

# **Minutes of the Meeting of the Fusion Energy Sciences Advisory Committee**

February 28-March 1, 2006  
Hilton Hotel, Gaithersburg, MD

## **Members present:**

Dr. Charles Baker, Sandia National Laboratories  
Prof. Riccardo Betti, University of Rochester  
Dr. Richard Callis, General Atomics  
Prof. Joseph Johnson, A & M University  
Dr. Rulon Linford, Lawrence Livermore National Laboratory  
Prof. Gerald Navratil, Columbia University  
Dr. Jill Dahlburg, Naval Research Laboratory  
Prof. Jeffrey Freidberg, Massachusetts Institute of Technology  
Prof. Richard Hazeltine, University of Texas-Austin  
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:**

Dr. Kathryn McCarthy, Idaho National Laboratory  
Dr. Martin Greenwald, Massachusetts Institute of Technology

## **Ex-officio members present:**

Dr. S. I. Abdel-Khalik (ANS), Georgia Institute of Technology  
Dr. John Steadman (IEEE), University of South Alabama

## **Ex-officio members absent:**

Dr. Melissa Douglas (APS-DPP), Los Alamos National Laboratory

## **Designated Federal Officer present:**

Dr. Anne Davies, Associate Director, Office of 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. Convey to Dr. McCarthy FESAC's recommended changes to the COV report.
2. For the PART review, keep the ten year goals as written, but have Prof. Navratil's panel recommend new intermediate milestones based on recent Panel reports and iterate with DOE as necessary.
3. Establish a five member FESAC sub-committee to develop recommendations on how to address the new charge.
4. Schedule the next FESAC meeting for early June to hear an update from the BPO on the plan for US participation in ITER, and to discuss progress on the new charge.

**1. Call to order, introduction of new members, and meeting logistics.**

Dr. Davies introduced Prof. Prager as the new chair of the FESAC, and the other members each introduced themselves. Prof. Prager outlined the meeting agenda and a change in the schedule.

**2. Department of Energy perspective.**

Dr. Ray Orbach, Director of the Office of Science, announced that Dr. Anne Davies and Dr. Michael Roberts are retiring from their DOE-OFES positions in April. He thanked Dr. Davies for her many years of service, describing her an "elegant advocate" for the field. He said her work was critical in laying the groundwork for the future reflected in the President's budget. Dr. Orbach described Dr. Roberts as a "tireless advocate of fusion energy". He stated that ITER negotiations could not have gotten to this exciting point without Dr. Roberts' efforts, who was attending a negotiations meeting in Paris at the time of the FESAC meeting.

Dr. Orbach began his budget discussion by quoting President Bush from his Jan. 31 State of the Union message announcing the American Competitiveness Initiative. This initiative would double in ten years the combined budgets of DOE, NIST, and NSF. He emphasized that the sum of the three agencies' budgets would double, and that the distribution between them would depend on program performance and ability to deliver on the President's trust. Within DOE, the Office of Science receives the largest increase in the FY07 budget, while the total DOE budget remains flat. The increase is, in part, to correct for the decrease in FY06. Dr. Orbach strongly urged support for the President's budget, since this will be the starting point for the ten year initiative.

ITER remains DOE's number one facility priority. Dr. Orbach stated that even though the US is a 10% partner, our influence is much greater. If intervening steps go as planned, the ITER construction phase would formally begin July this year. Other facility priorities described by Dr. Orbach include high end computation (three separate facilities), the Linac Coherent Light Source, and the Spallation Neutron Source (SNS). The on-time, on-budget completion of SNS has bolstered the Office of Science's credibility for major facility construction.

*FESAC discussion:* Several members asked about the role of technology in the program, noting that support for technology research is decreasing. Dr. Orbach acknowledged and agreed on the importance of technology but stated that science must remain the priority, and in particular making ITER work. In a similar discussion on the balance between ITER construction and DOE's stewardship of plasma science, Dr. Orbach observed that the challenge of maintaining a strong domestic program while major facilities are located abroad is not particular to the fusion

program, with other areas such as nuclear and high energy physics research facing similar challenges. It was noted to Dr. Orbach that a larger investment is required if fusion energy science is to obtain an order of magnitude dominance, a goal for the Office of Science in key scientific fields. Dr. Orbach expects FESAC to provide critical guidance on these issues. On a question of the role of high energy density physics (HEDP) research in the Office of Science, Dr. Orbach notes that an inter-agency working group has been formed for HEDP research (under OSTP leadership).

### **3. Office of Fusion Energy Sciences perspective.**

While introducing Dr. Anne Davies, Deputy Director of the OFES, Prof. Prager noted that this will probably be her last appearance before FESAC. Dr. Davies has worked in the DOE for 32 years. The FESAC committee presented flowers to Dr. Davies in deep appreciation of her work and dedication to the fusion program.

Dr. Davies described the FY07 proposed budget for Fusion Energy Sciences, which increases from FY06 by \$31M. Over the FY06-07 period, FES funding is up 20%, comparing favorably with other programs, which increase 11%. Funding increases are proposed for ITER fabrication and R&D, major facility operation, and SciDAC funding for two new projects. Funding decreases are proposed for the concept exploration portion of the Innovative Confinement Concepts program, high energy density physics research, theory, the NCSX project, plasma technology, and fusion materials science research. The non-ITER portions of the program were reduced in response to the threat by Rep. Boehlert (R-NY) “to kill the ITER project if there was not an agreement by March that the domestic fusion program has to be scaled back to pay for ITER.” Dr. Davies announced a new charge to FESAC to examine the evolution of the Fusion Energy Sciences program over the next decade.

*FESAC discussion:* Dr. Davies was asked why the proposed decrease in funding for high energy density physics is so large. She replied that partly this is because of a \$1M earmark in FY06, but mainly it reflects a priority for ITER support, in major facility operation and new SciDAC projects. Also, NIF and OMEGA provide substantial resources for the “physics” in HEDP. An OSTP-led inter-agency working group will be examining HEDP research, as noted by Dr. Orbach.

### **4. Office of Management and Budget perspective.**

Dr. Joel Parriott of OMB described the structure and process through which OMB makes decisions, emphasizing his role as a program examiner. He offered suggestions on how to make supporting arguments for the Fusion Energy Sciences program more compelling, for example, improving consensus reports. OMB reviews many reports, so executive summaries must be very good, and it must be easy to find content without reading the entire report. Typically workforce arguments are weak, but such arguments might become more important for the American Competitiveness Initiative. He discussed the proposed doubling of DOE, NIST, and NSF budgets under this initiative, emphasizing the doubling applies to the sum of the three agencies’ budgets (as emphasized by Dr. Orbach). Dr. Parriott notes that conclusions from past reports on the fusion program are still valid, but OMB is still waiting for advice on the science with a priority-driven strategy for the entire US program as a component of the larger international effort.

*FESAC discussion:* Dr. Parriott was asked about OMB's view of the role of technology. He replied that what the fusion program calls "technology," others do not. There is a general worry about getting too far ahead on technology (relative to science), but technology in support of the existing program is acceptable. In regard to priority setting, an observation was offered that charges to the community often do not ask hard questions, and the community tends to get caught in the middle, especially since consensus tends to be at odds with priority setting. Dr. Parriott recommended that the process should strive to imagine what the ideal program should look like, then figure out how to move toward this goal from where things are today.

### **5. Committee of Visitors report on large facilities, diagnostics, and enabling R&D.**

Dr. David Gates (PPPL) presented findings from the third COV, which examined OFES management of the large facilities (DIII-D, NSTX, C-MOD, MST), diagnostic program, and enabling R&D program. The management of the NCSX project was not reviewed by this COV (or previous ones). This COV agrees with the recommendations of the previous two COVs, which examined management of the other program elements. They note evidence that many of the earlier COV recommendations have been implemented by OFES. They recommend that FESAC further consider two issues: (1) providing opportunities to young/new principal investigators and (2) the balance between competitive versus non-competitive processes, especially for collaborations on the large facilities.

*FESAC discussion:* Questions were asked regarding the COV's view of the competitive versus noncompetitive role in the effectiveness of the proposal review process and quality of the resulting research. Dr. Gates replied that the COV did not come to a conclusion on this point, despite significant discussion. Because of the number of proposals involved, it was difficult to quantify the difference in management approach. Other questions probed the effectiveness and value of the COV process generally. In particular, all three COVs struggled to answer whether or not improved management would improve the quality of research or view of the program, for example its international standing. However, Dr. Davies commented that the COV process has certainly been valuable, for example motivating improved documentation of funding decisions. These decisions are not simple, involving, for example, concerns for program balance. Dr. Davies described the establishment of a noncompetitive process used for DIII-D collaboration as a "shotgun marriage," whereas the competitive process used by NSTX was set by design at the outset of the project. She acknowledged that portions of the COV charge regarding evaluation of program effectiveness and international standing were probably beyond the intended scope of the COV review.

### **6. Introduction and discussion of the new charge to FESAC.**

Prof. Prager described a new charge to examine the evolution of the Fusion Energy Sciences program over the next decade. Two possible approaches to answering the charge are formation of a small panel, with hearings from the community, or a Snowmass-like approach. The final report is due Feb. 2007. A FESAC sub-committee of about five members will be charged to recommend the best approach.

*FESAC discussion:* Several members were alarmed that the charge seems to imply that the US should be sending people overseas to new large facilities in favor of strengthening the domestic program. Others note that collaboration on facilities abroad is an opportunity, and the program

should not feel threatened. Also, other programs, e.g., high energy physics, cope with large facilities abroad, so the issue is not unique to fusion research, and the questions in the charge are legitimate. Because the charge implies international partnering, diplomacy will be essential. Will the international community agree with the US's view of opportunities? Dr. Davies notes that part of the charge is to consider reconfiguring existing facilities, and the community is free to propose any possibility within budget constraints. But it is unlikely that funds will be available for a large new facility in the US. The committee agrees that a careful approach to answering the charge is required, and therefore a FESAC sub-committee will be appointed to recommend the best approach.

#### **7. Panel report on program's progress toward achieving PART measures.**

Prof. Navratil described the status of the charge to review and rate the fusion program's progress toward achieving the long term Program Assessment Rating Tool (PART) goals. The high level ten year goals established for PART are acceptable, but the intermediate milestones need revision. A panel for this assessment has been formed, chaired by Prof. Navratil, but the timing and delay in the reforming of FESAC prevented receiving guidance on how to proceed until now. FESAC recommends that Navratil's panel suggest to DOE improved intermediate milestones based on recent Panel reports and iterate with them to ensure the milestones are appropriate for the PART goals. Dr. Davies notes that it is important to take this effort seriously, since a section in the budget includes program ratings, which can couple to funding levels.

#### **8. Public comments (five presenters).**

Prof. Steve Knowlton (Auburn Univ.), representing the University Fusion Association, described a UFA position letter on the FY07 budget. He thanked Secretary Bodman and Dr. Orbach for their leadership in achieving the proposed budget increase for the fusion program. The UFA strongly supports US participation in ITER. However, the budget includes 8% cuts to the Innovative Confinement Concepts program and theory program, which have especially large university participation. Prof. Knowlton described these as diverse programs, involving the training of 70-80 graduate students. The proposed cuts would result in a reduced number of graduate students involved in fusion research.

Dr. Stan Milora (ORNL/VLT) presented his concern that the budget for the base program in enabling R&D has eroded considerably since FY03. The enabling R&D base program contributed to ITER R&D in FY06, some of which was not returned. The proposed cuts in the FY07 budget will significantly reduce materials science and ICH R&D, plus eliminate magnet and gyrotron R&D. On the longer term, R&D from ITER will end in four years. He urged that the technology program contributions will need to be restored. He also noted that the technology community (VLT) was involved early in ITER and led planning of six of the US in-kind hardware contributions.

Dr. Ron Stambaugh (General Atomics) argued that the US has the best scientific facilities for doing fusion plasma science, citing US leadership in kink mode control, neoclassical tearing mode control, ELM control, and turbulence control via sheared flows. He noted that the international tokamak heating and current drive database for 100% non-inductive current drive with ITER's fusion power gain factor for steady-state operation is entirely DIII-D data. He would welcome any international arrangement that increased the ability of foreign scientists to

do experiments on US facilities. Asked to what degree the US major facilities are “user facilities,” Dr. Stambaugh replied that 515 researchers are involved in the DIII-D research program.

Prof. Miklos Porkolab (MIT) addressed the perception that DOE’s new charge implies that US participation on the new superconducting-magnet tokamak facilities abroad might replace operating our existing copper-magnet major facilities. The most important asset of a superconducting magnet tokamak is pulse length, but the science requirements, set by the L/R time for example, are attainable with the existing copper-magnet facilities. A record plasma pressure of 1.8 atmospheres has been obtained in C-MOD, record beta values in DIII-D and NSTX, and reactor-relevant non-inductive sustainment in DIII-D. Prof. Porkolab urges an in-depth study of the charge, with broad community participation.

Prof. Rob Goldston (PPPL) showed a graph of the projected budgets for fusion energy research over the next ten years. The budget was broken into two parts. The base program was illustrated to increase steadily at the rate of inflation. The part for ITER construction peaks then rolls off. The sum of these has a maximum of roughly \$0.5B. He emphasized the research opportunity represented in the ITER roll-off if the budget can be maintained at its maximum value, which is not far from the recommendations for the 35 year fusion development plan.

First day meeting ended at 5:45 PM

Second day meeting started at 8:30 AM

### **9. Report on ITER negotiations and status of agreement.**

Mr. Warren Marton, US ITER Program Manager, described the status of ITER negotiations. He reported that following the Feb. 7-11 meeting in Barcelona, there are no remaining technical level issues with the Joint Implementation Agreement. At the time of this FESAC meeting, ITER parties are meeting in Paris to negotiate Privileges and Immunities (PI). However, the US provision for PI will be through the congressionally established International Organizations Immunities Act. The steps remaining to the signing and ratification of ITER agreements were outlined. The ITER Director General nominee, Kaname Ikeda, is about to take his position full time, and the Principal Deputy General nominee is soon to be named (who will be a European Union candidate). The US is currently seeking candidates for the eight Deputy Directors General positions. The US ITER project office has been relocated from PPPL to ORNL to maximize ORNL’s project management and procurement expertise, as demonstrated on the Spallation Neutron Source project.

### **10. Status of US ITER project.**

Dr. Ned Sautoff, US ITER Project Manager, described the status of the ITER project. As a result of India joining ITER, the procurement allocations were refined. This was accomplished in a fashion to simplify inter-party interfaces and reduce multi-party duplication. For example, the US will now wind all seven of the central solenoid magnets, but Japan will provide all of the conductor. The US picks up 8% of the toroidal field magnet conductor to maintain a presence in superconducting materials. The US will no longer provide a share of the ICRH antenna nor the power supplies for electron cyclotron systems, but we will provide the transmission lines for both ICRH and EC systems. The US share of the blanket modules increases from 10% to 20%. A

Lehman mini-review of cost estimates was conducted in February following the setting of a new budget cap of \$1.122B for ITER construction, including \$60M for central reserve and allowance for a one-year project delay. Draft position descriptions for eight Deputy Director Generals were shown. The US will offer candidates for these positions. Staffing of the US ITER Project Office is mostly complete. To facilitate connections to other organizations, the Chief Scientist will be Prof. Ray Fonck (also Director of the US Burning Plasma Organization) and the Chief Technologist will be Dr. Stan Milora (also Director of the Virtual Laboratory in Technology).

### **11. Burning Plasma Organization discussion of approach to preparing a plan for US participation in ITER.**

Prof. Ray Fonck provided an update on the US Burning Plasma Organization. Community input gathered through visits to many institutions and discussions at technical meetings guided the formation of the BPO organizational structure. A workshop was held last Dec. at ORNL to discuss what the US should be doing to understand and resolve issues for successful burning plasma experiments in ITER. This workshop was a first step, not intended to resolve all the questions. The organization is progressing with the formation of working groups and a governing council. An urgent BPO task is to develop a plan for US participation in ITER required by the Energy Policy Act of July, 2005, at the request of OFES. This is to be done in consultation with FESAC. Prof. Fonck outlined the structure of the planned report, which will be developed by a BPO task group, drawing on many relevant community studies. The deadline for the report is June 30, 2006.

*FESAC discussion:* The meaning of “in consultation with the FESAC” was discussed regarding the charge to the BPO to develop a plan for US participation in ITER. Dr. Davies explained this will not be an official FESAC report, but that DOE requests FESAC comment on the plan. In order for this to happen, the next FESAC meeting will need to be held in early June, ahead of the June 30 deadline.

### **12. Status of the National Ignition Facility project.**

Dr. Allan Hauer, Director, Office of Inertial Confinement Fusion, NNSA, described the status of the US National Inertial Fusion Program. The National Ignition Facility is 85% complete, and commissioning is scheduled for 2009, with ignition experiments expected in 2010. Already 400 experiments have been performed using the completed first bundle. A National Ignition Plan (experimental strategy) has been developed, involving five laboratories and others. The OMEGA facility is being upgraded for petawatt capability (OMEGA EP) to be used for fast ignition studies. The Z pinch at Sandia National Laboratories is being upgraded (ZR project) for higher current, twice the diagnostic access, and twice the shot rate capability. The Z-Beamlet laser is being upgraded to petawatt power capability (Z-Petawatt), to be used as a backlighter and for integrated fast ignition experiments with ZR. The inter-agency working group on high energy density physics, led by OSTP, has met several times to date.

### **13. Preparation of the letter transmitting the COV report to DOE.**

Prof. Prager presented a draft of the letter transmitting the COV report to DOE, which was edited by the committee. Since FESAC sees no large need to take up the two issues as recommended by the COV (see 5 above), the COV will be asked to delete this recommendation from their report. Dr. Davies offered that DOE would consider establishing a young investigator solicitation on

fusion research, analogous to but separate from the basic plasma science solicitation. Also, the COV will be asked to delete the paragraph regarding NCSX management, because it is not fully accurate and probably not germane to the COV charge.

Meeting adjourned at 11:30 AM

**Appendix: public attendees.**

Tony Taylor, General Atomics  
Stephen Knowlton, Auburn U., UFA  
Robert Cauble, LLNL  
Stephen Dean, FPA  
Ron Stambaugh, General Atomics  
Kazuo Fujiki, JAEA (DC office)  
Ed Synakowski, LLNL  
Rob Goldston, PPPL  
Grant Logan, LBNL  
Ned Sautoff, PPPL  
Jeff Parrell, Oxford Instruments  
Raymond Fonck, U. Wisconsin-Madison  
Don Rej, LANL  
Angela Hardin, Inside Energy  
Rich Hawryluk, PPPL  
Mohamed Abdou, UCLA  
Mark Haynes, General Atomics  
Joel Parriott, OMB  
Rob Dimeo, OSTP  
Jon Morse, OSTP  
David Hill, LLNL  
Stan Milora, ORNL  
Ron McKnight  
Dave Gates, PPPL  
Mike Holland, House Sci. Comm.  
Alan Hauer, NNSA  
Dave Baldwin, General Atomics

Department of Energy:  
Ray Orbach  
Curtis Bolton  
T.V. George  
Warren Marton  
John Glowienka  
John Mandrekas  
Darlene Markewich  
Sharon Long  
JoAnne Wolf  
Dan Lehman  
Steve Eckstrand  
Sam Barish  
Al Opdenaker  
Mike Crisp  
Adam Rosenberg