

**Minutes of the Meeting of the  
Fusion Energy Sciences Advisory Committee  
November 6-7, 2008  
Gaithersburg Hilton, Gaithersburg, Maryland**

**Committee Members Present:**

Martin Greenwald (Chair) – Massachusetts Institute of Technology  
Riccardo Betti (Vice-Chair) – University of Rochester  
Richard Callis – General Atomics  
Richard Hazeltine – University of Texas  
Amanda Hubbard - Massachusetts Institute of Technology  
Hantao Ji – Princeton Plasma Physics Laboratory  
Rulon Linford – Retired  
Dale Meade – Fusion Innovation Research and Energy  
Kathryn McCarthy – Idaho National Laboratory  
John Sheffield – Joint Institute for Science and Sustainable Energy  
Edward Thomas – Auburn University  
Nermin Uckan – Oak Ridge National Laboratory  
Michael Zarnstorff - Princeton Plasma Physics Laboratory

**Ex-Officio Members Present:**

Farrokh Najmabadi (American Nuclear Society) – University of California, San Diego  
Ian Hutchinson (American Physical Society) - Massachusetts Institute of Technology  
John Steadman (Institute of Electrical and Electronics Engineers) University of South Alabama

**Committee Members Absent:**

None

**Designated Federal Officer Present:**

Albert Opdenaker III, Executive Assistant for Fusion Energy Sciences, US Department of Energy  
Others present: Gene Nardella, Acting Associate Director, Office of Fusion Energy Sciences – U.S. DoE

**1. Meeting agenda and opening remarks**

Ahead of the public meeting new members were sworn in. The meeting was called to order at 9:00 AM. The new chairman (Greenwald) and vice-chair (Betti) were announced and the entire committee introduced. The agenda was reviewed. Dr. Dehmer of DOE-OSC could not be present due to illness.

**2. OFES Perspectives (G. Nardella)**

Dr. Nardella began with a review of staffing issues for OFES. The search for a permanent Associate Director was closed on 10/22/08; action is expected within a few months. OFES also needs permanent Directors for its Research and ITER/International programs divisions. Announcements for these positions and action on the reorganization proposed by the former AD are delayed until the new AD is in place. OFES budgets were reviewed; it was noted that the program was operating under a continuing resolution (CR) that might be expected to last until late winter 2009. NCSX closeout plans were

presented including redirection of FY2009 funding originally targeted for that project. The largest share of that funding will be for upgrades and increased operations on NSTX. Additional funds will also be available for operations on C-Mod and DIII-D and for enhanced stellarator research. The stellarator community is preparing plans for pursuing the physics of quasi-symmetry in the absence of NCSX. It was noted that while DOE approved Critical Decision 1 (CD1) for the ITER project in 1/08, the FY2008 Omnibus Appropriation contained a significant funding cut. With this cut and under the CR for 2009, funding for ITER is at a subsistence level. However, the U.S. has remained fully engaged in international ITER activities at all levels. OFES is working on strategic planning at two levels. First, in response to a Congressional directive, a "Strategic Plan Overview" is being prepared for delivery to Congress by 3/1/2009. (While a draft of this plan is not yet available, the current thinking was reviewed by S. Eckstrand – see section 3. of these minutes.) This overview will be reviewed by FESAC at the January meeting. Second, a more comprehensive strategic plan will be developed for completion by 3/2010. The fusion community will have an opportunity for significant input into this plan via a Research Needs Workshop (ReNeW) scheduled for June 8-12, 2009. Current plans for this workshop along with preparatory tasks are described in section 4 of these minutes. There was considerable discussion following this presentation. Several committee members expressed their concern (which is shared by DOE) over the stability of ITER funding. Many felt that FESAC needed to go "on record" with these concerns. Discussion of a resolution to that end is described in section 15 of these minutes. FESAC members also voiced concern about the ability of FESAC to impact the strategic plan overview, especially given the short period of time for review. It was noted by OFES that the plan needed considerable internal government review and sign-off before it could be made public.

### **3. Strategic Plan Overview (S. Eckstrand)**

As noted above, the draft plan had not completed internal review and was not ready for distribution at the time of this meeting. FESAC was given a preliminary briefing on the current state of the plan. The overview is being prepared in response to a congressional mandate. It was clear that without that mandate, preparation of an overview would follow rather than lead the detailed strategic planning exercise which is also underway. The overview plan outlines three strategic themes 1. Develop the knowledge needed to create a sustainable fusion energy source 2. Pursue scientific opportunities and grand challenges in plasma science including HEDP. 3. Acquire the organization and management capability need to carry out the program missions. The overview also identifies five strategic goals a. Foster the success of ITER and maximize the benefit of the US participation in ITER b. Improve our understanding of how the properties of a confined plasma are determined by the confinement configuration. c. develop the knowledge needed to achieve predictable high-performance, steady-state burning plasmas. d. Develop the knowledge to design and build components that can survive the enormous heat, plasma and neutron fluxes of the fusion environment. e. Develop the materials and engineering science needed to harness fusion power. The briefing covered approaches for achieving each of these goals. A lively discussion followed this presentation. One theme that emerged was the perceived lack in the plan of a "bold vision". It was noted that the request from Congress specifically called for a bold plan for achieving fusion energy that would keep the U.S. in a "leadership role". Many FESAC members felt that there should be specific reference to a fusion energy development plan. There were several comments concerning the choice of the themes and goals – these were noted by OFES personnel. The absence of any mention of IFE was also raised by several members.

#### **4. Briefing on Plans for Research Needs Workshop (R. Hazeltine)**

This item was added to the agenda to bring FESAC up to date on planning for the ReNeW. A meeting of the organizers had taken place on Nov. 5, just a day ahead of the this meeting. The workshop and preparatory activities will be organized to create a set of initiatives. These are defined as “organized, multi-faceted attacks on some question or coherent set of questions, essential to magnetic fusion energy science and technology, using a combination of new and existing program elements”. The organizers estimated that something on the order of 15 initiatives would be identified. The final report of the workshop would describe each initiative in sufficient detail to allow an estimate of the resources required, but would not consider specific designs, proposals or budgets. It is assumed that the technical questions and research gaps have been thoroughly identified by recent FESAC panels. A set of 5 thematic working groups has been created and staffed with chairs and co-chairs. These have been subdivided into topical areas and leaders for each chosen. These groups will work to identify and describe, in detail, initiatives that address each topical area. The purpose of the workshop will be to integrate these building blocks into a consistent and compelling strategy. A schedule for the working groups and workshop were laid out. Highlights include thematic workshops on or around 3/30/08 and a draft report by 5/22. Following the workshop in mid-June, a final report will be issued on 7/19/08. FESAC members commented on the need for prioritization and asked about the process by which the workshop report would be used to create the OFES strategic plan. It was noted that the planning period will cover 10 or 20 years, so that staged implementation will be a key feature of the report and strategic plan.

#### **5. New Charge: Committee of Visitors (C. Bolton)**

A new charge from undersecretary Orbach was presented to FESAC. This charge requests a review of OFES to 1. Assess the efficacy and quality of management processes and 2. Assess the quality of the resulting program portfolio. The full charge is included in Appendix B of these minutes. Unlike the previous Committees of Visitors, the entire program will be reviewed by a single committee. The report is due on April 2009. Al Opdenaker will be the point of contact within OFES.

#### **6. Final Report: Panel on Toroidal Alternate Confinement Concepts (D. Hill)**

The final report of the FESAC panel on Toroidal Alternate Confinement Concepts was reviewed. The charge covered four toroidal confinement concepts; the Spherical Torus, Stellarator, Reversed Field Pinch and Compact Torus (Field Reversed Configuration and Spheromak). The panel was charged to

1. Identify and assess ITER-era goals,
2. identify and prioritize technical questions that need to be resolved to meet these goals,
3. Assess available means to address these questions and
4. Identify research gaps along with existing and new facilities for filling the gaps.

To help gather information, the panel solicited formal and informal input from the research communities of the four concepts and invited participation at their first meeting. The panel did not consider issues which would be generic to any magnetic confinement scheme (for example materials, tritium breeding or safety) as these have been carefully reviewed by other panels. The panel praised the overall quality of science carried out by the toroidal alternates and outlined the benefits that each provided to fusion science. Though the four concepts were at very different levels of development and had very different levels of performance, it was concluded that further research would be required before any definitive assessment of their fusion energy potential could be made. For each, an ITER-era goal was identified that were appropriate and ambitious. The panel attempted to assess the level of technical risk associated with

unknown science and required extrapolation. A critical part of the report is the identification and prioritization of scientific issues for each concept. These were divided into three tiers based on their importance, urgency and uncertainty. This set of prioritized issues provides a roadmap for further research. Questions from FESAC prompted a clarification on the position of the panel with respect to new facilities – these are not recommendations for action, but an assessment of what would be required to fully address issues. The place of the ST within the alternates program was debated along with its role if an “aspect-ratio optimized CTF” was found to be more like a standard tokamak than an ST. After discussion, FESAC voted to accept the panel’s report and forward it to DOE. This report will be available on the OFES web site <http://www.science.doe.gov/ofes/fesac.shtml>.

### **7. Report on Review of the DOE plan for US participation in ITER (D. Lang, M. Zarnstorff)**

The results of the recent National Research Council (NRC) review of the DOE plan for participation in ITER were presented. The DOE plan was drafted with the help of the Burning Plasma Organization (BPO) in response to language in the Energy Policy Act (EPAct) enacted by Congress in 2005. To paraphrase, the plan requested was to 1. Outline the U.S. research agenda for ITER, 2. Evaluate whether ITER was promoting progress toward fusion energy and 3. Describe how work on ITER related to other elements of the U.S. fusion program. EPAct also instructed DOE to request a review of the plan by the NRC. The NRC review was quite favorable. They found that the plan was well-aligned with DOE goals and has been operating in an effective manner. The NRC found that the US was well engaged in ITER planning activities and that its research plan was at least as mature as any of the other ITER participants. The NRC did note a major concern, that “US commitment to ITER appears to be uncertain” and that this “threatens the US role in ITER and the future benefit to US fusion program goals and national energy goals”. The NRC made a number of insightful recommendations that were well received by FESAC.

### **8. Status of ITER project (N. Sauthoff)**

The status of the ITER project and activities within the US ITER Project Office (USIPO) were presented. Despite reduced funding the USIPO has put into place a project team along with policies and procedures that will be required to execute the US scope of work. It was noted that US staffing at the ITER Organization site (IO) in Cadarache is somewhat below the nominal 9% level. At the same time, the US provided roughly 25% of the profession person years for the 2007 design review and 36% of the person years dedicated to resolution of issues identified by the Science and Technology Advisory Committee (STAC). The US has been asked by the IO to take responsibility for ELM control coils. This would add 24% to the US scope and will require further negotiation. Changes in the status and connection between the IO and domestic agencies are planned. Currently the IO management structure treats Domestic Agencies (DA) like the USIPO as vendors which does not reflect the collaborative nature of the relationship. A proposed solution is to form a Project Board which can coordinate activities across the entire project. The DA’s would report through the Project Board. The overall project schedule has been revised with a new construction endpoint at July 2018. The next phase of activities will require significant engagement with US industry with emphasis on early-delivery and high-risk systems. Long-lead materials procurements will begin as soon as designs are sufficiently mature and funding is available. In discussion, FESAC members asked about the impact if the current reduced level of funding were maintained for the rest of FY2009. Sauthoff felt that the overall project schedule would begin to be harmed if additional funding was not provided by April 2009. Members asked about US university involvement, a point that was raised in the NRC review. Sauthoff said the USIPO was eager to engage

the universities in appropriate areas. Southoff was asked if the US was recognized for its oversized contributions on the design review and STAC issues. He replied that the statistics quoted came from the IO itself who expressed appreciation for these efforts. He noted that our international partners have been understanding and patient about the funding difficulties within the US. The status of the TBM (Tritium Breeding Modules) program was discussed. It was pointed out that while the US participates at a technical level, this program is not part of the USIPO scope and is not part of current US plans. One concern is whether the TBM program will compromise physics operations – mainly through increased toroidal field ripple. Concern over the recent reduction in funding for US participation in ITER was raised by FESAC members.

#### **9. US Community support during preparations for ITER (C. Greenfield)**

ITER support activities outside the direct scope of the USIPO were reviewed. It is worth noting that to ensure project success, there is a significant level of activity required of all participants beyond the construction and procurements for the ITER device itself. The US Burning Plasma Organization (BPO) provides the overall coordination for these activities within the US with active liaison to our international partners through the ITPA as well as to the USIPO and to topical groups within the US already active in various areas. It was noted that improved lines of communication and authority, especially at the international level are required. The design review, while successful, was not felt to be a model for future coordinated activities. Future activities of the BPO will include 1. Close coordination with the ITPA on research needs. 2. Participation in the ReNeW process. 3. Continued participation in development of the ITER research plan.

#### **10. Status Report: Panel on High Energy Density Laboratory Physics (R. Betti)**

FESAC was provided with a status report from the panel charged with reviewing a joint OFES-NNSA program on High Energy Density Laboratory Plasmas. The charge asked 1. Identify the compelling scientific opportunities in fundamental HEDLP that could be investigated using existing and planned facilities in support of the OFES and NNSA missions. 2. Identify the scientific issues of implosion and target design that need to be addressed to make the case for inertial fusion energy as a potential future energy source. The panel, which has 17 members, held a workshop in August which drew 82 attendees. The panel has organized this very large research domain into a set of thematic areas and identified critical issues and questions within each. Criteria for prioritization of the general HEDLP issues were somewhat different from those directly related to IFE. The panel expects to complete its final report by Dec. 20 and to deliver that report at the next FESAC meeting. Members of FESAC asked about other elements of an IFE program, beyond what is encompassed under HEDLP. It was noted that, as for MFE, the OFES mission is for science and not energy. Thus IFE technology issues are not within the scope of the charge. Some issues related to integrated science for IFE systems will be considered.

#### **11. Public Comments**

##### **Dale Wesson (Florida A&M University)**

Prof. Wesson described a proposal to move the SSPX experiment from Livermore, where the project has been recently cancelled, to Florida A&M University. He argued that this would be an appropriate experiment for a University, would bring young scientists into the field and would increase the diversity

of researchers in FES. In the discussion, FESAC members stressed the importance of first identifying critical scientific issues that could be addressed by a continuation of the SSPX program.

**Mark Haynes (GA)**

Mark Haynes urged that the strategic plan under development stress the energy mission for fusion. He pointed out that with a new administration, a new Congress and renewed public awareness of energy issues, there was an opportunity that we should not miss. He felt that the distinction between the science and energy missions for fusion are lost on Congress and what they really wanted to hear about was fusion energy if it could be part of a solution to an important national problem. Several members of FESAC voiced their support for these sentiments.

**Glen Wurden (LANL)**

Glen Wurden urged more emphasis on energy applications for fusion, especially in the strategic plan that is under development. He suggested that a specific applications area for fusion energy be created within DOE, parallel to those for fossil or nuclear energy. Finally, he compared the lack to commitment of the US program to an energy mission to those in other countries. Some members supported these views and reemphasized the congressional call for a “bold credible plan”, but noted that there is currently no fusion energy industry thus comparison to fossil and nuclear are premature.

**Ron Stambaugh (GA)**

In response to the NRC review, Ron Stambaugh suggested metrics for participation in ITER. He noted that the ITER Physics Basis published in Nuclear Fusion had approximately 18,000 downloads over the past year and a half. This compares to about 300 hundred for typical “very popular” papers. He suggested that we track citations for and from ITER publications as one means of measuring impact and US participation.

The meeting adjourned for the day at 5:50 PM

**Second day**

The meeting reconvened at 8:30 AM

**12. White Paper of Fusion Diagnostic Development Needs (R. Boivin)**

The white paper proposing a new initiative on burning plasma diagnostics was reviewed. This white paper was prepared in July 2007 by the diagnostics working group of the BPO. The presentation stressed the importance of diagnostics in supporting the science mission for ITER and the inadequacy of existing programs for support of the long-term innovative developments that were required. In particular, the need for more engagement between diagnostics development and the technology programs was pointed out. Technical challenges were reviewed along with gaps in the ITER diagnostic plans. In discussion, it was noted that this was an area ripe for activity under the ReNeW process. It was suggested that opportunities for collaboration with other fields might exist, for example with the NNSA on final optics or with space and astrophysics on satellite instruments.

**13. Status of Research on Plasma-Materials Interactions (D. Whyte)**

This technical presentation outlined the challenges raised by plasma-wall interactions as plasma experiments move toward reactor parameters. These challenges include steady-state and transient heat loads; plasma particle flux leading to erosion and tritium retention; neutron loading; mechanical strength and maintenance of plasma purity. The main theme of the presentation was that much more research is required into basic plasma and material properties as well as into integrated processes that occur in real devices. Improved diagnostics for plasma-surface interactions were stressed.

#### **14. Summary of Workshop on Low Temperature Plasmas (M. Kushner)**

This presentation summarized a workshop carried out in response to the NRC "Plasma 2010" decadal survey. The NRC report covered five areas of plasma science including "Low Temperature Plasma Science and Engineering" (LTPS or LTPSE). This field covers a diverse range of physical regimes, many with important near-term applications. The workshop, carried out in March 2008 at UCLA attracted 35 participants from almost 30 institutions. The participants 1. Summarized the status of research in LTPS, 2. Identified major scientific questions including their importance and impact, 3. Described basic research activities to address these questions 4. Developed a roadmap for an initiative in LTPS. The report has been submitted to OFES and awaits action by the new AD.

#### **15. Resolution on ITER funding (M. Greenwald)**

After discussion, the following resolution was passed unanimously.

"The recent National Research Council review of the plan for U.S. participation in ITER contained what we believe is a crucial finding: "The committee's greatest concern is that the U.S. commitment to ITER appears to be uncertain at the present time. This uncertainty threatens the U.S. role in ITER and the future benefit to U.S. fusion program goals and national energy goals".

At our meeting on November 11-12 2008, the Fusion Energy Sciences Advisory Committee unanimously passed a resolution echoing this concern and noting the damage already caused by the lack of stable funding. We urge you to continue your steadfast support of this important project."

This resolution will be forwarded to Dr. Orbach.

#### **16. Resolution of thanks for Dr. Orbach**

With the change in administration, the committee agreed to send a letter of appreciation to Dr. Orbach for his tireless efforts and enthusiasm in support of the fusion program.

#### **17. Schedule**

The next meeting is currently scheduled for Jan. 13-14, 2009. Items on the agenda will include receipt of the final report of the panel reviewing the HEDLP program and formal comments on the OFES Strategic Plan Overview.

The meeting adjourned at 11:50 AM.

## **Appendix A: Attendee List**

Sam Barish, DOE/OFES  
Ben Brown DOE/OSC  
Curt Bolton, DOE/OFES  
Rejan Boivin, GA  
Robert Cauble, LLNL  
Jean Cottam, OSTP  
Mike Crisp, DOE/OFES  
Ben Cross, SRNL  
Anne Davies, Self  
Steve Dean, FPA  
Steve Eckstrand, DOE/OFES  
T.V. George, DOE/OFES  
Jim Glownia, DOE/SC  
John Glowienka, DOE/OFES  
Rob Goldston, PPPL  
Dave Goodwin, DOE/OFES  
Chuck Greenfield, GA/BPO  
Rich Hawryluk, PPPL  
Mark Haynes, GA  
Dave Hill, LLNL  
Jeff Hoy, DOE/OFES  
Joseph A. Johnson, III, FAMU  
Richard Jones, Ame Inst of Physics  
Arnold Kritz, Lehigh U  
Mark Kushner, U of Michigan  
Stephen Knowlton, Auburn Univ/UFA  
David Lang, NRC  
Ray Leeper, SNL  
Christian Mailhiot, LLNL/NNSA  
Darlene Markevich, DOE/OFES  
John Mandrekas, DOE/OFES  
Ron McKnight, Self  
Wayne Meier, LLNL  
Natalia Melcer, DOE/CFO  
J. Menard, PPPL  
Stan Milora, ORNL  
Neil Morley, UCLA  
Gene Nardella, DOE/OFES  
Erol Oktay, DOE/OFES  
Elizabeth O'Malley, DOE/SC  
Miklos Porkolab, MIT  
Don Rej, LANL



Michael Roberts, Self  
Ned Sauthoff, ORNL  
Walter Sadowski, Self  
Ralph Schneider, DOE/NNSA  
Ken Schultz, GA  
Sharon Stevens, DOE/OFES  
Karen Summers, DOE/SC  
Barry Sullivan, DOE/OFES  
Ed Synakowski, LLNL  
Francis Thio, DOE/OFES  
Tom Vanek, DOE/SC  
Tom Weaver, Boeing  
G. Dale Wesson, Florida A&M U  
Dennis Whyte, MIT  
Glenn Wurden, LANL

## **Appendix B: Committee of Visitors Charge**

November 6, 2008

Dr. Martin J. Greenwald, Chair  
Fusion Energy Sciences Advisory Committee  
Plasma Science and Fusion Center  
Massachusetts Institute of Technology  
NW17-107  
175 Albany Street  
Cambridge, MA 02138

Dear Dr. Greenwald:

I request that the Fusion Energy Sciences Advisory Committee (FESAC) establish a Committee of Visitors (COV) that can assist FESAC in:

- assessing the efficacy and quality of the processes used by the Office of Fusion Energy Sciences (OFES) to solicit, review, recommend, monitor, and document awards and declinations for universities, national laboratories, and industry.
- assessing the breadth, depth, and quality of the resulting program portfolio, and providing an evaluation of the program's national and international standing.

The last COV activity evaluated portions of the program over a three year period. Starting with this COV, I am asking FESAC to review the entire OFES program at the same time. Therefore, the tokamak research and enabling technologies portion of the program should be evaluated from 2006 to the present, the innovative confinement, general plasma sciences, and the High Energy Density Laboratory Plasmas portions of the program should be evaluated from 2005 to the present, and the theory and computations portion of the program should be evaluated from 2004 to the present. This will make it possible for the next COV to evaluate the entire program for a three year period.

The COV panel should be composed of recognized scientists and research program managers with broad expertise relevant to the fusion program. Panel members should be familiar with OFES research programs; however, a significant fraction of the COV members should not be involved in research that is being funded by OFES. Each panel member will be required to sign a Conflict of Interest statement and a Confidentiality statement. Examples of both statements are enclosed.

I believe that the COV reviews conducted in this manner will help the Office of Science maintain a high standard of scientific research. A report on the COV activity should be completed by April 2009.

Sincerely,

Raymond L. Orbach