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May 21, 2001

Dr. James Decker, Acting Director  
Office of Science  
U.S. Department of Energy  
1000 Independence Avenue, S.W.  
Washington, D.C. 20585

Dear Dr. Decker:

In a previous letter (12/5/00) to Mildred Dresselhaus, the Fusion Energy Sciences Advisory Committee (FESAC) expressed its preliminary response to the assessment of fusion science conducted by the Fusion Science Assessment Committee of the National Research Council (NRC). The FESAC found itself in broad agreement with the principal findings and recommendations of the NRC report, which we described as "thoughtful and penetrating," and deserving of "serious attention and respect." We also found "the recommendations given in the NRC assessment to be compatible with FESAC's sense of the program priorities."

Regarding the NRC comments on the quality and nature of fusion science-its achievements, rates of progress and remaining challenges-we have nothing to add to the December letter, beyond repeating our thanks to the NRC for its service to fusion science. The main purpose of the present message is to comment more specifically on the changes in fusion research policy that the assessment recommends. These recommended actions are listed below (in boldface), each followed by the FESAC reaction or interpretation.

- 1. Increasing our scientific understanding of fusion-relevant plasmas should become a central goal of the US fusion energy program, on a par with the goal of developing fusion energy technology, and decision making should reflect these dual and related goals.**

We strongly agree with the NRC Panel that the goal of developing scientific understanding of fusion-relevant plasma physics should play a role comparable to that of progress in fusion performance in setting program priorities.

The NRC assessment recommends that an organizational approach along scientific lines-one that facilitates promoting advances on cross-cutting scientific issues-be developed, in order to supplement the scheme based on stages of concept development. We fully agree with this recommendation.

The "stages of concept development" organizational scheme presently used in the Fusion Energy Sciences program was implemented with the express purpose of ensuring an appropriate balance between scientific advance and fusion performance. Based on the recommendation of FESAC's Alternatives Concept Panel, July 1996 (DOE/ER-0690), this scheme shuns the use of performance"... as the *only* measure of progress" or even as the primary metric. Four primary criteria for assessing progress were established by that Panel:

- (1) Advancement of general plasma physics;
- (2) Advancement of fusion plasma physics, including addressing issues specific to a concept as well as generic issues applicable to many *or* all fusion concepts;
- (3) Contribution to fusion energy development, including addressing issues such as burning plasma physics and development of fusion technologies; and
- (4) Development of candidates for fusion power plants.

Regarding these criteria the recommended policy was stated:

"The Panel does not believe that the potential to become an attractive fusion power plant should be used as a litmus test for fusion concepts that are at early stages of development... Rather, in early stages of development of concepts, the major benefits of research are in advancing general and fusion plasma physics (the first two criteria). At later stages of development, the emphasis gradually shifts towards fusion energy development and power."

Similarly, the recent Report of the Integrated Program Planning Activity (DOE/SC-0028) states that "[Concept exploration] should be interpreted to include experiments designed to test important basic fusion-relevant science concepts as well as potential reactor concepts."

**2. A systematic effort to reduce the scientific isolation of the fusion research community from the rest of the scientific community is urgently needed.**

We agree with this recommendation. It could be served by involving more funding agencies in the support of fusion research; by the institutional broadening discussed under recommendation #3, below; and by the efforts of individual fusion scientists, as they interact with other scientific colleagues, present their scientific findings publicly and participate in the affairs of the scientific community.

**3. The fusion science program should be broadened in terms of both its institutional base and its reach into the wider scientific community; it should also be open to evolution in its content and structure as it strengthens its research portfolio.**

The goal of broadening the institutional base to reach a wider scientific community is endorsed by the FESAC. An open, well-advertised solicitation for proposals for competitive peer review will encourage such broadening, and has been embraced by the Office of Fusion Energy Science for much of its funding of University research. The recent competition conducted by the Office, for the Scientific Discovery through Advanced Computing (SCIDAC) initiative, is an example of such open, peer-reviewed solicitation.

Because institutional broadening is likely to require increased funding, it requires careful consideration of program balance. Thus the appropriate fraction and scale of solicitations dedicated to this type of funding must be determined in the context of the overall needs of the fusion energy science program. In particular, the need to adequately fund the initiatives begun during the restructuring of the past 5 years, virtually all of which were peer-reviewed, must be weighed against the desire to increase the institutional base. Further, most of these initiatives fund university research at the concept exploration level; additional funding is required to adequately develop the potential of this research.

The scale of research required to answer the cutting edge questions in fusion science usually requires multi-disciplinary teams at significant scale. This is true for the major experimental facilities and can also be true for efforts to develop advanced computational models

and major diagnostics. The DOE National Laboratories were established for just this type of challenge. Although some of these challenges can be met by forming multi-institutional coordinated teams, it is important that the effort to broaden the base of institutions does not result in a balkanization that compromises our ability to address the critical issues. A healthy program in fusion energy science requires a pyramid of research: smaller-scale projects at the basic research level contribute to the scientific base for the larger scale, more integrated levels of research needed for the exploration of fusion-grade plasmas.

**4. Several new centers, selected through a competitive, peer-review process and devoted to exploring the frontiers of fusion science, are needed for both scientific and institutional reasons.**

FESAC supports the concept of forming Centers devoted to the frontiers of fusion science. Such Centers would be selected using a competitive, peer-review process and should open fusion research opportunities to institutions not presently participating in the program, as well as enhancing the participation of institutions already involved. The main criteria for selection should be

- (1) the scientific quality and relevance of the proposed research;
- (2) the novelty of the proposed program compared to existing fusion research efforts, especially regarding multidisciplinary activities and connections to other fields of science; and
- (3) the value added by virtue of Center organization, which implies an overarching focus for the research activities.

FESAC recognizes that the community synthesis achieved by funding multiple centers is desirable for the effectiveness of the Center concept. However, FESAC also notes that at most one Center could be formed under flat funding in FY 2002. New Centers will generally require additional support, and should be co-funded by the DOE and another funding agency.

It should be noted that multi-institutional groups that focus on key issues in a multi-disciplinary manner already exist in fusion research. New centers would extend that activity, especially by linking the research to scientific areas outside the current set.

**5. Solid support should be developed within the broad scientific community for US investment in a fusion burning experiment.**

We agree with this recommendation. The fusion community, through FESAC as well as other means, is in the process of examining the scientific and technical prospects of a burning plasma experiment. This examination is being conducted with full awareness that a decision to proceed could not be implemented without strong support from scientists outside fusion research.

**6. The National Science Foundation should play a role in extending the reach of fusion science and in sponsoring general plasma science.**

We agree with this recommendation.

**7. There should be continuing broad assessments of the outlook for fusion energy and periodic external reviews of fusion energy science.**

With some qualifications regarding the frequency and scope of such assessments, FESAC agrees with this recommendation.

We close with a more general comment. Implicit in the NRC recommendations is the need for the fusion program to re-examine its priorities. The FESAC considers such reexamination to be one of its central responsibilities; indeed, such recent meetings as that at Knoxville in August, 1999, were focused on the systematic approach to setting priorities. The influence of the NRC assessment on priority discussions within FESAC is unmistakably clear.

Yours truly,

//signed//

Richard D. Hazeltine, Chair  
Fusion Energy Sciences Advisory Committee

RDH/cv

cc: N. A. Davies  
FESAC Members