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# Fusion Energy Sciences Advisory Committee

## Committee of Visitors

### Review of the Innovative Confinement, General Plasma Physics, and Inertial Confinement Programs

April 2005



U.S. Department of Energy  
Office of Science

# Committee of Visitors

## Final Report March 2005

### I Introduction

This report summarizes the findings and recommendations of the second Committee of Visitors (COV) whose charge was to review the manner in which the Office of Fusion Energy Science (OFES) manages certain programs under its charter. The specific programs reviewed by this COV involve confinement innovation and basic plasma sciences. The first COV completed its work last year and was concerned with the Theory and Computation Program. The present Committee would like to acknowledge the substantial help we received from the first COV and its chairman, Dr. Bill Nevins.

The report is organized as follows. The first few sections set the background for the report by describing the charge to the Committee, the actual program elements reviewed, the composition of the Committee, and the process used to arrive at our conclusions. The last two sections contain the main results of our deliberations, comprised of our Findings and Recommendations.

### II The Background and Charge to the Committee

The request to establish a series of committees (COVs) was made by Dr. Ray Orbach, Director of the Office of Science, in August 2003. He transmitted his request to Dr. Richard Hazeltine, Chairman of the Fusion Energy Sciences Advisory Committee (FESAC). Professor Hazeltine has already established two COVs and will complete Dr. Orbach's request next year with the establishment of a third COV panel. Thus when a COV completes its report, it forwards it to FESAC which must then approve it and, finally, submit it to Dr. Orbach.

The charge to the Committee is given in Appendix A. Basically, the Committee is asked to review the way that OFES manages its program elements with respect to:

- The complete review processes involved in selecting proposals for awards
- The manner in which progress is monitored
- The connection between proposal awards and the overall program goals

The Committee is also asked to comment on the following:

- The breadth, quality, and portfolio balance
- The national and international standing of the portfolio elements

Although interesting and important, it was *not* in the charge to the COV to assess the present role of the confinement innovation and the basic plasma science programs within

the context of the overall balance in the fusion program. This lies in the domain of the ongoing “Priorities Panel” chaired by Dr. Charles Baker.

### **III The Specific Program Elements Reviewed**

There are many elements in the overall fusion program. The present panel was charged with reviewing program elements concerned with Innovative Confinement Concepts (ICC), General Plasma Physics (GPP), and Inertial Fusion Energy (IFE). The specific program elements reviewed are as follows.

- NSF/DOE joint program
- General plasma physics program at the national laboratories
- Fusion Science Centers
- Atomic physics
- Junior faculty program
- Innovative confinement concepts
- Inertial fusion energy/high energy density physics

These elements represent annual funding of more than \$49M. The largest elements are ICC research (\$26M), IFE/HEDP research (\$13.8), and GPP research (\$7.1M). This year, the Fusion Science Centers were added as a new element to the program with annual funding of \$2.3M.

Overall the Committee examined the review process for approximately 100 proposals. The Committee did not review the National Spherical Torus Experiment (NSTX) or the National Compact Stellarator Experiment (NCSX), which although being innovative confinement concepts, are grouped together with the large tokamak facilities as “large experiments.” Most of the proposals reviewed by the COV panel were submitted in response to formal solicitations of the DOE Office of Science. They included:

- Notice 03-19, “Research in Innovative Approaches to Fusion Energy Science,” <http://www.science.doe.gov/grants/Fr03-19.html>, Published March 4, 2003.
- Notice DE-FG01-03ER03-26, “Fusion Science Centers,” <http://www.science.doe.gov/grants/Fr03-26.html>, Published August 15, 2003.
- Notice DE-FG01-04ER04-18, “Research in Innovative Approaches to Fusion Energy Science,” <http://www.science.doe.gov/grants/FAPN04-18.html>, Published April 20, 2004.

In addition the Committee examined, in-part, proposals submitted to NSF as part of the NSF/DOE Partnership in Basic Plasma Science and Engineering: NSF 02-184, “Partnership in Basic Plasma Science and Engineering,” <http://www.nsf.gov/pubs/2002/nsf02184/nsf02184.htm>, Published October 1, 2002.

#### IV The Committee

The Committee was comprised of 14 members from universities, laboratories, and industry. All were relatively senior, having had considerable experience writing and reviewing technical proposals. Some members had research interests that were directly involved in the programs being reviewed. Some were members of the fusion community, primarily involved with tokamaks, while others were not directly in the fusion community but had related interests in plasma physics or nuclear science. We believe that the Committee had a good overall balance. The members, affiliations, and primary research interests are summarized in the table below.

<b>Name</b>	<b>Institution</b>	<b>Expertise</b>
Jeff Freidberg (Chair)	MIT	Tokamaks/ICC
Don Batchelor	ORNL	Tokamaks
Jeff Coderre	MIT	Non-fusion
Fred Driscoll	UCSD	Basic Plasma Physics
Gail Glendinning	LLNL	IFE/HEDP
Chuck Greenfield	General Atomics	Tokamaks
Dave Hammer	Cornell	Basic Plasma Physics
Mike Mauel	Columbia	ICC/Tokamaks
Ed Ott	U. of Maryland	Non-fusion
John Sarff	U. of Wisconsin	ICC/Basic Plasma Physics
Ed Thomas	Auburn U.	Basic Plasma Physics
Francois Waelbroeck	U. Texas, Austin	ICC/IFE/Tokamaks
Harold Weitzner	NYU	ICC/Tokamaks
Dan Winske	LANL	Non-fusion

#### V The Process

The process by which the COV arrived at its findings and recommendations involved several steps.

First, we had several discussions with the first COV to learn from their experiences. One member of the Committee also served on the first COV that reviewed the processes and procedures used to manage the Theory and Computations Program.

Second, after several conference telephone calls the Committee agreed upon a fairly detailed questionnaire concerning the way in which OFES manages the programs under consideration. This questionnaire was sent to OFES. Many of the questions were answered with written responses. Others were deemed slightly sensitive and OFES wanted to answer these in person during the site visit, which they did, in a cooperative and forthcoming manner. Based on the discussions the panel then wrote responses to these questions. A copy of the questionnaire and answers is included in Appendix B.

Third, after an additional conference call the Committee agreed upon a set of questions that were sent in the form of a simple multiple choice survey to relatively senior members of the fusion community directly involved in the programs being reviewed. The survey was sent to 61 scientists and we received 39 responses. A copy of the survey, including a summary of the results, is given in Appendix C. Interestingly, members of the community were quite willing to express their views with written comments in numbers far exceeding our expectations, thus being too lengthy to include in the report. The Committee considered these comments seriously, although not directly, in reaching our conclusions. A copy of the survey, including the written comments, was sent to OFES before the site visit.

The fourth step in the process involved a two-day site visit to OFES headquarters in Germantown. During this visit, the COV heard presentations by OFES (1/2 day), examined the proposals covered by our review (1/2 day), met in executive session to develop our findings and conclusions (2/3 day), and closed with a preliminary presentation of our report to OFES (1/3 day).

Through the usual series of emails and a conference telephone call we converged to this final report.

## **VI Findings**

### **A. Overall Summary**

Overall, the OFES staff does a very good job managing the way it solicits, reviews, awards, and monitors proposals included in the programs examined by the present COV. The staff is serious, conscientious, and dedicated in its efforts to generate a high quality research program by means of the peer review process. For a very large majority of the proposals submitted, it is the opinion of the COV that OFES makes sound decisions regarding which proposals should and should not be funded. For decisions on the borderline, where there can be legitimate differences of opinions, OFES has thought about the issues carefully and can provide a detailed rationale for its decisions. Often this rationale is explained in writing and included as part of the proposal folder. We urge OFES to do this for all proposals primarily to institute a history and sense of continuity for each project under consideration, which is particularly important as assignments in OFES change and personnel come and leave.

The survey revealed that in general the community has positive feelings about the review process. This is indeed a non-trivial result. Our interpretation of the main overall concern expressed by the fusion community is ultimately related to the flatness of the budget, and the corresponding lack of growth for the programs under consideration. There is a frustration in that it takes a considerable expenditure of time and effort for community members to continually prepare and submit new proposals, which are then prioritized through a time consuming peer review process, only to have high quality proposals unfunded because of budget limitations. Even so, it is important for OFES to maintain the peer review process. This is particularly so because in the near future with

the (hopeful) agreement to proceed with ITER there may be large changes in the program in terms of funding and research directions. When this occurs, the peer review process should be very helpful and play a major role in deciding which projects should and should not be funded.

Lastly, the COV would like to let members of the fusion community know that OFES is doing a good job reviewing their proposals. The community should have confidence that the peer review process, when properly carried through, is the best approach so far in selecting which proposals to fund. Some members of the community, like some members of the COV, tend to be somewhat suspicious of the way OFES reviews their proposals, although this feeling is largely generated by a lack of knowledge of the process. The COV, once it learned first hand how OFES actually carries out the review process, was favorably impressed. Based on our experience, the community can feel confident in the knowledge that their proposals will be reviewed fairly and conscientiously by OFES, even though the budget limitations may limit the total number of awards made in any given program.

## **B. Solicitation of proposals**

New request for proposals (RFP's) are officially announced on the public Federal website "Grants.gov" (<http://grants.gov/>) and also listed on the DOE Office of Science website (<http://www.science.doe.gov/grants/>). The survey indicates that fusion researchers virtually always know about a new (RFP's) in time to complete and submit proposals. We also note that non-government websites post links to the official proposal solicitations. These include Fusion Power Associates, <http://fusionpower.org/>, the University Fusion Association, <http://depts.washington.edu/ufoa/home.html>, and the "Fire" website, <http://fire.pppl.gov/>, at PPPL. These other online notifications help to keep the community informed. In addition, we appreciate (1) the verbal presentations by OFES staff at "town hall" meetings at the APS Division of Plasma Physics Annual Meeting and (2) the email announcements of DOE proposal opportunities that are sent by the APS-DPP to its membership. Verbal communications between OFES staff and appropriate members of the community are especially effective ways to announce RFPs. The COV encourages OFES to consistently use all of these forms of communication to insure the widest possible awareness of program solicitations.

In general OFES is able to complete the entire process from the issuance of the RFP to the final notification of awards on a reasonable time scale, on the order of 6 to 8 months. This is quite satisfactory.

## **C. Reviewing of proposals**

The review process requires several steps. (1) choosing reviewers, (2) choosing the method of review (i.e. mail vs. site visit), (3) analyzing and deciding which proposals to fund based on the reviewer input, and (4) documenting the review result for each submitted proposal for the purposes of continuity, future use, and internal (OFES) and external (COV) analysis. In addition, the COV reached several conclusions regarding the

overall effectiveness of the current peer review process. Our findings regarding these points are as follows.

The COV panel was favorably impressed by the quality of the scientists chosen to review proposals. These scientists are invariably senior members of the community with considerable experience in the technical area being reviewed. OFES chooses from a large number of reviewers and appears to have a good knowledge of which scientists routinely provide careful, detailed, well thought out reviews on a timely scale and which scientists do not. This knowledge is mainly in the heads of OFES staff through years of personal contact and experience. There is no organized computerized list of reviewers and OFES may want to consider establishing such a list in view of retirements and career changes. However, since the system is currently working, one should be careful expending too much time and energy fixing a process that is not broken.

Most of the proposals that we examined were for relatively small amounts of funding (i.e. single investigator proposals) and as such were reviewed by mail. The few larger ones involved site visits. In terms of efficiency this makes good sense. However, the site visit proposal writers have the advantage of directly addressing, face-to-face, any questions or problems raised by the review panel. They essentially have a built-in, real time, rebuttal procedure. The mail review proposal writers correctly note that this gives the larger projects an advantage since they (the mail review proposal writers) often do not have a chance to rebut any negative referee comment. In fact, a large majority of the responders from the community survey were very unclear about whether or not a unified rebuttal procedure exists and, if one did exist, did it have any impact on funding decisions. Addressing the question of rebuttals is one of the main recommendations of the COV and is discussed in the recommendations section.

Typically each proposal is reviewed by at least three scientists who score on the basis of 1 to 5, with 5 being the highest. A recommendation made by the first COV, and which we heartily endorse, is to put more appropriate word correlations with each grade to help each reviewer's ranking be better calibrated against the other reviewers. For instance, rather than stating that 5 = excellent and 1 = poor, a better system might be:

- 5 = must fund
- 4 = deserves funding
- 3 = OK to fund if resources available
- 2 = marginally acceptable, fund only for a crucial programmatic need
- 1 = not acceptable, do not fund under any circumstances

An important issue that was identified and partially quantified by the COV concerns the variation in the reviewers' scores as compared to the average scores of all proposals within a given RFP. Specifically, it was found that the average value of the standard deviation of the reviewers' scores on a given proposal was of the same order as the standard deviation of the average scores of all proposals. Some examples are given in Appendix D. The implication is that the numerical scores resulting from the peer review

process provide a reasonably good guideline as to which proposals should or should not be funded but are not a razor sharp, precision tool, upon which to base decisions.

OFES has recognized this problem and has adopted an internal team review process to help arrive at proper funding decisions. When the external reviews are collected, a group of typically four OFES members form a team to collectively review the results. This team attempts to sort out biases, eliminate inappropriate or occasionally misinformed reviews, and take into account programmatic needs. The team approach appears to work quite well. Four team members discussing the results lead to better decisions than would arise solely from a single OFES staff member who invariably would not have complete expertise in all areas under consideration (i.e. theory, computation, or experiment, with application to transport, heating, or confinement). The conclusion is that OFES carefully considers the reviewers rankings of the proposals but sometimes uses discretion in arriving at its final decisions; that is, awards are not based on a purely numerical ranking of the reviewers. However, based on the admittedly limited data in Appendix D, it would appear that this discretion is only used very occasionally. This is slightly worrisome in view of the fact that the deviation in the scores of the reviewers is comparable to the deviation in the average scores of the proposals.

Constrained by flat budget limitations, many funding decisions go to existing projects up for renewal because of the excellence of the research and the substantial investments that have already been made in terms of experimental hardware. Even so, there is turnover and balance in the program and new and sometimes quite innovative research is being supported. Also there is thought put into balancing university research versus projects at the national labs. This is crucial since, as stated, the numerical score from the external reviewers is not a precision tool. The COV has several recommendations on relatively simple ways to improve this process without imposing significant new burdens on the community or OFES staff. These are discussed in the recommendations section.

On a related issue, the Committee was very pleased to learn of the procedure followed by OFES when the terminations of large ICC research programs were recommended. Naturally, in an active and innovative research program like fusion, existing research programs must prepare renewal proposals that compete with new ideas and programs proposed by other research groups. This competition is the appropriate way to insure continued high quality of research and to provide review of research progress. The proposals that we examined included several proposals to renew ICC research programs. We noted that in the cases where reviews of existing programs would lead to project termination, OFES always allowed the PIs the opportunity to prepare rebuttals. The Committee strongly endorses this practice. Additionally, the Committee was also pleased to learn that closeout funds were provided to allow the completion of on going graduate dissertation work.

The last topic of interest involves documenting the review process for each proposal and, on a larger scale, for the RFP as a whole. OFES is making considerable progress in this area but OFES still has a way to go. Consider first the documentation for separate



proposals. It is essential that the folder for each proposal be uniform in structure. Also, a standard summary sheet serving as the cover page would be very helpful to OFES and future COV in order to quickly assess the status of the proposal and the reason why the proposal was funded or not. In this connection, a short paragraph explaining the justification for funding or the reason for not funding should be included on the summary page. In terms of documenting the results for the RFP as a whole, there was little information available. The COV found summary sheets prepared specifically for the site visit by Darlene Markovitch, Francis Thio, and Michael Crisp very helpful. Some samples are included in Appendix D. It was disappointing that such data for all the programs under consideration was not available for the Committee prior to the site visit, although it was requested in the original questionnaire to OFES. The reason is that this information is not readily or easily available to OFES in spite of its obvious usefulness for internal self-assessment. This is not due to a lack of interest on the part of OFES but much more to the lack of availability of an efficient DOE information system for processing and manipulating the data. We understand that DOE-wide efforts are underway to correct this situation but this does not help the present situation for OFES or other divisions. Until this situation is improved, many organizations in DOE will be lacking an important tool for internally assessing their overall performance on the review process.

Overall, the COV believes the current peer review process can be characterized as follows. Peer review has increased the fairness of the review process, both in perception and reality. Peer review has increased the quality of the proposals as well as the quality of the reviews. There is, however, no obvious metric that shows whether or not the actual quality of the research has increased. Stated differently, the quality of the research was already very high even before the peer review system was introduced and continuing improvements were made. Peer review requires a considerable effort on the part of the community and OFES in terms of writing and reviewing proposals. There was also strong feeling in the community that too many “new initiatives,” while desirable in the abstract, are not very desirable in the present environment. They require substantial amounts of additional efforts in the writing and reviewing of proposals, but in a flat budget are often funded by extracting funds from given programs to free up funds for the new initiative. Thus researchers feel they are doing a lot more work re-competing for funds that were already awarded. Even though some of these new initiatives are externally imposed unfunded mandates, OFES should be very cautious before they are implemented because of the flat budget situation.

#### **D. Fusion Science Center Solicitation**

For the first time, OFES issued a solicitation for Fusion Science Centers. This initiative was recently recommended by the NRC Fusion Science Assessment Committee (available at <http://www.nap.edu/books/0309073456/html/>). This initiative included a pre-proposal step, and included presentations of second-round proposals to a panel of fusion science experts. Overall the COV was very pleased with the review procedures and the fairness of the proposal process. However, the Committee notes that the scientists asked to review the Fusion Science Center proposals were all “fusion insiders.”

Since a central motivation for the fusion science centers is to increase the visibility and interaction with related areas of science, mathematics, and physics, OFES should seek to include scientists from outside the fusion program in future review processes. (A broad range of expertise is typical of the reviewers evaluating proposals for the NSF/DOE Partnership in Plasma Science.)

#### **E. Funding level of proposals**

The committee considered the question of the ratio between the amount of funding awarded and the amount requested. This ratio varied between the two years we examined, the average being close to 100% in 2003 and declining to 86% in 2004. In discussions, the OFES staff indicated that they tried to provide the requested funds whenever reasonable, and to stay as close to the requested amount as possible otherwise. The reasons for funding at reduced levels are varied but chief among them is the desire to preserve OFES investment into experimental equipment during funding fluctuations. OFES staff is keenly aware of the dangers of consistently under-funding budget requests and how this will likely lead to PIs routinely asking for the maximum plausible funding on any proposal. The COV commends OFES for their awareness of this potential problem and supports their vigilance in preventing it from occurring.

#### **F. Monitoring of proposals**

Most members of the community felt that OFES does a satisfactory job monitoring the progress of research on funded proposals. Some of the smaller projects felt, however, that there was almost no contact. On the other hand, OFES has stated in their questionnaire that large projects are required to report on a weekly basis. Clearly there is a sliding scale for the level of monitoring required dependent upon the size of the project. This makes good sense, but OFES may want to have some fine-tuning internal discussions to make sure the monitoring process is uniform and that at the extremes there is not too little or not too much reporting required by the principal investigators carrying out the research.

#### **G. National and international recognition**

The COV panel did not spend much time discussing the national and international perception of the quality of the ICC and BPP programs, primarily because there are no simple but meaningful metrics available for OFES to evaluate this issue. However, in all recent reviews of the US fusion and plasma science programs conducted by panels with broad membership, the whole of the program (including ICC and BPP research) is favorably regarded with respect to all areas of science research (2001 NRC Fusion Science Assessment Committee, <http://www.nap.edu/books/0309073456/html/>). Our Committee strongly endorses this view. We further note that the community survey we conducted suggests US scientists also believe that the ICC and GPP programs are highly respected and competitive, but at the same time they believe that the international community appears to be less interested in these areas of research because their programs have more of an explicit "energy mission" (dominated by tokamak research).

Nevertheless, significant ICC research occurs many places in the world, with especially large programs in Europe and Japan.

## **VII Recommendations**

Based on these findings the COV has developed a set of recommendations to help OFES improve the management of the ICC and GPP programs. Most of these recommendations are highly sympathetic with those made by the first COV. Moreover, these improvements can be implemented without significantly increasing the review burden on OFES or on the research community; we consider it important not to add to the already significant workload of proposal and review activities. The recommendations are given as follows.

### **A. A rebuttal procedure**

*OFES should develop a uniform, clearly stated, rebuttal procedure for proposal writers.*

At present there is no uniform rebuttal process in OFES. Rebuttals are occasionally allowed, but are not automatically requested. Also, the request for rebuttals is not uniform from RFP to RFP. The COV, in accordance with the fusion community, recommends that OFES clarifies and formulates a uniform rebuttal process.

When rebuttals are allowed they are communicated from the proposal writers directly to OFES program managers, typically via email. A return deadline is established and made clear to the proposal writers. This correspondence is collected and saved, but it typically does not later get included in the proposal folder. The OFES recognizes that clerical procedures regarding rebuttals could be improved, but also notes that there is usually little time between when rebuttals are received and when funding decisions must be made, so the effort is focused more on decision making.

At a minimum a rebuttal is read and reviewed by the OFES program manager responsible for the proposal, although in many (perhaps most) cases it is read and assessed by several members of the OFES review team. This is especially true for those proposals, which score near the cutoff between being funded and not funded, and for renewal proposals. Occasionally OFES will discuss a rebuttal with the proposal reviewers to receive additional input, but this is not standardized. In cases where a large discrepancy in several reviewers' scores is received, an additional person is sometimes asked to review the proposal in an effort to resolve the discrepancy.

The OFES agrees that the rebuttal procedure could be improved, but there are significant difficulties to overcome. A uniform process requires lengthening the overall time for the proposal review by several weeks. Some reviewers are slow to return their reviews, and to allow a second round following rebuttal introduces the risk that the time schedule will exceed mandated limits. In some cases, the rebuttal actually exceeded the length of the original proposal, rendering it unhelpful. The new PEERNET (online) review system

was not designed explicitly to handle rebuttals, and any particular programming solution implemented by the OFES would be expensive.

Despite the difficulties, the members of the OFES staff have been discussing possible solutions and described an example that encouraged the COV that a more uniform and effective process could be devised. Clearly, once an improved process is devised, it should be carefully elucidated in all RFP's.

## **B. Improving the review procedure**

### ***OFES should implement several relatively simple ideas in the peer review process to improve the accuracy of the final funding decisions***

The review process already works quite well. The COV has several additional recommendations to make that would, in our opinion, further improve the process, most likely in an incremental manner. First, the directions to reviewers should include descriptive correlations between numerical score and suggested funding decisions as described in Finding C.

Second, reviewers should be allowed to offer more accurate scores using decimal values. The current procedure of requiring integer scores between 1-5 appears to be a low-resolution instrument in terms of measuring excellence. Even allowing scores of half integers (i.e. for instance 3.5) would be an improvement. The half-integer system is sometimes, but not uniformly, used at present. If implemented, the decimal option should be clearly stated in the RFP.

Third, on a related point reviewers should be discouraged from using a low score of 1 for a proposal which is technically competent but not responsive to the solicitation guidelines. The discrepancy in multiple reviewers' scoring was sometimes large for this reason. Instead, for example, the rating sheet could include a specific request for the reviewer's opinion on responsiveness to solicitation guidelines, separate from the 1-5 rating, which would be reserved for judging technical merit.

Fourth, OFES should press very hard on reviewers who complete the informational portion of their reviews but for one reason or another do not enter a final numerical score. This would save OFES from having to enter its own educated guesses whenever there is a missing numerical score.

## **C. Uniform review folders**

### ***OFES should improve the uniformity and consistency of the information contained in the review folders***

The uniformity and consistency of the review folders for each proposal is under steady improvement by OFES. The COV panel commends OFES for recognizing the importance of this activity and urges them to continue these efforts.

Of particular importance is a clear, concise summary sheet containing, among other things, the funding decision, the funding level if funded, the reviewers' scores, a justification for those proposals funded, and an explanation describing why other proposals were not funded.

Also, each folder should contain all the comments of the reviewers, the rebuttals if any, and the OFES or reviewer responses to the rebuttals.

Finally, OFES could probably improve its "big picture" of the review process by creating simple overview data sheets as presented in Appendix D. This would require some additional work, but would not be too much of a hardship if the data were collected at the time of the final decision making for each RFP. Such data would help OFES to compare the quality and the amount of OFES discretion required for each RFP. It would also allow comparisons between one RFP and another.

## **VIII. Conclusion**

Based upon the survey responses and our own appraisals of the large number of proposals submitted from our solicitations, it is the opinion of the Committee that the OFES supports a high-quality research program in innovative confinement concepts, general and basic plasma physics, and IFE/high energy density physics. Indeed, all proposals submitted in the most recent ICC solicitation were rated good or better by peer review. A comment often repeated, and one that we share, is the frustration of limited funds during a time of great excitement and numerous innovative research proposals that must remain unfunded.