Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account

November 22, 2005

Table of Contents

INTRODUCTION

DEFINITION OF MREFC ACCOUNT

ELIGIBILITY FOR MREFC FUNDING

NSF ROLES AND RESPONSIBILITIES

THE MREFC PROCESS
- Conceptual Design Stage
- Preliminary Design/Readiness Stage
- NSB Approved/Final Design Stage
- Construction Stage
- Commissioning Stage
- Operation Stage
- Renewal/Termination Stage

APPENDICES
1. NSF Roles and Responsibilities
2. MREFC Panel Schedule
3. Ranking Criteria For Prioritizing MREFC Projects
4. Project Management Components of a Construction-Ready Project Execution Plan
5. NSF Facility Plan Description
6. Other Documentation Relevant to Review of MREFC Projects
7. References

Guidelines for Planning and Managing the Major Research Equipment and Facilities Construction (MREFC) Account

The purpose of this document is to clearly define the MREFC Account, including the policies, processes, and requirements by which candidate projects are identified, developed, prioritized, and selected for funding. *A companion document, the Facilities Management & Oversight Guide (July 2003), is currently under revision. When completed, it will incorporate this document, as well as several stand-alone modules that address special topics, such as risk management, use of contingency resources, and roles and responsibilities of NSF staff.*[1]

INTRODUCTION

To maintain the stunning pace of research, many researchers and entire fields of science and engineering depend upon the development of new and powerful tools. Identifying and funding the kind of tools that will truly transform research in science and engineering is an essential part of the National Science Foundation's (NSF) mission. During the past half-century, unique tools provided by NSF have enabled scores of unprecedented discoveries and remarkable innovations.

As described in NSF's Strategic Plan[2], NSF investments provide state-of-the art tools for research and education, such as laboratory and field instrumentation and equipment, multi-user research facilities, distributed instrumentation networks and arrays, and mobile research platforms. In addition, investment is increasing in highly sophisticated information technology-based infrastructure, including distributed sensor networks, vast data-storage and transmission capabilities, advanced computing resources, and Internet-based distributed user facilities.[3]

A subset of the NSF investment in tools is funded through the Major Research Equipment and Facilities Construction (MREFC) Account.

DEFINITION OF MREFC ACCOUNT

The MREFC Account is an agency-wide account. It provides funding for the establishment of major science and engineering infrastructure, with total construction costs ranging from several tens to hundreds of millions of dollars. With Congressional approval, NSF established this appropriations account in FY 1995 to promote effective planning and management for the support of such sizable investments made over a limited period of time. Specifically, the Account was intended to:

- Provide a special account to fund acquisition, construction and commissioning of major facilities and other infrastructure projects;
- Prevent large periodic obligations from distorting the budgets of NSF directorates and program offices;

---

[1] Since the revised *Facilities Management & Oversight Guide* is expected to take longer to develop, this document is being published separately to provide early guidance to NSF staff and the S&E community.
[2] National Science Foundation Strategic Plan: FY 2003 – 2008, p18. http://www.nsf.gov/od/gpra/
[3] These resources, many of which are now in development, are collectively known as "cyberinfrastructure".

- Ensure availability of resources to complete large projects that are funded over several years;[4] and
- Provide uniform NSF standards for large facility projects that ensure accountability and maximize success.

The MREFC Account supports state-of-the-art tools that are centralized in nature, integrated systems of leading-edge instruments, and/or shared-use networked infrastructure in advancing one or more fields of scientific study. Examples include accelerators, telescopes, research vessels, aircraft, earthquake simulators, networked high-tech research platforms, and advanced computing resources. To qualify for MREFC investment, networked infrastructure must exhibit systems characteristics greater than inferred simply by the connectivity of its parts.

The MREFC Account is used to support the acquisition, construction and commissioning of a facility.[5] Other activities, including research, design, development, and operations costs, will be covered under the R&RA and/or EHR appropriations accounts. When funds from these separate appropriations are obligated under a single award, there should be included provisions that specify the appropriations account under which the expenditures are to be charged and restrict any reprogramming of such funds by the awardee.

ELIGIBILITY FOR MREFC FUNDING

To be eligible for consideration for MREFC funding, each candidate project must represent an outstanding opportunity to enable research and innovation, as well as education and broader societal impacts. Each project should offer the possibility of transformative knowledge and the potential to shift existing paradigms in scientific understanding, engineering processes, and/or infrastructure technology. Moreover, each must serve an urgent contemporary research and education need that will persist for years, much greater than the often lengthy process of planning and development.

In addition a candidate project must:

- Be consistent with the goals, strategies and priorities of the NSF Strategic Plan;
- Establish a long-term tools capability that is accessible to an appropriately broad community of users on the basis of merit;
- Require large investments for construction/acquisition, over a limited period of time, such that the project cannot be supported within one or more NSF

<u>Eligibility Rule:</u> The total cost of construction and/or acquisition of a proposed MREFC project should represent an investment greater than <u>ten percent</u> of the Originating Organization(s)' current plan, adjusted to exclude activities (such as SBIR and SRS) that cannot be reasonably expected to contribute to or benefit from the development of the facility.

[4] Reliable long-term funding commitments are essential to maintaining partnerships and for preventing cost overruns due to schedule delays.
[5] In some cases, MREFC funds may be used to support development after construction of a facility begins.

Directorate(s)/Office(s) without severe distortion to the funding of its portfolio of activities;

- Have received strong endorsement of the appropriate science and engineering communities, based upon a thorough external review, including an assessment of (1) scientific and engineering research merit; (2) broader societal impacts; (3) importance and priority within the relevant S&E communities; (4) technical and engineering feasibility; and (5) management, cost, and schedule issues;

- Be of sufficient importance that the Originating Organization[6] is prepared to fully fund the costs of pre-construction planning, design and development, operation and maintenance and associated programmatic activities (remembering that ultimately, for a long-lived facility, the operations costs may amount to many times the construction costs); and

- Have been coordinated with other organizations, agencies and countries to ensure complementarity and integration of objectives and potential opportunities for collaboration and cost-sharing.

NSF ROLES AND RESPONSIBILITIES

Appendix 1 describes the NSF organizations and officers that are involved throughout the conception, development, approval and implementation of an MREFC project. Readers not familiar with NSF and its processes should review this material before proceeding.

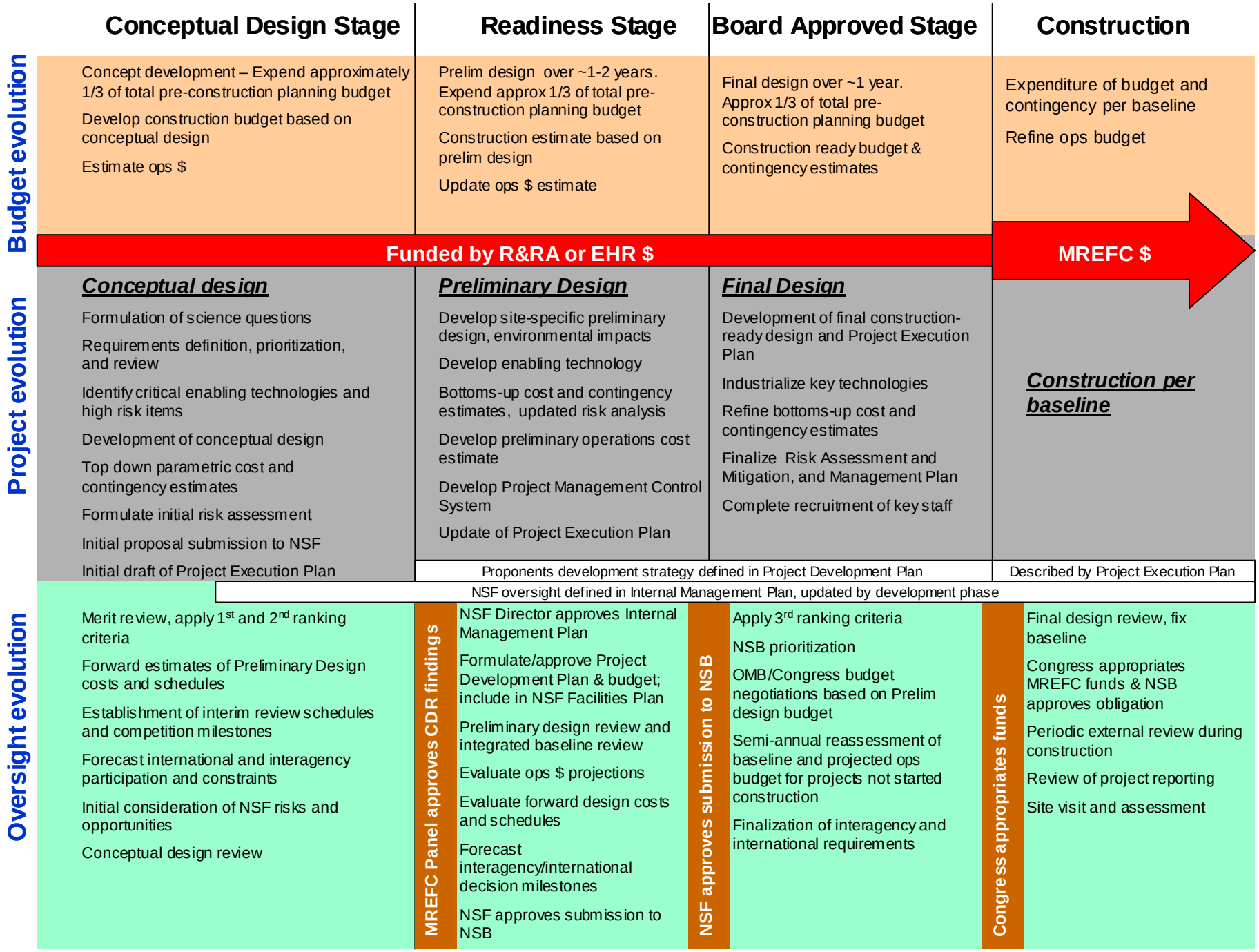
THE MREFC PROCESS

As the diagram on the next page (Figure 1) indicates, pre-construction planning and development for MREFC candidate projects progresses through a sequence of steps of increasing investment, planning, assessment, and oversight. These steps, or stages, coordinate the technical evolution of the project with the planning required by NSF to make the budgets for further planning and eventual construction available.

These stages are described below in terms of the development of the project and the review and approval needed to obtain NSF funding, and the development of the NSF budgets that support these activities. Entry and exit from each stage are clearly defined including required documents and deliverables. In the early stages of a project, there must be sufficient NSF investment so that the project is well defined when proposed by NSF for construction funding. Careful planning minimizes the risk of significant alterations to the initial budget, scope, and schedule after the National Science Board (NSB or "Board") approves the project for inclusion in a future NSF budget request.

[6] See Appendix 1 for definition.

Figure 1: *Summary of the pre-construction planning and development process for candidate MREFC projects.*



As in all NSF endeavors, inquiry begins with the research communities, which alert program staff to the most promising and exciting topics and the most important equipment needed to explore them. Currently NSF utilizes National Academy studies, community workshop reports, professional society activities, Directorate advisory committees, and many other methods to ensure community input to this process. NSF program officers are always alert for breakthrough concepts and actively encourage continued thinking and planning. These ideas and opportunities identified by the research communities typically have a 5 to 20 year forward look.

Conceptual Design Stage

The goal of the conceptual design stage is to develop the ideas that motivate a future large research facility to a level of maturity where NSF can consider together:

- Definition and relative prioritization of the research objectives and science questions that the proposed facility will address;
- Description of the research infrastructure needed to meet the science objectives
- System level design, including definition of all functional requirements and major systems;
- Site-independent design;
- Budget and contingency estimates appropriate to a Conceptual Design[7];
- Initial concept for a construction and commissioning schedule;
- Initial risk analysis and mitigation strategy for construction; including identify enabling technologies and high risk or long lead items;
- Potential environmental and safety impacts, to be considered in site selection;
- Description of the scope of work, budget, and schedule needed to continue planning the project to bring it to preliminary design;
- Plan for project management, including description of possibilities for international and interagency partnering; and
- Initial estimate of annual operations and maintenance funding that will be needed if facility is constructed and operated.

Conceptual Design Stage Activities

Early in this stage, NSF and/or other institutions begin to invest research and development funds in conceptual development and design, and in efforts that promote community building and planning. Typically this investment is about one-third of the total pre-construction planning budget, but this can vary.[8] The total pre-construction investment in research, planning and development may range from five to twenty-five percent of the total construction cost, depending on the complexity of the project, and are typically of the order of ten percent of the amount expended for actual construction. The technology needed to construct a facility may be uncertain, unproven or immature. This may require substantial R&D over a period of years. On

[7] The budget information should be provided using a Work Breakdown Structure (WBS) format, identify the basis for estimate, and include a WBS dictionary that defines the scope associated with each WBS element. Contingency estimates should include an explanation of the methodology used to calculate the estimate.

[8] Some projects come to NSF very well developed, requiring little in the way of conceptual design stage support. Such projects are subjected to rigorous scrutiny as they are developed by the responsible NSF Directorates of Offices.

the basis of unsolicited and/or solicited proposals, NSF will fund the planning and early development efforts of particularly promising concepts. [9] These efforts include workshops in one or more disciplines, National Academies' studies, and research projects related to the development of new technologies.[10]

Also early in this stage, an NSF Program Officer should be assigned to be the primary point of contact. The Program Officer maintains close contact with the research community to ensure that NSF reacts appropriately to community needs. At the earliest opportunity, the Program Officer should organize a Project Advisory Team (PAT)[11] to provide advice and counsel implementing developmental oversight.

Proponents of projects are urged, at the earliest point possible, to provide NSF with notional plans for executing envisioned projects through normal NSF strategic and implementation planning processes and documents. The plans[12] should address, even if only in the most cursory way, each of the essential elements that must be realized in a formal construction plan. These earliest plans identify, to the proponents as well as to NSF, not only what is known at this point in project development, but what tasks remain to be accomplished in order for NSF to consider them for eventual funding. In the near term, they also define what work must be done to develop a project proposal to the Conceptual Design level of maturity.

In response to the development of an early version of a Project Execution Plan, the Program Officer, with the advice of the PAT, develops an Internal Management Plan[13] (IMP). This internal document specifies how NSF will conduct management and oversight of a project, and provides budgetary estimates for developing, constructing, and operating the facility. It also identifies termination liabilities, and lays out a strategy for financing these activities as well as the concomitant NSF oversight requirements. The Program Officer develops the IMP with advice and assistance from the Deputy Director for Large Facility Projects (DDLFP), the Project Advisory Team, including the Contracting Officer or Agreements Officer, and other NSF staff. The IMP is formally reviewed by the Facilities Panel, which is chaired by the DDLFP, and which includes other members experienced in the technical and administrative aspects of large project oversight. The IMP, which may be brought to the MREFC Panel for discussion and recommendations, describes the plan for NSF funding the project to Conceptual Design Review (CDR), proposes transitional steps to be taken if the project is admitted to the Preliminary Design/Readiness Stage, and lays out NSF's plan to apply oversight to the development of the project through CDR and internal review.

---

[9] Future issues of the Grant Proposal Guide and the Guide to Programs will announce that funds are available for these planning and development efforts.

[10] NSF encourages disciplinary and interdisciplinary science planning by all of the research communities that NSF supports. In particular, NSF encourages formal planning in fields in which scientists and engineers have traditionally not been organized to identify MREFC projects needed for breakthrough advances.

[11] See Appendix 1 for a complete description of the Project Advisory Team. See also "Roles and Responsibilities of NSF Staff Involved in the Management and Oversight of Large Facilities".

[12] Appendix 4 describes the most common elements of a Project Execution Plan.

[13] See the "Guidelines for Development of Internal Management Plans for Large Facilities" on the internal NSF website for a full description of the IMP and what is included within it.

Exit from the Conceptual Design Stage

The requirements necessary to advance to the subsequent Preliminary Design/Readiness Stage include the following:

Successful Review of a Proposal: The conceptual design, along with analyses of how the design satisfies science requirements, and supporting infrastructure description, management plan, budget and contingency estimates, risk analysis, potential environmental impacts, description of partnering opportunities, etc. should be contained in a proposal submitted to NSF.[14] As in the initial "notional plan" first transmitted to NSF, every topic contained in a full construction proposal should be addressed at the completion of Conceptual Design, even if only to identify what is not known at this point in project development.[15] NSF will subject the proposal to external merit review, applying the first ranking criteria[16] as well as NSF's standard merit review criteria.

At a minimum, the following components of a Project Execution Plan should be included within the proposal as essential elements to be considered before a candidate project can advance to the Preliminary Design/Readiness Stage:

- Definition and relative prioritization of the research objectives and science questions that the proposed facility will address;
- Description of the research infrastructure needed to meet the science objective;
- System level, site independent design, including definition of all functional requirements and major systems;
- Analysis of technical feasibility;
- Budget and contingency estimates appropriate to a Conceptual Design[17] level of detail. The budget should be presented in a Work Breakdown Structure[18] (WBS) format and include a WBS dictionary describing the intended scope of each WBS element and the basis for each estimate. Contingency budgeting, also presented in a WBS format, should result from an initial risk analysis of each WBS element. The risk analysis methodology should be described.
- Initial estimates of the budget required for future operation of the proposed facility;
- Description of the scope of work, budget, and schedule needed to continue planning the project to arrive at a preliminary design. This plan should include the proponents'

[14] Typically, unsolicited proposals are submitted to NSF but on rare occasions NSF may request proposals from the community by issuing a formal solicitation or RFP.

[15] Components of a construction-ready Project Execution Plan, which should be fully completed by the time a final design is reached, are provided in appendix 4.

[16] See Appendix 3 for a description of the ranking criteria.

[17] The budget information should be provided using a Work Breakdown Structure (WBS) format, identify the basis for estimate, and include a WBS dictionary that defines the scope associated with each WBS element. Contingency estimates should include an explanation of the methodology used to calculate the estimate.

[18] A 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 hierarchical framework that organizes and documents individual project components representing work to be accomplished, aggregating the smallest levels of detail into a unified project description. WBS integrates and relates all project work (cost, schedule and scope) and is used throughout the project management to identify and monitor project process. The project budget and contingency are defined by WBS element. A WBS dictionary describes the intended scope of each element, the basis of estimate for budget entries, and the methodology for calculating contingency for that element.

intended course of action, in the event the project advances to the Preliminary Design stage, to obtain and apply suitable project management expertise to direct the proposed design, development and construction planning activities.

Other topics that should be included, depending on the specific nature of the project, are:

- Description of work that must be done to establish technical feasibility, including description of high risk technologies;
- Identification of long lead time items that pace the development of the design or construction of the facility;
- Role of interagency or international partners in future planning and development and/or construction;
- Configuration management and change control during design evolution;
- Plans for system integration, commissioning, testing and acceptance of the facility;
- Plans for transitioning from construction and commissioning into operation;
- Liabilities at the end of facility life for site remediation, decontamination, etc. where appropriate;
- Environmental, safety, and health issues that may arise through all project phases;
- Quality assurance and quality control requirements and description of processes;

The following topics are helpful to NSF in its assessment of the project's suitability for advancement to the Preliminary Design/Readiness Stage:

- Initial concept for a construction and commissioning schedule;
- Initial risk analysis and mitigation strategy for construction;
- Potential environmental and safety impacts, to be considered in site selection;
- Anticipated funding profile and cash flow analysis during construction;
- Plan for project management during construction; and
- Initial estimate of annual operations and maintenance funding that will be needed if the facility is constructed and operated.

As indicated earlier, Project Execution Plan (PEP), comprised of the above topics and submitted with the Conceptual Design proposal, should contain every topic anticipated to be included in a complete construction-ready PEP. At this early stage of development, the PEP may contain little detail or might only acknowledge that the topic exists and remains to developed during the Preliminary or Final Design. This *pro forma* document serves to inform the NSF, as well as project proponents, of the scope of work to be completed during subsequent planning phases.

Review and Approval of the Conceptual Design: If these reviews indicate sufficient merit, NSF then conducts a Conceptual Design Review (CDR)[19], which may, as appropriate, involve external experts, consulting firms, and in-house expertise in the science, technology, and business communities to scrutinize and validate the supporting planning documents. The scope of this review includes assessment of the scientific, technical, and project management aspects of

[19] NSF uses the same definition of CDR as the research community proposing the facility, recognizing that there are discipline-specific differences in this definition. Generally, it is understood to mean a definition of the research questions that the facility is intended answer, the functional requirements of the proposed facility, definition of the major subsystems included in the facility, and a site-independent design with parametric cost and contingency estimates.

the proposal. The review is jointly organized and conducted by the NSF Program Officer and the DDLFP. At this point, the conceptual design baseline is likely to have significant uncertainties typical of a project at the conceptual design stage of maturity. Contingency estimates, representing work scope not yet defined but nevertheless essential to the completion of the project, will be a significant fraction of the total project budget estimate. Significant unknowns and uncertainties often remain to be addressed in more advanced stages of planning and development. However, the conceptual design, system requirements, supporting budget estimates, risk analysis, and forecasts of interagency and international partnerships should be detailed enough for NSF program officials to decide whether the project concept warrants further funding for development. Proposed budgets, contingency analyses, and risk estimates are presented in a Work Breakdown Structure[18] (WBS) format, supported by a WBS dictionary defining the intended scope of the individual elements.

Submission of a Project Development Plan (PDP): Projects that review successfully with respect to merit and Conceptual Design are invited by NSF to submit a Project Development Plan that describes in detail the work scope to be undertaken by the proponents to bring the project to a "Preliminary Design" level of maturity, along with the required budget and schedule for doing so.

Approval of an Updated Internal Management Plan (IMP): Concurrently, the Program Officer updates the IMP to describe plans for oversight, key decision points, and a budget plan for supporting this activity. The Program Officer also includes an internal analysis of development risks to the project in the IMP. In addition to technical, environmental, and programmatic risks, this includes analysis of partnering opportunities, competition from other programs, and other NSF-specific issues. "Not-to-exceed" cost guidance for construction and anticipated operating costs is defined by NSF as input to the development of the PDP and IMP. (At each subsequent stage in the MREFC process (at Preliminary Design and Final Design completion), the IMP is updated to define NSF's project-specific expectations for readiness – including budget, schedule, decision points, and not-to-exceed cost guidance that are determining factors in continued NSF support for the project.)

When a candidate MREFC project has undergone a successful review of the formal proposal, conceptual design, PDP and IMP, it may be considered for entry into the Preliminary Design/Readiness Stage. The Originating Organization(s) is required to submit a memorandum to the MREFC Panel recommending the project for support and explaining how it meets the requirements for MREFC funding and the following criteria:

- The project's science (research) program addresses one or more science objectives in the current NSF *Facility Plan*[21], clearly demonstrating a significant need for the project;

---

[20] A 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 hierarchical framework that organizes and documents individual project components representing work to be accomplished, aggregating the smallest levels of detail into a unified project description. WBS integrates and relates all project work (cost, schedule and scope) and is used throughout the project management to identify and monitor project process. The project budget and contingency are defined by WBS element. A WBS dictionary describes the intended scope of each element, the basis of estimate for budget entries, and the methodology for calculating contingency for that element.

[21] A complete description of the Facility Plan and its purposes is provided in Appendix 5.

- The project has been reviewed by the research community and by NSF, in consultation with Directorate Advisory Committees, and has been assigned a very high priority;[22]
- The project's CDR indicates that (1) the engineering design and construction plans are appropriately defined at the conceptual design level of project maturity and that the management plans and budget estimates for further planning and development, as well as constructing and operating the facility are reasonable; (2) the sponsoring Directorate endorses the IMP and PDP for further development to the Preliminary Design/Readiness Stage; (3) the technology to create the facility exists or can exist shortly to be used without excessive risk; (4) other risks to development are satisfactorily defined and minimized or otherwise addressed in the IMP and PDP[23] and (5) there are no better alternatives to the facility (i.e., with a better mix of cost and quality) that would address the science objectives in a timely manner.

Copies of the approved CDR, along with the IMP, PDP, and proposal merit review evaluations should accompany this memorandum. On the basis of this documentation, and discussions with NSF program staff, the MREFC Panel reviews candidate projects and recommends to the Director those projects that should move into the Preliminary Design/Readiness Stage.[24] The Director evaluates the Internal Management Plan to ensure that the resources NSF proposes to commit towards further development of the proposed project are adequately matched to the anticipated scope of work, risks, partnering possibilities, and other considerations related to further development. If satisfied, the Director personally approves the Preliminary Design Stage IMP and then decides which projects should move into this stage. These projects are then included in the annual *Facility Plan*, which is released annually in March. The NSB is asked to concur with the Director's decisions by approving the annual *Facility Plan*.

Preliminary Design/Readiness Stage

The Preliminary Design/Readiness Stage further develops concepts for large facility projects to a level of maturity where there is a crisp definition of the motivating research questions, a clearly defined site-specific scope of the intended facility, a PDP that addresses major anticipated risks in the completion of design and development activities and in the undertaking of construction, and a robust bottom-up budget estimate that can be brought forward, with high confidence, to the NSF Director, NSB, the Office of Management and Budget (OMB), and Congress for consideration for inclusion in a future NSF budget request. To satisfy these requirements, the project is developed to a Preliminary Design[25] level of maturity. Results of this development are

[22] Evaluation by NSF includes external merit review, using the NSF merit review criteria and the 1st ranking Criteria in Appendix 3 and evaluation by the MREFC Panel, using the 2nd ranking Criteria.

[23] This judgment is based upon information supplied by the Program Officer, the Originating Organization, and the DDLFP.

[24] When an Originating Organization(s) proposes more than one candidate project for consideration by the Panel within a two-year time frame, it should prioritize its slate of projects and provide a rationale for its recommendations to the Director.

[25] NSF utilizes the conventional definition of preliminary design as used by project managers; – a site specific design defining all major subsystems and their interconnections, a level of design completeness that allows final construction drawings to proceed, cost estimating based on construction bidding to proceed, and bottom-up estimates of cost and contingency. Preliminary design usually has a specific meaning within a particular industry or discipline, and NSF adopts that meaning most appropriate to each particular project, as defined in the Project Development Plan.

reflected in a revised and updated Project Execution Plan[26]. Components of the updated plan that deserve particular emphasis are:

- Refinement of the research objectives and priorities of the proposed facility;
- Update of the description of the required infrastructure, site-specific design, definition of interconnections of all major subsystems;
- Environmental assessments or Environmental Impact Statement (if necessary); a
- Bottom-up budget and contingency estimates, presented using a WBS structure and supported by a WBS dictionary defining the scope of individual elements;
- Updated construction schedule;
- Implementation of a Project Management Control System and inclusion within the preliminary design of resource loaded schedule;
- Updated risk analysis, including time dependent factors. The preliminary design budget will be the basis for the NSF budget request to Congress if the project successfully emerges from the Preliminary Design/Readiness phase. Costs and risks must be projected forward to the anticipated award date for construction funds;
- Demonstration that key technologies are feasible and can be industrialized if required;
- Definition of budget and schedule needed to go from preliminary design to final design (updated PDP);
- Plans for management of the project during construction, including preliminary partnership arrangements and international participation, oversight of major sub-awards and subcontracts, organizational structure, and management of change control[27]; and
- Estimates for future operating costs of the facility.

Preliminary Design/Readiness Stage Activities

During this stage the preliminary design is developed and refined. As the design and planning effort progresses, additional work scope is defined. Consequently, the budget uncertainty for the projected construction is much reduced relative to the conceptual design completed earlier, since budgeted contingency funds are re-allocated to defined WBS elements that result from this planning activity. (Additional planning and development during the final pre-construction design stage will result in further transfers of contingency budget to the detailed work scope.) Typically, about one third of the total pre-construction planning budget is expended achieving the preliminary baseline.

Off-ramps: Projects may be removed from the Preliminary Design/Readiness stage by the NSF Director due to insufficient priority over the long-term, failing to satisfy milestones or other criteria defined in the IMP/PDP, eclipse by other projects, collapse of major international agreements, extensive estimated or actual cost overruns, significant changes in schedule for development, unexpected technical challenges, changes in the research community that indicate eroding support for the project, or any other reason that the Director deems sufficiently well-founded. Specific reasons for removing an MREFC project from this stage will be made available to the public via the NSF Facility Plan.

[26] See Appendix 4.

[27] These plans are a preliminary version of the Project Execution Plan that defines how the project will conduct itself during the construction phase – see appendix 4.

Projects in this stage will be reviewed semi-annually by the MREFC Panel, based upon updated IMP and PDP documents, and the Program Officer's analysis of how the project has progressed. Interim reviews[28] during development will be conducted by NSF as described in the IMP. This stage culminates in a Preliminary Design Review (PDR), conducted by NSF, to ensure that all aspects of the project definition and planning are robust. The results of the PDR are reported by the MREFC Panel to the Director for decision on forwarding to the NSB.

Preliminary Design Review

NSF conducts a PDR, organized by the DDLFP in coordination with the Program Officer, to assess the robustness of the technical design and completeness of the budget and construction planning. The effectiveness of the project management through this stage of development is also scrutinized, as are project management plans for completion of the final design and eventual construction and operation of the proposed facility. The PDR may utilize, as appropriate, external experts, consultants, and outside firms to scrutinize the project's proposed plans and budgets. The PDR also examines the management structure and credentials of key staff to assure NSF that an appropriately skilled management organization is ready and capable to complete final design activities and execute the construction phase of the project.

At the same time as the PDR, the DDLFP, in coordination with the Program Officer, arranges an external non-advocate review (NAR), conducted to the same requirements as the PDR. The results of both the PDR and NAR are brought simultaneously to the MREFC panel for discussion The MREFC Panel evaluates the findings, conclusions, and recommendations from both reviews for consistency and examines areas where they may differ in their assessments. Once the project has completed the requirements of these reviews and any outstanding issues between them have been resolved, the MREFC Panel recommends to the Director that the project is ready for advancement to the Final Design Stage of development and is a candidate for National Science Board approval for inclusion in a future NSF budget request for construction funding.

Following the PDR, the NSF Program Officer updates the IMP to describe proposed plans for budgeting, oversight, and to finalize commitments from interagency and international partners during final design. The Program Officer directs the project's external proposers to update the PDP to lay out the work scope, budget, and schedule necessary to bring the project to Final Design. The completion of project planning and development, culminating in a Final Design, must be aligned with the expected time-scale for requesting and appropriating construction funds. The NSF Director is the coordinator for this critical planning activity, bringing projects forward for construction only if, in the Director's judgment, OMB and Congress are likely to approve the request and appropriation of funds within the time duration over which the Preliminary Design plans and cost estimate remain valid.

Exit from Preliminary Design/Readiness Stage

A candidate project exits from this stage and enters the Final Design/Board Approved stage after successful review by the MREFC Panel, and when the NSF Director subsequently recommends the proposed project to the NSB for approval to include in future year budget request. In order to

[28] Interim reviews are typically be held semi-annually. Exceptions to this, dictated by the needs of a particular project, are justified in the IMP.

be considered by the Director for this, the MREFC Panel and the Director must first be satisfied that the following conditions have been met:

- The Preliminary Design has been successfully reviewed internally and by an external panel of experts in order to obtain the best possible objective advice from authorities in the fields and disciplines utilized by the project;
- The DDLFP concurs that the Preliminary Design is reasonable and poses an acceptable level of risk, and anticipated costs for construction and operation are reasonably well known;
- The NSF Chief Financial Officer certifies that the Preliminary Design budget has been satisfactorily defined;
- The NSF Director is satisfied that external participation in all phases of the project (other agencies, international, private sector, etc.) is well planned;
- Updated IMP and PDP documents have been reviewed and approved by the Facilities Panel, the MREFC Panel, and the Director;
- Appropriate Project/Leadership management team is in place; and
- The MREFC Panel asserts that the proposed MREFC project, when compared to other proposed projects – whether within the same field, across related fields, or across different fields[29] – falls into the top priority grouping.

Based on its review of the information provided and discussions with program and project staff, the MREFC panel, chaired by the Deputy Director, and on the advice and recommendation of the DDLFP and the CFO, forward one or more projects in priority order to the Director, who makes the decision to forward to the NSB for approval. The rationale and criteria used for the selection and prioritization of these projects is clearly articulated in the Facility Plan.

NSB Approved/Final Design Stage

The goal of the NSB Approved/Final Design Stage is to meet the requirements necessary to advance the proposed project to the subsequent Construction Stage. Budgetary and administrative requirements for entry include NSF review and approval of the project's preliminary design as described in the Project Execution Plan and NSB approval to include the project in a future NSF budget request. Technical requirements include delivery of designs, specifications and work scopes that can now be placed for bid to industry, refined bottom-up cost estimates and contingency estimates, implementation of a Project Management Control System for project technical and financial status reporting, completion of recruitment of the complement of key staff and cost account managers needed to undertake construction of the project, industrialization of key technologies needed for construction, finalization of commitments with interagency and international partners, and submission to NSF of a Project Execution Plan[30] (PEP) for construction. Successful exit occurs when a final, construction-ready PEP has been completed, reviewed, and approved by NSF, and Congressional appropriation of MREFC funds occurs, based upon a specific budget request to Congress.

NSB Submission and Approval

[29] In making this determination, the second and third ranking criteria in Appendix 3 are judiciously applied.
[30] Further discussion of the PEP are found in the NSF document "Guidelines for developing Project Execution Plans" and summarized here in Appendix 4 and in the NSF's Facilities Management and Oversight Guide.

The Originating Organization(s) is responsible for preparing the documentation needed for the NSB to review and approve a proposed MREFC project for inclusion in a future budget request.[31] Prior to NSB submission, the Director's Review Board (DRB) reviews and approves the documentation supporting advancement of the project into the NSB Approved Stage, (such as prior stage reviews, committee evaluations, PDP evaluation, and reviewed proposal ratings) to ensure adherence to NSF processes and policies.

In considering projects for approval, the NSB reviews the PEP and IMP, and documented evaluations and reviews from the DDLFP, the MREFC Panel, the community and the relevant Directorate Advisory Committees. The NSB considers the following elements, applying primarily the third ranking criteria in Appendix 3, as appropriate:

- the research and science enabled by the proposed facility;
- construction plans together with their risk and readiness;
- budget justification for construction and operation of the facility;
- the likelihood that funding will be available in the next two or so years; and
- the priority of the project against one or several of the objectives in the *Facility Plan*.

Once the NSB has approved a project for future year funding, it specifies its priority among all projects in the Board approved stage.[32] If a project is not approved, or if an approved project's plans are no longer deemed to be clearly and fully construction ready, the NSB will remand that project back to the Preliminary Design/Readiness stage for further work. Projects should not languish in this stage; i.e., they are expected to be resubmitted to the NSB in the following year.

<u>Inclusion in an NSF Budget Request:</u> As part of the annual budget preparation, the Director will propose funding for some subset of the Board-approved projects in their priority order, as budget constraints permit, and then negotiate with OMB on budget inclusion.[33] The considerations used by the Director and the NSB to rank one MREFC project over another for inclusion in NSF's annual budget requests will be clearly described in the budget request and the Facility Plan.

The PDP and IMP schedules for development, budgeting, and oversight are coordinated by the Director so that the work to complete the final design is closely linked to the anticipated availability of appropriated construction funds.

<u>Final Design Review</u>

NSB approved projects should continue to receive pre-construction development funds in order to produce a Final Design, which includes the following:

- A final construction-ready design;
- Tools and technologies needed to construct the project;
- A project management plan describing governance of the project, configuration control plans, plans for reporting technical and financial status, managing sub-awardees, and working with interagency and international partners;

[31] See Appendix 8 for description of required documentation.

[32] The Board ascribes the very highest priority to projects that are under construction. There is no priority among them; they should all move forward at a suitable pace.

[33] It is possible that OMB may reject or change the Foundation's prioritizations.

- A fully implemented project management control system, including a final version of the resource-loaded schedule and mechanisms for the project to generate EVM reports on a monthly basis and use them as a management tool. Path dependencies, schedule float, and critical path are defined;
- Updated budget and contingency, including risk analysis, presented in a detailed WBS format accompanied by a WBS dictionary defining the scope of all entries;
- All partnership agreements and Memoranda of Understanding are in place;
- Project design includes fit-up and installation details of major components, commissioning strategy;
- Plans for Quality Assurance, Safety; and
- Updated operating cost estimates. All of the pre-construction planning topics, including those listed in Appendix 4, are fully complete and determined to be adequate.

After Congress appropriates MREFC construction funds for the project – but before such funds are released – an approved Final Design Baseline must be in place. NSF reviews and approves the Final Design Baseline to ensure that the project plans and budget are fully ready for construction and that there is a high degree of confidence that the facility can be delivered within the parameters defined in the project baseline.[34]

The Program Officer and the DDLFP are responsible for organizing the Final Design Review (FDR). The review is conducted according to the same standards as described previously for the CDRs and PDRs. The scope of the FDR includes assessment of the technical and project management components of the proposed project. Review panel participants provide an objective view of the project and a critical evaluation of the plans and risks embodied in the proposed program. Participants provide expertise in the principal disciplines and specialties utilized by the project, and their composition is a balance of scientific, engineering, business, and project management expertise. In addition, the IMP should continue to be updated and assessed annually to ensure that the underlying assumptions about the project are still valid. If construction funds fail to be appropriated as planned, the Director may choose to remand the project to the Preliminary Design/Readiness stage or mandate annual project status reviews to assure NSF of the continued viability of the project's plan and budget for construction.

Construction Stage

After Congress appropriates funds for an MREFC project, NSF proceeds to award the contracts and/or cooperative agreements for construction of the facility. The policies and procedures in the internal NSF Proposal and Award Manual (PAM) apply to MREFC projects. The PAM covers the internal award process from proposal generation through merit review, DRB and NSB reviews, and the final award.

Following review of the final design baseline, the Director recommends to the NSB the making of the construction award(s)[35], if successful. The NSB reviews the recommendation and authorizes the making of the award(s). Following this approval, a cooperative agreement(s) between NSF and the Awardee institution is negotiated, and construction activities begin in

[34] This scrutiny emphasizes the importance of initial planning and definition of the technical scope, budget, and schedule, and implementation of a transparent process for management of changes to the final baseline.
[35] See Appendix 6 for required documentation.

conformance with the final baseline. The awardee(s) provides periodic financial and technical status reports to NSF according to the terms of the Cooperative Agreement, and is subjected to periodic post-award status reviews of technical performance, cost, schedule, and management performance throughout the course of construction activities. These reviews are typically held at the facility and involve panels of external experts that advise NSF.

During construction NSF will carry out regular reviews focusing on cost, schedule and management. These reviews are organized and conducted by the Program Officer, in partnership with the DDLFP. They supplement the normal internal project review activities carried out by the project. In some cases, it may be necessary for the project to re-baseline, for example when variance reporting relative to the approved baseline becomes so cumbersome that a new baseline would be a more effective management tool. Re-baselining requires approval of NSF. In such cases, a new baseline review must be carried out.An increase in construction cost exceeding 20 percent of the NSB approved baseline cost or $10 Million (whchever is smaller) must be reviewed and approved by the NSB on the recommendation of the MREFC Panel and the Director.

In addition to supplying regular status reports required in cooperative agreements, it is essential that MREFC project staff inform NSF staff in a timely manner of major issues or significant changes in project status, such as re-baselining, problems with partnerships, or surprising research and development results. NSF management, the MREFC Panel, and the NSB should in turn be informed of such developments.

On rare occasions, MREFC projects under construction may encounter unforeseen budget or programmatic challenges that are of a substantial enough level to be considered grounds for termination or significant modification to original project goals. NSF will provide the NSB with appropriate information and a recommendation. The NSB will decide whether termination or significant modification to the original project goals is warranted.[36]

Commissioning Stage

The transition from construction to operations is rarely abrupt. Many facility projects require a testing and commissioning phase, funded through the MREFC Account. The scope of these activities is defined in the PEP and included in the initial MREFC budget request. The PEP is included by reference in the NSF's Cooperative Agreement or contract with the Awardee institution, documenting the mutual understanding of the work scope funded by MREFC funds. In some cases, particularly with distributed facility projects, early operations funding begins to ramp up as aspects of a facility come online, although full construction funding may not have concluded. Although these phases overlap in time, they are budgeted and managed separately.

NSF will ask for a commissioning plan at least one year prior to initial commissioning activities. The scope of commissioning work is to undertake initial operation of the facility and bring it up to the design level of operation in accordance with IMP. The IMP is updated prior to operations

[36] Reference: NSB/NSF "Setting Priorities for Large Research Facilities Projects Supported by the National Science Foundation, NSB-05-77.

stage to define reviews, decision points, strategies for renewal or re-competition, plan for advanced R&D or technology refresh, upgrades, etc.

Operations Stage

NSF does not directly manage the operations of the facilities it supports. However, NSF does manage the oversight of facility awards during each of the stages of the facility's lifecycle. To do this, NSF employs a team-oriented approach, with its scientific and engineering staff working hand-in-hand with its business operations staff.

The Awardee normally submits a proposal for operation of the facility during the construction stage. This proposal is peer-reviewed following NSF's traditional guidelines for merit review. Operations activities are funded through NSF's R&RA and /or EHR account. Testing and acceptance, user training, and engineering studies occur as the facility transitions to full operation for its intended research use. 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. The Awardee provides periodic status reports on facility performance to NSF. In addition, NSF convenes periodic merit review of operations activities using peer review, and receives input from various advisory committees, planning bodies of the discipline served by the facility, and other FACA committees. The bodies advise NSF on renewal of the facility operations award, upgrades, re-competition, and termination as appropriate.

The Program Officer, supported by the Originating Organization, is responsible for overseeing facilities operations and carrying out periodic reviews. These reviews will address business operations, management, cost and scientific productivity and will ensure that awardees are performing to the terms and conditions of their awards. The DDLFP is responsible for ensuring that during operations, all facilities follow NSF procedures and proper oversight is being provided by NSF. The DDLFP will attend reviews where appropriate and oversee the complete portfolio of large facilities.

Renewal/Termination Stage

The operations stage of large facilities is typically more than 10 years, with significant variation within NSF's portfolio. To stay at the research frontier, upgrades and renewal of equipment are usually required. In the case of an observatory this may include new instruments and cameras; for a sensor network it may include the deployment of additional sensors or renewal of cyberinfrastructure. At an accelerator facility, the upgrades may take the form of higher energy or luminosity or new detectors. In general, these upgrades and renewals will be funded from Directorate or Divisional funds, often from a portion of the operating funds designed for such purposes. Funding for more significant upgrades whose cost exceeds the MREFC threshold may come from the MREFC account. In this case, the approval process is the same as that for a new MREFC project.

Most NSF facilities will be operated by a managing organization; current examples include AUI for NRAO; UCAR for NCAR; Cornell University for NAIC. Since facility lifetimes are long, (some current facilities have operated in excess of 40 years), the issue of recompetition of the

management naturally comes up. Whenever practical, NSF seeks to make competitive renewal awards for operation of NSF's large facilities after external merit review. NSB resolution 97-224 states, "*expiring awards are to be recompeted unless it is judged to be in the interest of US science and engineering not to do so*". Consistent with NSB policy, NSF will, at appropriate intervals, consider whether or not to recompete the management. The goal of competition is to stimulate new approaches toward more effective management that may offset any potential for increased costs, and ideally may achieve some cost savings. Important considerations beyond the performance of the current managing organization include how recompetition at the time might affect the scientific productivity of the facility and the burden it would place on the community. The determination of whether to compete the effort should be based on the expert advice of NSF staff and, where applicable, external sources using the facility, and must be presented to the NSB for approval.

Each NSF facility represents a large capital investment, which upgrades and other renewals can keep scientifically productive almost indefinitely. However, to stay at the frontier and build new facilities NSF must retire existing facilities. Such decisions will be difficult to make, in part because of the number of stakeholders and interested parties, and will require extensive community consultation and input, which may come from blue ribbon panels, National Academies committees and professional societies. In some cases, it may be possible to transfer ownership of a facility which can continue to be productive to another entity, e.g., another agency, a university or a consortium of universities. It is the responsibility of the Directorates and Divisions to periodically review its facilities portfolio and to consider which facilities may have reached an appropriate end of NSF support.

When the decision is made to close or transfer ownership of a facility, a transition plan will be developed, which includes all termination costs and liabilities, including disposal of equipment, environmental and site remediation or restoration, pension and health care responsibilities, etc.

The closure or transfer of a facility built from MREFC funds requires the concurrence of the MREFC Panel, the Director, and the NSB.

Appendix 1

NSF ROLES AND RESPONSIBILITIES

The following NSF officers and organizations are involved throughout the conception, development and implementation of an MREFC project:

NSF Program Officer (PO) – exercises primary oversight responsibility within NSF for all aspects of the project. The PO facilitates community development of research motivating proposals for large facility projects. The PO also organizes external reviews of developmental research, authors and implements NSF Internal Management Plan for oversight and financial support of a candidate facility project, and oversees facility construction, commissioning, and operation.

Deputy Director for Large Facility Projects (DDLFP) – scrutinizes management aspects of large facility projects to assure the NSF Director and Chief Financial Officer that proposed projects are well planned, and that projects selected for construction are properly scoped and well managed during construction and operation. The DDLFP works with the Program Officer to plan, carry out, and assess the results from external reviews of the project and assists the Program Officer on all project management issues. In close collaboration with NSF senior management, the DDLFP also leads the development and implementation of policies, guidelines, and procedures for the oversight of large facility projects.

Project Advisory Team – Assists the NSF Program Officer in the planning, review and management of the MREFC project. Advises and assists the Program Officer in creating and updating the Internal Management Plan, planning and assessing internal reviews, and providing counsel on all aspects of the project as requested by the Program Officer. The team should be composed of experts who are familiar with the technical, management and administrative issues associated with various types of infrastructure projects. This team should meet regularly to review the status of the project.

Contracting Officer/Agreements Officer – NSF official with authority, subject to statutory limitations, to award and administer cooperative agreements. As a member of the PAT, participates in management reviews, risk assessment and issues management. Plans and coordinates development of award documents from early planning stages through award administration and closeout. Negotiates terms and conditions, interprets NSF policy, reviews business proposals and budgets, significant subawards, Memoranda of Understanding and partnership agreements. Monitors awards for compliance with the most current NSF financial and administrative policies and procedures.

Originating Organization(s) – are NSF Directorates, and through their Divisions, the Program Offices that propose projects for funding through the MREFC Account. The Divisions have primary responsible for the planning, working with the community, reviewing, oversight, and funding of Large Facilities. Their responsibilities include coordination of planning; serving as the interface with relevant scientific and engineering communities; preparing all required documentation for project consideration and approval; conducting merit review of proposals;

fully funding costs of operations, maintenance and relevant programmatic activities; and overseeing the project.

Facilities Panel – reviews and recommends approval by the NSF Director of the initial Internal Management Plan for each project, as well as subsequent revisions. The Facilities Panel is chaired by the DDLFP. The other members of the panel are typically three experienced business operations personnel and three experienced programmatic personnel, all of whom have prior experience in the technical and administrative aspects of large project oversight. The Facilities Panel also provides preliminary review of the materials submitted to the MREFC, DRB, and NSB packages.

MREFC Panel – provides governance of the overall MREFC process; review of specific cases as presented by the Originating Organization(s). (See Appendix 2 for a schedule of MREFC activities and meetings of the MREFC Panel.) The Panel consists of the NSF Deputy Director (Chair), the Assistant Directors, Program Office Heads, the Chief Financial Officer, and in non-voting capacity the Deputy Director for Large Facility Projects, the General Counsel, and the Directors of the Office of International Science and Engineering, Office of Legislative and Public Affairs, and the Office of Institutional Resource Management.

Director's Review Board (DRB) – reviews and approves the documentation associated with all projects proposed to the NSB for funding, including MREFC projects. The DRB is composed of the NSF Deputy Director, three Assistant Directors/Office Heads serving on a rotating basis, the NSB Executive Officer, the Chief Financial Officer, the Office of General Counsel, a staff advisor from the Office of the Director, and the DRB Executive Secretary.

NSF Director –As NSF's Chief Executive Office, has ultimate responsibility for the obligation of funds from the MREFC Account and for proposing new MREFC projects to the NSB, OMB, and the Congress. The Director approves all Internal Management Plans, as well as all materials submitted to the NSB, OMB or Congress.

National Science Board (NSB) – establishes policy, reviews and approves MREFC Account budgets, and reviews and approves specific MREFC projects for funding. The NSB is an independent policy body established by Congress in 1950 with dual responsibilities to oversee and guide the activities of, and establish policies for, the NSF. Within the NSB, the Committee on Programs and Plans (CPP) oversees NSF program initiatives and major new projects and facilities. The NSB sets the priority order of projects recommended for construction.

MREFC Panel Schedule

January Congressional Budget Formulation	February ★ First Monday - Congressional Budget Submission; immediately condense appropriate section of the budget into the 'ongoing projects section' of the Facility plan; Prepare Final Facility Plan for NSB Mailout MREFC Panel Meeting: Ongoing Projects Review and "Exit Readiness Stage" Review	March Submit Facility Plan to the NSB NSB New Start review
April	May NSB New Start Review NSB Reprioritization	June OMB Budget Formulation
July ★ MREFC Panel Facility Plan Review Meeting: Review of Opportunities and Objectives section; Proposal of Horizon Projects; Identification of projects that will be brought forward for Readiness Review at the next meeting. OMB Budget Formulation →	August NSB New Start review	September ★ OMB Budget Submission MREFC Panel Readiness Review Meeting Begin Drafting Facility Plan (following Readiness Review)
October MREFC Panel EMAIL review/discussion of Facility Plan drafts (excluding section on Ongoing Projects) →	November OMB Passback, late November; possible appeal/settlement	December ☆ MREFC Panel meeting, ***if necessary***, to finalize all sections of Facility Plan except the ongoing projects section. Begin Congressional Budget Formulation

★ indicates an MREFC Panel meeting; ☆ indicates a potential MREFC Panel meeting.

NOTE: The MREFC Panel will not specifically review the "ongoing projects" section of the Facility Plan; it will be strictly a condensed form of the MREFC narratives submitted in the Congressional Budget, which will be reviewed as part of the Budget formulation process.

Appendix 3

RANKING CRITERIA FOR PRIORITIZING MREFC PROJECTS

First Ranking: Scientific and Technical Criteria Assessed by Researchers in a Field or Interdisciplinary Area

- Which projects have the most scientific merit, potential, and opportunities within a field or interdisciplinary area?
- Which projects are the most technologically ready?
- Are the scientific credentials of the proposers of the highest rank?
- Are the project-management capabilities of the proposal team of the highest quality?

Second Ranking: Agency Strategic Criteria Assessed Across Related Fields

- Which projects will have the greatest impact on scientific advances in this set of related fields taking into account the importance of balance among fields for NSF's portfolio management in the nation's interest?
- Which projects include opportunities to serve the needs of researchers from multiple disciplines or the ability to facilitate interdisciplinary research?
- Which projects have major commitments from other agencies or countries that should be considered?
- Which projects have the greatest potential for education and workforce development?
- Which projects have the most readiness for further development and construction?

Third Ranking: National Criteria Assessed Across All Fields

- Which projects are in new and emerging fields that have the most potential to be transformative? Which projects have the most potential to change how research is conducted or to expand fundamental science and engineering frontiers?
- Which projects have the greatest potential for maintaining US leadership in key science and engineering fields?
- Which projects produce the greatest benefits in numbers of researchers, educators, and students enabled?
- Which projects most need to be undertaken in the near term? Which ones have the most current windows of opportunity, pressing needs, and international or interagency commitments that must be met?
- Which projects have the greatest degree of community support?
- Which projects will have the greatest impact on scientific advances across fields taking into account the importance of balance among fields for NSF's portfolio management in the nation's interest?

Appendix 4

Project Management Components of a Construction-Ready Project Execution Plan

Essential components of a construction-ready Project Execution Plan, common to most plans for construction of large facilities, are listed below, as an example of the extensive nature of the pre-construction planning that must be done prior to expending MREFC funds to execute the project. Additions or alterations to this list are likely, due to the unique nature of each specific project. While many of the listed topics cannot be substantively addressed at the earliest stage of project planning, it is important that project advocates are aware, at the outset, of the full scope of pre-construction planning activities that must be undertaken and the consequent pre- resources required. As the project matures through Conceptual Design, Preliminary, and Final design, these topics become correspondingly well defined.

- Description of the research objectives motivating the facility proposal
- Description of the infrastructure necessary to obtain the research objectives
- Work breakdown structure (WBS)
- Work breakdown structure dictionary defining scope of WBS elements
- Project budget, by WBS element
- Description of the basis of estimate for budget components
- Project risk analysis and description analysis methodology
- Contingency budget and description of method for calculating contingency
- Project schedule (and eventually a resource loaded schedule)
- Organizational structure
- Plans and commitments for interagency and international partnerships
- Acquisition plans, subawards, and subcontracting strategy
- Project technical and financial status reporting, function of the Project Management Control System, and description of financial and business controls
- Project governance
- Configuration control plans
- Contingency management
- Internal and institutional oversight plans, advisory committees, and plans for building and maintaining effective relationships with the broader research community that will eventually utilize the facility to conduct research
- Quality control and quality assurance plans
- Environmental plans, permitting, assessment
- Safety and health issues
- Systems engineering requirements
- Systems integration, testing, acceptance, commissioning, and operational readiness criteria
- Plans for transitioning to operational status
- Estimates of operational cost for the facility

Appendix 5

NSF FACILITY PLAN

The NSF *Facility Plan* – updated at least annually and made public – serves as valuable planning tool within NSF. It also provides a comprehensive exposition of needs and plans to inform decision making in the Executive Branch and Congress, and serves as an important vehicle for communicating with the S&E communities.

The first section of the *Facility Plan* provides an extensive discussion of the frontier research objectives and opportunities that provide the context and compelling need for major facilities. The contents of this section derive from workshops, advisory committees, NRC reports, the expertise of visiting and permanent scientific staff, and unsolicited proposals from the community. The second section provides periodic updates on the status and progress of each MREFC project and candidate project. It also maps these projects against the objectives and opportunities contained in the first section. In particular, this section addresses:

- *Preliminary Design/Readiness Stage Projects:* Projects in various stages of readiness, including those that will be ready to go the NSB for approval within approximately the next year, and those that the MREFC panel has recommended for advancement to the *Preliminary Design/Readiness Stage*.

- *NSB Approved Projects:* Projects that the NSB has approved for funding in a future budget request.

- *New Starts:* facilities for which initial MREFC funding is requested in NSF's annual budget request.

- *Ongoing MREFC Projects*: facilities already in operation or under construction.

In addition to providing regular status reports, the *Facility Plan* reflects the Administration's priorities for new start projects, NSB priorities for NSB-approved projects, and the NSF Director's priorities for projects in the *Preliminary Design/Readiness Stage*. Ongoing MREFC projects are always given the highest budget priority.

Every year new science and engineering opportunities arise and new priorities assert themselves. As a result, no roster or ranking of potential MREFC projects is ever final. Responsible stewardship of public funds demands that all candidate efforts be evaluated and reevaluated constantly in the context of the latest, most pressing research goals and the most profoundly important unanswered questions.

It is the responsibility of the MREFC Panel is to develop and maintain the *Facility Plan*. The plan is approved by the Director and submitted to the NSB in March.

Appendix 6

OTHER DOCUMENTATION RELEVANT TO REVIEW OF MREFC PROJECTS

For MREFC Projects requesting NSB approval (for inclusion in a future budget request): In addition to the NSF Form 10 (for clearance) and the Assistant Director/Office Head endorsement(s), items (a) and (b) described below, both of which must be clearly marked as "pre-decisional – Do Not Distribute", must be prepared:

(a) Director's Memorandum to Members of the NSB: briefly summarizing the project, the need for the project, and cost estimate. The Director's Memorandum should include the following statement:

"With the Board's concurrence that this project is meritorious and that its planning is sufficiently advanced, the Director will take appropriate action in preparation of a budget request. Board approval of this project for planning purposes does not imply NSB approval of project implementation. Any such approval will be requested from the NSB at the appropriate time."

The Director's Memorandum should conclude with the following resolution:

"RESOLVED, that the National Science Board concurs that planning for the <project title> is sufficiently advanced, and the intellectual value of the project sufficiently well demonstrated, to justify consideration by the Director and the Board for funding in the FY 20XX or a future NSF budget request."

(b) A project report (usually 6-8 pages) should provide an update of the documentation provided to the MREFC Panel.

For NSB approval of MREFC project implementation: Before project construction can be initiated, project implementation approval must be granted by the NSB. First, the Director should prepare a *Memorandum for NSB Action*[37]. The Director's memorandum to the NSB should summarize information and issues related to the proposed implementation of the project, potential policy issues/implications, precedents involved, prior NSB discussion, and any other factors that could be considered non-routine.

It should normally contain a brief science/engineering overview; a description of connections to any national and international programs; a description of the project; a summary of the review process and a short statement of response to any major concerns raised by reviewers; a schedule; budget totals including consideration of contingencies; the impact that technological advances would have on the project during construction; the percentage of program or division budgets that the proposed award represents and out-year implications; and a description of plans for project management.

The Memorandum should also include a statement regarding plans for the end of the award period, consistent with the policies set forth in NSB-97-216, "NSB Statement on Competition and Renewal of NSF Awards" and the accompanying Resolution passed by the NSB at its meeting of November 13, 1997. The Memorandum should conclude with the following resolution:

[37] See PAM VI.H.3.b.

"RESOLVED, that the National Science Board authorizes the Director at his/her discretion to make an award for implementation of < Title > to < Institution or Entity > in an amount not to exceed $XXX, XXX, XXX for XX months."[38]

- Project Management Documentation In addition to the other required materials (described in PAM VI.H.3.b.), MREFC project implementation approvals must include a Project Execution Plan and an Internal Management Plan, as detailed in Appendices B and C. Other documentation that may be relevant to preparation of MREFC projects is included in Appendix D.
-

For procurements: Federal Acquisition Regulations. Staff should consult with the Contracts Branch of the Division of Contracts, Policy and Oversight when considering issuing a Request for Proposals (RFP). Note that National Science Board approval is required for all programmatic RFPs that will result in contracts that meet the NSB review threshold.

For program design: Activity Design, Review and Management Protocol (O/D 93-02; January 5, 1993). This design and review protocol covers newly proposed funding activities and applies to any proposed programmatic activity that has budget or management impact. It is designed to apply more generically to the initiation of new programmatic research thrusts, especially those new "programs" that require National Science Board review and approval.

For Environmental Assessment (EA) or Environmental Impact Statement (EIS): Proposal and Award Manual, Chapter VIII, section 800 – Environmental Impact Statements. This section of the PAM describes the policy and procedures applicable to NSF actions requiring the preparation of an Environmental Impact Statement in accordance with the National Environmental Policy Act

[38] The resolution should be modified if there are any special conditions (e.g. "pending congressional approval" or "pending the availability of funds.")

Appendix 7

REFERENCES

"*Science and Engineering Infrastructure Report for the 21st Century -The Role of the National Science Foundation*," February 8, 2003; NSB-02-190; http://www.nsf.gov/nsb/documents/2002/nsb02190/nsb02190.pdf

Priority Setting for Large Facility Projects (NSB-04-96), National Science Board White Paper, May 2004, http://www.nsf.gov/nsb/meetings/2004/may_srprt.doc.

"*Setting Priorities for Large Research Facility Projects Supported by the National Science Foundation*," a 2004 National Academies report, http://books.nap.edu/catalog/10895.html.

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.

Proposal and Award Manual **WWW**.inside.nsf.gov/pubs/2002/pam/pamdec02.toc.htm is a compendium of internal policies and procedures related to the proposal and award process.

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**,

Grant Policy Manual http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpm

General Conditions for Grants **WWW.NSF.GOV/PUBS/2001/GC101/GC101REV1.PDF**

Director's Review Board Procedures (O/D 97-07; June 10, 1997): O/D 97-07 sets forth the function of the Director's Review Board (DRB) and establishes procedures to be followed for items requiring DRB review. As part of its responsibilities, the DRB reviews actions and information items prepared for the National Science Board (NSB) and items to be considered for delegation of authority by the Director.

Proposal and Award Manual, Chapter III, section 300 -Program and Award Recommendations and Information Items to the National Science Board: This section of the PAM sets forth the policy and procedures governing the preparation and review of action and information items for the National Science Board and the DRB.