

NATIONAL SCIENCE FOUNDATION

**FACILITIES
MANAGEMENT & OVERSIGHT
GUIDE**

July 31, 2003

Table of Contents

	Page
I. Introduction	3
A. Context and Rationale	3
B. What is a Facility?	5
C. Framework	6
D. Using this Guide	7
II. Overview – Roles, Responsibilities, and Requirements	9
A. How Large Facility Projects Are Identified and Selected	9
B. Roles and Responsibilities	11
C. Overview of Requirements	14
1. Decision Points	15
a. Concept	15
b. Development	15
c. Implementation	17
d. Operations & Maintenance	17
e. Renewal or Termination	18
2. Budgeting and Funding	18
3. Documentation	18
4. Oversight, Reviews, and Reporting	19
III. Detailed Procedures and Best Practices	20
A. Concept Stage	20
B. Development Stage	25
C. Implementation Stage	30
D. Operations & Maintenance Stage	35
E. Renewal or Termination Stage	37
IV. Special Topics	40
A. NSF Review and Approval and the Federal Budget Process	40
B. Budgeting and Funding	41
C. Risk Assessment and Management	44
D. Documentation	48
E. Oversight, Reviews and Reporting	49
F. Partnerships	51
G. Operating Budgets	52
Appendices:	
1. List of MREFC Projects	54
Glossary	55
Key Word Index	57

I. Introduction

A. Context and Rationale

Among Federal agencies, NSF is a leader in providing the academic community with advanced instrumentation needed to conduct state-of-the-art research and to educate the next generation of scientists, engineers and technical workers. The knowledge generated by these tools sustains U.S. leadership in science and engineering (S&E) to drive the U.S. economy and secure the future. NSF's responsibility is to ensure that the research and education communities have access to these resources, and to provide the support needed to utilize them optimally, and implement timely upgrades.

The scale of advanced instrumentation ranges from small research instruments to shared resources or facilities that can be used by entire communities. The demand for such instrumentation is very high, and is growing rapidly, along with the pace of discovery. For large facilities and shared infrastructure, the need is particularly high. This trend will accelerate in the future as increasing numbers of researchers and educators rely on such large facilities, instruments, and databases to provide the reach to make the next intellectual leaps.

NSF makes awards to external entities, primarily universities, consortia of universities or non-profit organizations, to undertake construction, management and operation of facilities. Except for the South Pole Station, NSF does not directly construct or operate the facilities it supports. NSF retains responsibility for overseeing the development, management and successful performance of the projects. This approach provides the flexibility to adjust to changes in science and technology while providing accountability through efficient and cost-effective management and oversight.

NSF currently provides support for facility construction from two major accounts: the Major Research Equipment and Facility Construction (MREFC) Account, and the Research and Related Activities (R&RA) Account. The MREFC account, established in FY 1995, is a separate budget line item that provides an agency-wide mechanism, permitting directorates to undertake large facility projects, on the order of tens of millions to hundreds of millions of dollars, without a large distortion of their budgets. Construction projects, ranging from millions to tens of millions of dollars, continue to be supported from the R&RA Account.

A further distinction between these two accounts is that the MREFC Account provides funding for *acquisition and construction* – activities distinguished by slow outlays - in contrast to other activities, such as *planning, conceptual design, development, operations, and maintenance* - which are funded from the R&RA Account. To date, twelve projects, ranging in size (total construction cost) from \$26M to \$376M, have been approved for funding through the MREFC Account (see Appendix 1 for list of projects). As these projects grow in size, cost and complexity, they increasingly involve interagency and international partnerships. Additionally, the MREFC account has evolved from funding single purpose large facilities only to now include funding large infrastructure projects and networks that affect broader research communities.

The growth and diversification of large facility projects require that NSF remain attentive to the ever-changing issues and challenges inherent in their planning, construction, operation, management and oversight. Most importantly, dedicated, competent NSF and awardee staff – those people who are at the point of direct responsibility and accountability for the project – are needed to manage and oversee these projects, giving the projects the attention and oversight that common sense dictates and that proper accountability to taxpayers and Congress demands. To this end, there is also a need for consistent, documented requirements and procedures to be understood and used by these NSF program managers and by awardees for all such large projects. There is also a need for improved understanding and consideration of full lifecycle costs associated with a project to prepare the way for obtaining the needed funds for operations and effective utilization by the community.

Given this perspective, the purposes of the *Facilities Management and Oversight Guide* (Guide) are as follows:

- Provide requirements and guidance to NSF staff and awardees on strong project management and oversight of large facilities.
- State clearly the policies, procedures and requirements that come into play at each stage of the facility project – throughout its lifecycle.
- Document the experience, knowledge and best practices gained over many years in order to facilitate a process of continuous improvement, based upon the learning of best practices.

While the Guide does not replace existing formal procedures required for all NSF awards, it draws upon them and links them together with best practices for the purpose of providing clear, step-by-step guidance regarding NSF management and oversight of projects and what is needed and expected at each stage.

This Guide does impose some totally new requirements on Awardees and NSF staff. The Guide identifies the NSF requirements for project management oversight and review. For example, while project oversight and review has always been required, this Guide prescribes a more consistent and comprehensive oversight and review process. Specifically, this Guide addresses the following:

- Highlights the requirement for the awardee to provide a comprehensive Project Execution Plan, providing a clear statement of what will be done and how it will be accomplished.
- Requires a comprehensive Internal Management Plan that describes how NSF manages the agency side of the project.
- Describes a new position within the NSF to help manage and oversee the overall large project portfolio – the Large Facility Project (LFP) Deputy within the Office of Budget, Finance, and Award Management. The role of the LFP Deputy will be to enable consistent management and oversight of all large projects, including all business and financial aspects.
- Describes the role of NSF's internal Facilities Panel, comprised of experienced large project technical and business staff to review Internal Management Plans and help transmit lessons learned and best practices to NSF Program Officers.
- Requires the use of NSF Project Advisory Teams (PAT) to advise Program Officers on business, financial, legal, and other related aspects of projects and project management. The role and responsibilities of the PAT are defined.

The Guide is considered and *living document* that will be updated periodically to reflect additional requirements and/or policy changes as they are reviewed by the MREFC Panel, NSF Director and the National Science Board. This Guide is not to be used as a standalone document but is meant to be used with several Large Facility Project Modules, to be developed over the summer and online for use by Fall, 2003. The Modules will provide more in-depth discussion on topics such as financial management, reporting requirements, risk management and the roles and responsibilities of NSF management and the Awardee. The chapters that follow are structured around the project lifecycle organization framework: (Chapter II) an overview of the requirements and key elements in large project approval, management, and oversight throughout the project lifecycle; (Chapter III) detailed procedures and best practices that are used in managing and overseeing the project through its various lifecycle stages – Concept, Development, Implementation, Operations & Maintenance, and Renewal or other path; and (Chapter IV) more detailed discussion of some of the more complex yet very important special topics that are essential to understand in managing and overseeing projects. Before moving to these next chapters, it is important to -clarify what a facility is and the characteristics of facilities -through each of the five project life cycle stages.

B. What is a Facility?

For purposes of this Guide, “facilities” are defined as shared-use infrastructure, instrumentation and equipment that are accessible to a broad community of researchers and/or educators. They may be centralized or distributed-but-integrated in nature. They may be large-scale networking or computational infrastructure, multi-user instruments or networks of multi-user instruments, or other infrastructure, instrumentation and equipment having a major impact on a broad segment of a scientific or engineering discipline. In the past, awards have been made for such diverse activities as accelerators, telescopes, vessels, aircraft and geographically distributed-but-networked earthquake engineering simulation equipment.

NSF develops and supports a broad continuum of facilities, not all of which warrant the same degree of planning, review and approval scrutiny. They all, however, warrant a level of Awardee management and NSF oversight commensurate with their complexity and risk. This Guide applies to the “large” facilities, as defined in Table 1, for which the most rigorous oversight is expected.

Table 1. “Large” Facilities

Award for facility construction and/or acquisition and funded through the Major Research Equipment and Facilities Construction (MREFC) account;

Award for facility construction and/or acquisition and eligible for funding through the MREFC account;

Award for facility operation and replacement cost would be similar in size to MREFC-funded and MREFC-eligible projects.

The MREFC Panel, with approval by the NSF Director, reviews policies concerning MREFC projects throughout the year. Current policy states that awards eligible for funding through the MREFC account are those for which the construction and/or acquisition cost is expected to represent an investment greater than 10% of the Directorate/Office’s annual operating budget, adjusted to exclude activities that cannot reasonably be expected to contribute to, or benefit from, development of the facility (activities such as the SBIR program or OPP operational funds). Additional information on MREFC eligibility is available in Chapter XIII of the *Proposal and Award Manual*.

While “large” represents the threshold for facilities subject to this Guide, other facilities and non-facility projects will benefit to varying degrees from the principles of sound project management described throughout. And, while the determination of “large” appears to depend upon cost alone, other factors such as complexity, risk and duration will also play a part in determining the applicability of this Guide and the requirements and best practices contained herein. NSF staff must use their judgment in proportionately scaling the requirements and best practices for application to the projects they oversee. Assistance in this endeavor will be available from a Facilities Panel, chaired by the LFP Deputy and experienced programmatic and business operations personnel. The Facilities Panel will assist Program Officers with determining the appropriate level of management (i.e., the Awardee’s Project Execution Plan) and oversight (i.e., the Program Officer’s Internal Management Plan) and will serve as a point of review prior to the submission of projects for consideration by NSF management, the Director’s Review Board and the National Science Board. There is now a great deal of expertise within NSF on issues of management and oversight. The purpose of the Facilities Panel is to share the many management and oversight lessons learned. While there is not a need for rigid consistency among projects, neither should these lessons have to be re-learned. NSF believes that introducing consistency in its processes will obviate the need for rigid consistency among projects, which, at NSF, are quite varied.

C. Framework

In developing a framework for Awardee management and NSF oversight of facilities, this document draws upon generally accepted principles of project management to describe NSF's responsibilities and the Awardee's responsibilities. This approach allows us to create a common understanding and common language across the diversity that is NSF, and allows us to make use of project management tools and techniques that have already been developed and used widely.

To describe the full lifecycle of a facility, we adopt a set of distinct stages: **Concept, Development, Implementation, Operations & Maintenance**, and **Renewal or Termination**. The science and engineering communities provide intellectual leadership and are direct beneficiaries of the opportunities presented. The NSF role differs at each stage, but its overall responsibility is stewardship of the research and education enterprise and oversight of Federal funds. The activities occurring within each stage are depicted in Table 2 below (Chapter III discusses the stages and the respective responsibilities of NSF and the Awardee in more detail). While each stage is shown sequentially, it is important to note that the stages often overlap; this, too, is discussed in more detail in Chapter III.

Table 2. Facility Lifecycle

Stage	Activity
CONCEPT	Idea for a facility is articulated and project planning and design begins.
	This stage includes activities such as preliminary R&D; verification of need and requirements; assessment of technical feasibility, costs, benefits and risks; development of conceptual design; exploration of funding partnership possibilities; and definition of <i>conceptual</i> (as opposed to final) cost, schedule and performance goals.
DEVELOPMENT	Project planning and design are completed and proposal is submitted.
	During this stage, R&D, prototypes/test beds (if applicable), risk analysis, final designs and planning for system integration are completed; <i>final</i> cost, schedule and performance baselines are established; a Work Breakdown Structure (WBS) is created; Internal (NSF) Management Plan and external (Awardee) Project Execution Plan are finalized; and funding partnerships and Memoranda of Understanding are finalized.
IMPLEMENTATION	Awardee Project Execution Plan is executed and controlled by Awardee and overseen by NSF.
	This stage includes construction and/or acquisition; system integration, commissioning, testing, acceptance; transition to operations; and management of these efforts.
OPERATIONS & MAINTENANCE	Use of the facility for its intended purpose.
	This stage includes the day-to-day work required to support and conduct research and education activities, to ensure that the facility is operating efficiently and cost-effectively, and to provide small- and intermediate-scale technical enhancements when needed to maintain state-of-the-art research capabilities.
RENEWAL or TERMINATION	Decisions regarding continued support of a facility are made.
	During this stage the information learned during the Operations & Maintenance stage and through various reviews of the results of research and education activities and facility management is used to determine whether the facility will be renewed, upgraded, ¹ recompleted or terminated.

D. Using this Guide

This Guide provides for effective project oversight for our Program Officers and conveys NSF’s expectations for sound project management to our Awardees. In so doing, it documents the requirements with which all projects must comply and best practices for managing and overseeing the pre- and post-award aspects of facilities – from the earliest planning efforts to ultimate decisions regarding renewal or termination.² This Guide is not intended to be a standalone document. It should be used with the upcoming online Modules in Project Management for greater clarification and with existing NSF policy documents.

¹ “Upgrades” may also occur during the Operations & Maintenance stage. If the planned upgrade costs on the order of MREFC or MREFC-eligible projects, they become a project in and of themselves, and thus would follow the facility lifecycle beginning with Concept.

² Chapter II gives an overview of the basic roles, responsibilities, and requirements with which all projects must comply. Chapter III contains best practices and is arranged to follow the flow of the facility lifecycle from Concept through to Renewal or Termination. Overviews of some topics are included as appendices in order to collect all guidance on the topic in one place.

Each of NSF's facilities is unique, and challenges that have arisen during the course of establishing and operating them has led to the development of accepted best practices. Accordingly, in compiling this Guide the authors have drawn upon the wealth of experience within NSF, its Awardees and its Federal agency partners. Program Officers are encouraged and expected to continue to identify best practices so as to enhance the principles contained in the Guide. In this way, NSF retains the flexibility that is the hallmark of NSF and that enables the most efficient and cost-effective delivery of tools to the research and education communities.

This Guide assumes that the facility is being funded via a Cooperative Agreement.³ Cooperative Agreements are used when the project being supported requires substantial NSF involvement during the project performance period; for example, when an activity is technically or managerially complex or when extensive or close coordination with other federally supported work is required. The Cooperative Agreement details the respective responsibilities of NSF and the Awardee, and it is through the terms and conditions of the Cooperative Agreement that the Program Officer requests and receives the various information, documents, plans, reports, etc., that are discussed in this Guide. Guidance on developing and executing these award instruments can be found in Chapter VIII of the *Proposal and Award Manual*.

The requirements and best practices contained herein complement existing NSF policies and procedures and Federal regulations. For example, the NSF Government Performance and Results Act (GPRA) *Strategic Plan* www.nsf.gov/pubs/2001/nsf0104/start.htm contains the basic rationale for all NSF support. The *Proposal and Award Manual* <http://www.inside.nsf.gov/cgi-bin/getpub?pam> is a compendium of internal policies and procedures related to the proposal and award process. The *Proposal and Award Manual*, in turn, supplements guidelines relevant to grants and other assistance agreements; e.g., the *Grant Proposal Guide* www.nsf.gov/pubs/2003/nsf03041/start.htm, the *Grant Policy Manual* www.nsf.gov/pubs/2002/nsf02151/start.htm, and *General Conditions for Grants* www.nsf.gov/pubs/2001/gc101/gc101rev1.pdf and Cooperative Agreements and the *Contracts Manual* www.inside.nsf.gov/bfa/dacs/contracts/docs/nsfcont010611.doc.

This Guide is considered a *living document* that will be revised periodically to update existing information, reflect changes in NSF policies and procedures, and incorporate additions or changes in applicable Federal regulations.

³ In some cases, grants or contracts may be appropriate. Grants are used when the accomplishment of project objectives requires only minimum NSF involvement. Contracts are used to acquire products, services and studies required primarily for NSF or other Government use. With contracts, the NSF role is that of a purchaser or buyer who establishes specific requirements or specifications and judges acceptability of the product or service against those requirements and specifications. At the earliest possible stage, the Program Officer should consult with the LFP Deputy, the Division of Grants and Agreements, and the Contracts Branch of the Division of Acquisition and Cost Support to determine whether these other funding mechanisms are more appropriate than a Cooperative Agreement.

II. Overview – Roles, Responsibilities, and Requirements

This Chapter presents an overview of: (A) the project selection process; (B) the roles, responsibilities, accountability, and authority of various internal and external entities involved in the project; and (C) the requirements with which all Large Facility Projects must comply. Within (C) are included: (1) Decision Points in the framework described in Chapter I (Concept, Development, ...); (2) Budgeting and Funding, (3) Documentation, and (4) Oversight, Reviews, and Reporting. While the requirements are noted here, the ways in which compliance with the requirements may be achieved are described in Chapter III through a thorough discussion of the procedures and activities occurring during each stage of the facility lifecycle.

A. How Large Facility Projects Are Identified and Selected

The concept behind Large Facility Projects generally originates within the science or engineering community: an outgrowth of a community coming together and deciding a new facility or new infrastructure is essential for advancement of the field. The community processes vary greatly from field to field. Typically, the process includes long-range planning activities, workshops, conferences, collaboration building, dialog with funding agencies, and development of the interest of potential foreign partners. NSF Program Officers are the key people who have to make the requirements for approval of such projects clear to the community. Program Officers are also the key people inside NSF who must make the case to higher level NSF management.

In order for a project to attain funding, decisions regarding priority must be made – both within the S&E communities and within NSF. It is therefore important to understand the essential attributes of a project that directly inform NSF decisions regarding priorities. These include:

- Exceptional S&E opportunity to enable frontier research and education
- Transformational regarding S&E impact
- High priority within relevant S&E communities
- Accessible to appropriately broad user community
- Partnership possibilities exploited
- Technical feasibility and risks addressed thoroughly
- High state of readiness

NSF will address issues surrounding these elements; hence the S&E communities and the Program Officers must address them as well. The NSF Director and the NSB will address these same issues and also address the issue of balance across fields.

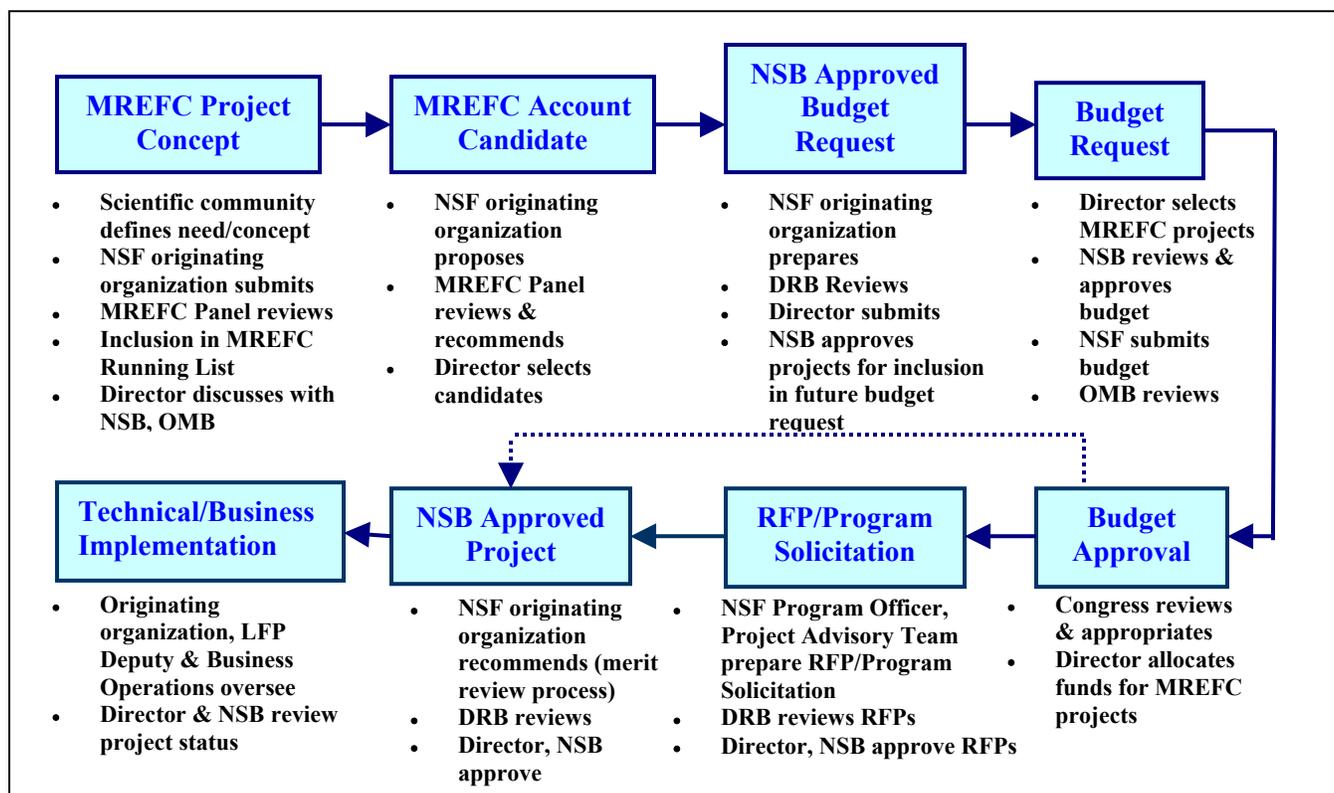
Facility construction projects may be funded through the MREFC Account or the R&RA Account. This choice is largely determined by the size of the project, which is calculated by total construction cost. MREFC eligibility requires that:

- Project construction funding be more than 10% of the submitting Directorate/Office budget, and
- Project funding of a magnitude that it would distort the base budget of the submitting organization.

The Directorate/Office Assistant Director/Office Head initiates the process, and the MREFC Panel reviews and recommends a path. If the decision is made to use the MREFC Account, the process of selection proceeds as shown schematically in Fig. 1 (following page), for R&RA, as shown in Fig. 2 (page 10). The first two stages of a project's lifecycle – Concept and Development – are depicted in these figures. These are the stages during which project construction is approved.

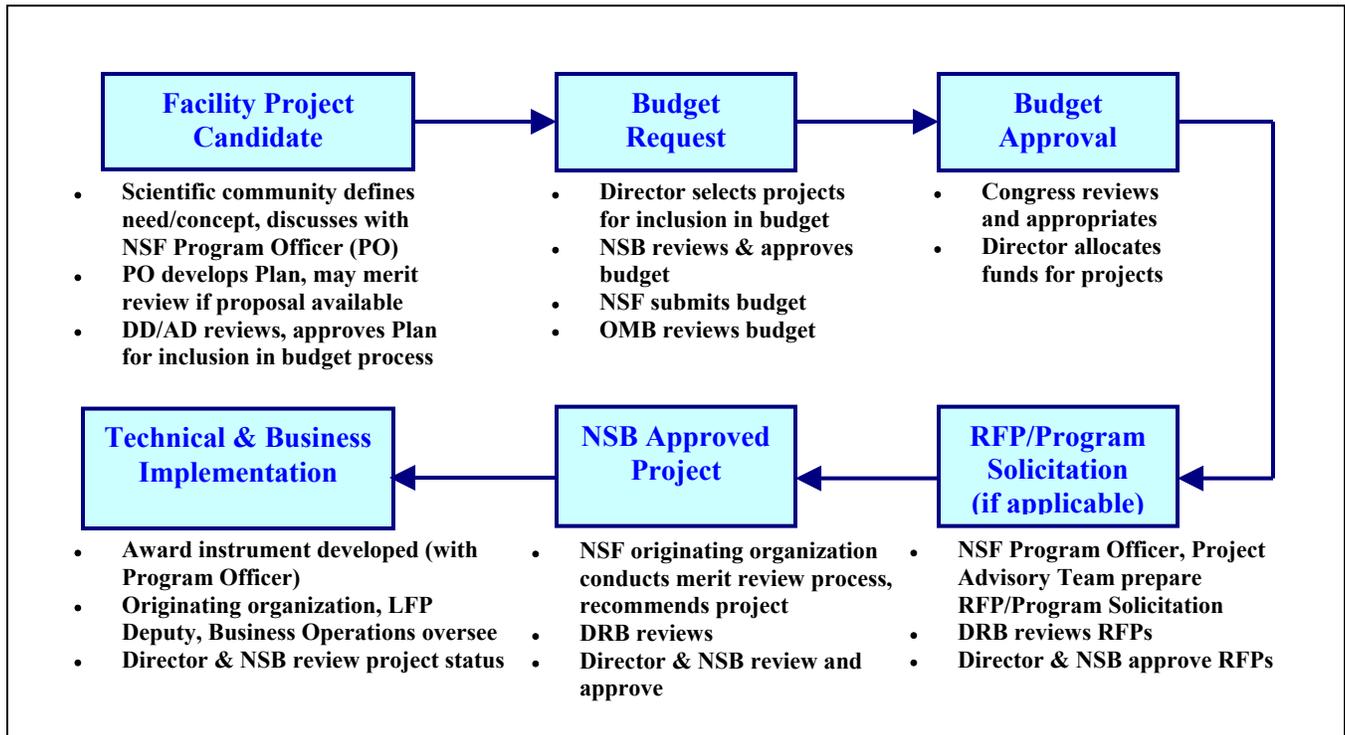
For the MREFC path, the Concept stage begins with the community and ends with the MREFC Panel placing the project on the MREFC Panel’s ‘running list’. At this point potential exists for the project to be considered in some future budget request to Congress. At this stage, a great deal of early work remains to be done regarding community alignment and prioritization, and regarding exploration of opportunities for partnerships. The Development stage begins with conduct of essential R&D (if needed) and flows to development and submission of a full proposal, to peer review, to the MREFC Panel, which must place it at a high enough priority to recommend start of funding. The NSF Director, at her/his discretion, then must recommend it to the NSB for approval that the project funding be included in the budget request to Congress. If the Congress appropriates funding, the proposal moves through a final stage of approvals – illustrated in Figure 2.

Figure 1. MREFC Project Selection & Award Process Flow Diagram



The corresponding project selection and award process for R&RA funding is depicted in Figure 2 (below). The major change is the absence of the MREFC Panel function and process. Funding for the project then becomes more directly a priority within the managing Directorate/Office and appears as such in the request to the OMB and Congress.

Figure 2. Facility Project (R&RA) Selection & Award Process Flow Diagram



In many cases, for both MREFC projects and projects funded through the R&RA account, well-defined proposals will exist at the Project Candidate stage depicted above and can be merit reviewed. In some cases, however, the Program Officer will have verified the project merit and need in other ways and is able to articulate a strong case and support for the project. The case in which a Request for Proposal (RFP) or a solicitation will be issued following funding is such an example.

B. Roles and Responsibilities

The conceptualization, development, implementation, operation, and renewal of all Facility Projects require the coordinated efforts of the NSF, other agencies, and the science or engineering community that proposes the project. In order to undertake such a coordinated activity, it is essential for all parties to understand all the roles and responsibilities throughout the project lifecycle. The matrix of these various roles and responsibilities is shown in Table 3 (following page).

Table 3. Roles & Responsibilities in Facility Projects Lifecycle

	Concept	Development	Implementation	Operations & Maintenance	Renewal & Termination
S&E Community	Workshops, studies, committees, and other vetting processes	R&D; proposal & MOU development; peer review	External peer review of technical progress	Reviews, site visits; facility users; review of operations proposal	
Potential Awardees	Discuss concept with NSF; may submit unsolicited proposal	Conduct R&D; develops proposal, Project Execution Plan	Implement project execution plan; reports to NSF; develops plans, proposal for operations	Operate facility; allocate resources to users; report to NSF; develop renewal proposal	Participate in upgrade, phase-out of facility (if appropriate)
NSF Originating Organization, NSF Program Officer (PO)	Initial talk with potential awardees, external partners; internal & external vetting; reviews unsolicited proposals	Fund R&D; solicitation developed if req'd; merit reviews proposal; award recommended; Internal Management Plan; funding	Monitors performance through site visits, progress reviews; reviews & approves all changes; merit reviews operations proposals	Conducts site visits & reviews; merit reviews renewal proposal; develops plan for renewal, recompetition, upgrade, or termination	Implements renewal, or other plans for facility, including phase-out and decommissioning
Partner Agencies and Governments	Discuss mutual interest with NSF, including potential cost sharing	MOUs; helps manage the overall project review; provides funding	Helps provide oversight of project; co-reviews operating proposal	Helps provide oversight of operations; co-reviews renewal proposal	Participates in implementation of renewal plan
LFP Deputy	Provides advice and assistance to PO on project management	Advises PO on non-technical aspects of management & oversight	Develops protocols for pre- and post-award management and oversight reviews	Teams with PO to conduct oversight reviews; advises on potential problems	Assists PO as required
Project Advisory Team		Advises PO on business, financial, legal, policy matters related to project planning and the award instrument	Advises PO on business, financial, legal matters related to management and oversight of project	Advises PO on business, financial, legal, and policy matters related to oversight of project, and renewal	Advises PO on business, financial, legal, and policy matters related to renewal/termination
Facility Panel (chaired by LFP Deputy)		Reviews project Internal Mgmt Plan; advises PO on management & oversight	Advises PO on management and oversight		
Business Oversight Team	Assists NSF Program Manager with planning and budgeting	Early budget and non-technical reviews; helps develop, review, approve solicitation, award instrument (with PO)	Participates in project reviews as appropriate	Reviews/approves changes to award instruments (e.g. cost, schedule & project scope)	General oversight and monitoring; participates in management and oversight reviews
MREFC Panel (if applicable)	Initial review of projects for inclusion in the MREFC running list	Reviews & recommends projects to NSF Director for inclusion in budget request	Regularly reviews status of all projects	Regularly reviews status of all projects	Regularly reviews status of all projects
Director's Review Board⁴	Reviews projects going to NSB as information items	Reviews and approves MRE projects & other submissions to NSB	Reviews release of applicable RFPs, recommended awards	Reviews projects going to NSB as action and information items	Reviews projects going to NSB as action and information items
National Science Board	NSB (CPP) reviews projects on running list	Approves facility projects for inclusion in budget request	Approves applicable RFPs and awards (See PAM)	Reviews status of projects; approves applicable awards	Reviews status of projects; approves applicable awards
NSF Director	Reviews/discusses projects with NSB, and OMB	Selects projects for inclusion in a particular budget request	Approves/signs MOUs; approves/allocates funding	Reviews status of projects; approves annual budget requests; allocates funding	Reviews project status reports; approves annual budget; allocates funding

⁴The Director's Review Board (DRB) reviews large NSF awards. It is chaired by the Deputy Director/COO and comprises NSF senior line managers.

The parties described in Table 3 are further defined below:

- Science & Engineering (S&E) community – the research/education community that uses the facility or infrastructure project, or that peer reviews the project and other activities within the area of science or engineering impacted
- Potential Awardees – the institutions and the faculty or staff at these institutions to which awards will be made for the construction or acquisition, or for the operation of the facility
- NSF Originating Organization – the NSF Directorate or Office that manages the project, extending from the Program Officer to the Assistant Director or Office Head
- Partner Agencies – other U.S. federal agencies, state agencies, educational or research institutions, private corporations, other governments, or other entities that are participating in the funding and oversight of a project
- LFP Deputy – within the NSF Office of Budget, Finance, and Award (BFA) Management, the Deputy Office Head for Large Facility Project (LFP) management and oversight
- Project Advisory Team – the NSF advisory group assembled by the Program Officer managing the LFP with expertise in grants management, contracts, and legal, legislative, and international aspects of project management, and which meets regularly with the Program Officer
- Facilities Panel – a panel of NSF experts in project management and in grants management and oversight, chaired by the LFP Deputy, that advises Program Officers managing and overseeing LFPs and reviews the NSF Internal Management Plan before the project proceeds and prior to higher level review
- Business Oversight Team – the staff of BFA whose responsibilities include the formal making of awards and the oversight of the business side of projects
- MREFC Panel – a panel of the NSF Assistant Directors and Office Heads, chaired by the NSF Deputy Director, that reviews all projects proposed for funding through the MREFC account, prioritizes such projects, and recommends them to the NSF Director for consideration for inclusion in the NSF budget request
- Director’s Review Board (DRB) – a panel of NSF senior managers, chaired by the NSF Deputy Director, that reviews all large NSF proposals, not only LFPs, for funding, specifically those that are going to the NSB for approval, and those above the DRB threshold described in the Proposal and Award Manual Chapter VI.
- National Science Board (NSB) – committee appointed by the President of the United States charged with review and oversight of all activities of the National Science Foundation
- NSF Director – the Chief Executive Officer of the NSF, appointed by the President of the United States

The science and engineering community has many roles – from conceptualizing the project, to conducting R&D, to forming collaborations that will develop the proposal, to peer review, to building and operating the facility, to assisting in site visits and oversight of the project, to actively engaging in utilization of the facility in research and education. The NSF, in many cases with help from other agencies or governments, has the responsibility to manage the selection, funding, and management and oversight of the process.

Large Facility Projects demand the attention of many distinct organization units within the NSF. As the financial stakes are very large compared to the single investigator awards, NSF has adopted a well-defined set of procedures for management and control. Consistency in this process allows the various parties – from the S&E community to foreign partners to the Congress – to understand and appreciate the considerations that take place throughout a project.

Within NSF, the processes for MREFC selection and oversight and management have evolved as the agency undertook more and more large projects. These processes involve many people with expertise throughout NSF and a number of internal reviews to assure clearly defined checks and balances that are essential considering the magnitude of taxpayer investments and the manpower involved in creating and utilizing a new facility. Central to the NSF role is the Program Officer, key to the agency’s response to a new perceived need on the part of the S&E community. Another important NSF role is the MREFC Panel process. The Panel, made up of the NSF Deputy Director and the Assistant Directors, reviews and recommends a prioritized list of projects to the Director. They provide a viewpoint that stretches across fields and disciplines. The pivotal role is played by the NSF Director and the National Science Board. They determine the final priority ranking and whether a project will move forward to implementation considering strategic goals, overall budget issues, balance issues, and administration policies.

Authority and Accountability in the management and oversight of Large Facility Projects are established as follows:

The **Awardee** (institution) has primary management responsibility for the conduct of their projects. To the extent that NSF does not reserve responsibility for coordinating or integrating the project activities with other related activities or does not assume a degree of shared responsibility for certain aspects of the project, all such responsibilities remain with the Awardee. The Awardee management structure must include business and financial controls with appropriate reporting mechanisms. The Awardee must designate one person – with strong project management experience – to be the Project Director, with overall control and responsibility for the project in the Awardee organization.

NSF Division Director and/or Assistant Director/Office Head appoint a full-time Program Officer knowledgeable in the technical substance of the project and with prior (or it may be possible to acquire) training or experience in the oversight of large, complex projects and use of state-of-the-art project management tools to oversee the project.

The **Program Officer** exercises primary responsibility within NSF for all aspects of the project, including coordination of planning; serving as the interface with the relevant communities; preparing all required documentation for project review and approval; conducting merit review of proposals; fully funding the costs of operations, maintenance and related programmatic activities; and overseeing the project.

The **Project Advisory Team**, assembled and chaired by the Program Officer with the concurrence of his or her Division Director, advises and assists the Program Officer in establishing realistic cost, schedule and performance goals; developing the terms and conditions of Cooperative Agreements; overseeing the project; and providing proactive assistance in moving the project through any “minefields” encountered. The Project Advisory Team will include the LFP Deputy (or designee) as well as technical experts and representatives from Budget, Finance, Grants and Agreements, Acquisitions, General Counsel, Legislative and Public Affairs, and International Programs, as appropriate, and will adhere to a regular (e.g., weekly, bi-weekly, monthly or quarterly, depending upon the scope and complexity of the project) meeting schedule.

The **LFP Deputy** serves as NSF’s principal agent for advising Program Officers on project management issues, monitoring the business operations aspects of facilities, ensuring consistent representation on Project Advisory Teams for the purpose of transferring lessons learned, and chairing and convening the Facilities Panel. The LFP Deputy is consulted on all policy matters involving facilities, including responses to inquiries made by NSF management, the NSF Office of Inspector General, the Office of Management and Budget, and the Congress.

The **Facilities Panel**, chaired by the LFP Deputy and including experienced programmatic and business operations personnel, assists Program Officers with determining the appropriate level of management (i.e., Awardee’s Project Execution Plan) and oversight (i.e., Program Officer’s Internal Management Plan) and serves as a point of review prior to submitting projects for consideration by NSF management, the Director’s Review Board and the National Science Board.

C. Overview of Requirements

This section defines the key activities within the project lifecycle that must be carried out to ensure adherence to principles established by NSF for the management and oversight of Large Facility Projects. Identified here are the high level requirements on the part of the Awardee and on the part of the NSF with which all Large Facility Projects must comply. The detailed procedures are contained in Chapter III. Within the present Overview of Requirements are included: (1) Decision Points in the framework described in Chapter I (Concept, Development...); (2) Budgeting and Funding, (3) Documentation, and (4) Oversight, Reviews, and Reporting. While the requirements are noted here, the ways in which compliance with the requirements may be achieved are described in Chapter III through a thorough discussion of the procedures and activities occurring during each stage of the facility lifecycle.

1. Decision Points

The various stages in the project lifecycle are normally depicted as sequential, but there may be gaps in moving through them (e.g., funding may not be available) or overlaps (e.g., activities in a later stage may begin before completion of earlier ones). Nevertheless, in the orderly development of Large Facility Projects there are clearly defined Decision Points that must be recognized. Decision Points usually identify where one stage of the project ends and the next stage begins. The following Decision Point descriptions touch upon the requirements of NSF review and approval process, one that is complex and lengthy and that must be understood by the Program Officer, the Awardee, and any partners.

a. Concept

During the Concept stage, an Awardee submits an idea or a proposal to the Program Officer. The Program Officer presents *conceptual (as opposed to final) plan* to his or her Division Director and Assistant Director/Office Head. That plan includes design, cost, schedule and performance goals, and his or her vision for developing, implementing and, eventually, operating and maintaining the facility and supporting researchers and educators at the facility.

The Division Director and Assistant Director/Office Head authorize the Program Officer to proceed to Development. For projects that will seek funding through the MREFC account, the Assistant Director/Office Head notifies the MREFC Panel and the project is included on the Running List.

b. Development

The Development stage, during which period all essential R&D is carried out and plans finalized for conduct of the project by the Awardee, culminates in the Awardee submitting a proposal that articulates: the science/engineering merit; expected research, educational and other broader impacts and outcomes; and contains a ***Project Execution Plan*** (PEP) that defines the project, its scope, cost, and schedule, and addresses how the project will be organized and managed. Among other topics, the Plan must deal with risk management, which includes how contingency and change will be managed. Details of the Project Execution Plan are described in Chapter III.

The Program Officer reviews proposals in accordance with the merit review procedures contained in Chapter V of the *Proposal and Award Manual* and presents a recommendation for funding, together with an ***Internal Management Plan*** addressing how the NSF will manage and oversee the project, from project justification to full project cost (over the project lifecycle) and cash-flow analysis to coordination with partners to a plan for transitioning to operations. The Program Officer presents this Plan to his or her Division Director and Assistant Director/Office Head. Assistant Director/Office Head authorizes the Program Officer to proceed as follows. Details of the Internal Management Plan are described in Chapter III.

For projects to be funded through the Research and Related Activities (R&RA) and/or Education and Human Resources (EHR) accounts, the Program Officer recommends the making of an award in accordance with the proposal processing procedures contained in Chapter VI of the *Proposal and Award Manual* (note that for nearly all facility proposals, packages for Director's Review Board (DRB) review and National Science Board (NSB) action will need to be prepared) and, together with the Division of Grants and Agreements, drafts the Cooperative Agreement that will govern the project in accordance with the procedures contained in Chapter VIII of the *Proposal and Award Manual*. The Division of Grants and Agreements makes the award once the Cooperative Agreement is executed by it and the Awardee.

For all Large Facility Projects seeking funding, MREFC or R&RA-funded projects, there is a two-step process before an award is made. It is very important that potential partners understand this process. Firstly, funds for the project must be appropriated by Congress and allocated by the Director. The process is described schematically in Figure 3– the Appropriation and Allocation Process. Secondly, the NSB must approve the making of an award, which represents a final check on readiness to start the actual construction or acquisition. This process is described in Figure 4– the Approval and Award Process. Information on what must be prepared and presented to the various review and approval bodies may be found in the *Guidelines for Planning and Managing the Major Research Equipment [and Facilities Construction] Account*.

Figure 3. Appropriation and Allocation Process

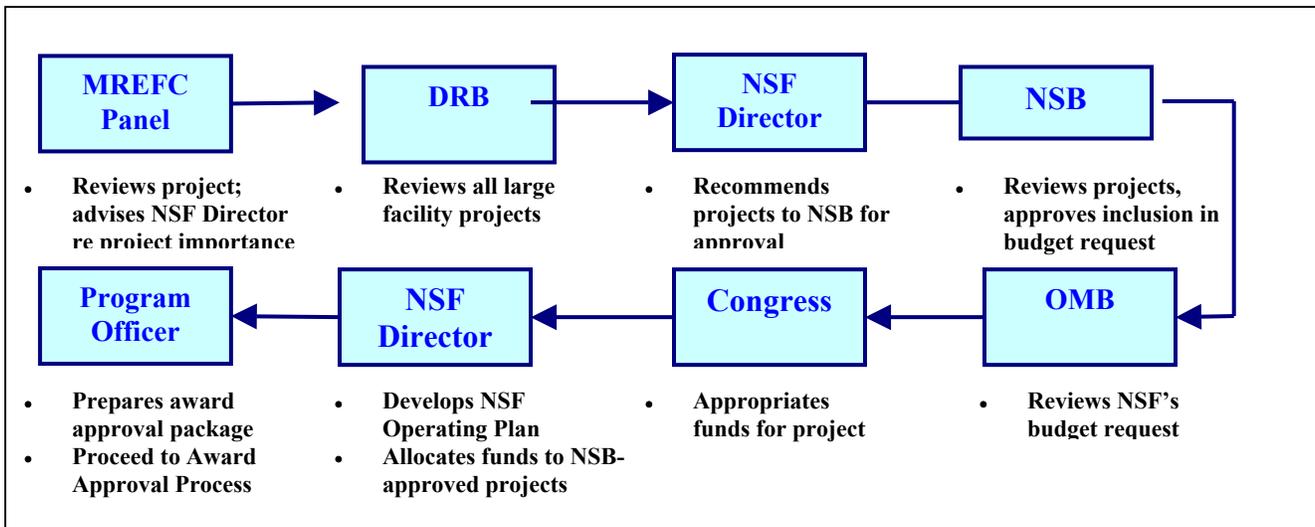
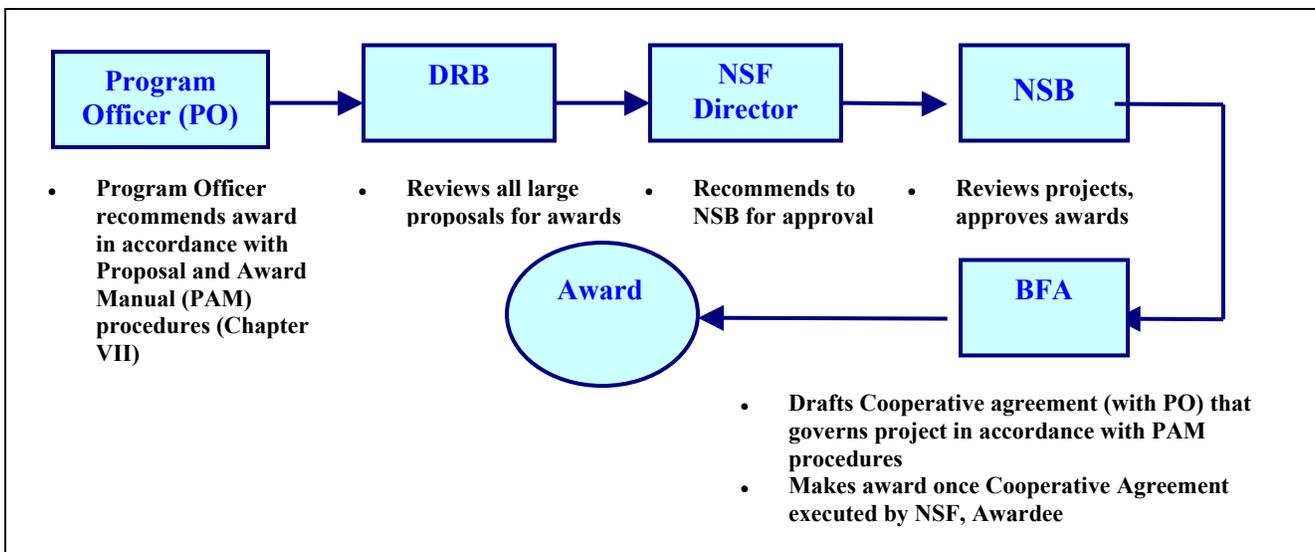


Figure 4. Award Approval Process:



Awards are made to the submitting institution. For awards involving property, the Program Officer consults with the Office of General Counsel, the Division of Finance and the LFP Deputy to determine whether the value of the

property must be included on NSF's financial statements. The LFP Deputy will coordinate as necessary with other Budget, Finance and Award Management divisions as required.

c. Implementation

Throughout the Implementation stage, the Awardee executes and controls the project – either construction or acquisition – in accordance with the Cooperative Agreement and the Project Execution Plan and the Program Officer oversees the project in accordance with the Internal Management Plan. This phase of the project includes all installation, testing, commissioning, and acceptance. By the end of the Implementation stage, **a proposal is submitted for Operations & Maintenance** to the Program Officer. The Program Officer reviews proposals in accordance with the merit review procedures contained in Chapter V of the *Proposal and Award Manual* and presents a recommendation for funding to his or her Division Director and Assistant Director/Office Head.

The Director's Review Board (or DRB) reviews proposals for awards exceeding the Director's Review Board threshold (*see*, Chapter VI of the *Proposal and Award Manual*). Following DRB, the NSF Director recommends awards above the National Science Board threshold for approval to the National Science Board (NSB). The NSB reviews and approves awards recommended by the Director. Following this, the Assistant Director/Office Head, through the Division Director, authorizes the Program Officer to recommend the making of an award in accordance with the proposal processing procedures contained in Chapter VI of the *Proposal and Award Manual*.

The Program Officer, together with the Division of Grants and Agreements, drafts the Cooperative Agreement that will govern the project in accordance with the procedures contained in Chapter VIII of the *Proposal and Award Manual*. The Division of Grants and Agreements makes the award once the Cooperative Agreement is executed by it and the Awardee.

d. Operations & Maintenance

Throughout Operations & Maintenance, the Awardee operates and maintains the facility and the research and education program in accordance with the Cooperative Agreement. The Program Officer oversees to ensure operations and maintenance of the facility and the research and education program are performed in accordance with the Cooperative Agreement and in an efficient, cost-effective manner.

The operations and maintenance of these projects represent costly, high-risk, cutting-edge research and therefore have scheduled reviews by external special emphasis during the term of the award. Typically, these awards are funded for a five-year period with a formal review conducted in year three. The Program Officer, prior to the expiration of the award will make a preliminary determination as to whether he or she will recommend renewal, upgrade, recompetition or termination. Business Operations personnel assist the Program Officer by reviewing areas of facility management within their expertise. In making a determination, Program Officers will follow the National Science Board Resolution on Competition, Recompensation and Renewal of NSF Awards (NSB-97-224, November 13, 1997), wherein the Board, "Affirmed its strong support for the principle that expiring awards are to be recompeted unless it is judged to be in the best interest of U.S. science and engineering not to do so. This position is based on the conviction that peer-reviewed competition and recompetition is the process most likely to assure the best use of NSF funds for supporting research and education." It is essential that NSF determine periodically whether a particular facility still represents the best use of NSF funds, however, because of the complexity of major facility awards there is no single procedure for their review.

The Program Officer then makes a preliminary recommendation regarding renewal, upgrade, recompetition, or termination path and how this process will be managed (nature of the reviews, factors to be considered) to his or her Division Director and Assistant Director/Office Head. Considerations affecting recommendations as to renewal or other options are listed in Chapter III. They range from opportunity costs and cost/benefit considerations to various options that may be open. The Assistant Director/Office Head, through the Division Director, authorizes Program Officer to proceed to Renewal or Termination.

e. Renewal or Termination

At the beginning of the Renewal or Termination stage, the Program Officer develops and implements a plan, including appropriate external review, for orderly renewal, upgrade, recompetition or termination in accordance with his or her recommendation. Included in the termination option of this phase would be any necessary decommissioning, decontamination, or environmental remediation. The Cooperative Agreement -will clarify any special terms or responsibilities for such activities on the part of the Awardee, NSF, or other partner agencies, governments, or other entities.

2. Budgeting and Funding

In the budgeting process, the Awardee is responsible for developing budgets to establish and/or operate a facility. The Program Officer is responsible for reviewing such Awardee budgets, and the assumptions used to develop them, for completeness, appropriateness and reasonableness, and then recommending them. The Program Officer then develops a funding profile and a cash flow analysis and secures appropriate commitments from all internal and external sources of funds.

Actual funding, for the activity (concept, implementation, operation, ...) is derived from the appropriate NSF budget account – R&RA, EHR, or MREFC. Barring documented exceptions, the R&RA/EHR accounts will be used to fund Concept, Development, Operations & Maintenance and Renewal or Termination costs, while the MREFC account (if applicable) will be used to fund Implementation costs. If the latter is not applicable, the R&RA/EHR accounts also fund all Implementation costs. When funds from separate appropriations are obligated under a single award, the Cooperative Agreement must include provisions that specify the account to which expenditures are to be charged and restrict any reprogramming of funds by the awardee (NSF Bulletin 01-15, “Major Research Equipment Funds under NSF Awards”, July 3, 2001).⁵ The Program Officer and the Grants Officer assure that this process is adhered to.

3. Documentation

The Program Officer is responsible for producing and maintaining documentation related to the review and processing of proposals and awards. Chapter VI of the *Proposal and Award Manual* requires that proposal decisions be clearly documented, and Chapter XII of the *Proposal and Award Manual* requires that award records be retained and either retired or disposed of in accordance with Federal law and regulation.

Awardees are responsible for retaining financial records, supporting documents, statistical records and other pertinent records for a period of at least three years from submission of the Final Project Report. In addition, access to any pertinent books, documents, papers and records must be made available to the NSF Director and the Comptroller General of the United States or any of their duly authorized representatives to make audits, examinations, excerpts and transcripts.

Both the Program Officer and the Awardee are responsible for ensuring that there is a document management system in place that provides for retention of essential and significant documentation related to the project. To the extent possible, project documentation should make maximal use of electronic processes; however, some paper records are also necessary. Of particular importance is the maintaining of good records of project reporting, cost and schedule performance, project scope and changes thereto by written change orders and approvals. Lists of issues, action items, and their resolution must be maintained.

⁵ The Bulletin is available at <http://www.inside.nsf.gov/pubs/2001/ib0115/ib0115.htm>

4. Reporting, Oversight, and Reviews

The Awardee is responsible for complying with the reporting requirements contained in the Cooperative Agreement (e.g., technical and financial reporting, Government Performance and Results Act (GPRA) reporting, and final reporting and closeout requirements for termination of the award). The Awardee is responsible for providing internal oversight of its own activities. This may require internal reporting and reviews by committees established by the Awardee institution for the purpose of oversight.

The Program Officer has continuous responsibility for oversight of the process through reviews and reports in accordance with the Internal Management Plan. Of particular importance is the implementation stage when the project is converted from a plan to reality. During this phase, the following practices are required:

- application of the principles of project management, with particular attention to cost and schedule variances, and project tracking relative to plans;
- review and analysis of quarterly reports to assess technical progress;
- periodic site visits, at least semi-annually and meetings with the Awardee Project Director and project technical staff to review progress first-hand;
- semi-annual or annual review of progress with external reviewers to assess technical, cost, and schedule progress, identify issues and risks, and develop plans to address issues and risks (action items);
- provide monthly update on project to LFP in writing;
- semi-annual or annual reviews of projects must include review of management and business practices, and be coordinated with the LFP Deputy;
- discussion of overarching issues of performance and management with Awardee institution higher management.
- PAT has regularly scheduled meetings.

Oversight and reporting are also important during the operations phase, and the above elements must be followed, changed only in the emphasis of the reviews, for example, identifying issues relating to: facility performance, user satisfaction, resource allocation, maintenance, needed upgrades or enhancement, environmental or safety issues, management, and importantly S&E impact.

III. Detailed Procedures and Best Practices

This section discusses the activities occurring during each stage of the facility lifecycle and provides the required information to assist Program Officers and Awardees in designing management and oversight plans for pre- and post-award aspects that are both in compliance with the requirements noted in Chapter II and appropriate for the particular project at hand. Much of the discussion is drawn from best practices developed by NSF, by our Awardees, and by our Federal agency partners.

Note that this Guide is primarily concerned with the management and oversight of facilities provided by the Program Officer and other NSF entities. Thus, while activities such as proposal generation, review and award are mentioned where they apply, there has been no attempt to repeat the more detailed guidance contained in the *Proposal and Award Manual*. Attempts have been made to direct the Program Officer to the appropriate sections of the *Proposal and Award Manual*, but it is incumbent on the Program Officer to be familiar with the requirements contained therein and to not rely solely on this Guide. In addition, because each stage builds upon work conducted in prior stages, it is incumbent upon the Program Officer and the Awardee to familiarize themselves with the information contained in each stage.

The procedural steps outlined for each stage are meant as a guide – and not all steps will be necessary or appropriate for all projects. The Program Officer must evaluate the importance of each to his or her project in order to ensure that no important steps are overlooked. The Modules being developed will be released in the Fall 2003 and provide more detailed guidance to both Program Officers and Awardees to assist them.

A. Concept Stage

Stage	Activity
CONCEPT	Idea for a facility is articulated and project planning and design begins. This stage includes activities such as preliminary R&D; verification of need and requirements; assessment of technical feasibility, costs, benefits and risks; development of conceptual design; and definition of <i>conceptual</i> (as opposed to final) cost, schedule and performance goals.

Ideas for facilities are generated externally by the science and engineering communities or internally by NSF's science and engineering personnel in recognition of a need or an opportunity in the affected discipline. Needs and opportunities arise in any number of ways. For example, new or expanded capabilities may be needed to make progress, research may uncover new science and engineering questions, or a technological breakthrough may make an important new line of research feasible. The impetus may stem from long-range planning exercises, special studies or workshops, professional society meetings and conferences, or advisory committees.

The Program Officer typically will not have direct responsibility for developing an idea. It is more typical for a community of researchers and/or educators to notify NSF, informally or through a proposal, that a need or opportunity exists. During the Concept stage the community, with or without the input of a Program Officer, will be verifying needs, assessing technical feasibility, costs, benefits and risks, and defining conceptual design, cost, schedule and performance goals. NSF funding may or may not be made available to the community during the Concept stage. If funding is provided, it is usually limited to awards for R&D or for planning conferences and workshops. These activities, if funded, are funded through NSF's R&RA and/or EHR accounts.

At the point when the conceptual elements are known, the Program Officer discusses the potential project with his or her Division Director and Assistant Director/Office Head. The Program Officer will also discuss the research and education needs and opportunities that justify development of the facility; how any necessary R&D will be accomplished; if technical feasibility is unknown, how it will be demonstrated; and his or her vision for

developing, implementing and, eventually, operating and maintaining and supporting researchers and educators at the facility. Some Directorates/Offices have established a formal process for conceptual review, while others have an informal process; the Program Officer should determine in which form the information should be presented.

PROCEDURAL STEPS

Initial Planning Steps

- (1) Program Officer interacts with the community/collaboration/group involved in the idea, in the following ways:
 - Communicates the NSF vision for the facility to potential Awardees.
 - Seeks and evaluates input from end users.
 - Supports and/or reviews R&D, planning conferences and workshops.
 - Verify needs; assess technical feasibility, costs, benefits and risks; develop conceptual design; define *conceptual* (as opposed to final) cost, schedule and performance goals.
 - Examines the costs and benefits of the proposed investment versus alternative investments.
- (2) Program Officer evaluates the idea to determine whether it (1) meets the definition of “facility” and (2) embodies the following attributes required for NSF support:
 - Projects must be **intellectually well-justified**, consistent with NSF’s goals, strategies and priorities, and represent an exceptional opportunity that enables discovery, research and education essential to the Nation’s science and engineering enterprise.
 - This might include the potential to revitalize established communities or to build new ones. The need for the project must be articulated in the context of other existing or planned resources in the discipline, opportunities that would be foregone by not undertaking the project, and its effect on the balance and concentration of research and education within the discipline.
 - Projects must exhibit a **broad base of support** within the relevant research and education community. Beginning with the earliest planning activities, projects must be well vetted in external meetings and workshops, by review and advisory committees, and through planning documents and reports.
 - Projects must have the potential to **positively impact the education and training** of students and the next generation of leaders in science and engineering. The project must also explore how the investment can be leveraged by outreach activities.
 - Projects must **fully exploit opportunities for partnerships** and the rationale for the partnership, the costs, benefits and risks, level of collaboration and funding arrangements must be made clear.
 - Projects must be **scaled and operated** to match the stated research and education goals and objectives and the estimated number of users that will be served.
- (3) Program Officer interacts with potential partners:

With respect to facilities, partnerships are important because they can make possible for a community what might otherwise be impossible because of cost. There are broader impacts of partnerships as well. For example, new opportunities in education and outreach are important outcomes of NSF’s investments. The Program Officer will work with all partners to incorporate and maximize these broader impacts, as well as the research potential, of facilities. Where partners negotiate to contribute additional scope to a

project rather than to offset costs, the additional scope should add important new capability and the need for the capability should be clearly demonstrated.

As early as possible in the planning process, the potential for partnerships should be fully and actively explored. For all prospective partnerships, the Program Officer must establish early communication with the prospective partners in order to develop and document shared vision and respective funding, management and oversight arrangements. For partnerships with external entities, such as other federal agencies, private institutions, foundations, and foreign countries, the following activities are advised:

- Evaluate NSF's role (NSF's authority and responsibility varies depending on its status as executive agent or majority, equal or minority partner), assess risks and develop plan to address, e.g., controls that limit NSF's exposure to overruns (*see, Risk Assessment and Management, Chapter IV*).
- Ensure that all partners understand the review and approval process of all partners (*see, NSF Review and Approval and the Federal Budget Process, Appendix 1*).
- Prior to entering into a partnership, develop and execute, a Memorandum of Understanding.

Memorandum of Understanding (MOU)

MOUs are broad, general agreements between NSF and other parties to pursue activities of mutual interest and benefit; cooperate in areas where science and engineering interests coincide; and provide a framework for cooperation. A typical MOU includes the purpose of the Understanding; authority of the parties to enter into an Understanding; scope of the Understanding, including a project description and the respective responsibilities of each party for funding, management and oversight (including procedures for resolving conflicts and dealing with defaults); rights of each party with respect to access, ownership and intellectual property (Chapter VII of the *Proposal and Award Manual*); and a termination clause. MOUs are developed by the Program Officer and cleared according to procedures outlined in Chapter VIII of the *Proposal and Award Manual*.

Some added steps for international partnerships include:

- Consult with the Office of International Science and Engineering,
- Use established organizations to initiate and foster international participation (e.g., Organization for Economic Cooperation and Development (OECD), International Union of Pure and Applied Physics (IUPAP), G7 and Organization of American States (OAS), and,
- Explore OSTP involvement if geopolitical ramifications warrant.

(See Chapter IV for further details on International Partnerships, and Partnerships generally.)

- (4) Program Officer explores options for generating proposals and develops proposal generating document with his or her partners in the project:

Issue a Program Announcement or Solicitation?

- ➔ **Announcements** utilize the *Grant Proposal Manual's* eligibility and proposal preparation guidelines and the National Science Board-approved merit review criteria; do not specify additional award conditions or reporting requirements; do not require cost sharing beyond the statutory 1%.

- ➔ **Solicitations** are appropriate when the Program Officer wants to: provide supplemental proposal preparation guidance or otherwise deviate from the *Grant Proposal Manual* guidelines; tailor the evaluation criteria; specify categories of proposers; limit the number of proposals that may be submitted by a single organization/researcher/educator; specify additional award conditions or reporting requirements; use a Cooperative Agreement; eliminate the statutory 1% cost sharing; or permit payment of fees to awardees.

Will there be multiple awards or a single award?

- ➔ With **multiple Awardees**, the Program Officer will - nominate a coordinating Awardee (the Program Officer may have the expertise to manage many Awardees but not the time).
- ➔ Alternatively, a **single Awardee** could make subawards. With this option, however, Program Officers need to be aware that NSF loses “privity” – or a legal relationship and thus the ability to intervene or deal directly – with the subawardees.

Steps in Preparation for Management and Oversight
(also *see*, Oversight, Reviews and Reporting, Chapter IV)

During the Concept stage, the Program Officer is required to take the following steps (the information noted below is most probably developed and submitted in draft stage, to be finalized during later stages in the facility lifecycle):

- 1) Establish a tentative framework of authority, responsibility and communication within NSF (e.g., Divisions, Directorates/Offices) and with other partners.
- 2) Estimate the funding and personnel needed to oversee the facility through each stage in its lifecycle (*see*, Budgeting and Funding, Chapter IV) and verifies that the resources are available for, and would be dedicated to, the proposed activity. The costs of oversight include the following:
 - Site visits and/or reviews by internal personnel (i.e., full-time NSF employees) (funded through the S&E allocation),
 - Site visits and/or reviews by external personnel (includes IPAs and other temporary NSF employees) (e.g., technical experts, design and engineering reviews) (for projects funded through the MREFC account, these costs may be included in the MREFC budget; otherwise, they would be funded through the R&RA and/or EHR accounts),
 - Whether videoconferencing could be used to defray travel costs, and
 - Additional costs due to distributed facilities or multiple Awardees;
 - Personnel slot(s), appropriate in number for the scale of the proposed project; and,
 - Cost of project management tools (e.g., equipment such as enhanced computers and printers, videoconferencing equipment and high performance network connections for interfacing with Awardees; commercially available software for cost and schedule development and tracking; copies of industry standards and references; and training in project management).
- 3) Develop a draft annual funding profile and a draft annual cash flow analysis for each stage of the facility lifecycle. The funding profile estimates all costs noted below. The cash flow analysis examines the funds to be provided by NSF and the funds to be provided by external partners. The profile/analysis is used to identify not only the total cost of the facility, but also any funding shortfalls that must be addressed prior to proceeding (*see*, Budgeting and Funding, Chapter IV):
 - **Concept.** Include the cost of all awards made in *direct* support of the facility; e.g., R&D and planning awards. Note that, at times, awards are made that lead indirectly to an idea for a facility. Though fortuitous, the cost of these awards should not be attributable to the total cost of the facility.

- **Development.** Include the cost of all awards made in *direct* support of the facility; e.g., R&D and design awards.
- **Implementation.** Include the costs of construction/acquisition, system integration, commissioning, testing and acceptance, transitioning to operations and management of these efforts. Inflation, according to the factors published by the Office of Management and Budget each year (available from NSF’s Budget Division) or other accepted methods, as well as contingency and the cost to manage and oversee construction/acquisition – need to be included; e.g., internal and external site visits and reviews.
- **Operations & Maintenance.** Based on the estimated expected lifespan of the facility, determine the annual costs to operate and maintain it for its intended use, any planned upgrades to the facility, its instrumentation and the IT components (the cost and approximate time of investment; the Program Officer can expect that IT components will need to be upgraded at least every three to five years), and the funds that will be required to support research and education at the facility. Program Officer determines the amount of base support and of any other needed infrastructure support, e.g., special IT resources, and determines how to provide this support (e.g., increases in or redistribution of R&RA and/or EHR funds to support research and education). (See Chapter IV.G for more detailed discussion.)
- **Renewal or Termination.** Include an estimate of the funds that would be required to transition management of the facility from one awardee to another or to terminate support of the facility including, if applicable, the cost of environmental remediation.

The Program Officer will develop a plan to address any funding shortfalls demonstrated by the profile/analysis or that occurs as a result of plans not being executed as planned. The following questions are pertinent to this task:

- o Will a portion of budgeted contingency be withheld?
- o Will NSF and/or funding partners agree to contribute equally or proportionally to any funding shortfalls?
- o Will additional contributions be contingent on additional funds being made available through the appropriations process (for U.S. agencies) or other funding processes (for other partners)?
- o Are there plans to de-scope that will be implemented if sufficient funding is not available?

Decision Point 1: Concept; Proceed to Development
--

By the end of the Concept stage, the following needs to be accomplished:

- 1) Awardee submits an idea or a proposal to the Program Officer.
- 2) Program Officer presents *conceptual* (as opposed to final) design, cost, schedule and performance goals and requirements, and his or her vision, **including cost estimates**, for developing, implementing and, eventually, operating⁶ and maintaining the facility and supporting researchers and educators at the facility to his or her Division Director and Assistant Director/Office Head.

At this stage, the design and requirements are conceptual, to be refined in later stages. From the conceptual stage, the design moves to the more refined preliminary design to the final design, which is needed before the project can finalize cost and schedule goals and move into Implementation. Many projects use the conceptual/preliminary/final framework and formal reviews are conducted prior to moving from one design phase to the next.

⁶ See Chapter IV; section G for detailed considerations regarding operating budgets.

- 3) Assistant Director/Office Head authorizes the Program Officer to proceed to Development. For projects that will seek funding through the MREFC account, the Assistant Director/Office Head notifies the MREFC Panel and the project is included on the Running List.

B. Development Stage

Stage	Activity
DEVELOPMENT	Project planning and design are completed and proposal is submitted.
	During this stage, R&D, prototypes/test beds (if applicable), risk analysis, final designs and planning for system integration are completed; <i>final</i> cost, schedule and performance baselines are established; a Work Breakdown Structure (WBS) is created; Internal (NSF) Management Plan and external (Awardee) Project Execution Plan are finalized.

Once a decision is made to move into the Development stage, the Program Officer provides guidance to the community to ensure that all necessary work is carried out and that the Awardee is aware of any cost or schedule constraints (e.g., are there annual or total funding limits? does the project have to be completed within a specified period of time?). Thus, the Awardee is completing R&D, prototypes/test beds (if applicable), risk analysis, final designs and planning for system integration. The results of these activities will drive establishment of the baseline cost (including inflation and contingency), schedule (including milestones) and performance requirements – collectively referred to as the Baseline Project Definition that is used throughout Implementation as the benchmark against which progress on the project will be measured. The Awardee collects this information, together with other project-specific plans and processes, into a Project Execution Plan and a proposal.⁷

At essentially any point up to, but prior to moving into Implementation, NSF will have received a proposal from an Awardee.⁸ The proposal may have been received in response to an NSF announcement or solicitation or may have been generated as the result of activity in the research and education community. When the proposal comes to NSF, the Program Officer reviews it and obtains approval to make an award in order to move into Implementation. In addition to the “normal” procedures (with reference as appropriate to Chapters V and VI of the *Proposal and Award Manual*, facility proposals require additional and different review as described in the Procedural Steps below.

PROCEDURAL STEPS

1) Project Execution Plan

The Program Officer reviews proposals to ensure that the Project Execution Plan contains the elements identified in the sidebar at right. Each of these elements must be fully developed. Details of this plan and some common definitions are given below:

Organizational Structure: The project organization, internally and externally, will show clear lines of authority, responsibility and communication between NSF, any partners and the Awardee, and will include a discussion of all significant interfaces between

Project Execution Plan (PEP)

- Organizational Structure;
- Baseline Project Definition;
- Work Breakdown Structure;
- Risk Assessment and Management;
- Contingency Management;
- Configuration Management and Change Control;
- Quality Assurance and Quality Control;
- Safety, Environment and Health;
- Financial and Business Operations Controls;
- System Integration, Commissioning,
- Testing and Acceptance; and,
- Plan for transitioning from Implementation to Operations & Maintenance.

⁷ Although it is preferable to finalize this information prior to making an award, NSF understands that this may not always be possible (e.g., the Awardee may not be able to support such an effort without funding). In this case, NSF allows the Awardee a period of time after award to submit finalized documents for Program Officer approval.

⁸ The remainder of this section assumes that a proposal has been received and, if not, that the Program Officer does what is necessary to generate proposals.

internal and external entities and how these will be coordinated (e.g., how, and how often, will interface with the user community be accomplished?). The Awardee must designate one person – with strong project management experience – to be the Project Director, with overall authority and responsibility for the project and interactions with the Program Officer.

- In executing the Project Execution Plan, the Project Director manages the project “to the baseline” – the approved cost, schedule and performance requirements. Generally, this is a full time job and takes a dedicated individual, supported by a competent technical staff committed to the project and the principles of sound project management. For projects that are implemented through multiple awards, the Program Officer will ensure that one of the Awardees has the capability and resources necessary to take responsibility for the overall management and successful performance of the project, and that any other Awardees agree to the arrangement (memorialized in a Memorandum of Understanding executed by all Awardees). A project can fail (i.e. not meet the baseline requirements) if the Project Director is not effective. The Program Officer should recognize that as a facility progresses through its different stages, the Project Director may change as it is difficult to find individuals with the requisite training and experience to successfully manage every stage of the lifecycle. Correspondingly, oversight at each stage will always include a management review to determine whether corrective actions regarding management are needed.

Baseline Project Definition: contains the final cost, schedule and performance requirements to be used as the benchmark against which all progress on the project will be measured:

Cost: Estimate of all costs, including inflation in accordance with annual guidance issued by the Office of Management and Budget (available from NSF’s Budget Division) or other accepted measures and contingency (based on industry standards or experience gained from establishing similar facilities) to complete the project. The Program Officer will require the Awardee to have an independent cost estimate performed, and Budget Justification containing the assumptions used to develop costs, inflation and contingency.

Schedule: Schedule for the overall project and each major subsystem that includes system integration, commissioning, acceptance, testing and transition activities; and, major milestones and milestones for reviews, critical decisions and deliverables.

Performance: Technical characteristics that the facility must be capable of performing upon completion in order to meet the science or engineering needs. This includes the following:

Work Breakdown Structure (WBS): contains a product-oriented grouping of project tasks that organizes and defines the total scope of the project. The WBS is a multi-level framework that organizes and displays each project component that represents work to be accomplished. Each descending level provides detailed definition of a project component. WBS integrates and relates all project work (cost, schedule and scope) and is used throughout the project management to identify and monitor project process.

Risk Assessment and Management: see, Risk Assessment and Management, Chapter IV and the upcoming Risk Management Module for in-depth guidance.

Contingency Management: good managers will include ‘risk dollars’ as part of the cost estimate for each WBS component as appropriate. These dollars are the project funds reserved to deal with unexpected events during the project. The method used should be adapted to the specific needs of the project. *Contingency* is the portion of the project budget that can be held by NSF or the Awardee in reserve to accommodate the unknowns regarding requirements and uncertainty that is outside the scope of the contract, but is within the scope of the project. Contingency is used for additional scope and work to meet the necessary requirements of the project. Contingency is developed during the risk analysis process that weighs the risk likelihood and impact and results in a plan to alleviate the risk. See the upcoming Financial Management Module for an in-depth discussion.

Configuration Management and change control: identifies and defines items in a project, controlling changes of these items, controlling and managing through a documented process how requirements are to be met.

Quality assurance and quality control program: the Awardee is responsible for establishing a program, conducting inspections and retaining records of the inspections conducted.

Safety, environmental and health issues: a plan that addresses safety, health, environment and quality issues and is integrated throughout all the project phases. This plan will ensure that worker, environmental and public safety is appropriately addressed in performing every task.

Plans for securing human subjects clearances: if applicable (e.g., assessments of education-related activities).

Financial and business operations controls: will be used to ensure that the project are in compliance with NSF policies and procedures and Federal regulations.

Plans for system integration, commissioning, testing and acceptance: Project Director establishes a turnover, occupancy, and acceptance process that includes a punch list item resolution, user walkdowns, verification of compliance with project requirements, system startup for proper operations.

Plans for transitioning from construction and/or acquisition to operations: a planned, structured and organized project transition includes the identification of the budget necessary for required activities, as well as adequate staffing.

Once the Program Officer has reviewed the Project Execution Plan, he or she will convene an external panel to assist with reviewing project-specific plans and processes. For example, with respect to technical feasibility, risk, and constructability issues the following questions need to be addressed:

- Has feasibility been demonstrated through adequate study and prototyping and, if not, what additional support is needed from NSF, partners and/or the community?
- Is the technology well matched to end user needs?
- Does the technical approach minimize operations and maintenance costs? What is the cost of operations and how was it estimated? (See Chapter IV, section G.)
- Does the technical approach lend itself to cost-effective upgrades, thus avoiding predictable obsolescence?

Other issues to be addressed by a panel include: cost and schedule realism, adequacy of budgeted contingency, and review of organizational structure and management.

2) Internal Management Plan

Following review of the proposal, and just prior to recommending it for funding, the Program Officer finalizes the Internal Management Plan. The sidebar at right lists the Internal Management Plan essential elements that must be fully developed. This plan - will be drafted during the Concept stage, and at this stage will be updated to include technical and other information learned during the Concept stage and from the proposal submitted and reviewed in the Development stage. Expanding some on the essential elements listed at right, the Internal Management Plan needs to include discussion of the following items and questions:

Internal Management Plan (IMP)

- Science/engineering Justification;
- R&D;
- Technical Feasibility;
- Annual Funding Profile and Cash Flow Analysis;
- Commitment to funding the Implementation and Operations & Maintenance stages
- Proposal Generation and Review;
- Awardee's Project Execution Plan;
- Organizational Structure;
- Internal and External Partners;
- Oversight, reviews and reporting; and,
- Plan for transitioning from Implementation to Operations & Maintenance.

Science/engineering Justification: provides a synopsis of the research and education needs and opportunities that justify development of the facility.

Research and Development: if research and development is needed, an explanation for how it be accomplished and how it will be funded.

Technical Feasibility: description that addresses the demonstrated feasibility of the project if that is known and if not, what additional support will be needed.

Funding Profile: detailed description of the expected annual funding profile of the project, including cash flow analysis.

Commitment to Funding: description of funding the Implementation and Operations & Maintenance stages of the facility, including steps needed to realize the required funds. (See Chapter IV.G for detailed discussion.)

Proposal Generation and Review: Program Officer's plan for issuing program solicitations/announcements for the project and the management plan of reviewing them.

Project Execution Plan: the Awardee's Project Execution Plan that has been approved by the Program Officer.

Organizational Structure: the plan, both internally and externally, with clear lines of authority, responsibility and communication between NSF, any partners and the Awardee, and a discussion of all significant interfaces between internal and external entities and how these will be coordinated; where external partners are involved, include executed MOUs.

Internal and External Partners: a description of the project's stakeholders and their roles, responsibilities and meeting schedules.

Oversight, Reviews, and Reporting: plans for and the associated cost of oversight, reviews and reporting requirements, including who is responsible for performing oversight (e.g., NSF, jointly with partners, etc.) and how often it is planned, the content and frequency of reviews to be conducted, and the content and frequency of reports to be submitted by the Awardee. The upcoming Reporting Module will cover this area in detail.

Transitioning from Implementation to Operations and Maintenance: plans for transitioning from Implementation to Operations & Maintenance will describe how the ramp-down/ramp-up will occur and how it will be funded, including when a proposal for O&M will be developed, taking into account any and all time constraints imposed by the Division, Directorate/Office, Director's Review Board, Director and National Science Board review and approval process and the Federal budget process.

The Program Officer submits the Internal Management Plan to a Facilities Panel chaired by the LFP Deputy and composed of three experienced programmatic and three experienced business operations personnel. The Panel will review management and oversight aspects of the Internal Management Plan for their appropriateness in light of the complexity and risk associated with the project. Using their collective experience and judgment, the Panel will either concur with the Program Officer's Internal Management Plan or suggest improvements thereto. Use of the Facilities Panel will provide NSF with a consistently applied process for reviewing critical management and oversight issues and ensuring that they are appropriately tailored to the project at hand.

The Project Execution Plan and Internal Management Plan will be updated and revised as required, with appropriate notification regarding changes that will have a significant impact on project scope, cost, or schedule.⁹

3) Review and Approval

- a. In accordance with the procedures outlined above (with reference as appropriate to Chapters V and VI of the *Proposal and Award Manual* and the *Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction Account*.
- b. For awards involving property, the Program Officer consults with the Office of General Counsel, the Division of Financial Management and the LFP Deputy to determine whether the value of the property must be included on NSF's financial statements. The LFP Deputy will coordinate as necessary with other Budget, Finance and Award Management divisions as required. The upcoming Financial Management Module will provide more detailed information.
- c. The Program Officer, all partners in the effort, and the potential Awardee must be aware that a funding hiatus between Development and Implementation is not only possible, but highly likely. To illustrate, Chapter IV contains an overlay of NSF review and approval against the Federal budget process. Thus, all plans should attempt, to the extent possible, to incorporate such a hiatus in their plans – for example, contingency for increases in cost, schedule or changes in technology need to be included in all estimates. Once cost and schedule for the required performance have been estimated, the Awardee will need to analyze the state of the underlying technology and adjust cost and schedule, as required, to account for technology changes that are slower or faster than the anticipated schedule. And, once funded, the documentation developed for the proposal – such as the Project Execution Plan and the Internal Management Plan – will need to be updated to account for any changes that occurred during the hiatus.

Decision Point 2: Development; Proceed to Implementation

Whether the project is funded through the R&RA, EHR or MREFC accounts, following final approval to make an award, the Program Officer will, with the assistance of the Division of Grants and Agreements, draft the Cooperative Agreement that will govern the project. The Cooperative Agreement is agreed to by NSF and the Awardee, and typically contains:

- Section I, Special Conditions:
 - Statement of Purpose,
 - Period of Performance,
 - Statement of Work and Awardee Responsibilities,
 - NSF Responsibilities,
 - Funding and Funding Schedule,
 - Reporting Requirements and Reviews,
 - Key Personnel, and,
 - Other Conditions (e.g., subaward approval, title to equipment).
- Section II, General Conditions:
 - In this section, the terms and conditions of NSF's General Grant Conditions (GC-1) and Cooperative Agreement General Conditions (CA-1) are incorporated by reference.

⁹ The NSF Director must be notified if changes will increase cost above the NSB-approved level. The NSB must approve changes that will increase cost by 20% or \$10M above the NSB-approved level. (See Chapter VI of the Proposal and Award Manual.)

- Section III, Order of Precedence:
 - In the event of an inconsistency between the terms and conditions contained in any of the other sections, this section provides guidance on which sections take precedence in resolving the inconsistency.

C. Implementation Stage

Stage	Activity
IMPLEMENTATION	Awardee Project Execution Plan is executed and controlled by Awardee and overseen by NSF.
	This stage includes construction and/or acquisition; system integration, commissioning, testing, acceptance; transition to operations; and management of these efforts.

With the input and concurrence of the Program Officer and upon execution of the Cooperative Agreement by the Division of Grants and Agreements and the Awardee, the Implementation stage begins. While the Awardee has primary responsibility for executing and controlling the project in accordance with the Project Execution Plan and the Cooperative Agreement, the Program Officer has continuous responsibility for oversight of the process in accordance with his or her Internal Management Plan and through various reviews and reports, such as periodic updates to the MREFC Panel (if applicable) and the National Science Board.

Prior to moving into the Operations & Maintenance stage the completed facility usually requires a commissioning period to integrate subsystems and fully test all components. The complexities of system integration, commissioning, testing, acceptance and transition to operations need to be carefully thought through in advance. Implementation is complete following successful operation of the facility in accordance with the acceptance criteria outlined in the Awardee’s Project Execution Plan.

PROCEDURAL STEPS

Awardee – Execution and Control

- 1) The Project Director, who is responsible for executing and controlling the project in accordance with the Project Execution Plan and the Cooperative Agreement, reports to the Program Officer on a periodic basis (no less than quarterly). This report must include the following:
 - Summary of work accomplished during the reporting period including major scientific and/or technical accomplishments and milestones achieved,
 - Comparison of actual cost and schedule to planned cost and schedule,
 - Review of current or anticipated problem areas and corrective actions, and,
 - Management information such as changes in key personnel, subcontracts and subcontractor performance, and any other information about which the Program Officer needs to be aware;

The Project Director adheres to the Awardee’s institutional practices regarding financial and business operations controls, and internal reporting (e.g., Principal Investigator, Dean, etc., as applicable and required).

- 2) In executing and controlling the project, the Awardee manages the project to the Baseline Project Definition and cost and schedule.
 - Progress must be tracked and measured using the **Earned Value method** (this method is required by the Office of Management and Budget in its *Planning, Budgeting, Acquisition, and Management of*

Capital Assets circular). Earned Value is an objective analysis of a project’s cost and schedule progress as compared to the Baseline Project Definition (or, Rebaselined Project Definition). Tracking cost and schedule variances (as described below) enables decision makers to assess overall project performance and, when there are budget overruns or schedule slips, to implement corrective actions. Earned Value uses three “building blocks” (Planned Value (PV),¹⁰ Earned Value (EV),¹¹ and Actual Cost (AC)) to calculate Schedule (EV – PV) and Cost (EV – AC) variances. Negative results indicate that a project is over budget and/or behind schedule. To use Earned Value, one needs to determine the percent of a task that has been completed. For purposes of Government Performance and Results Act (GPRA) reporting, a simple measure of Earned Value will be used: if a task has not been started, it is 0% complete; if a task has been started it is assumed to be 50% complete; and only when a task has been completed is the whole value earned. There will be a more in-depth discussion of Earned Value in the EVM section of the upcoming Financial Management Module.

- The Awardee will notify the Program Officer of cost and schedule variances on a periodic basis (e.g., monthly, quarterly or annually, depending upon the project’s cost, schedule and complexity). Variances in excess of negative 10% or more will be accompanied by an explanation and a proposed plan for maintaining the cost and schedule (e.g., use contingency, de-scope). Where maintaining the baseline is not possible, the Awardee will consult with the Program Officer to determine whether re-baselining the project is warranted. When deciding which course of action to pursue, the Program Officer will need to balance the effect of failing to achieve the project’s performance goals against the impact on the research and education proposed for the completed facility.
 - The Program Officer will advise NSF management of cost and schedule variances that exceed 10% and will request approval via a memo to the Division Director and Assistant Director/Office Head prior to re-baselining a project. This activity will require notification to the MREFC Panel (if applicable), the Director, the National Science Board, the Office of Management and Budget and the Congress. The upcoming Financial Management Module will provide more detail regarding the process involved.
 - Use of contingency is an appropriate means to deal with project uncertainties. When computing cost and schedule variances, one must compare earned value to planned value. However, when a task costs more than expected and contingency funds are needed to complete the task, the original planned value is adjusted by the addition of the contingency funds used. The adjusted planned value is then used to compute variances. This adjustment ensures that projects are not penalized for utilizing contingency. Adjustments may also be necessary to account for approved change orders that affect the project’s cost or schedule.
 - Variances may result from any number of factors – some as a result of poor project planning or poor management but others as a result of things not within the project director’s (or manager’s) control; e.g., failure to identify the complexity in particular tasks (such as integration), failure to budget for adequate labor, materials or time versus unexpected increases in the cost of labor and/or materials, unavailability of labor and/or materials, weather, etc.
- 3) Within two years of the Implementation stage the Awardee is required to perform a formal review of the Baseline Project Definition. This exercise will include a reassessment of the approved cost, schedule and performance requirements against progress made to date and the activities remaining and will take into account any changes in technology. If it appears that additional funds or time will be required in order to complete the project, the Program Officer works with the Awardee to determine the best course of action. Possible courses of action include (a) “re-base lining”, or seeking a formal revision to the Baseline Project

¹⁰ Previously called Budgeted Cost of Work Scheduled.

¹¹ Previously called Budget Cost of Work Performed.

Definition, and requesting additional funds or time, or (b) “de-scoping” the project in order to remain within the cost and schedule goals of the project. If additional funds or time will be requested, the review and approval process followed in the Development stage is repeated. Once a Rebaselined Project Definition has been approved, the re-baselined requirements replace the Baseline Project Definition as the standard against which progress is measured. Thus, it would be incorrect to characterize costs in excess of the Baseline Project Definition as “overruns.”

- 4) **Contingency Management** is a responsibility of the Awardee and the Program Officer. The Program Officer typically makes funds available to the Awardee. However, in the case of distributed-but-integrated projects or other projects for which there are many Awardees, the Program Officer can retain some or all of the contingency at NSF in order to ensure its equitable availability to all Awardees. The Awardee’s process will be required to indicate:
- Who authorizes – the Awardee can delegate authority to approve the use of contingency to various levels within the project. For example, the Project Director might be authorized to approve any use, while the Project Manager might be authorized to approve 10% of remaining contingency funds (these levels –need to be outlined in the Project Execution Plan; the Program Officer (perhaps with the advice of the LFP Deputy or the Project Advisory Team, with the concurrence of the Facilities Panel, will approve the delegations proposed by the Awardee). However, contingency to expand project scope cannot be authorized without prior notice to the Program Officer and the prior written approval of the Grants Officer.
 - Who is notified – Awardees must provide notification of the use of expenditure internally in accordance with the procedures it develops for contingency management and will retain documentation of the use of contingency in a Contingency Log (a Contingency Log documents each use of contingency, the reason why the use of contingency was necessary, and a record of approvals); if the Program Officer so chooses, he or she can require notification from the Awardee (through the terms and conditions of the Cooperative Agreement) of all uses, of uses that exceed a particular dollar threshold or of uses that represent a particular percentage of remaining contingency.
 - While use of contingency is an appropriate means to deal with project uncertainties, its use - must be controlled and monitored to ensure that an adequate amount of contingency remains available through the project’s completion. The Awardees contingency management plan - will outline its plan for ensuring that an adequate amount of contingency remains available through the project’s completion.
- 5) **Configuration Management and Change Control** is a responsibility of the Awardee. He/she proposes, in the Project Execution Plan, a process for configuration management that includes a discussion of who is involved in the process, the changes that can be authorized, and who is notified of the changes. The Program Officer, (, with the concurrence of the Facilities Panel, approves the process. This process may include the establishment of a Change Control Board.
- The **Change Control Board** is typically chaired by the Awardee’s Project Director or Project Manager, and includes the Principal Investigator and a representative of the user community. The Program Officer needs to be included in decisions rising to a particular level. The Change Control Board authorizes any change to the final design having an impact on the approved cost, schedule, or performance requirements of the project or that will affect system interfaces. The Program Officer will require that the Awardee request prior approval for changes that rise to a particular cost, schedule or performance level (this should be done but we need to decide what the particulars are). The Change Control Board must provide notification of approved changes internally in accordance with the procedures developed by the Awardee for configuration management and will retain documentation for all approved changes in a Change File; if the Program Officer so chooses, he or

she can require notification from the Awardee (through the terms and conditions of the Cooperative Agreement) of all approved changes or of approved changes that exceed a particular cost, schedule or performance impact.

6) **System Integration, Commissioning, Testing and Acceptance** are Awardee functions, and are an essential part of complex construction/acquisition projects. They are highlighted here because failure to perform them, or to adequately plan for them, can lead to serious cost and schedule overruns. The Awardee is required to describe its plans for System Integration, Commissioning, Testing and Acceptance in the Project Execution Plan. The Program Officer approves these plans, but is also required to include review of progress in these areas in his or her oversight activities:

- **System Integration** is the bringing together of the many physical and performance interfaces in a project;
- **Commissioning** is the process of substantiating the capability of the facility to function as designed by systematically bringing various system components on-line first sequentially and then in simultaneous operations to study and affirm the interaction between subsystems;
- **Testing** assesses the operation of the facility by applying the criteria established in the Project Execution Plan to measure acceptable performance;
- **Acceptance** lays out the expected condition of the facility, its performance attributes, the tests the Awardee will perform and the data it will consider prior to accepting the facility or components of the facility and declaring it ready for Operations & Maintenance. In some cases, a phased approach to acceptance will be required. For example, for distributed-but-integrated facilities or for facilities with complex instrumentation and equipment, the Program Officer will want the Awardee to demonstrate performance and perform acceptance procedures for part of the system prior to proceeding with construction and/or acquisition of other systems. The Program Officer, in consultation with his or her Division Director and Assistant Director/Office Head, will determine whether the Awardee will conduct the tests and accept the facility or whether the Program Officer will participate in the testing and accept the facility on behalf of the government.

7) A detailed **Transition Plan** needs to be developed by the Awardee, incorporated into the Project Execution Plan and approved by the Program Officer. (It might be preferable for construction/acquisition to end before operations begin. Frequently, however, this is not the case – rather, some aspects of construction and/or acquisition will continue while limited operations are beginning.) In reviewing the Transition Plan, the Program Officer considers the following questions:

- Will the project have parallel periods of construction/acquisition and operations, with some components coming on-line at earlier times than others?
- Is there a plan to bring in personnel with the requisite technical skills to operate and support the facility at appropriate times?
- Have training needs been addressed?
- Do the budgets reflect a proper allocation between construction/acquisition and operations? For projects funded through the MREFC account, even if limited operations are undertaken, the changeover from MREFC-funding to R&RA and/or EHR funding does not have to occur until the facility has been accepted and the Program Officer ensures that the budget is estimated accordingly. Where R&RA and/or EHR funding will be used prior to acceptance, the Program Officer will ensure that the budget justification clearly describes the changeover and that the earlier changeover is estimated and budgeted accordingly.

Program Officer – Oversight

- 1) The Program Officer (the central point of contact between NSF and Awardee and any partners) ensures that the Awardee is managing the project efficiently and cost-effectively through periodic reports and site visits/ reviews (conducted by internal and/or external personnel and, in the event that there are partners in the project, with the partners) of management; progress against cost, schedule and performance requirements; and other aspects of project management (e.g., documentation). Where problems with the Awardee’s execution and control of the project are an issue, the Program Officer initiates corrective action with the Awardee, involving/advising any partners, the Project Advisory Team, NSF higher levels of management, and the National Science Board as appropriate. He/she also informs NSF management and partners of project progress and emerging issues; reviews subcontracts/subawards proposed by the Awardee as required by the Cooperative Agreement (typically those over \$100,000); and, establishes and maintains a dialogue with the end users.
 - The **Project Advisory Team (PAT)** is chaired by the Program Officer. It includes the LFP Deputy (or designee) and technical experts and representatives from Budget, Finance, Grants and Agreements, Acquisitions, General Counsel, Legislative and Public Affairs, and International Programs as required. The PAT advises and assists the Program Officer in overseeing various aspects of the project (e.g., technical; budgeting and funding; cost and schedule; management; subcontracts and subawards; legal; legislative and public affairs; and international issues); and provides objectivity and proactive assistance in moving the project through any “minefields” encountered. The PAT meets regularly (e.g., weekly, monthly or quarterly, depending upon the scope and complexity of the project). Since this internal group is from various offices of the NSF, each member represents diverse expertise with specific knowledge, skills, and abilities necessary to support the successful execution of projects. The PAT provides independent advice and oversight to the Program Officer and the project.
 - The **Deputy Director, Large Facility Projects** advises Program Officers on project management issues; monitors business operations aspects; ensures consistent representation on Project Advisory teams; chairs and convenes the Facilities Panel; and, is consulted for all policy matters involving facilities, including responses to inquiries made by NSF management, the NSF Office of Inspector General, the Office of Management and Budget, and the Congress.
 - The **Facilities Panel** is chaired by LFP Deputy and including experienced programmatic and business operations personnel; assists Program Officers with determining the appropriate level of management and oversight; and, serves as a point of review prior to the submission of projects for consideration by NSF management, the Director’s Review Board and the National Science Board.
- 2) External partners are responsible for providing oversight for their agencies/institutions and for participating in overall project oversight; participate in periodic resource review meetings to discuss any emerging project issues or funding issues; participate in external reviews of the project; and, provide for timely provision of cash or in-kind contributions to the project in accordance with commitments outlined in the Memorandum of Understanding.
- 3) Advisory panels or consultants should be retained to advise the Program Officer on technical issues that cannot be addressed within NSF or with NSF’s partners.

Decision Point 3: Implementation; Proceed to Operations & Maintenance

- Proposals to operate a facility may have been received in connection with the original proposal to establish the facility or will be received sometime prior to acceptance of the facility. In the former, the proposal has already gone through the requisite review and approval process but may need to be revisited. In the latter, the proposal must be prepared well in advance of the anticipated start date for operations (i.e., approximately 6 months to 1 year prior to the end of construction/acquisition activities) in order to avoid funding gaps. The potential Awardee and/or the Program Officer need to establish a dialogue with the user community to determine the resources needed for full exploitation of the facility. In addition, the proposal must include:
 - all costs to operate, maintain and periodically upgrade the facility, its instrumentation and the IT components (the cost and approximate time of investment; the Program Officer can expect that IT components will need to be upgraded at least every three to five years), physical facility and its infrastructure;
 - the costs of an in-house research program (as a separate line item in the budget), if applicable, including an indication of how the overall research program will be managed and how the research program resources will be allocated; and,
 - education and outreach plans and costs.

The review of the proposal (either earlier or later) includes a realistic assessment of the costs to operate and maintain the facility in a safe and effective manner and consistent with NSF’s Government Performance and Results Act (GPRA) goals for facilities. (The Program Officer is also responsible for oversight of his or her operational facilities through the various reviews and reports described in his or her Internal Management Plan.)

- In addition to following the procedures referenced as appropriate to Chapters V and VI of the *Proposal and Award Manual*, the Program Officer considers (with the assistance of reviewers with expertise in managing comparably-scaled user facilities):
 - Is the facility ready for reliable operations and is the infrastructure adequate?
 - Do the Operations & Maintenance plans allow for optimal utilization of the facility by users (e.g., scheduled operating time versus down-time)?
 - Is there an appropriate balance between in-house research and external users?
 - Safety, environmental and health issues, if any, addressed?
 - Plans for securing human subjects clearances if applicable (e.g., assessments of education-related activities) are included?
 - Have all costs been considered and estimated and is the available funding sufficient?
- Program Officer, together with the Division of Grants and Agreements, drafts the Cooperative Agreement that will govern the project in accordance with the procedures contained in Chapter VIII of the *Proposal and Award Manual*. The Cooperative Agreement will include plans for NSF oversight, will reflect the needs of the facility users and address how the user program will be managed and how user time will be allocated.

D. Operations & Maintenance Stage

Stage	Activity
OPERATIONS & MAINTENANCE	Use of the facility for its intended purpose.
	This stage includes the day-to-day work required to support and conduct research and education activities, and to ensure that the facility is operating efficiently and cost-effectively.

Throughout this stage, the Awardee is operating and maintaining the facility in accordance with the terms and conditions outlined in the Cooperative Agreement. The Program Officer provides oversight for all aspects of operations, maintenance and the research and education program. The Program Officer also maintains an awareness of emerging technical, managerial and financial issues through contact with the facility managers and users, and through oversight, reviews and reports.

PROCEDURAL STEPS

Budgeting and Funding (see, Budgeting and Funding, Chapter IV)

- 1) The most challenging aspect of this stage is maintaining a balance between support for operations and maintenance and support for users. The Program Officer should refer to the funding profile and cash flow analysis developed earlier in making budgeting and funding decisions. Budgets are required to be carefully reviewed to ensure that the assumptions used to develop them are valid and that the estimate is complete, appropriate and reasonable. (See Chapter IV.G.) Budgets are required to include inflation, according to the factors published by the Office of Management and Budget each year (available from NSF's Budget Division) or other accepted methods; when budgets are flat, reductions in staff and/or operations may be required.
- 2) Funding is through the Directorates/Office R&RA account. Other sources of support may be provided through other agency awards, partner funding. Support for education/outreach may come through EHR, if the activity is appropriate, or through EPSCoR if the awardee is eligible.

Management and Oversight

- 1) **Operations & Maintenance management** is the responsibility of the Awardee. This normally includes: preventive maintenance program; repairs as required; and, development of facility-specific safety, environmental and health manuals and compliance with any Federal, state or local safety, environmental and health regulations.
- 2) **Research management** is the responsibility of the Awardee; this includes:
 - a) Usage of the facility:
 - overseeing the merit review of user proposals for facility access time;
 - Allocation of access time to the facility. Note that for facilities built or operated in partnership with other agencies or organizations, resource allocation should be addressed in Memoranda of Understanding (e.g., access time proportional to contribution to cost of construction/acquisition or operations); and,
 - Where user fees are charged (e.g., to fund personnel, equipment upgrade and replacement), they must be set and charged according to Office of Management and Budget requirements.
 - b) Data rights, access, and security issues:
 - Data storage, formats, and protocols are normally the responsibility of the Awardee;
 - Data distribution is the responsibility of the user in accordance with the terms and conditions of the award under which funding is received.
 - Awardees are responsible for IT, biological, radioactivity and other security risks associated with use of the facility, as well as security of the facility itself.
- 3) **Education and Outreach management** is the responsibility of the Awardee; this normally includes public tours, education tours, lectures, summer research experiences, teacher involvement or tutorials, and more.

- 4) **Oversight of Operations & Maintenance, Research, and Education and Outreach** is the responsibility of the Program Officer; this normally includes:
- Approval of Operations & Maintenance, Research, and Education and Outreach plans proposed by the Awardee.
 - Review of periodic reports containing programmatic and business operations performance information, meetings with the Awardee and with the user community, and site visits.

When special issues arise, the Program Officer may convene a panel of external reviewers (e.g., concern over research progress). As discussed in Chapter II, approximately mid-way through the award period, the Program Officer, together with Business Operations personnel, reviews the facility to make a preliminary determination as to whether the facility/activity should be renewed, upgraded, recompeted, or terminated. In making this determination, Program Officers will refer to the National Science Board Resolution on Competition, Recompetition and Renewal of NSF Awards (NSB-97-224, November 13, 1997). The factors that are required to be considered at this stage are described in the following section.

Decision Point 4: Operations & Maintenance; Proceed to Renewal or Termination

- Program Officer makes a preliminary recommendation regarding the renewal, upgrade, recompetition, or termination path and how this process will be managed (nature of the reviews, factors to be considered) to his or her Division Director and Assistant Director/Office Head.
- Assistant Director/Office Head authorizes Program Officer to proceed to Renewal or Termination.

E. Renewal or Termination Stage

Stage	Activity
RENEWAL or TERMINATION	Decisions regarding continued support of a facility are made. During this stage the information learned during the Operations & Maintenance stage and through various reviews of the results of research and education activities and facility management is used to determine whether the facility will be renewed, upgraded, ¹² recompeted or terminated.

While most NSF-supported facilities are expected to operate successfully for many years, NSF awards do not last indefinitely. The Program Officer’s Internal Management Plan will specify the useful life of the facility and include a cost-loaded exit strategy. An example would be NSF providing funds for decommissioning or for transferring responsibility for the facility to a different Awardee or a third party.

Approximately 18 months prior to the expiration of an award,¹³ the Program Officer will review (or will convene a panel of experts to review) the results of research and education, the affected community’s needs, and the facility’s management. The reviews will be used to determine whether to renew the award, upgrade the facility, recompeted the award, or terminate the facility. If the reviews show that the facility is of low priority or is otherwise not meeting its goals and objectives, the Program Officer, working with his or her Division Director and Assistant Director/Office Head, prepares a plan for either (1) upgrading its capabilities to a more effective level or (2) terminating support. If the reviews show that the facility remains a high priority and has been

¹² “Upgrades” may also occur during the Operations & Maintenance stage. If the planned upgrade costs on the order of MREFC or MREFC-eligible projects, they become a project in and of themselves, and thus would follow the facility lifecycle beginning with Concept.

¹³ The Program Officer should use his or her judgment and consider the complexity of the facility in determining whether to begin the review process earlier.

successful in meeting its goals and objectives, the Program Officer determines whether renewal or recompetition is in the best interests of NSF and the affected community.¹⁴

In the event that a decision is made to re compete or to terminate support for a facility, the Program Officer will give the incumbent Awardee as much notice as possible, but in any event not less than one year, so that all necessary arrangements to transfer (in the case of recompetition) or terminate (in the case of termination) obligations to vendors and employees can be planned and implemented.

PROCEDURAL STEPS

Opportunities and Opportunity Costs

The Program Officer analyzes the costs and benefits of the facility, taking into consideration the following issues:

- o Is the facility needed by the community and is the community strong and actively engaged?
- o Is the facility meeting the research and education goals and objectives as originally proposed?
- o Will meeting the goals and objectives place the U.S. in a leading position?
- o Is the facility a high priority of the field, as established by long-range planning?
- o Is the facility operating in an efficient and cost-effective manner or are there alternative, more efficient and cost-effective ways to meet the need?
- o What research opportunities and education opportunities are being lost by continued support of this facility?

Options

The Program Officer analyzes what can and what needs to be done in light of the available funding, and considers the following options:

- o Recompete the award;
- o Renew NSF support;
- o Renew NSF support and plan upgrades to the facility;
- o Renew NSF support to allow operations to transition to self-sufficiency (through, for example, institutional, industrial, or other modes of support);
- o Renew NSF support to allow operations to ramp-down, leading to termination; or,
- o Terminate NSF support.

Review and Approval

A renewal proposal is received from the Awardee institution, and possibly from other institutions in the case of a recompetition. The proposal(s) is (are) merit reviewed in accordance with procedures in Chapters V and VI of the

¹⁴ In deciding whether to renew or re compete, the Program Officer should consider that the National Science Board has expressed its preference for re competing all awards. Awards may be renewed without recompetition or with only limited competition if there is sufficient justification; e.g., facilities or facility sites with special features that preclude moving or recompetition, or partnership-related complexities that prevent recompetition. Federally Funded Research and Development Centers cannot be renewed until a comprehensive review is performed. The review must meet the requirements outlined in the Federal Acquisition Regulations (Part 35.017-4, Reviewing FFRDC's): (c) An FFRDC review should include the following: (1) An examination of the sponsor's special technical needs and mission requirements that are performed by the FFRDC to determine if and at what level they continue to exist; (2) Consideration of alternative sources to meet the sponsor's needs; (3) An assessment of the efficiency and effectiveness of the FFRDC in meeting the sponsor's needs, including the FFRDC's ability to maintain its objectivity, independence, quick response capability, currency in its field(s) of expertise, and familiarity with the needs of its sponsor; (4) An assessment of the adequacy of the FFRDC management in ensuring a cost-effective operation.; and (5) A determination that the criteria for establishing the FFRDC continue to be satisfied and that the sponsoring agreement is in compliance with 35.017-1.

Proposal and Award Manual. Approval levels are according to the normal thresholds for DRB and NSB approval.

Decision Point 5: Renewal or Termination: Proceed to Implementation Plan

- Program Officer develops and implements a plan for orderly Renewal or Termination.

IV. Special Topics

This section provides further detail on a number of key activities that bear on the Large Facility Project selection, award, and management process.

A. NSF Review and Approval and the Federal Budget Process

The review and approval process for moving facilities through the decision points in the lifecycle is complex and lengthy, and must be understood by the Program Officer responsible for shepherding it through the process. It is equally important that the Awardee and any partners understand the process. The process starts with the Program Officer and extends through the Division and Directorate/Office level. From there, projects take various paths to final approval. As a project moves through the review and approval levels and the various paths, different criteria are considered and priorities are established. The chart below depicts the review and approval process for a facility that will be funded, and governed, under a Cooperative Agreement between NSF and the Awardee. While this is the general process, there may be variations depending, for example, on whether there is a well-defined construction/acquisition project or a distributed network with as yet undeveloped elements.

Table 4. Review and Approval over the Facility Lifecycle

Stage	NSF Action (s)	NSF Review & Approval
CONCEPT	Make R&D and planning awards; present/review/approve conceptual plans for design, cost, schedule and performance goals; MREFC Panel (if applicable) is notified.	PO, DD & AD.
DEVELOPMENT	Review/approve Implementation proposal; prepare MREFC (if applicable), DRB, NSB packages.	Review for budget inclusion: PO, DD & AD; MREFC Panel (if applicable), DRB, Director, NSB; OMB and Congress If funds are appropriated by Congress, review for award approval: PO, DD, AD; MREFC Panel (if applicable), DRB, Director, NSB.
IMPLEMENTATION	Monitor progress.	PO, DD, AD; LFP Deputy; PAT; MREFC Panel (if applicable), Director, NSB, OMB and Congress.
	Accept facility.	PO.
	Review/approve Operations & Maintenance proposal; prepare DRB, NSB packages.	PO, DD, AD; DRB, Director, NSB.
OPERATIONS & MAINTENANCE	Monitor progress.	PO, DD, AD; Director, NSB.
RENEWAL or TERMINATION	Comprehensive review; make/implement decision to renew, upgrade, recompete or terminate.	PO, DD, AD; Director, NSB.

B. Budgeting and Funding

This section provides guidance to the Program Officer preparing or reviewing facility budgets, and outlines the appropriation accounts used to fund each stage.

Budgets are usually developed by an external entity proposing to establish or operate a facility and reviewed and approved by the Program Officer. Setting realistic budgets to establish and operate facilities is extremely important. The budget not only establishes the cost of a particular effort, but also determines whether the affected Directorate/Office can “afford” the effort and how much remains available to fund other efforts. In reviewing and approving facility budgets, the Program Officer must be cognizant of the activities occurring throughout the various stages of the lifecycle, and must ensure that all costs associated with these activities are estimated. In addition to determining the funds that need to be provided directly to an Awardee, the costs associated with the Program Officer’s oversight of the effort must also be identified.

The budget and the assumptions used to develop it must be reviewed for completeness, appropriateness, and reasonableness. The budget must include not only the cost to implement the project and deliver it according to the performance baseline but it must also identify and estimate all costs to operate the facility and to fund the research and education activities expected to occur. There must be a plan to make the anticipated funds available by the final year of construction and/or acquisition. The plan is required to also specify the sources of all NSF funds and any plans to share costs between Directorates/Offices and with partners. If there are partners, the plan address the conditions under which advanced payments are appropriate, and how advanced payments will be accounted for. Proper support of end users is essential to the efficient utilization of a facility. Accordingly, the Program Officer may have to increase the end user’s budget or redirect support within a program to support new investigators. Planning for end user support must be started in the Concept stage and continues throughout the project.

The Program Officer should be aware that information related to budgeting and funding is used for many purposes. For example, the projected budget will be incorporated into NSF’s annual budget request. Thus, it is imperative that the Program Officer is accurate and consistent when reporting information on budgeting, funding, schedules, milestones and performance for these various purposes.

In general, Awardees are funded through the MREFC, R&RA and/or EHR accounts. When funds from these separate appropriations are obligated under a single award, the award instrument must include provisions that specify the account to which expenditures are to be charged and restrict any reprogramming of funds by the Awardee (NSF Bulletin 01-15, “Major Research Equipment Funds under NSF Awards”, July 3, 2001).¹⁵ In all cases, attention must be paid to the fundamental difference between building the basic infrastructure – i.e., constructing and/or acquiring the facility and all its installed instrumentation and equipment – and enabling others to use the infrastructure once it has been established. “Enabling” the infrastructure is typically done through grants, funded by NSF through the R&RA and/or EHR accounts and/or other agencies, to individual researchers to conduct research at the facility.

The LFP Deputy and the Project Advisory Team will assist the Program Officer in these matters.

Some areas that have been overlooked in the past deserve mention at this point:

- Ensure that all budgets are based on the approved cost, schedule and performance requirements outlined in the Baseline Project Definition.
- Ensure that where budget caps are imposed that there are strategies to de-scope the project or, alternatively, include a scope contingency in the budget.

¹⁵ The Bulletin is available at <http://www.inside.nsf.gov/pubs/2001/ib0115/ib0115.htm>

- Ensure that adequate funds are provided for system integration. Failure to address integration issues, including appropriate staffing and funding, can lead to serious cost overruns and corresponding schedule slips.
- Ensure that funding is included for commissioning, testing, acceptance of the facility and transition from construction/acquisition to operations. The budget must include funding for the staff to perform these activities and to train the operations personnel. Roles change when going from construction to commissioning to operations and the time and staffing requirements need to be carefully thought out in advance.
- Ensure that sufficient funds to enable optimal use of the facility are available. For example, will funds for research and education, as distinct from operations, be provided through the facility Operations & Maintenance budget or through direct awards to investigators? Is there adequate funding for needed instrumentation? Is there a special need to increase base support for the field to make optimal use of the new facility?
- Ensure that, if partnerships are involved, monetary contributions to construction and/or acquisition and eventual operations and usage are timely and sufficient.
- Ensure that all IT costs – both initial cost and continuing costs of hardware, software, maintenance, upgrades and operations – are fully considered. Rapid advances in computing may require upgrades as often as every three to five years.

Table 5. Budgeting and Funding over the Facility Lifecycle

Stage	Budgeting	Funding
CONCEPT	Awards for R&D, planning.	R&RA and/or EHR for all projects.
DEVELOPMENT	Awards for R&D, design.	<p>R&RA and/or EHR.</p> <p>For MREFC projects, the MREFC Panel recommends approval for use of the MREFC account to fund R&D essential to construction/acquisition.</p>
IMPLEMENTATION	<p>Ensure that all labor and material costs are estimated, including:</p> <ul style="list-style-type: none"> ❑ Management, including safety and quality assurance/control programs; ❑ Inflation; ❑ Contingency for cost, schedule and performance; ❑ Environmental compliance costs, including special studies, permits and approvals; ❑ Cost of construction/acquisition; ❑ System integration, commissioning, testing, acceptance and transition; ❑ Recent events make it likely that, in the future, facilities established with federal funds will have to incorporate physical security features. 	<p>MREFC for MREFC-funded projects.</p> <p>R&RA and/or EHR for non-MREFC-funded projects.</p> <p>R&RA and/or EHR for any costs associated with operations (e.g., technical or support staff, beginning research and education efforts) following acceptance of the facility or facility components or earlier in accordance with the budget and budget justification.</p>
OPERATIONS & MAINTENANCE	<p>Ensure that the following are estimated:</p> <ul style="list-style-type: none"> ❑ Management, both technical and business operations; ❑ Labor and materials to operate, including technical and support staff; ❑ Cost of the research to be conducted at or funded through the facility and the cost of education and outreach efforts; ❑ Labor and materials to maintain and the cost of planned upgrades to the facility and any installed equipment; ❑ IT needs, such as hardware, software, maintenance, upgrades, and staffing; ❑ Other direct costs such as travel, supplies. 	R&RA and/or EHR for all facilities.
RENEWAL or TERMINATION	Cost-loaded exit strategy (e.g., decommissioning or transferring to a different Awardee or a third party).	R&RA and/or EHR for all facilities.

C. Risk Assessment and Management

Once NSF approves a Baseline Project Definition there is an expectation by NSF management, the Office of Management and Budget and the Congress that the project will be managed by the Awardee, with appropriate oversight by the Program Officer, to achieve the stated cost, schedule and performance requirements. Therefore, it is essential for the Awardee to analyze the risks associated with achieving the Baseline Project Definition early in the process. Risk is an inherent part of any project to establish a facility, but diligence in assessing and managing the risk affords benefits and opportunities. The obvious benefit is a project that comes in on time, on schedule and according to specifications. Opportunities are presented when a thorough understanding of the risks allows them to be managed up-front.

Risk management is a prepared, prescribed, and disciplined approach, focused on the necessary steps to determine and control risks to an acceptable level. Risk takes many forms; e.g., employing untested technologies, uncertainty in procurement (e.g., contractor failure), unrealized partnerships or an inability to estimate the useful life of key system components. Furthermore, risk is generally present in each of the facility lifecycle stages, although its character may change. Failure to analyze the impact of risks can lead to cost overruns, schedule slips and/or a facility that fails to perform as expected. Such failure can often be traced to poor management or poor oversight. Therefore, the Program Officer and the Awardee are required to develop risk management plans early in the Concept and Development stages. The Program Officer's plan is included in his or her Internal Management Plan and the Awardee's in the Project Execution Plan. The risk management plans must identify the potential risks to the project and document appropriate strategies for managing those risks. Appropriate strategies might include provision of additional funds or time. Because risk management is a continuous process of identifying, analyzing, responding to and controlling risks to maximize the potential for success, risk management plans must be reviewed and updated periodically.

A key risk management strategy is establishment of an appropriate contingency – a quantity of money or time intended to reduce the impact of missed cost, schedule or performance requirements or to take advantage of advances in technology – within the Baseline Project Definition. There is no “magic number” for the proper level of contingency, but there are good estimating techniques and best practices for developing estimates. Traditionally, contingency represents uncertainties in the cost and schedule estimates for the defined performance that result from factors such as technical scope errors and omissions; uncertainty in the feasibility for producing instrumentation with desired performance; natural hazards; pricing variances; and the complexity of the design. For a project that requires significant R&D that pushes the envelope of existing technologies, the risk to achieve the desired performance, and consequently the contingency, may be very high; e.g., on the order of 40-100% of the cost. For projects that use commercial-off-the-shelf technology, the risk, and hence the contingency, may be considerably lower.

The Risk Management Module will provide all of the necessary information for developing a risk management plan.

The Table 6 outlines some common risks that the Program Officer will need to consider in developing the Internal Management Plan and in reviewing and approving the Awardee's Project Execution Plan.

Table 6. Types of Risks to NSF over the Facility Lifecycle

Stage	Cost Risks	Schedule Risks	Performance Risks	Oversight Risks
CONCEPT	<ul style="list-style-type: none"> ❑ Concept performance exceeds need, associated costs too high. 	<ul style="list-style-type: none"> ❑ Time required to develop technology and achieve concept performance under-estimated. ❑ Time required to secure review/approval underestimated. 	<ul style="list-style-type: none"> ❑ Performance may not be achievable within reasonable cost, schedule, existing technology, or R&D efforts. 	<ul style="list-style-type: none"> ❑ Scientific need not fully developed. ❑ Insufficient consideration of safety, environmental and health considerations. ❑ Insufficient NSF resources (staff, travel funds) to observe and fully understand scope of concept development.
DEVELOPMENT	<ul style="list-style-type: none"> ❑ Failure to estimate all costs, associated funding insufficient. 	<ul style="list-style-type: none"> ❑ Schedule for needed tasks not fully developed. ❑ Schedule for needed tasks not properly sequenced. ❑ Insufficient time allowed to complete all needed R&D. ❑ Time required to secure review/approval underestimated. 	<ul style="list-style-type: none"> ❑ Failure to develop adequate technical scope. ❑ Failure to adequately address system integration. ❑ Failure to design effective commissioning, testing and acceptance and transition plans. 	<ul style="list-style-type: none"> ❑ Awardee PEP does not develop or implement adequate management or controls to conduct the project. ❑ NSF IMP does not address all oversight responsibilities. ❑ Failure to consider all safety, environmental and health issues. ❑ Inadequate staff, travel funds to oversee project. ❑ Lack of expertise for proposal review. ❑ Essential partnerships failed to be realized within required timeframe, budget. ❑ Failure to identify and plan for all risks.

Table 6. Types of Risks over the Facility Lifecycle (continuation 1)

Stage	Cost Risks	Schedule Risks	Performance Risks	Oversight Risks
IMPLEMENTATION	<ul style="list-style-type: none"> ❑ Project schedule delayed due to delayed NSF and/or partner funding; project will not meet GPRA cost goals. ❑ Underestimation of cost, contingency. ❑ Unforeseen construction problem or overrun requires additional NSF funding. 	<ul style="list-style-type: none"> ❑ Project schedule delayed due to delayed NSF and/or partner funding; project will not meet GPRA schedule goals. 	<ul style="list-style-type: none"> ❑ Technical performance not achieved; intended long-term research vision will not be achieved by the facility, nor will user requirements be met. 	<ul style="list-style-type: none"> ❑ Awardee progress demonstrates inadequate management/controls. ❑ Failure to adequately consider safety, environmental and health issues. ❑ Insufficient S&E funds to oversee project. ❑ Failure to get adequate external expertise to review project progress. ❑ Partnerships fail within needed time or budget.
OPERATIONS & MAINTENANCE	<ul style="list-style-type: none"> ❑ Underestimate of required maintenance/operation, research/education funds. ❑ Inadequate funding of research/ education and maintenance/operation from NSF or partners. ❑ Unforeseen changes in technology require new and unplanned development and implementation costs. Unforeseen repairs not included in budget. ❑ Cost to train support personnel/users in specialized systems. 	<ul style="list-style-type: none"> ❑ Increased cost and higher level of maintenance leads to unforeseen loss in facility availability for research, thus facility does not meet GPRA goal for operating time. ❑ Time to train support personnel/users in specialized systems. 	<ul style="list-style-type: none"> ❑ User community participation not realized due to misidentification of needs or technical performance of facility not realized. ❑ Facility not available to users due to improper maintenance or unforeseen downtime. 	<ul style="list-style-type: none"> ❑ Awardee progress demonstrates inadequate management/controls to operate and maintain the facility. ❑ Failure to plan/budget for safety, environmental and health issues. ❑ Insufficient NSF staff, S&E funds for oversight. ❑ Failure to get adequate external expertise to review O&M, research and education. ❑ Partnerships fail within needed time or budget.

Table 6. Types of Risks over the Facility Lifecycle (continuation 2)

Stage	Cost Risks	Schedule Risks	Performance Risks	Oversight Risks
RENEWAL or TERMINATION	<ul style="list-style-type: none"> ❑ Funds to renovate or upgrade the facility not available. ❑ Funds to decommission or transfer facility not available. 	<ul style="list-style-type: none"> ❑ Existing facility is overextended by the time a decision to upgrade is made, leading to disruption in research and education. 	<ul style="list-style-type: none"> ❑ Scientific impact not realized. ❑ Scientific capability has been surpassed by another facility or technology. ❑ Facility infrastructure, instrumentation and/or equipment are obsolete. 	<ul style="list-style-type: none"> ❑ Inadequate NSF planning for renewal, upgrade, recompetition or termination. ❑ Insufficient time allotted for renewal, upgrade, recompetition or termination process, including decommissioning, if appropriate.

D. Documentation

The documentation required, and the responsibility for producing and maintaining it, varies according to the stage in the facility lifecycle. During Development, the Program Officer is responsible for producing and maintaining documentation related to review and approval of awards. Managing the documentation pertaining to the review and processing of proposals and awards is the Program Officer's responsibility. Chapter VI of the *Proposal and Award Manual* requires that proposal decisions be clearly documented. Chapter XII of the *Proposal and Award Manual* requires that NSF award records be retained and either retired or disposed of in accordance with Federal law and regulation.

There are exceptions, but Awardees must retain financial records, supporting documents, statistical records and other records pertinent to a grant for a period of three years from submission of the Final Project Report. In addition, access to any pertinent books, documents, papers and records must be made available to the NSF Director and the Comptroller General of the United States or any of their duly authorized representatives to make audits, examinations, excerpts, and transcripts.

With respect to awards made to establish a facility, much occurs between the making of an award and submission of the Final Project Report. Both the Program Officer and the Awardee are responsible for ensuring that there is a document management system in place that provides for retention of essential and significant documentation related to the project.

During Implementation, essential and significant documentation can be defined as the record of any decision affecting the cost, schedule or performance baseline. The system should not only aid in identifying the types of documents to retain, but should also contain appropriate controls over official documents such as drawings to ensure that only the most recent drawings are being used and that only authorized personnel are able to access and modify them. A sound document management system will help prevent miscommunications and misunderstandings and will ensure that the facility operators have the information required to maintain the facility.

Awardee documentation may take many forms, from informal e-mail communications to formal letters, bids and contracts. During Implementation, at a minimum, the following forms of documentation must be retained:

- Memoranda of Understanding and any other project agreements or deals;
- Architectural, engineering, shop and as-built drawings;
- Correspondence identifying a situation, the resolution process, and the final decision;
- Contingency log;
- Change requests and approvals; and,
- System integration, commissioning, testing and acceptance plans and results.

During Operations & Maintenance, the Awardee documents facility performance in terms of the facility itself (e.g., historical record of all costs related to maintenance (preventive, deferred, repairs, emergency), operating time, scheduled as well as unscheduled downtime) and use of the facility for research and education (record of users that includes the name, affiliation, funding agency, award number and annual award amount for each user).

NSF documentation must include all partnership and other agreements, standard jackets in the NSF-required format [PAM reference], the Internal Management Plan, the Baseline Project Definition, the record of oversight (including all reviews and reports) and significant project correspondence.

E Oversight, Reviews, and Reporting

Reviewing Awardee Performance

The Awardee is expected to provide appropriate internal oversight of its own activities and is expected to comply with the reporting requirements contained in the Cooperative Agreement (e.g., technical and financial reporting, and final reporting and closeout requirements for termination of the award). In addition, reviews and reporting are an important part of the oversight process that allows the Program Officer to monitor performance and compliance with project goals. Due to the complex nature of facilities, the level of oversight will be considerably greater than for a typical NSF research grant.

It is important to keep in mind that reviews and reporting come with certain costs. The majority of the time these costs are in the form of travel and accommodations for panel members, the cost to rent facilities to host reviews and administrative support costs associated with the production of reports. In some cases these costs will be minimal or non-existent, but depending on the size of the project and the distribution of the information, these costs may be significant enough to warrant inclusion in the project budget. Review and reporting plans and costs must be identified in the Program Officer's Internal Management Plan and in the Awardee's Project Execution Plan so that they can be adequately considered in the project budget and schedule. The upcoming Reporting Requirements Module will provide more detail on the minimum reporting requirements.

Oversight, reviews and reporting requirements change as the facility moves through the lifecycle. In general, oversight of construction/acquisition projects consists of a combination of the activities listed below. While any or all of them may be conducted for operational facilities, it is more typical for operations to be reviewed on a semi-annual, annual or even award-period basis.

- Reports. The Program Officer must clearly define the reporting requirements of the Awardee in the Cooperative Agreement and these requirements must be noted as milestones on the project master schedule. Reports are generally provided on a monthly and/or quarterly basis, with a comprehensive annual report provided by a pre-determined date. Some projects, particularly those with construction activities or those subject to frequent changes in design, will need more frequent reporting intervals. For construction/acquisition projects, reports typically include: project tasks completed; milestones achieved; percent complete; cost and schedule variances; remaining contingency; emerging technical, managerial and financial issues; etc. For operational facilities, reporting shifts to operational performance and efficiency; Advisory Committee (or equivalent) reports; user demand versus supply; research developments, progress and achievements; information on users (faculty, postdocs, students, degrees resulting); analysis of operating time; maintenance activities; facility improvements; etc.

Requiring the awardee to provide reports is only one part of the oversight process. It is important for the Program Officer to have a good understanding of the level of effort required to read and understand the reports. In some cases it will be necessary to seek assistance from other NSF personnel or from external experts. Reading and understanding reports can be an extremely time-consuming process, and it is the responsibility of the Program Officer to balance the reporting requirements so that he or she receives the information required to conduct adequate oversight without overwhelming the Awardee or becoming overwhelmed. Consideration also needs to be given to Conflict of Interest rules and Privacy Act restrictions when distributing and sharing reports containing proprietary or confidential information.

- Performance Reviews. Through the terms and conditions of the Cooperative Agreement, the Program Officer can require the Awardee to organize regular reviews during which the Program Officer, along with the Project Advisory Team or other review personnel chosen by the Program Officer, assesses project progress and performance. Such a review may, for example, address:
 - Project cost;
 - Project schedule;
 - Project performance;
 - Procurement issues;
 - Safety, environmental and health issues;
 - System integration; commissioning, testing, acceptance and transition; and,
 - Plans for Operations & Maintenance.

- Independent Reviews. It is recognized that external peer reviews are a valuable means of assessing the status and health of a project. The Program Officer typically identifies the need for such a review and coordinates the review panel's membership. Careful consideration must be given to the selection of independent reviewers, and in all cases the skill sets of the reviewers must be matched to the type and kind of review to be conducted. Broad programmatic review panels charged with reviewing all aspects of a project will generally have representation from the academic and broader national/international research community and experts in administrative aspects of facilities/project management, whereas a review panel focusing on specific administrative or technical aspects of a project would have a different set of skills.

- Standard Reviews. The Program Officer uses standard review "templates" developed by other Federal agencies engaged in establishing and operating similar facilities (e.g., Department of Defense and Department of Energy). These well-defined review formats provide a broad outline against which the project can be compared and checklists that can be used to assess the status of the project. These reviews can be particularly helpful in the pre-award phase in ensuring that the project is ready to be implemented.

- Site Visits and On-Site Representation. Consideration is required to be given to the level of direct oversight required by the Program Officer. At a minimum, the Program Officer must conduct on-site reviews of all aspects of the project on an annual basis. Most of NSF's projects in the past have conducted quarterly reviews, and a good number do this on a monthly basis. In some cases, such as large construction activities or projects in which NSF reviews and approves technical changes, it may be necessary to have personnel – either NSF staff or contractor staff – on-site to oversee the project.

Government Performance and Results Act

In accordance with Office of Management and Budget requirements, NSF developed goals to measure construction/upgrade and operations performance. Information related to these goals is collected from Awardees via the "Performance Data Reports" module of the FastLane Project Reports system.

Performance reports are currently required from all NSF-supported facilities undergoing construction/upgrade costing over \$5 million total and from facilities that receive more than \$1 million per year in operations support. Each year, NSF uses the lessons learned from previous years to determine whether its facilities goals need to be refined. The following goals are in effect for FY 2003 GPRA Reporting:

Table 7. GPRF Facilities Performance Goals for FY 2003

Activity	Performance Goal
CONSTRUCTION/UPGRADE	For ninety percent of <u>construction, acquisition and upgrade projects</u> , keep any negative cost and schedule variances to less than 10% of the approved “annual” expenditure plan.
	For ninety percent of <u>completed construction, acquisition and upgrade projects</u> , keep any negative cost and schedule variances to less than 10% of the approved “project” expenditure plan.
OPERATIONS	For ninety percent of operational facilities, keep <u>scheduled operating time lost</u> to less than 10%.

F. Partnerships

For projects on the scale of MREFC projects, partnerships are an essential consideration at the outset of project inception. Partnerships may take many forms, but typically include counterpart funding from U.S. states or state institutions, other federal agencies, and foreign funding agencies. While considerations regarding partnerships are discussed in a number of sections within this Guide, here the central focus is on how NSF manages projects when partnerships are involved. Below, international partnerships are discussed, generally the most complex. The key issues are thus cast in terms of foreign partnerships, but apply to other agency and state partnerships as well, changed only in emphasis.

The first of these issues is ‘**culture shock**’. The science or engineering culture in different countries will generally exhibit great variations in procedures when it comes to funding, managing and overseeing, constructing, and operating a facility. Differences include lack of understanding of the role and function of project management. Each nation cannot run/manage its part of the project without close connection and oversight on the part of the central Project Manager. The Project Manager must be in place before funds are released and, to be most effective, must be given budget authority (or authority over in-kind resources), not simply act as a coordinator. In terms of oversight, reviews of project status by U.S. agencies are not universally accepted. U.S. agencies use reviews heavily, but not all countries do. Full project transparency is essential to project success. In some countries, reviews that uncover problems may be received without a sense of urgency and may not be acted upon quickly. U.S. partner agencies may be able to insist upon resolution of issues when playing a majority role in funding, but when it can’t, other steps must be taken.

The second consideration is to **start negotiating with international partners early** in project planning. This point is made often in the previous chapters. There is a need to start with a clear understanding by all partners as to how the project is to be managed and, later, the facility operated. It is also important to know how agencies in different countries view the project, i.e., shared goals, including the science or engineering case for the project and its priority. If countries both rate the priority of a project at the highest level, then commitments carry more weight. Funding risks associated with international partnerships must be assessed and contingency plans developed regarding potential changes in commitment. Finally, early negotiation also provides a means to establish and maintain regular agency-to-agency contacts, providing an early understanding of funding pressures and other emerging pressures

in each country. The NSF Office of International Science and Engineering must be advised of potential international partnerships early in the process.

Funding of projects involving partnerships is obviously a central consideration. International partner agencies need to understand the *funding process* in the different countries involved. Ours is complex. This can lead to misunderstandings regarding the schedule of funding and project approvals. Then, because of the great variation among countries as to how labor costs are counted, it is good practice to adopt standard costing techniques for equipment, labor, commissioning, and operations of a facility. Memoranda of Understanding¹⁶ (MOUs) need to be developed, detailing the foreign contributions. In some cases this may be cash or in-kind level of effort, but, deliverables must be specified. As with all such projects, *contingency funds* (or equivalent) need to be identified by all partners. In this regard, there is great variation in practice among countries, again because labor costs may or may not be included in contributions to the project. This can have a great impact on the project, when, for example, it may be expeditious in a cost overrun situation to simply stretch the project out. This may work for one country, resulting in less focus on schedule issues, but generally does not work for U.S. projects where ‘standing army’ costs are real. Also, when partner funding is in cash, variations in exchange rate can have a big effect on the ability of a given country to meet their commitment on deliverables. Therefore, scope contingencies need to be explored. When international partners do not include adequate contingency, and the U.S. does, funding ‘caps’, agreed upon in advance, are an appropriate policy. While caps may enforce discipline, there is, however, at least one important implication to understand. When there are schedule slips and ‘standing army’ costs go up, this will limit the deliverables that may be provided. Strict adherence to caps may therefore compromise the overall S&E performance goals.

Lastly, with respect to **project management**, there are a number of important considerations to explore. The project management plan and how the project is to be run need to be understood well by all partners, for a number of reasons. When different countries have responsibilities for separate subsystems, strong system integration and comprehensive interface documents become very important. The change control process needs to be well understood. Change control is made very complex because performers in one country may be ill equipped to handle or adapt to required changes. It is also very important to establish a sound schedule baseline and adhere to it. Schedule pressures are less important in countries where labor costs are not counted against project cost, but in other countries facing ‘standing army’ pressures, measuring cost and schedule performance and developing means to staying on schedule are essential.

There are many factors that make international partnerships complex, but the benefits far outweigh these complexities. Individual countries and individual agencies can no longer afford to ‘go it alone’ in funding the construction and operations of large cutting edge facilities. Not only that, there are enormous educational benefits associated with large international projects. Program Officers should explore opportunities to exploit international projects for such broader benefits. Generally, other countries share these goals.

G. Operating Budgets

It is incumbent upon NSF to provide adequate support for the effective utilization of Large Facility Projects undertaken. This includes support for operations and maintenance of the facility, and for support of end users of such facilities. These points are made throughout this document. Given funding constraints, a proper balance must be struck between support for users of facilities and the facilities themselves. In many cases, such support extends to in-house users of the facilities.

¹⁶ See Chapter III, section A for details regarding the content of MOUs.

When to start the process: In order to prepare for the operating phase of a large facility or infrastructure project, it is essential to begin in the concept stage to establish what funding is needed for operations. The choice of technology may impact this funding level, and the project design must be optimized with operating cost being a key element. At the end of the development stage, the project baseline performance and scope is defined, and it is at that time that the Awardee must provide solid, reviewable estimates of operating costs. This may be done in a number of ways. In the case for which similar but smaller-scale facilities have been built and operated, one may start by scaling those operating costs appropriately. In the end, it is up to the Awardee to put together an accurate, ‘bottom-up’ estimate, identifying the individual technical and administrative staff needed.

What does operating entail? Certainly salary costs are the major factor: professionals and technicians to operate and maintain the facility; IT specialists; administrative and grounds staff; environmental, health, and safety specialists; machinists, designers, engineers, and software experts to support users; engineers/scientists to conduct R&D for continuous improvement to the facility and related instrumentation; liaison staff to interface with the community; project management specialists for on-going projects; financial and budget specialists; and staff to meet reporting requirements, are but a few examples. Power costs must be considered. Expendables (cryogenics, gases, etc.) must be considered. Spare parts and ancillary equipment such as refrigerators must be considered. Information technology needs must also be carefully evaluated. An assessment needs to be made of emerging IT technologies, such as grid-computing, to ensure that the research community has what it needs to make best use of the data and to assume leadership roles in the field. Initial IT capital costs and the cost of software development need to be carefully evaluated¹⁷. Furthermore, informed estimates regarding the small and mid-scale instrumentation needs of the facility and users of the facility must be made. Lastly, because of the time scale to complete large facility project construction, one must be careful to include appropriate inflation factors.

Estimating Costs: While many rules of thumb exist for operating costs, they are generally not accurate at the level NSF needs to understand in order to plan appropriately and identify the funding sources. Realistic, detailed planning at the level of individuals needs to be undertaken. Rough scaling rules and rules of thumb may be used to provide a reality check on estimates, and bottom-up methodology may be used on other existing facilities to calibrate the approach.

Planning and Reviewing: The NSF Internal Management Plan must identify the source(s) of funding for operations, with appropriate commitments. In some cases, turnover in support of operations at existing facilities serving the same community may be redirected and provide an offset in operating costs. The Plan must also discuss how the project is to be reviewed. How are operating costs estimates to be reviewed? Experienced directors of other facilities, not necessarily all from the same community that the proposed facility serves, should be used in a comprehensive review process to verify these estimates and projections. Users should also be part of the review process. The peer community, which will be impacted by funding decisions on operations, must be part of the review process.

Operating cost information and a careful exploration and evaluation in the review process are essential inputs to informed understanding on the parts of Division Directors, Assistant Directors, the NSF Director, and the NSB, and for obtaining approvals. These inputs also serve the NSF budgeting process by providing OMB and the Congress with insights regarding future operating costs.

¹⁷ While specific computing costs generally drop with time (Moore’s Law), the data volume is increasing at least as fast, and greater and greater bandwidth is required for the transmission of data to remote users. As a result, the time frame for IT upgrades/turnover is in the 3-4 year time frame.

Appendix 1. List of MREFC Projects and other Large Facility Projects

Below is a list of the past and current MRE or, now, MREFC projects, along with the lead directorate, construction status, and NSF construction cost. The processes described in this Guide are derived, in part, from experiences learned during the management of these projects. Note that the MRE(FC) budget account was established in FY 1995. Prior to that time large construction/acquisition projects were funded through the R&RA account. Several projects listed below (NHMFL, LIGO, GBT, and Gemini) were begun prior to FY 1995, but are listed here as examples of other large projects that NSF has undertaken.

For a number of the below-listed projects, significant funding is or has been provided by partner U.S. agencies and states, or by foreign governments. This is the case for Gemini, NHMFL, LHC, ALMA, and IceCube. In the case of LHC, partner funding dominates.

Project	Directorate and Division	Construction Funding Status	Construction Cost (\$M)
Gemini [twin] 8-Meter Optical/Infrared Telescopes	MPS/AST	Complete	88.0
Green Bank [Radio] Telescope (GBT)	MPS/AST	Complete	74.5
Laser Interferometer Gravitational-wave Observatory (LIGO)	MPS/PHY	Complete	271.9
National High Magnetic Field Laboratory (NHMFL)	MPS/DMR	Complete	147.5 ¹
South Pole Station Modernization (SPSM)	OPP	Underway	133.44
South Pole Safety Project	OPP	Complete	25.5
Polar Support Aircraft Upgrades	OPP	Underway	32.9
High-performance Instrumented Airborne Platform for Environmental Research (HIAPER)	GEO	Underway	137.5
Large Hadron Collider (LHC)	MPS/PHY	Underway	80.9
Network for Earthquake Engineering Simulations (NEES)	ENG	Underway	81.8
Atacama Large Millimeter Array (ALMA) R&D	MPS/AST	Underway	32.0
ALMA Construction	“	Underway	344.1
IceCube Phase I	OPP	Underway	15.0
Terascale Computing	CISE	Underway	135.9

¹ NHMFL funding includes development, construction, and some operations over a 10-year period, roughly equivalent to MREFC project development, construction, and commissioning.

Glossary

Baseline: original plan for a project or activity; used in particular with project cost, schedule, or scope (or performance), as in the project's *baseline cost*.

Baseline Project Definition: the project cost, project schedule, and project scope, including a list of technical project deliverables and capabilities (see Project Scope).

Change Control: monitoring changes to cost and schedule; process and procedure oriented; refers major changes to a committee of stakeholders, sometimes referred to as a *Change Control Board*.

Contingency: possible future occurrence or outcome associated with presently known causes, the cost impact of which cannot be determined accurately.

Configuration control: maintaining higher-level project baseline definition, and monitoring and controlling changes to the baseline.

Cooperative Agreement: the legal instrument of an award made by the NSF for the purpose here of constructing or acquiring a facility; the Cooperative Agreement contains a statement of work and terms and conditions of the award, including responsibilities of the NSF and the awardee, and signed by the awardee.

Cost Sharing: cash or in-kind contribution of awardee institution to a project, either statutory, voluntary, or required by the terms of the solicitation, if any.

Cost Variance: deviation of project cost from the planned cost; monitored throughout project to recognized problems in time to correct them or estimate additional funding needs. (See Earned Value.)

Deliverables: specific products or activities that the awardee has responsibility to deliver in a timely fashion, once the award is made.

Deputy Director, Large Facility Projects (LFP Deputy): advises Program Officers on project management issues, monitors business operations of large facility projects, ensures consistent representation on Project Advisory Teams, chairs and convenes the Facilities Panel, and is consulted for all policy matters involving facilities, including responses to inquiries by NSF management, the Office of the Inspector General, OMB, and the NSB.

Director's Review Board (DRB): composed of NSF Deputy Director, three Assistant Directors/Office Heads serving on a rotating basis, the NSB Executive Officer, the Chief Financial Officer, a staff advisor from the Office of the Director, and the DRB Executive Secretary, reviews all projects proposed to the National Science Board for funding.

Earned Value (EV): a project management term used to describe costs of tasks within a project; earned value is the budgeted cost of the work performed, as measured against the budgeted cost of the work scheduled (or planned value [PV]) or as measured against the actual cost of the work performed [AC]; cost variances [EV-AC] measure the cost performance of the project relative to planned costs; schedule variances [EV-PV] are a measure of schedule performance relative to the planned schedule. Negative variances indicate project is over budget or behind schedule.

Facility: shared use infrastructure, instrumentation, or equipment that is accessible to a broad community of researchers for the conduct of research and education.

Facility Lifecycle: the phases of a project – concept development (or initiation), development (or planning), implementation (construction or acquisition), operation and maintenance, and renewal, upgrade, or termination.

Facility Panel: internal NSF Panel to advise or assist NSF Program Officers on issues project planning, management, and oversight; membership includes three experienced programmatic and three experienced business operations personnel.

Internal Management Plan: internal NSF plan containing: the project justification, feasibility, R&D needed, funding needed (for R&D, implementation, and operations), proposal generation and review process, the awardee's project execution plan, project organizational structure, internal and external partners, review and oversight process, plan for transitioning from implementation to operations.

Maintenance: systematic upkeep of a facility to maintain its full operating capability with minimal downtime

Memorandum of Understanding: an agreement between one institution and another, signed by both, in which one institution agrees to provide agreed-upon deliverables to the project on an agreed-upon schedule, with any associated funding arrangement between the two institutions, or arrangement to supply any other resources, described in detail, including any and all commitments and all terms and conditions.

MREFC (for Major Research Equipment and Facility Construction): NSF congressional budget line item; funding used for purpose of constructing large facilities.

MREFC Panel: consisting of NSF Deputy Director, and Assistant Directors/Office Heads, reviews projects submitted by directorates or offices for consideration for MREFC funding, and advises the NSF Director concerning importance, eligibility, and readiness.

Operations: the stage of a project following implementation (e.g., construction or acquisition, commissioning, and acceptance) in which the facility provides the intended research deliverable (access time, viewing time, beam time, ...)

Partnerships and Partners: other funding agencies involved in a project; may be other U.S. federal agency or state partnerships, or funding agencies in other countries; may involve multiple agencies and countries, as well.

Project Advisory Team (PAT): advises the Program Officer responsible for the project on project issues; membership includes staff from BFA/DGA, BFA/CPO, OGC, OLPA, INT, other technical staff (as appropriate), and the Large Facility Projects Deputy (within BFA) or designee; meetings held periodically throughout the project.

Project Director: awardee-designated person responsible for executing and controlling the project in accordance with the Project Execution Plan.

Project Manager: awardee-designated person responsible for managing the project; in some cases the Project Manager is also the Project Director; in some cases the awardee designates a Project Manager to manage the day-to-day engineering or technical aspects of the project, while the Project Director has overall responsibility for the project.

Project Execution Plan (PEP): awardee's plan to construct or acquire the facility, equipment, or other infrastructure, covering: project organization and management structure; baseline project definition; WBS; risk assessment and management; contingency management; configuration management and change control; quality assurance and quality control; safety, environmental, and health issues; financial and business operations controls; system integration, commissioning, and acceptance; and plan for transitioning from implementation to operations.

Property: physical assets that are developed by the awardee as part of the project implementation, the title for which either is held or will be held by the NSF.

Risk or Project Risk: probability of uncertain occurrences that may impact a project negatively in cost, in performance, or in schedule.

Schedule Variance: deviation of project schedule from the planned schedule; monitored to recognized problems in time to correct them (e.g., add people or funding) or change expectations regarding scheduled completion. (See Earned Value.)

Scope or Project Scope: project capabilities regarding technical performance, user access, user throughput, or other responsibility to end users; should be matched to the scientific need and the intended user community; scope may be revised ('de-scoping') during project to reflect changes in available funding, unanticipated costs, unanticipated technical problems, or unanticipated technical limitations.

Statement of Work: tasks to be carried out by the awardee under terms of the Cooperative Agreement.

Work Breakdown Structure (WBS): a hierarchically structured grouping of tasks associated with a project, starting at the highest or most encompassing level of definition, and extending down to the most detailed or specific level of activity. Each descending level of detail provides a more detailed description of the previous level, extending down to the lowest level, or *work package level*.

Key-Word Index

Baseline 7,25-26,30-31,41,48,52,55(df)
Baseline Project Definition (or Project Definition) 25-26,30-32,39,41,44,48,55(df)
Change Control 27,52,55(df)
Change Control Board 32,55(df)
Contingency 15,24-27,29,31-32,41,43-44,46,48-49,51-52,55(df)
Configuration Control 55(df)
Cooperative Agreement 8,14-15,17-19,23,29-30,32-36,40,49-50,55(df)
Cost Sharing 12,22,23,55(df)
Cost Variance (see Variances)
Deliverables 26,52,55(df)
Deputy Director, Large Facilities Projects (LFP Deputy) 4-5,12-14,16-17,19,28-29,32,34,40-41,55(df)
Director's Review Board (DRB) 5,12-15,17,28,34,55(df)
Earned Value (EV) 30-31,55(df)
Facility 3-5,12,55(df)
Facility Lifecycle 7,9,14,20,23,40,43-45,48,55(df)
See also:
 Concept 4,6-7,9-10,12-15,18,20,23-24,27,40-41,43-45,53
 Development 3,11-12,15,18,20,22,25,27,29,32,36,40,44-45,48-49,53-54
 Implementation 4-7,11-12,17-19,24-25,28-31,35,39-40,43,48,55(df)
 Operation and maintenance 6,12,17-18,24,28,30,33,35-37,40,42-43,46,48,50
 Renewal, upgrade, or termination 3,6-7,12,17-18,24,37,39,40,43,47,53
Facility Panel 5,9,12,17,55(df)
Information Technology (IT) 53
Internal Management Plan 4-5,12-15,17,19,27(full description),-28-30,35,37,44,48-49,53,55(df)
Memorandum of Understanding (also Memoranda of Understanding and MOU)
 7,12,22,24,26,28,32,34,36,48,52,56(df)
MREFC (Major Research Equipment and Facility Construction) 3,5,9-13,15-16,18,23,25,29,33,40-41,43,51,54,56(df)
MREFC Panel 4-5,9-13,15,25,30-31,40,43,56(df)
Partnerships (also Partners) 3,7-10,12-13,15-16,20-25,27-29,34,36,40-46,48,51-52,56(df)
Project Advisory Team (PAT) 4,9,12-14,32,34,41,50,56(df)
Project Definition (see Baseline Project Definition)
Project Director 8,14,19,26-27,30-32,56(df)
Project Manager 32,51,56(df)
Project Execution Plan (or PEP) 4,5,7,12,14-15,17,25,30,32-33,44,49,56(df)
Property 16-17,29,56(df)
Risk or Project Risk 4-5,7,9,17,19,22,28,36,44-45,56(df)
Schedule Variance (see Variances)
Scope (or project scope) 12,14-15,18,21-22,26,29,32,34,41,44-45,52-53,56(df)
Statement of Work (see also Cooperative Agreement) -29
Variances (Cost or Schedule) 19,34,44,49,51,55-56(df)
Work Breakdown Structure (WBS) 7,25-26,56(df)