no longer among the leaders in the experimental program. The US has many studies and plans, but is not able to respond quickly.

Sheffield said, concerning #1, that those goals were set against budgets. He agreed with Navratil that if we don't get these budgets, we fall behind. Concerning #3, he said that the FESAC Opportunities document does list science issues and the ability to cross-map; that document did do something, although maybe more could be done. We could make a list and rank the US program internationally in various areas, then add up the scores.

Rosenbluth agreed with Freidberg. Generally the program is consistent with the Knoxville report. The strategic vision for 5 years is still valid. Some of those goals were too optimistic (a "wish list"), and are even more optimistic now. IPPA is problematic—it is opposed to the NRC thrust and suffers from fuzzy metrics. Hence, he said that his response to the question about IPPA is, No. Concerning #3, he said that we probably all agree on the strengths and weaknesses of the US program.

Morales said that he does not endorse the IPPA document. Concerning #3, he commented that overall, the US is no longer the leader in the fusion field.

Phillips said that the September 1999 Priorities and Balances document is still pretty much valid. The IPPA report gave background to Priorities and Balances, but provided no guide (perhaps it will be forthcoming?). Concerning #3, she said that the US is on verge of falling behind. Maybe it is not yet discounted as a world leader.

Boozer said, concerning #1, that the program does not have to claim the need for a radically different program, but also it should not fail to respond to the NRC report. Concerning #3, he commented that categories are critical. It is ridiculous to say yes or no concerning the whole program. We need to define areas of excellence by December 15. The absolute size of tokamak experiments would be a category in which the US is lacking.

Baker said, concerning #1, that last year's Priorities and Balances report still stands, although the budget got behind. IPPA is a bit of a catalog, not a hard-hitting plan. It does not include hard-hitting metrics and milestones—but this is about as far in this direction as this community is able to go, without screams of protest. Concerning #3, he said that international benchmarking should to be done thoughtfully. Yes, we in the US are still world leaders—but not a strong Yes. We are slipping in a number of areas.

McCarthy said, concerning #1, that the 1999 Priorities and Balances document is still valid. We do need to review the budget levels. These are goals, after all. She said that IPPA is not a guide, but she doesn't know how it could have been improved, having worked on it herself. Concerning #3, she said that the US is slipping. International collaborations are extremely important in order not to lose technical capabilities in areas where we are slipping.

Lindl said, concerning #1, that the Priorities and Balance document is still valid. Budget levels have not materialized; hence progress will be slower. We should tell Dresselhaus where additional money would help. Inertial fusion thinks IPPA does provide a guide, with deliverables, as long as the budget is achieved. Hence inertial fusion is happy with it as a guide. It has more structured deliverables for IFE. Concerning #3, he said that the US does have leadership in IFE. The US has the potential to become the leader in energy applications in IFE. In MFE, we should say that the US have initiated a thrust in alternate concepts, but the funding is such that may be difficult to impact world program on a reasonable time scale.

Sauthoff said that his responses to the questions in #1 are yes, yes, and yes. IPPA was an attempt to structure the program on the basis of MFE and IFE goals. It is a structure that takes the six goals and then attempts to go deeper, showing how these goals could be implemented (not "should" be implemented). Consequently IPPA reads like a database. It does not provide a guide, but it does provide a structure. However, the program will have to fill in the database, which is currently empty. It won't be useful until there is a deliberate effort to fill out the database. #3—Simple statements can be made. Foreign program leaders will say their programs are energy programs, whereas we will say the US program is a science program. Are we "among" the leaders? Yes, in several areas, although I can't give an explicit list quickly. I would not say that the US is the undisputed leader. I agree that the US is slipping in some areas. My quick response is that the US needs access to international programs. We should ask ourselves whether the US would receive invited talks to a "virtual" international meeting.

14. Recess and Reconvene

The chair recessed the meeting at 3:08 p.m. for a break and reconvened it at 3:30 p.m.

15. Discussion of Theory Program Review Charge

The chair recused himself and asked Charles Baker to present the new FESAC charge from the director of the Office of Science concerning a review of the fusion science theory program (text of the charge in Appendix D of these minutes). Baker assumed the chair at 3:32 p.m.

Baker introduced the charge, with its five associated questions concerning the theory and computation program's overall content, plans, structure, and governance, and three more questions specifically concerning program governance. The due date for a response is May 1, 2001.

Baker reported that John Sheffield has been asked to chair a panel to address the theory program review charge. He asked FESAC members to send names of suggested panel members to Sheffield and himself. In response to a suggestion from a FESAC member, Baker agreed that the panel should have some experimentalists among its members and also possibly scientists from outside fusion and foreign scientists.

Baker summarized the consensus opinion that emerged during the discussion, namely, that FESAC should interpret this charge in a broad context (e.g., addressing not only programmatic management, but also current opportunities for theory and scientific computing and modeling).

The panel will provide an informal progress report at the next FESAC meeting.

Hazeltine resumed the chair at 4:10 p.m.

16. Public Comments

By common consent FESAC agreed with the chairman's recommendation that all the public comments would be scheduled today, since the NRC item of business tomorrow will require more time for discussion.

The chair introduced those persons who had expressed a desire to make public comments.

David Baldwin (General Atomics):

He noted that two dimensions are not addressed in the FESAC burning plasma charge. (1) Length of the pulse—how long, and reasons for it. This is related to the interaction of burning plasma and advanced tokamak physics. (2) Whether there is generic science. Tokamak knowledge has been successfully transferred to alternate concepts, and the same success should be expected with burning plasmas.

He noted that two years ago when FESAC came to General Atomics for its meeting, there was the question of disruptions in tokamaks. Disruption avoidance will emerge naturally with increased understanding of stability and steady-state operation. He reported that the DIII-D tokamak has recently obtained some first results, which show that precise control near the beta limit is the key to avoiding disruptions. The MSE diagnostic shows that the current density profile has reached resistive equilibrium with q on axis of about 1.5. Hence, constant profiles can be held in stable regions of operating space, the disruption problem is mastered. Therefore this result addresses the question that was asked at the FESAC meeting a year and a half ago.

Richard Siemen (Los Alamos National Laboratory):

He noted that building a consensus for a burning plasma experiment has been difficult. The community certainly has a "yearn to burn," but a vocal minority has misgivings about the need for such an experiment, largely related to cost effectiveness. The upcoming UFA workshop is a good thing, based on the grassroots, to build a consensus. The question about identifying burning plasma issues that are not accessible in existing machines can be inverted to ask what can be done on existing machines, since people are still unconvinced about cost-effectiveness of a full burning plasma experiment. Alternate concepts were told to go away on this basis. The question must be addressed of why this larger facility is really needed.

Steve Dean (Fusion Power Associates):

He stated that a panel's advice could be predicted on the basis of what is the charge and/or what is the composition of the panel. We should not over-react to advice from committees (e.g., FuSAC). He said he thinks that the FuSAC advice is not inconsistent with the advice from the SEAB and PCAST panels; FuSAC just looked at it from a different point of view.

He said that the reason for the last minute Strategic Questions charge from Dresselhaus is her concern that our community might take a right-angle turn and change gears on her. He advised not discarding previous advice, but rather adding on the best of the new advice. FuSAC acknowledged that their charge was to review the science of MFE, not IFE or technology. Hence it did not review the entire fusion science program. Hence their advice does not apply across the board. We have also a responsibility to develop the inertial program and to integrate it into fusion, and to develop and find innovative concepts (not just for generic science, but because they have particular advantages). It is not sufficient to evaluate things once every ten years (contrary to the FuSAC report or the OMB examiner). The FuSAC report is fine, in spite of some criticisms of the energy goal. We're not running a program that just responds to the FuSAC report.

He noted that Dresselhaus said she needs an initiative. There isn't time for a brand-new full-blown initiative. He recommended proposing (1) advanced computing, and (2) increased facilities utilization.

Franco Porcelli (Torino Polytechnique, now visiting MIT):

He reported that an international panel set up by Dr. R. Pellat, High Commissioner of the French C.E.A., has proposed establishing an international study group on burning plasma. (This panel's report will be issued shortly.) The objective of this international study group would be to promote a broader scientific dialogue among plasma physicists and fusion researchers, and to develop a deeper scientific basis, common guidelines, and methodologies in support of the international burning plasma experimental program. The group will not have as one of its objectives the proposing or backing of specific next-step experiments.

This group would be structured to operate as a network of participating plasma scientists around the world, who would contribute part of their time to the group activities, while remaining affiliated with their respective institutions. A core group should integrate the progress on the various network activities. Also the core group would propose relevant plasma physics issues and contribute to their solutions; promote fusion physics as basic plasma science; and contribute to the training of young scientists. The core unit would have a leader and 4 or 5 experienced fusion scientists (full time), plus 6-10 young researchers at the Ph.D. and postdoctoral level, plus a think-tank of visiting scientists (up to 10 man years/ year).

Its funding should not come from a single source. For the same reason and also because it makes scientific sense, this group should be international in character.

Bick Hooper (Lawrence Livermore National Laboratory):

He addressed the subject of burning plasmas from the viewpoint of innovative concepts. In the near term, a burning plasma will almost surely be a tokamak (or maybe a spherical torus). How, therefore, does the innovative confinement concepts community identify issues? One high-level issue is the effect of alpha particles. The UFA meeting on burning plasma science should address these high-level questions. The Innovative Confinement Concepts community is discussing whether to have a spring meeting; if it does, it might address burning plasma issues in one of its sessions.

He commented that fusion physicists should express their scientific issues in such a way that the rest of the scientific community can access them.

Ron Stambaugh (General Atomics):

He stated that leadership in making progress toward fusion energy has moved abroad. However, leadership in fusion science involves more than facilities. The US remains a leader in fusion science, although some countries have pulled abreast. In order to be able to capitalize on discoveries, we should remain in the business of making some discoveries. Flat budgets put pressure on the equipment situation, and then on personnel. Foreign programs have better facilities currently. Maximal utilization of national facilities should be an emphasis.

He said that he applauds the increase in theory funding for FY 2001. He is especially excited by the ability to calculate transport. However, machine run time and technology have been cut back. Can they keep pace with theory? Proposals for what can be done on current facilities to explore electron transport are interesting; however, a new facility may be needed for these investigations. Could this be a new initiative to promote?

He commented that the FuSAC report should be read thoughtfully. Its main conclusion on page 1 (i.e., that the quality of fusion science is easily on par with that of other fields) should be the headline. Also, he noted that the italicized statement in the FuSAC executive summary gives validity to the energy goal. However, the problem of communication must be addressed. The focus on the energy goal is not the reason for the isolation. Almost every scientific field is disconnected and disinterested in other fields. We need to engage them in what we are doing and meet them on their ground. We used to involve atomic physicists. In divertors and erosion codes, we can still do this. These are linkage areas where we can reach out to atomic, nuclear, chemical, and materials science.

He stated his opinion that the FuSAC panel was misguided on the issue of science versus performance. For the last five years, we have done nothing but science. The DIII-D program has been one of scientific investigations.

He said that the FuSAC report was also a little too critical about the stages of development. The language and the structure of the development stages could be interpreted as being too concept-oriented; however, it has eliminated bickering and unified the field. Still, the program needs to be described in terms of scientific objectives.

Miklos Porkolab (Massachusetts Institute of Technology):

He commented about the educational aspects of fusion science. At MIT, the number of fusion students has increased. This year there were 22 new students. Was it because of better outreach? It was because of excitement about new research opportunities (e.g., dipole experiment, advanced tokamak research with transport barriers and profile control, etc.).

He noted that high temperature fusion has a natural outreach to astrophysics—but that this outreach is difficult.

Concerning the request for new initiatives, he proposed (1) upgrading diagnostic capabilities—e.g., the electron transport regime needs zonal flow measurements and fluctuation imaging; (2) upgrading profile control tools—e.g., the pressure profile (for bootstrap current), which would have an impact on whether we can deliver an advanced tokamak in several years; and (3) upgrading facility utilization.

17. Groups to Compose Response to the Strategic Questions Charge

The chair requested that FESAC members write a paragraph or two in response to the new Strategic Questions charge. He proposed writing a letter of no more than about 2 pages. He set up two small groups: Navratil and Lindl (to draft a response to the first group of questions), and Sauthoff and Chan (to draft a response to the third group of questions). These two groups will report tomorrow morning with written drafts.

18. Appreciation Expressed to the Former FESAC Chair

The chair expressed high appreciation for John Sheffield's effective leadership as the previous chair of FESAC.

19. Recess

The chair recessed the meeting at 5:10 p.m. for the evening.

Wednesday, November 15, 2000

20. Reconvene

The chair reconvened the meeting at 9:00 a.m. on Wednesday, November 15.

FESAC member Ned Sauthoff was absent during today's meeting.

21. Briefing on the Report of the NRC Fusion Assessment Committee

The chair introduced Dr. Robert Rosner, professor of astrophysics at the University of Chicago and a member of the Steering Committee of the National Research Council's Fusion Science Assessment Committee (FuSAC).

Dr. Rosner presented a briefing on the findings and recommendations in the recently released NRC FuSAC report. Dr. James Drake (University of Maryland), another member of the FuSAC Steering Committee, also participated in the discussion.

Rosner noted that of the 15 FuSAC panel members, only five were fusion scientists.

Rosner first briefly summarized the NRC findings and recommendations as follows:

- Fusion research has led to great science and technological innovation, on a par with that in other fields of science.
- Fusion science is isolated. The science is not widely appreciated outside the program.
 - There is reduced respect and credibility for the field on the "outside."
 - It is difficult to replace faculty at major research universities.
 - Selling of new initiatives is much more difficult.
- Over-arching scientific themes should play a greater role in program decision making and organization.

Charles Kennel joined the meeting at 10:12 a.m. by speaker telephone.

Rosner then listed and described in some detail each of the 13 Findings and seven Recommendations of the NRC report. This presentation was interspersed with discussion by FESAC members.

In response to a request for some examples of successful centers that are multidisciplinary and focus on range of problems, Rosner mentioned the NSF Center for Astrophysical Research in Antarctica and the ASCI Center for Astrophysical Thermonuclear Flashes.

A FESAC member commented that the FuSAC report does not mention collaborations with NASA. Kennel agreed that these would be possible.

In response to a question, Rosner agreed that distributed-type centers might be able to satisfy the FuSAC recommendation for the establishment of new centers.

Kennel commented that FuSAC discussed two levels of periodic review: (1) community-wide review, and (2) review of the wider outlook for fusion. With the first type of review, there is a natural desire for program stability to get the job done and for program evolution. A regular schedule of reviews, advertised and open, would allow for new ideas to be aired at these times and still permit stability. For the second type of review, a broad-scale international assessment would demonstrate progress in the program, remind the world of the importance of the fusion energy endeavor, and also indicate the importance of science for the achievement of this goal.

A FESAC member noted that the plasma community is under-represented in the National Academy. Kennel replied that this indicates a lack of broader understanding of and appreciation for the scientific implications of fusion science research. Also, in the National Academy of Science, there is no clear focus on where plasma physics fits—whether in physics, astrophysics, applied math, or condensed matter. He mentioned that there is a group of plasma physicists who want to try to remedy this situation.

Kennel promised that he would be involved actively to present and promote the findings and recommendations of the NRC FuSAC report to policy makers. He ended his participation (by telephone) in the meeting at 10:55 a.m.

22. Recess and Reconvene

The chair recessed the meeting at 10:55 a.m. and reconvened it at 11:10 a.m.

23. Response to Strategic Questions Charge, Part 2

The chair presented a draft that he had written to respond to the second part of the Strategic Questions charge, the part concerning the NRC Report. FESAC members commented on this draft.

24. Response to Strategic Questions Charge, Part 3

The chair presented a draft written by Sauthoff and Chan to respond to the third part of the Strategic Questions charge, concerning international standing. FESAC members commented on this draft.

25. Response to Strategic Questions Charge, Part 1

The chair presented a draft written by Navratil and Lindl to respond to the first part of this charge, concerning the 1999 FESAC Priorities and Balance document.

Some FESAC members disagreed whether the IPPA report provides a satisfactory guide for program direction. The chair proposed taking IPPA out of the response, except to say that it is underway.

The chair said that he would do a re-edit and zeroth-order rewrite, and then circulate it by email to FESAC members for their comments and approval before sending it to Dr. Dresselhaus.

24. Date of Next Meeting

The next FESAC meeting was scheduled for Tuesday and Wednesday, February 27 and 28, 2001, to be held in Gaithersburg, MD.

25. Adjourn

The chair adjourned the meeting at 12:00 p.m.

Minutes submitted by: James W. Van Dam, FESAC Secretary

Approved by: Richard D. Hazeltine, FESAC Chair

APPENDIX A: Guest List (partial)

Name	November 14	November 15
David Baldwin—GA	X	X
Roger Bangerter—LBNL	X	X
Everett Bloom—ORNL	X	
Curt Bolton—DOE/OFES		X
Rick Borchelt—USDOE	X	
David Cherington—PPPL	X	
Mike Crisp—DOE/OFES	X	
Ron Davidson—PPPL		X
Steve Dean—FPA	X	
James Decker—DOE/SC	X	
James Drake—U. Maryland		X
Mildred Dresselhaus—DOE/SC	X	
Steve Eckstrand—DOE/OFES	X	X
Ray Fonck—U. Wisconsin		X
Rob Goldston—PPPL	X	
Richard Hawryluk—PPPL	X	X
Mark Haynes—GA	X	X
Mike Holland—OMB		X
Bick Hooper—LLNL	X	X
Arnold Kritz—Lehigh U.	X	X
Chuan Liu—U. Maryland		X
Grant Logan—LLNL	X	X
Darlene Markevich—DOE/OFES	X	
Warren Martin—DOE/OFES	X	X
Dale Meade—PPPL	X	X
Stan Milora—ORNL	X	X
Erol Oktay—DOE/OFES	X	X
Albert Opdenaker—DOE/OFES	X	X
Franco Porcelli—MIT/Torino Polytechnic	X	
Miklos Porkolab	X	X
Howard Powell—LLNL	X	X
Michael Roberts—DOE/OFES	X	X
Robert Rosner—University of Chicago		X
Walter Sadowski—DOE/OFES	X	
John Sauter—DOE/OFES	X	
John Schmidt—PPPL	X	
Don Shapiro—NRC	X	
Richard Siemen—LANL	X	
Ron Stambaugh—GA	X	X
Gloria Sulton—USDOE	X	
Bill Valdez	X	
John Willis—DOE/OFES	X	X
Scott Willms—LANL	X	X

APPENDIX B: Burning Plasma Physics Charge

October 5, 2000

Professor Richard D. Hazeltine, Chair
Fusion Energy Sciences Advisory Committee
Institute for Fusion Studies, RLM 11.218
University of Texas at Austin
Austin, TX 78712

Dear Professor Hazeltine,

For many years, the U.S. magnetic fusion community has recognized that burning plasma physics is the next frontier of fusion research. In this regard, it is important to note that the September 1990 Fusion Policy Advisory Committee report recommended "...construction as soon as possible of the U.S. Burning Plasma Facility." In the last two decades, the program has made several attempts, both international and domestic, to move forward on design and construction of a tokamak experimental device in which the science of burning plasmas could be explored. For various reasons, all these attempts failed.

In the last few years, the U.S. fusion community has reconsidered its priorities and reorganized its efforts. The FESAC Report on Priorities and Balance within the Fusion Energy Sciences Program includes burning plasma physics as a part of a major thrust area, and the draft Integrated Program Planning Activity report includes a section on two aspects of this issue. Therefore, I would like FESAC to address the scientific issues of burning plasma physics, as follows:

1. What scientific issues should be addressed by a burning plasma physics experiment and its major supporting elements? What are the different levels of self-heating that are needed to contribute to our understanding of these issues?
2. Which scientific issues are generic to toroidal magnetic confinement and which ones are concept-specific? What are the relative advantages of using various magnetic confinement concepts in studying burning plasma physics?

As part of your considerations, please address how the Next Step Options program should be used to assist the community in its preparations for an assessment in 2004, as recommended in the Priorities and Balance report.

I would like you to provide your report to the Office of Science by the end of July 2001.

Sincerely,

/s/

Mildred S. Dresselhaus
Director
Office of Science

APPENDIX C: Fusion Program Theory Review Charge

November 9, 2000

Professor Richard D. Hazeltine, Chair
Fusion Energy Sciences Advisory Committee
Institute for Fusion Studies, RLM 11.218
University of Texas at Austin
Austin, TX 78712

Dear Professor Hazeltine,

This letter provides a charge to review a specific element of the Office of Fusion Energy Sciences (OFES) program—the theory and computation program. Since the restructuring of the fusion program in 1996, most elements of the program have been reviewed by the Fusion Energy Sciences Advisory Committee (FESAC). The theory and computation program is the only major element remaining to be evaluated. Recent changes in the OFES review processes for the theory and computing program make this an opportune time to review the theory and computing program.

The Fusion Energy Advisory Committee report *A Restructured Fusion Energy Sciences Program* noted that “theory and modeling, in conjunction with experiment, provide the capability at the core of the scientific research endeavor.” The recent draft *Assessment of the Department of Energy’s Office of Fusion Energy Sciences Program* prepared by a National Academy of Sciences committee recommended that increasing scientific understanding of fusion relevant plasmas should become a central goal of the fusion program. It also recommended that the program should be open to evolution in terms of content and structure as it continues to strengthen its portfolio of research. Because the National Academy of Sciences committee has already provided a detailed review of the scientific quality of the fusion program, FESAC should focus its effort on reviewing the theory and computation program’s overall content, plans, structure, and governance.

In reviewing the theory and computing program, I request that the review address at least the following questions:

1. What is the appropriate role of theory and computation in the OFES program? Is the current balance between theory/computing and the rest of the fusion program reasonable?
2. Is the current structure and balance between the elements of the theory/computing program appropriate? What changes, if any, are needed in program content?
3. Several groups and numerous individual investigators at many institutions carry out theory/computing research. Is the distribution of research among these research performers appropriate? Are there structural changes that would make the program stronger?
4. In many areas of physics “modeling/simulation” studies are now viewed as a third discipline, distinct from both experimental and theoretical studies. How effectively are the modeling/simulation and theory communities working together to support the needs of the rest of the fusion program?
5. How should the modeling/simulation efforts be conducted to increase their contribution to the overall program, considering issues such as code proliferation, legacy codes that are expensive to maintain and difficult to upgrade, introduction of modern computational techniques, and formation and functioning of multi-institutional modeling/simulation teams?

In reviewing program governance, FESAC should consider the following topics: planning and goal setting processes, merit review procedures, and coordination of international collaboration. Specific questions FESAC may wish to consider include:

1. Are the current management practices of the program, such as program planning and merit review, sound?

2. Is the role of various organizations in managing certain elements of the program reasonable (e.g., IFS coordination of the Joint Institute for Fusion Theory {with Japan} or PPPL coordination of the Plasma Science Advanced Computing Initiative)?
3. What management changes would strengthen the program?

Please carry out this review using experts outside of FESAC membership as necessary. Complete this evaluation and provide recommendations for the theory and computing program by May 1, 2001, as this advice will be important for supporting the FY 2002 budget.

I appreciate the time and energy that members of FESAC and FESAC panels have provided to these continuing efforts to evaluate and to improve the OFES program. I am confident that the Committee's findings and recommendations on the theory and computing program will also benefit the OFES program.

Sincerely,

/s/

Mildred S. Dresselhaus
Director
Office of Science

APPENDIX D: Program Strategic Questions Charge

November 13, 2000

Professor Richard D. Hazeltine, Chair
Fusion Energy Sciences Advisory Committee
Institute for Fusion Studies, RLM 11.218
University of Texas at Austin
Austin, TX 78712

Dear Professor Hazeltine,

A year ago, FESAC completed its review of the restructuring of the Fusion Energy Sciences program and submitted its report on the priorities and balance in the program. After a year, and the recent review by the National Research Council, I would like to ask FESAC views on several strategic questions for the fusion program.

First, are the priorities and thrust areas called out in the September 1999 Priorities and Balance report still valid for this program? Is the strategic vision for five years out still valid? Are the five-year goals for each thrust area still valid? Does the Integrated Program and Planning Activity report provide a guide for how to achieve the five-year vision?

Second, I would like to have FESAC reaction to the draft NRC report. Are the findings and recommendations consistent with the priorities of the program as seen by FESAC? If not, what are the inconsistencies? Are any changes in direction called for now, in light of either the NRC report or scientific and technical results in the program?

Third, please compare the U.S. fusion program with fusion programs abroad. Given the contraction of the program, are we still among the world leaders in fusion science? Are we capable of responding quickly to breakthroughs in fusion research abroad?

A letter report by mid December would be sufficient.

Sincerely,

/s/

Mildred S. Dresselhaus
Director
Office of Science