

Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee

March 1-2, 2007
Marriott Hotel, Gaithersburg, MD

Members present:

Dr. Charles Baker, Sandia National Laboratories
Prof. Riccardo Betti, University of Rochester
Dr. Richard Callis, General Atomics
Dr. Jill Dahlburg, Naval Research Laboratory
Prof. Jeffrey Freidberg, Massachusetts Institute of Technology
Dr. Martin Greenwald, Massachusetts Institute of Technology
Prof. Richard Hazeltine, University of Texas-Austin
Prof. Joseph Johnson, Florida A & M University
Dr. Rulon Linford, Lawrence Livermore National Laboratory
Dr. Kathryn McCarthy, Idaho National Laboratory
Prof. Gerald Navratil, Columbia University
Prof. Stewart Prager (chair), University of Wisconsin-Madison
Dr. John Sheffield, University of Tennessee, Joint Institute for Energy and Environment
Prof. Edward Thomas, Auburn University
Dr. Michael Zarnstorff, Princeton Plasma Physics Laboratory

Members absent:

None

Ex-officio members present:

Dr. Vincent Chan (APS-DPP), General Atomics
Dr. Jeffrey Latkowski (ANS), Lawrence Livermore National Laboratory
Dr. John Steadman (IEEE), University of South Alabama

Ex-officio members absent:

None

Designated Federal Officer present:

Albert Opdenaker III, Executive Assistant for Fusion Energy Sciences, US Department of Energy

FESAC Executive Secretary:

Dr. John Sarff, University of Wisconsin-Madison

Other persons attending the meeting are listed in the appendix.

Action items from the meeting:

1. FESAC members have one week following the meeting to provide final input on the PART assessment report.
2. A panel will be appointed to begin work immediately on preparing a report to FESAC responsive to the new charge.
3. At its next meeting, FESAC will consider possible next steps in assessing progress and issues in workforce development.

1. Meeting Logistics and Agenda Approval.

The meeting was called to order at 8:30 am. Prof. Prager welcomed new FESAC members Drs. Vincent Chan and Jeffrey Latkowski. He also relayed the exciting news that Prof. Raymond Fonck has been appointed Associate Director for the Office of Fusion Energy Sciences effective Mar. 1. He also noted that the fusion community owes a huge debt of gratitude to Dr. Thomas Vanek for serving as the acting Associate Director.

Prof. Johnson raised the question of reviewing the recommendations of FESAC's work force development study. He claimed that the Office of Science appears to be lagging other agencies in implementing recommendations resulting from parallel work force development studies. He requested that this issue be added to the agenda or a future FESAC meeting's agenda. Prof. Prager acknowledged the importance of this issue. A discussion of possible next steps in assessing progress and issues in workforce development will be scheduled for the next meeting of FESAC.

Additional discussion on the PART assessment was added to the agenda as the first item of business on the second day of the meeting.

2. Annual Ethics Briefing.

Ms. Tina Hymer of the Office of the General Counsel conducted an ethics training session for FESAC members. This ethics training and disclosure of potential conflicts of interest are required annually for FESAC members. She reports that analysis of the disclosure information provided by the FESAC members found it unlikely that any waivers will be required. If members have questions regarding potential conflicts of interest as they arise, they may contact FESAC's designated federal officer, Mr. Al Opendaker.

3. Panel Report: Progress toward PART Measures.

Prof. Navratil presented the modified draft report *Assessment of Progress towards Long Term Goals of the Fusion Energy Sciences Program*. He reviewed the PART long term goals established by OFES and OMB and the strategy to use intermediate milestones as the method to illustrate and characterize progress in achieving the long term goals. Since the last FESAC meeting, two other communities have completed their PART analysis. The high energy physics community adopted a strategy similar to FESAC's approach.

FESAC discussion: Generally FESAC agreed with the style and approach of the assessment, but there was discussion regarding the particular content and the way it would be perceived. For example, the assessment judges the progress "excellent," yet the definition of excellent for purposes of the assessment describes a level of accomplishment that has not yet been achieved.

The credibility of the assessment might therefore be damaged. It was recommended that the report make clear that there is “excellent progress,” so that the meaning is clear and accurate. There was also discussion on whether or not it is wise to attach specific dates to the intermediate milestones. Dr. Vanek noted that one of the assessment’s main audiences is OMB, and that having specific dates is indeed the best approach. There was also discussion on how recent changes in the management of the high energy density plasma and inertial fusion components of the program might impact the assessment, since one of the three long term goals covers this area of research. Prof. Navratil explained that the long term goals are not negotiable at this time, so the assessment needs to include this area. There were also concerns expressed that the whole committee was not given adequate time to review the draft report prior to this meeting.

FESAC voted to accept the report, subject to the requirement that no substantive change in content would occur in any final revisions following the meeting. FESAC members will be given approximately one week following the meeting to provide additional editorial input.

4. U.S. Burning Plasma Organization: Status Report.

Dr. James W. Van Dam (University of Texas and USBPO Director) described organizational changes and activities occurring in the U.S. Burning Plasma Organization (USBPO). A number of changes in USBPO leadership have occurred in recent weeks. Dr. Van Dam takes over as USBPO Director from Prof. Raymond Fonck (the new Associate Director of OFES). Dr. Charles Greenfield (GA) will be taking over the Deputy Director position formerly held by Dr. Tony Taylor (GA). Dr. Amanda Hubbard (MIT) is the new Chair of the USBPO Council, and Dr. Michael Zarnstorff (PPPL) is the new Vice Chair of the Council. Dr. Van Dam stressed the importance of U.S. involvement in the upcoming ITER design review. A number of physics tasks and issue cards have been submitted to the ITER organization. It is important that appropriate technical expertise be involved in these processes, and Dr. Van Dam reports good cooperation and support are being provided by the major project leaders.

FESAC discussion: The status of the NRC review of the report on US participation in ITER submitted to Congress under the Energy Policy Act was discussed. Dr. Vanek explained that this is in progress and the review work will begin soon.

5. ITER Project Status.

The status of the ITER project was reviewed by Dr. Thomas Vanek (OFES) and Dr. Ned Sauthoff (U.S. ITER Project Office). Dr. Vanek commented on the spectacular nature of the ITER agreement signing ceremony in Paris, France. Prior to its signing, the agreement passed the 120-day congressional review period, with a “yes” coming from the House Subcommittee on Science. The ITER Organization is currently operating under the Arrangement of Provisional Application until the ITER Agreement is ratified by all parties, which is expected to be completed by mid-2007. The U.S. has requested the status and plans for integration of the Broader Approach Agreement signed by EU and Japan.

Dr. Sauthoff described the ongoing development of the ITER organizational staff and management structure for both the ITER Organization (IO) and the U.S. ITER Project Office (IPO). The U.S. is supporting the IO as it builds its project management and business systems infrastructure. An ITER design review is being prepared to update the 2001 ITER FDR, establish

the project baseline, and develop a preliminary experimental operations/research plan. The review will be conducted this year by eight working groups. The U.S. has at least one member on each of these working groups. Dr. Sauthoff noted that it is important that the U.S. fusion community participate in the design review.

FESAC discussion: Asked if there are export license control issues for U.S. contributions to ITER, Dr. Sauthoff explained that the DOE and the U.S. IPO have been working with the Department of Commerce to arrange for export of US-provided hardware and to allow the release of certain information important to the success of the ITER project. The most difficult issue within the U.S. ITER Project is deemed-export. Dr. Sauthoff highlighted that the U.S. ITER Project does not include a Test Blanket Module program. He noted that it is the responsibility of employers to make sure that employees are educated and aware of export control obligations. The U.S. IPO will be focused on “training the trainers” located at various institutions and business entities. Dr. Sauthoff was asked about the possible need to de-rate the magnetic field strength in ITER due to problems with the superconductors. He explained that an engineering analysis is underway, while in parallel, prototypes of new designs and materials are being fabricated for testing. Dr. Sauthoff was asked how the scheduled date of 2016 for first plasma was determined. He replied that not all of the parties have submitted schedules for their contributions, so it is not yet possible to complete the integrated schedule for the project. The possibility for U.S. participation in the EU/JA Broader Approach was discussed. Dr. Vanek noted that the U.S. would have strong scientific interest for participation, but that financial constraints might be limiting. Also, although EU and Japan are considering inviting other parties to join, they are not ready to discuss the issue in detail.

6. Office of Science 2008 Budget.

Dr. Raymond Orbach, Under Secretary for Science, discussed the Office of Science budget request for FY 2008. He began by commenting how wonderful it is that Prof. Fonck has stepped forward to assume the duties of the Associate Director for OFES. He commented that it is a mark of a mature community when it supports such a commitment by one of its own members, as in this case. He noted that this is as much a good reflection on the community as it is on Prof. Fonck. He also thanked Dr. Vanek, not only for his management but also his leadership as acting Associate Director. In other general comments, Dr. Orbach noted the importance of ITER as a model for the globalization of construction and operation of large scientific research projects. He described the challenges associated with off-shoring scientific facilities, using analogies in high energy physics research. This is the essence of the new charge to FESAC: how will we invest in the program in the next 10-20 years to maintain its quality? He explained that the use of “DEMO” in the charge is intended to give concreteness to the time scale of the planning. On the FY 2008 budget request, Dr. Orbach notes that the 52% increase in the OFES funding is a clear indication that DOE is committed to maintaining the domestic fusion program while following through on the U.S. ITER commitment. No other program in the Office of Science would receive a larger increase in funding. He emphasized the importance of completing ITER on time and on budget to maintain confidence in Office of Science. He also noted the order of magnitude greater computational capability in the U.S. than elsewhere in the world, which will provide a large computing resource opportunity for fusion (and other) research.

FESAC discussion: It was noted that fusion research has many computational needs that do not require heroic performance. Dr. Orbach agrees that computing resources need to be balanced, and we should be careful not to make too great a distinction between “capacity” computing versus “performance” computing. He is personally interested in our opinions on these matters, inviting personal email if computational capability issues are not being addressed adequately at the community level. It was also noted that remote participation is increasingly important in the globalization of large project research. Dr. Orbach agreed, noting recent improvements in ESNet performance. He urged to take home this message, since often network performance is limited by the “last mile link.” It was noted that many of the issues related to achieving a successful DEMO are technology related, and that the technology components of the fusion program have struggled to maintain funding. Dr. Orbach resisted answering these questions because he is frustrated by the debate over distinguishing that which is research from that which is technology. He urged the community simply to identify those issues that need to be addressed. Asked about progress in work force development in the Office of Science, Dr. Orbach outlined programs at the laboratories aimed to increase workforce diversity and to promote science education, particularly at the middle school level. In regard to improvements in the workforce for the domestic program, Dr. Orbach reminded FESAC that additional people resources are included in ITER funding. On the new charge, it was noted that the development of fusion energy is a worldwide effort, but that at some point a DEMO will need to be built on U.S. soil. In identifying gaps, should the fusion community consider only those things we are presently good at or also those things we eventually need to do? Dr. Orbach answered that the goal is to maintain a world leading fusion program, and we need to identify research areas where we will clearly be leaders.

7. Fusion Energy Science 2008 Budget.

Dr. Thomas Vanek, acting Associate Director OFES, outlined the FY 2008 budget request for the Office of Fusion Energy Sciences. He characterized it as a good budget, funding ITER while maintaining the base program at about the inflationary level. He noted that major facility operations are increased modestly, though still not at the full usage level. He emphasized the need to hold the total project cost for ITER within the specified limit.

FESAC discussion: Dr. Vanek was asked if higher political levels are aware that a new baseline for the ITER project is being developed. He replied that ITER was a presidential initiative. Having a schedule and cost cap was effective in convincing Congress to accept U.S. participation in the project. The worst case scenario would be to move away from the established cap. There are presently two escape clauses, one for escalation (inflation) above the U.S. Government's estimates and one for currency fluctuation. Asked about consideration of upgrades to ITER, Dr. Vanek noted that a good analogy would be the Spallation Neutron Source; while the SNS was under construction, plans were being made for upgrades, but that the funding for the upgrades would be separate. On the budget, Dr. Vanek was asked what fraction of “Other Universities” funding goes to historically black colleges and universities (HBCU). Dr. Vanek replied that he did not recall this level of detail in the budget and that the question is best put to the HBCU program manager. Mr. Opdenaker estimated the HBCU funding to be flat at about \$1M. Dr. Vanek was also asked what are OFES views on programs like the junior faculty development, various centers, and NSF partnering. He replied that OFES is doing everything it can to optimize these programs. Dr. Vanek was also asked about the funding of the materials development program and high energy density physics research. On materials, he replied that it would be

necessary to assess whether or not Basic Energy Sciences is serious about (fusion) materials research. On HEDP, the new joint program is the outcome of a two year discussion. There is no new funding, and the joint program needs to show that it can cooperate with NNSA before additional funding can be expected.

8. U.S. ITER Test Blanket Module: Status and Plans.

Dr. Thomas Vanek and Prof. Mohamed Abdou described the U.S. position on the Test Blanket Module (TBM) program for ITER. The TBM research is part of the ITER mission, but it is not included in the scope of the ITER agreement. Funding for TBM research is not included in the ITER MIE. Prof. Abdou emphasized that the blanket is *the* key component in what he calls the five pillars of fusion energy, yet no fusion blanket has ever been built or tested. There are three equatorial plane ports on ITER dedicated to TBM research. The present plan calls for two independent TBM assemblies to be tested simultaneously in each port, for a total capacity of six assemblies. This alone creates competition, given seven parties involved in ITER. Since the eventual success of fusion power depends critically on the functions of the blanket, there is also tension from party concerns on sharing critical information, in the absence of negotiated agreements. To prepare for the D-T stage of ITER experiments, it is important that the TBM testing begin in the earlier hydrogen stages, essentially from day one operation. Prof. Abdou argues that it is therefore urgent for the U.S. to commit to a TBM program. A technical plan and cost estimate for an effective TBM program have been developed. The projected cost is order \$10M/year, which for reference is less than the cost of tritium (which could be as much as \$100M/kg). Prof. Abdou stressed that funding at less than an optimum level could still allow significant progress.

FESAC discussion: In response to the question what is the present U.S. policy on the TBM program, Dr. Vanek explained that there is presently no commitment to proceed. For several reasons there has not been sufficient focus on this issue in OFES. Since the required funding is outside the ITER agreement, the TBM program would have to be supported from the base program funding. An ITER organization level discussion of the TBM program is planned for the Interim ITER Council meeting in March. Several questions were raised regarding the cooperation between the parties in TBM development. Prof. Abdou answered that in his view an agreement similar to that for ITER construction would facilitate resolving the tricky issues in sharing information and coordinating experiments. He noted that the major hindrance to the development of a coordinated plan is the lack of U.S. commitment on the TBM.

9. Presentation of New Charge.

Dr. Raymond Fonck, Associate Director OFES, presented a new charge to FESAC. The primary goal for the charge is to identify opportunities for U.S. leadership in fusion energy science and technology in the ITER era. These opportunities are anticipated to derive from the “research gaps” in the required knowledge base for a fusion DEMO. A high level discussion is requested, not specific to particular facilities or next step facility concepts. However, the charge does ask for an assessment of all available means to address the issues, e.g., existing and planned facilities worldwide, theory, and modeling. The scope of the charge is not to include high energy density laboratory (HEDLP) plasmas or energy-related HEDLP.

FESAC discussion: The questions and discussion probed the scope and intent of the charge. Prof. Prager summarized that the main intent of the charge is to inform discussion of major new initiatives. If this is true, then the charge needs to be put in that context, otherwise the charge elements are extremely broad. Dr. Fonck added that major initiatives should correspond to large research gaps. It was noted that a good interpretation of the level for analysis is identifying classes of facilities or classes of priorities. It was also noted that accounting of the world view is very challenging, and the possible inclusion of non U.S. members on the panel was discussed. Dr. Fonck noted that the world program is coming into focus, particularly in regard to proposed major new facilities. Asked if a major initiative could be composed of a number of components, Dr. Fonck agreed, so long as the components have an integrated mission, not just a collection of separate ideas out of which one might distinguish itself. Several questions probed the prioritization aspect of the charge, for example, how to prioritize flexibility as new knowledge becomes available, and also differentiating the priority of components in an integrated fusion system. Dr. Fonck emphasized that this is to be viewed as a “living” process, which will need to be updated. He agreed that decision points should be identified. In regard to the non inclusion of high energy density physics (HEDP), Dr. Fonck was asked if this implies HEDP is removed from FESAC’s jurisdiction. He replied no, only for this charge. Dr. Vanek added that it is not yet clear what advisory committee will be set up for HEDP. A related observation was that since HEDP is not included, the charge implies that DEMO should be interpreted to mean a tokamak DEMO. Dr. Fonck reiterated that DEMO is used in the charge primarily to define a time scale for the analysis. He added, though, that this does constrain consideration of options based on other configurations, but he generally agreed that it would be appropriate to respond with issues that are configuration specific. On the charge process, Dr. Martin Greenwald was named chair of a panel to be appointed by FESAC to answer the charge. Exactly how community input will be solicited is yet to be determined, but it will not be a Snowmass-like process for this charge. Dr. Greenwald invited FESAC input on how best to proceed.

First day, adjourned, 5:30 pm

Second day, called to order, 8:30 am

10. High Energy Density Physics: What’s Happening.

Dr. Francis Thio, OFES, described changes occurring in the federal stewardship of high energy density laboratory physics (HEDP) research. An inter-agency task force has recommended that OFES and NNSA establish a joint program in HEDLP to accommodate recommendations of several NRC and other reports on HEDP. The task force was sponsored by OSTP and included members from DOE, DOD, NASA, NSF and NIST. Research activities in these agencies have been mapped onto 15 scientific thrust areas identified in a report by the National Task Force on High Energy Density Physics led by Dr. Ron Davidson. There is as yet no new funding, rather the HEDP elements of the various agencies are gathered in the new joint program. It is possible that a new advisory committee will be established for the joint program.

FESAC discussion: Several questions were asked regarding the longer range view of HEDP scope and funding, for example is a single line item in the budget planned for the future and will the new joint program be the “final” home for inertial fusion energy. It was observed that the HAPL program, the project with largest funding in this area, is not included in the new joint program. Drs. Thio and Vanek said it was too early to say, and that this discussion will follow

from the report. The DOE budget explanation already includes a description of the new program, but line items remain in the OFES and NNSA budgets. Dr. Vanek offered that convergence between the NNSA and DOE programs will need to occur before a single line can be considered. Concern was raised that the new joint program will tend to divide the IFE and MFE communities, not draw them together as in recent years to speak with a common voice in the development of fusion energy. The new charge, being focused on MFE, might also be a dividing force. It was suggested that if the new charge does not include IFE, a second parallel charge might be required, building on the anticipated successful ignition experiments on NIF.

11. Fusion Simulation Project: Status and Plans.

Dr. John Mandrekas (OFES) and Prof. Arnold Kritz (Lehigh University), described the Fusion Simulation Project (FSP), which is a computational initiative aimed to develop “whole device” predictive simulation capability, focusing on ITER. The project is led by OFES in collaboration with OASCR. A workshop will be held in May to develop a detailed roadmap with major scientific and computational milestones. The program committee and participants span a broad cross section of the fusion and advanced computation communities.

FESAC discussion: Several questions were raised in regard to FSP connections to the base theory program. It was noted that there needs to be strong coupling with the theory program, and that FSP should not place sole emphasis on peta-scale computing, which is a main driver for OASCR but not the required level of computing for many fusion science problems. It was also noted that in the budget transition for FY 2006 to FY 2007, the base theory funding was reduced while the SciDAC projects were increased by the about the same amount. Prof. Kritz emphasized the need for “high fidelity” physics models, which will largely come from the base theory program. He also answered that coding and documentation standards are included in the plan, which should improve the ability of theorists to identify and understand the models included in the codes. Dr. Makrekas explained that the funding changes between FY06 and FY07 should not be interpreted as a transfer of funding. Also, the plan is for FSP to be supported by new funds. Members commented that it should be emphasized in the FSP plan that new money is required and that no funding should be transferred from the base theory program in support of FSP. An objection was raised in the use of “whole device simulation” as a characterization of the FSP goal, since the models are primarily focused on the plasma volume. Also, no visible connection to the ITER project is seen in the organization. Dr. Mandrekas responded that edge modeling will be included. Another observation was that the FSP is characterized as a tokamak-specific project, but that the effort could have profound impact on other magnetic configurations, underselling the potential scope of the project. Prof. Kritz replied that it is important to recognize limits to what can be accomplished with available funding.

12. Public Comments.

Prof. Thomas Jarboe, University of Washington-Seattle, addressed FESAC on behalf of the Innovative Confinement Concepts (ICC) program committee. He reminded FESAC of the role of ICC research as noted in recent studies, including the Integrated Program Planning Activity, Snowmass 2002, and the Plan for the Development of Fusion Energy (so-called 35-year plan). He summarized several ways in which ICC research is important to development of DEMO. He argued that since the new charge points to a second charge which is expected to encompass the

entire program, it is essential that ICC research be included in the process used to address the new charge.

Dr. Stephen O. Dean, Fusion Power Associates, presented a letter to FESAC expressing his disappointment in the wording of the new charge, which he believes leaves too large a range of interpretation in its meaning. He argues that if this charge opens the door to a discussion of the path to DEMO, then the process needs to include inertial fusion energy (IFE) and innovative confinement concepts (ICC), not just the tokamak approach. He observes that the three camps, tokamak, alternate (or ICC), and IFE research have not always worked together well, and this charge could create uneasiness between these camps. He believes that if the new charge is carried out as written, then some people will feel they have missed the boat. He urged FESAC to include IFE and ICC in addressing the charge, or to ask DOE for a parallel charge on these other programs, whose report would be simultaneous with that for the new charge.

13. Preparation of Letter to DOE.

The FESAC committee edited the cover letter for its report on the *Assessment of Progress towards Long Term Goals of the Fusion Energy Sciences Program* for the OMB Program Assessment Rating Tool.

Meeting adjourned at 12:00 pm

Appendix: public attendees.

Raymond Orbach, DOE
Grant Logan, LBNL
Anne Davies, Self
Ronald Davidson, PPPL
Miklos Porkolab, MIT
Thomas Jarboe, University of Washington
Ronald Stambaugh, General Atomics
Tim Durkin, JAEA
Makoto Ooka, JAEA
David Baldwin, General Atomics
Donald Rej, LANL
Michael Roberts, self
Rich Hawryluk, PPPL
Dale Meade, Fusion Innovation Research Energy
George Tynan, UCSD
Dan Lehman, DOE/SC
Joanne Wolfe, SC 1.21
Kohl Gill, SC 1.22
Stan Milora, ORNL
Stephen Dean, FPA
Richard Nygren, Sandia Nat. Labs.
Bill Tang, PPPL
Arnold Kritz, Lehigh University

James W. Van Dam, IFS-Texas
John Willis, self
Mike Campbell, General Atomics
Mark Haynes, General Atomics
Earl Marmar, MIT
Casey Clark, DOE
Ben Cross, Savannah River National Lab.
Tony Taylor, General Atomics
Mohamed Abdou, University of California-Los Angeles
Chris Carter, PPPL DC Office
Ed Synakowski, LLNL

DOE OFES:
Raymond Fonck
Thomas Vanek
Al Opdenaker
Barry Sullivan
T.V. George
Steve Eckstrand
Gene Nardella
Rostom Dagazian
Joanne Wolf
Sharon Stevens

Francis Thio
Marvin Singer
John Mandrekas
Adam Rosenberg
Sam Barish
Mike Crisp
Curtis Bolton