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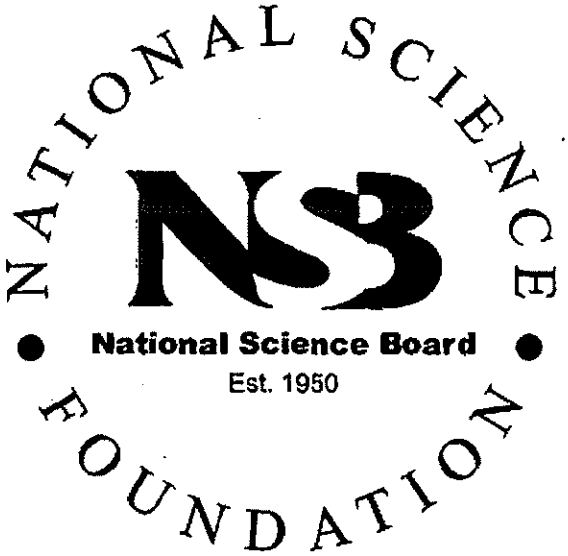
Report to Congress on Pre-construction Funding and Maintenance and Operations Costs Associated with Major Research Equipment and Facilities at the National Science Foundation



February 7, 2008

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Report to Congress on Pre-construction Funding and Maintenance and Operations Costs Associated with Major Research Equipment and Facilities at the National Science Foundation

The America COMPETES Act[1] directs the National Science Board (Board) to evaluate the appropriateness of National Science Foundation (NSF) policies for preconstruction funding and maintenance and operations costs for major research equipment and facilities. The following evaluation and recommendations result from the Board's independent assessment of data provided by NSF and records in the Board's archives. The Board has held numerous discussions on the topic of this report before and after passage of the America COMPETES Act directive to the Board. We have also reconsidered both the 2004 National Academies report[2] and the 2005 Board report[3] on setting priorities for large research facilities supported by NSF. Finally, the Board reviewed its role in the project development process for two NSF large facilities that have not yet been funded under the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

The NSF Director deserves recognition for his proactive proposal that the Board review and prioritize proposed MREFC projects upon successful completion of conceptual design and early baseline budgets in order to address at an earlier stage the issues described in this report. NSF has also established an internal working group to address the key issues raised by this report, including the implementation of a 'zero' budget overrun policy by the Director. The Board is working with the Director and NSF staff to address the specific recommendations outlined below, as well as working on potential additional changes related to other important issues identified in this report.

Current Role of the National Science Board in MREFC Projects

The National Science Board has statutory responsibility for the oversight of activities funded out of the MREFC appropriations account. This involves approval of including an NSF-proposed MREFC project in a future budget request to Congress,[4] approval of the funding priority list for previously approved MREFC projects that have not yet been funded by Congress,[5] and approval for release of congressionally-appropriated MREFC funds to an NSF awardee.[6]

In 2002 Congress provided the Board with oversight responsibility of research infrastructure projects funded out of the NSF's MREFC appropriations account over concerns that lack of transparency in the MREFC planning, evaluation, prioritization, and selection process caused uncertainty and confusion about the prospect for the funding of major facilities. The Board has been firmly committed to this responsibility. Moreover, both NSF management and the Board have been concerned with the operational costs of major facilities prior to the passage of the America COMPETES Act.

Although funding for major research infrastructure comes from the NSF's MREFC appropriations account, in 2001 Congress expressed concern that the co-mingling of funds from NSF's appropriations accounts in the construction of research infrastructure "obscures the full cost of these projects."[7] In conference report language accompanying the NSF's FY 2002 appropriations legislation, NSF was instructed that the "MREFC account is to provide resources

for the acquisition, construction, and commissioning of large scale research facilities." Planning, design, operations, and maintenance costs are to be funded from the Research and Related Activities (R&RA) appropriations account.

The current policies for funding MREFC projects were approved by the Board in May 2005,[8] and a copy of that Board report is attached. Those policies specify the Board is to 'concur' on the 'readiness' of projects to proceed to the final design phase. As a matter of practice, the Board is often provided with information on the status of candidate MREFC projects during their planning and pre-construction design phase. However, the process specified in the 2005 policy does not provide the Board with an opportunity for meaningful analysis and oversight of the proposed projects in their pre-construction phases or their suitability for the 'readiness' designation.

Current Process for NSF Planning of MREFC Projects

The NSF's largest research facility and equipment projects are the subject of years of planning and preparation before they are commissioned for use by our Nation's scientists. NSF designates four project evolution phases of this planning and preparation as:

1. Conceptual design
2. Preliminary design
3. Final design (readiness)
4. Construction per baseline

The conceptual design phase involves the formulation of science questions, defining requirements, and identifying enabling technologies and high risk factors. Top down cost, contingency, and risk analyses are included in this phase, which concludes with an initial proposal submission to NSF. A graphical presentation of the current phases of the NSF MREFC planning process is provided in the Appendix.

NSF may award funds during the conceptual design phase to academic institutions to organize one or more workshops to solicit essential input from the user community and other stakeholders. The subsequent phases also involve NSF awards for the preparation of the more detailed designs. Multiple design awards may be made, particularly in the preliminary design phase, so that competing approaches can be evaluated through NSF's Merit Review process by Federal Advisory Committees (composed of members from all relevant science, technology, and management communities).

Construction of these major facilities is supported through NSF's MREFC appropriations account. However, NSF funds the three pre-construction design activities predominantly from its R&RA appropriations account. Pre-construction planning and design phases for developing MREFC projects usually require significant levels of funding from the R&RA account. For example, the Advanced Technology Solar Telescope (ATST) and the Deep Underground Science and Engineering Laboratory (DUSEL) have been awarded approximately $13M over a 6 year period and $21M over an 8 year period, respectively, from R&RA funds. On an annual basis, NSF awarded approximately $23M of R&RA funds to support development of seven proposed

MREFC projects in FY2005, and approximately $24M of R&RA funds to support development of five proposed MREFC projects in FY2006.

Current Board Process for Evaluation of MREFC Planning, Prioritizing, and Funding

As ATST and DUSEL illustrate, considerable planning and funding of MREFC projects may occur prior to formal involvement by the Board. For ATST, the Board's first official action occurred 6 years after planning commenced; for DUSEL, over 7 years has passed since the initial concept was proposed within NSF, and the Board has yet to have substantive involvement. The Board often sees individual proposals for different aspects of the planning and design phase when these proposals exceed R&RA award cost thresholds that mandate Board approval.[9]

The Board appreciates the completeness and thoughtfulness of the MREFC proposals brought before it by NSF. Programmatic and operational issues are generally identified and resolved in these proposals prior to Board action, a process that allows for efficient use of the Board's time. However, the Board is concerned that such late and restricted involvement limits its ability to adequately oversee the deployment and operation of the NSF's scientific infrastructure, as we believe Congress intended. The NSF Director has also made clear his desire for the Board to become much more significantly engaged in setting MREFC development and planning priorities, and to do this earlier in the MREFC process than currently occurs.

Under the current process, it is difficult for the Board to develop a comprehensive and systematic view of the science underlying a given proposal, the linkage between science and design requirements, and the impacts of the design on the ultimate costs for operations and maintenance (O&M). The difficulty in developing a system-wide perspective is even more complicated for MREFC proposals that are "networks" of capability rather than a single (although expensive) piece of hardware such as a telescope. Such networks can be scaled up or down (for example, fewer nodes or less capable nodes) depending on budget constraints. Such scaling will have significant impacts on the science that can be achieved as well as on the operating costs. It is essential for the Board to be able to provide appropriate oversight in determining the required scale for a network to achieve its proposed science objectives.

The cost oversight abilities of the Board are particularly impacted under the procedures currently used. The major lifecycle cost component for any MREFC project is for the cumulative O&M incurred after commissioning. The management of the collective O&M costs for a portfolio of major research facilities is a priority issue for the Board. The Board is concerned that its ability to influence the total lifecycle costs for major research infrastructure projects—particularly O&M—decreases significantly as the designs for those facilities mature. This concern is multiplied as the number of major research facilities under NSF sponsorship continues to increase.

A second Board concern is that the use of funds from the R&RA appropriations account for the three design stages of major facilities reduces the funding available for research and for the O&M of already commissioned facilities. The Board has different approval policies for R&RA and MREFC expenditures. For MREFC the Board has statutory responsibility for project approval and prioritization of approved, but not-yet-funded, MREFC projects. As part of this responsibility, the Board believes it should have a significantly enhanced understanding of all

aspects of a project in all of the phases of bringing an MREFC facility online, and should be significantly engaged in prioritizing which proposed MREFC projects receive funding for pre-construction planning and design.

A third Board concern is the challenge in placing individual MREFC proposals within the larger constellation of planned, under construction, and existing MREFC projects given that projects are brought to the Board individually and not as part of an overall portfolio. A system-wide view is essential to ensure that there is a balanced portfolio of facility capabilities for the breadth of NSF-funded science as well as a sustainable budget capacity in the out-years for construction and O&M. As noted in 2006 by the NSF Division of Astronomical Sciences Senior Review Committee,[10] there must be a systematic commissioning and decommissioning of facilities in order to ensure that NSF does not forego investments in new capabilities simply because it is maintaining older, less capable facilities.

We believe an earlier and more thorough decision-making role for the Board in the MREFC process will considerably enhance the Board's ability to fulfill its oversight and fiducial responsibilities for new construction and for the O&M of NSF's individual MREFC projects, as well as for the major facilities portfolio as a whole.

Board Recommendations

The Board recommends considering the following changes to existing policy for MREFC projects.

I. The Board should become formally engaged in reviewing and approving priority order and actual funding of all post 'initial proposal' stages for MREFC projects. In the early stages of an individual project proposal, the Board should consider the proposal impacts on the overall science and funding portfolio of NSF.

II. MREFC funds should be used for pre-construction planning and design activities, construction, and for facility decommissioning (if necessary), once the Board approves including funds for pre-construction planning and design activities in a budget request (a go/no-go decision point), and once an appropriation is received, after which the Board may reserve the right to review and approve such proposed action item for an award. R&RA funds should be used for the preparation of the initial proposal and for O&M. The respective 'communities' (i.e., represented through the NSF Directorates) should be willing to support the initial proposal and the O&M stages with R&RA funds that would otherwise be allocated to NSF research awards.

The specific details of when the Board will become engaged in reviewing and approving priorities for pre-construction activities, as well as which specific pre-construction planning and design costs should be funded with MREFC accounts funds, will be provided in a follow-up Board report to Congress later in 2008. This next report will also consider the appropriate decision points (go/no-go points) needed to move a project between each pre-construction planning and design stage, as well as into consideration for construction as an MREFC facility.

Conclusion

The largest and most visible investments in new scientific facilities by NSF are in the very large projects, mostly at the forefront of an existing or a new field of research. The MREFC program is an integral part of the NSF investment in "tools," and enables the construction of facilities to perform research on new frontiers. Selecting the best projects, providing adequate program management, as well as oversight for the operations of such facilities, are all substantial challenges. However, an equally important challenge is that by supporting these essential facilities we not sacrifice our ability also to provide adequate support for the individual researcher proposals that are the cutting edge of potentially transformative research.

The Board should be provided with the most up-to-date inflation-adjusted O&M cost estimates for candidate facilities at each design phase. Otherwise, there will be fewer opportunities for controlling future O&M costs as the project planning progresses. The availability of this O&M information will greatly enhance the Board's ability to oversee the deployment and operation of the NSF's major research infrastructure responsibly.

A recent report from the National Academies called upon the Board to oversee an NSF process to develop a 'roadmap' for large research facilities over the next 20 years.[11] The Board believes that the changes proposed here will significantly facilitate its ability to accomplish this oversight. In addition, and very importantly, utilization of MREFC funds for pre-construction planning and design phases will free significant levels of R&RA funds to support more classic principal investigator-type grants by NSF, increase proposal success rates for the broader research community, and result in significantly more opportunities for early career scientists and engineers to receive funding for their proposals.

Later in 2008 the Board expects to consider and approve detailed modifications to the MREFC project planning, prioritizing, and funding process and to define the role of the Board throughout this new process.

Endnotes

[1] Section 7014 (a) of Public Law 110-69 (America COMPETES Act)

[2] Committee on Setting Priorities for NSF-Sponsored Large Research Facility Projects, National Research Council (2004), *Setting Priorities for Large Research Facility Projects supported by the National Science Foundation.*

[3] National Science Board (2005), *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*, NSB-05-77. Available at http://www.nsf.gov/pubs/2005/nsb0577/index.jsp.

[4] 42 U.S.C. § 1862n-4 (a)

[5] 42 U.S.C. § 1862n-4 (a)

[6] 42 U.S.C. § 1862n-4 (d) and National Science Foundation Proposal and Award Manual, Revision XI, page VI-20, December 15, 2007

[7] See e.g., Conference Report H.R. 107-272 p 171-172 (November 6, 2001). See also, Committee on Setting Priorities for NSF-Sponsored Large Research Facility Projects, National Research Council (2004), *Setting Priorities for Large Research Facility Projects supported by the National Science Foundation*, page 158.

[8] National Science Board (2005), *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*, NSB-05-77. Available at http://www.nsf.gov/pubs/2005/nsb0577/index.jsp.

[9] Criteria for R&RA cost thresholds requiring Board approval are described in the National Science Foundation Proposal and Award Manual, Revision XI, page VI-20, December 15, 2007.

[10] http://www.nsf.gov/mps/ast/seniorreview/sr_report_mpsac_updated_12-1-06.pdf

[11] National Academy of Sciences, National Academy of Engineering, Institute of Medicine (2006), *Advanced Research Instrumentation and Facilities*, page xii. See also, Committee on Setting Priorities for NSF-Sponsored Large Research Facility Projects, National Research Council (2004), *Setting Priorities for Large Research Facility Projects supported by the National Science Foundation*, page 2.

Appendix – NSF MREFC Planning Process

From the National Science Foundation Large Facilities Manual (May 2007)