

CRS Report for Congress

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National Science Foundation: Major Research Equipment and Facility Construction

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Summary

The Major Research Equipment and Facilities Construction (MREFC) account of the National Science Foundation (NSF) supports the acquisition and construction of major research facilities and equipment that extend the boundaries of science, engineering, and technology. The facilities include supercomputer centers, earth simulators, astronomical observatories, and the South Pole Station. Currently, the NSF provides approximately \$1 billion annually in support of facilities and other infrastructure projects. The funding for individual facilities ranges from several tens of millions to hundreds of millions of dollars. While the NSF does not directly design or operate research facilities, it does have final responsibility for oversight and management. Recently, questions have been raised by many in the scientific community concerning the adequacy of the planning and management of NSF facilities. In addition, there has been considerable debate related to the backlog of approved but unfunded projects, and the criteria used to select projects for MREFC support. This report will be updated periodically.

Background. The Major Research Equipment and Facilities Construction (MREFC) account of the National Science Foundation (NSF) was established in FY1995 and supports the acquisition, construction and commissioning of major research facilities and equipment that extend the boundaries of science and engineering.¹ Major research facilities are complex in their design, construction, and operation and require a large investment over a limited period of time. These complex projects sometime involve the participation of international partners. Currently, the NSF provides approximately \$1

¹ Formerly identified as Major Research Equipment, the name was changed by conferees to better define the mission of the activities in this account and to clearly and distinctly distinguish the spending activities from the Research and Related Activities Account. House Committee on Appropriations, *Departments of VA, HUD, and Independent Agencies Appropriations Bill, 2002*, (P.L. 107-073, H.R. 2620), 107th Cong., 1st. Sess., July 25, 2001, pp. 94-95.

billion annually in support of facilities and other infrastructure projects.² The funding for individual facilities ranges from several tens of millions to hundreds of millions of dollars.

With the significant exception of research facilities in the Antarctic, the NSF does not directly design or operate research facilities. Rather, it makes awards to other organizations such as universities, consortia of universities, or nonprofit organizations which have the responsibility of construction, operation and management. The NSF enters into cooperative agreements with these external entities, and has the final responsibility for oversight of the development, management and performance of the facilities.

During the past few years, NSF's portfolio of facilities has expanded and diversified to include complex multidisciplinary projects and distributed projects. Because these major facility projects are multi-year, their accounting, management and oversight require more complexity and detail than the traditional average grant award. There are concerns from Congress and from some in the academic and scientific community about the adequacy of the planning and management of NSF facilities.³ Discussions have focused on how major facility projects are selected for funding. Other questions have centered on the types of costs to be funded through the MREFC account and NSF personnel involved in major facility projects. In the FY2002 budget submission, President Bush directed the NSF to develop clearer policies and procedures for managing all aspects of large facility projects, including funding controls and effective project management.⁴ The FY2002 budget document, *A Blue Print for New Beginnings: A Responsible Budget for America's Priorities*, directed that "NSF will develop a plan to enhance its capability to estimate costs and provide oversight of project management and construction. This plan should help ensure that NSF is able to meet and stick to cost and schedule commitments for major facility projects."⁵

Definition of a Major Research Facility. The MREFC is an agency-wide capital asset account that funds major science and engineering infrastructure projects that

² House Science Committee, *National Science Foundation's Major Research Facilities: Planning and Management Issues*, 107th Cong., 1st Sess., September 6, 2001, p. 10.

³ House Science Committee, *National Science Foundation's Management of Large Facilities*, 59 p. and Mervis, Jeffrey, "New Facilities: Congress Grills NSF on Selection Process," *Science*, vol.293, September 14, 2001, pp. 1972-1973.

⁴ In December 2000, the Office of Inspector General (OIG) of the NSF released an audit of the Gemini Project, reporting that the Gemini Project had cost overruns exceeding its approved construction level of \$184 million. The OIG further stated that the NSF had used or was planning to use approximately \$52.8 million from the Research and Related Activities Account (RRA) to cover the excess construction and commission costs. NSF management refuted the conclusions of the OIG, maintaining that the excess costs were operational in nature and as a result, properly supported through the RRA as opposed to the MREFC account.

⁵ Office of Management and Budget, *A Blueprint for New Beginnings: A Responsible Budget for America's Priorities*, Washington, February 28, 2001, p. 161.

cost more than one program's budget could support.⁶ Major research facility projects are defined as those awards made for establishing and/or operating a major tool or facility that will benefit a community of researchers and/or educators. A research facility is considered "major" if its cost exceeds 1% of the sponsoring directorate or office budget or if a program's cost exceeds 3% of the budget of the sponsoring office. The majority of large facility projects are funded through the MREFC,⁷ but some are also supported through the Research and Related Activities Account (RRA) and the Education and Human Resources (EHR) account.

Planning and Management Issues. In September 2001, NSF released a draft report, *Large Facility Projects Management and Oversight Plan*.⁸ The Plan covers pre-award and implementation phases and places increased emphasis on post-award oversight of construction and management. The Plan describes NSF's goals and strategies for incorporating the existing approaches and practices into a system for selecting, managing, and overseeing large facility projects so as to "... ensure not only that a large facility is built right but also that it is the right facility to build."⁹ The Plan employs a team approach and details the cooperation between the scientific and technical staff and the business operations staff. The lines of authority and responsibility are defined for the NSF Director, the participating Division Director, the NSF Program Manager, and the awardees project director. In every large facility project, the NSF Program Manager, with the support of the participating Division Director, has primary responsibility for all aspects of management. In addition, the NSF Program Manager is responsible for determining whether the project director and project management staff have the necessary training and skills for working on the project. A Project Advisory Team (PAT) is to be convened for all large facility projects. The purpose of the PAT is to "... provide advice and assistance on planning, review and management of the project to assure the establishment of realistic cost, schedule and performance goals and to develop terms and

⁶ The proposed facilities are too large to fit within the account of any one directorate or program.

⁷ Since its establishment, the MREFC has funded the following projects: Atacama Large Millimeter Array R&D (ALMA, design phase), ALMA II (construction phase), High-performance Instrumented Airborne Platform for Environmental Research (HIAPER), IceCube Neutrino Detector R&D, Large Hadron Collider, Laser Interferometer Gravitational Wave Observatory (LIGO), George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES), Polar Support Aircraft Upgrades, South Pole Safety Project and South Pole Station Modernization, Terascale Computing System and Distributed Terascale Facility, EarthScope I, (U.S. Array and San Andreas Fault Observatory at Depth), EarthScope II (plate boundary observatory), National Ecological Observatory Network (NEON) Phase I, the Gemini Observatory, and the Laser Interferometer Gravitational Wave Observatory (LIGO). Also, Ocean Observatories and Rare Symmetry Violating Processes are major projects that have been approved by the National Science Board (NSB) and are priorities for consideration in future budget requests. For project descriptions and funding profiles of the major research facilities, please see National Science Foundation, *Facilities Funded Through the Major Research Equipment and Facilities Construction Account*, February 28, 2002, Arlington, VA, 46 pp.

⁸ National Science Foundation, *Large Facility Projects Management and Oversight Plan*, September 10, 2001, Arlington, VA, 9 pp.

⁹ *Ibid.*, p. 2.

conditions of awards for constructing, acquiring and/or operating the facility.”¹⁰ The PAT will be composed of individuals with the necessary expertise in the relevant science and engineering fields, in addition to those with extensive knowledge of the management, business, and legal aspects associated with the project.

Large facility research projects advance through several phases. A MREFC Panel evaluates the projects based on, among other things, project definition, intellectual justification, connection to NSF strategic goals and priorities, life-cycle cost profile, partnerships, and project management plans, schedules, and reviews. Based on the review, the MREFC Panel submits to the NSF Director its recommendation on the project’s relative importance, eligibility, and readiness, with readiness defined as its ability to be included in the upcoming budget request. The Director then makes the selection of projects based on: 1) strength and substance of the information; 2) the appropriate balance among various fields, disciplines, or directorates; and 3) opportunities to leverage MREFC funds. The Director submits her selections to the National Science Board (NSB) for project approval. While the NSB may approve a project for inclusion in a future budget request because it has been deemed meritorious and its planning is “sufficiently advanced,” approval does not necessarily mean that the NSB will recommend its inclusion in the upcoming budget request. It does indicate that the project will be considered for inclusion, depending on current budget levels. Those large facility projects that the NSB includes in a budget request and submits to the Office of Management and Budget (OMB) must be accompanied by a Capital Asset Plan.¹¹ The Capital Asset Plan provides a summary of spending for project stages; justification and information on program management and acquisition strategy; and cost, schedule, and performance goals and milestones.

Congressional Hearing on Planning and Management Issues. On September 6, 2001, the House Committee on Science, Subcommittee on Research, held a hearing on planning and management issues associated with major research facilities at the NSF. These hearings grew out of concerns expressed by some in the academic and scientific community and in Congress about the management and oversight of major projects selected for construction and the need for prioritization of potential projects funded in the MREFC. In testimony before the Subcommittee on Research, then NSF Director, Rita R. Colwell¹², stated that the draft of the *Large Facility Projects Management and Oversight Plan* codifies practices already in place and develops new guidelines for oversight of financial and business functions. She responded to criticism that the lines of authority for project management included in the draft plan were ambiguous and that those with oversight functions for the projects were program officers who may not have the expertise necessary for overseeing a complex project. Colwell described the *Plan* as one that did ensure lines of authority and responsibility, from the NSF Director to awardee project manager, with project management remaining with the scientists and engineers. The *Plan* established a new position, Deputy, for Large Facility

¹⁰ Ibid., p. 4.

¹¹ OMB Circular A-11, Part 3: “Planning, Budgeting, and Acquisitions of Capital Assets” and its supplement “Capital Programming Guide”.

¹² Rita R. Colwell resigned as director of NSF on February 21, 2004.

Projects.¹³ Under the *Plan*, the Deputy will be responsible for implementing and managing guidelines and procedures for facility management and oversight, maintaining lines of authority for facility management, and providing project management training for NSF staff engaged in large facility projects.

There has been considerable debate concerning the selection of major research facility projects for funding. In testimony before the Subcommittee on Research, Anita K. Jones, Vice Chair, NSB, stated that because not all facilities can be built at the time they are considered, the NSB has established guidelines for approving major facility projects.¹⁴ She emphasized that there is a prioritization process for selecting major projects, one that involves the NSF and the community, with the NSB actually making the priority decisions. The NSB reviews the need for the facility, the research that will be enabled, the readiness of plans for construction and operation, construction budget estimates, and operations budget estimates before making its decisions. Jones acknowledged that the NSB does not rank-order proposed projects and therefore gives NSF considerable flexibility in responding to unforeseen changes in the performing organization or in the funding level for the MREFC in a particular budget request.

Another issue brought before the Subcommittee was that of maintaining distinct records of spending activities in the MREFC. Subcommittee members questioned the types of costs to be funded through the MREFC account because the differentiation between construction and operation is not always clearly defined.¹⁵ The Subcommittee noted that internal mechanisms need to be created in order to prevent the combining of MREFC and RRA funds. Currently, NSF is clarifying its policies and guidance for the use of MREFC and RRA funds during the various phases of major facilities.

Audit of Funding for Major Research Equipment and Facilities. In May 2002, the NSF's Office of Inspector General (OIG) released a draft report, *Audit of Funding for Major Research Equipment and Facilities*.¹⁶ The report noted that the current policy for major research equipment and facilities projects is limited to only the MREFC and does not include major facilities for other programs in NSF. In addition, the existing guidelines stipulate a single financial review and do not offer directives on how the review should be conducted. The audit finds that this single review is inadequate and does not guarantee that all costs are within the funding authorized. Also, according to the audit, the current policies do not provide direction to NSF program managers on how to address the problem of potential cost overruns; and while federal guidelines require that the total cost of major research equipment and facilities be tracked through all stages of

¹³ On June 9, 2003, Mark Coles, formerly director of the Laser Interferometer Gravitational Wave Observatory in Livingston, LA, assumed the position of Deputy Director for Large Facility Projects.

¹⁴ National Science Board, *Guidelines for Setting Priority for Major Research Facilities*, NSB01-204, Arlington, VA, November 15, 2001, 2 pp.

¹⁵ Acquisition, construction and commissioning are funded through the MREFC. Planning, design, and development are support through the RRA, in addition to operations and maintenance upon completion of the project.

¹⁶ National Science Foundation, Office of Inspector General, *Audit of Funding for Major Research Equipment and Facilities*, OIG02-2007, May 1, 2002, Arlington, VA, 17 pp.

a project, NSF's current policies and procedures do not provide full accounting costs in its financial reports in accordance with the federal standards.

Because of NSF's inconsistencies in tracking costs and funding sources of its major research and equipment and facilities, the OIG recommended that NSF review and revise its policies and procedures by complying with the directives that were detailed in the FY2002 appropriations bill. The recommendations made in the audit called for NSF to: 1) track the full costs of major research equipment and facilities throughout the life cycle of the project in accordance with federal accounting and management guidelines; 2) define a process that makes clear and consistent distinctions in types of costs to be funded - - construction (MREFC-funded) as opposed to research (RRA-funded); 3) establish a procedure for addressing costs overruns and approving subsequent funding; and 5) provide training on revised or updated policies to all NSF personnel involved with review agreements and awards.

Congressional Activity. In June 2002, Congress requested the National Academy of Sciences (NAS) to review NSF's management of its large facility projects.¹⁷ The study, which began in February 2003, was to examine how the NSF sets priorities in determining which competing projects to fund, and to offer recommendations on how to strengthen the process. The recommendations are contained in a January 2004 report prepared jointly by the NSB and the NSF – *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*.¹⁸ At the October 13, 2004 meeting of the NSB, the NSF was directed to begin implementation of the proposed large facility project review and prioritization process outlined in the report. The report notes that in addition to there being a backlog of approved but unfunded projects, there is a lack of support for disciplines conducting idea-generating activities, and lack of funding for conceptual development, planning, and design. The Committee on Setting Priorities offered several recommendations. They include the following:

- The NSB should oversee a process whereby the NSF produces a roadmap for large research facility projects that it is considering for construction over the next 10-20 years. Broad inputs from the scientific community must form the basis for the roadmap.
- The NSF, with the approval of the NSB, should base its annual MREFC budget submission to Congress on the roadmap. The annual budget submission should include the proposed yearly expenditures over the next five years for committed projects and for projects that will start in that period. It should include the rationale behind the proposed budget, the project ranking, and any differences between the budget submission and the roadmap.¹⁹

¹⁷ The NSF Authorization Act of 2002 (P.L. 107-368, H.R. 4664) contained language directing the NAS to conduct the study of NSF's priority-setting process of its large facility projects.

¹⁸ National Academy of Sciences, Committee on Science, Engineering, and Public Policy and Global Affairs Division, Board on Physics and Astronomy, *Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*, Washington, DC, January 14, 2004, 215 pp.

¹⁹ *Ibid.*, p. 3.