

# Report of the Subcommittee on Recompetition of Major Research Facilities

## January 5, 2012

### EXECUTIVE SUMMARY

The charge to this Subcommittee from the Business and Operations Committee states that our purpose “is to recommend to the Committee ideas for implementing the National Science Board’s Policy on Recompetition, particularly as it pertains to NSF’s major facilities.” To this end, we held two days of hearings, and received dozens of written statements from leaders of user communities of major facilities and from executives and PI’s of the facilities’ operating organizations. In this executive summary we summarize our findings and recommendations.

### Findings

- The terms *recompetition* and *renewal* do not have uniform meaning across the various programs of NSF, and there is no clear statement of the goals of each.
- The eighteen NSF major facilities are a very diverse set, ranging from big-science experiments (e.g., LIGO) to consortia of all the research institutions in a field (e.g., IRIS).
- Although there should be a consistent definition and process for recompetition across NSF, the diversity of the facilities implies flexibility in application; e.g., varying the time between recompetitions in recognition of their special characteristics and circumstances.
- Despite the complexity and despite the encumbrances of recompetition on some facilities, we find no facilities for which recompetition is not eventually appropriate.
- Five years is too short a time for recompetition after the initial award, provided that the awardee is found by a rigorous review to be performing well.
  - Preparation for a recompetition typically begins two or three years before the end of the award period. In the case of a recompetition after only five years, not enough time has elapsed to demonstrate improvements the awardee has proposed to implement; e.g., an enhanced user base.
  - Recompetition every five years results in less time spent by the awardee in enhancing the science and more in preparing for recompetition.
  - An initial operating period that is too short could create a disincentive to innovative proposals like the one that led to the move of the National High Magnetic Field Lab to Florida, leveraging an NSF investment of less than \$100M with nearly \$400M in state funds.
- The preceding finding is reinforced by the extensive number of internal and external reviews of major research facilities conducted by NSF:

- An annual review of the facility's Science/Engineering Program, Management, and Long Range Planning
- An annual ARRA audit (until ARRA funds are fully expended)
- A Management and Renewal Review every five years
- A Business Systems Review every five years
- An audit by the NSF Inspector General every five to ten years, or earlier if deemed necessary.

## **Recommendations**

- NSF should adopt a statement of goals and principles guiding the recompetition of major research facilities (see Section I for suggestions).
- NSF should adopt uniform definitions for the terms “recompetition” and “renewal” across NSF programs.
- NSF should adopt a uniform, Foundation-wide, checklist of considerations that should go into a decision to recompute. The checklist should specify timetables. See Sec. III for suggested items for such a list. In short summary, the decision process to conduct a non-competitive renewal or to recompute a facility should begin only after the NSF has made the decision to continue support of a facility, based on its scientific merits. Then, the decision about whether to conduct a non-competitive renewal of, or to recompute, a facility should be a deliberate one that weighs the potential benefits of an effective recompetition against the tangible and intangible costs of holding that recompetition. Regardless of the costs, important triggers for recompetition include (a) dissatisfaction with facility capabilities or operations by the user community, (b) a stagnant user community that is unresponsive to critical review of facility operations, and (c) significant inefficiencies that adversely affect operating costs.
- Though we find that five years is normally too short an interval, it is probably appropriate to recompute facility cooperative agreements every 10 to 15 years, depending on the characteristics and circumstances of each facility, so as to foster new vision. We recommend that 20 years be the maximum period for which a facility is supported without recompetition.
- A decision to recompute having been made, NSF needs a well-defined process for large facility recomputations that is general to the entire Foundation and that is made known to facility managers (incumbents) and potential competitors, on which progress can be reported to the NSB. See Sec. IV for elements that should be considered for a recompetition process checklist.
- Assign to one person at NSF the responsibility to manage the process for all recomputations of major facilities. The Subcommittee recognizes that the recompetition of a major facility is a significant undertaking requiring the effort and expertise of many individuals. Nevertheless, or perhaps because of this, we believe that the NSF would benefit from a designated “recompetition manager” whose responsibility would be to work with the program office responsible for each facility competition to ensure that competition goals are articulated clearly, realistic schedules are developed and met, communication strategies are put in

place, legal and policy issues are recognized early, and perhaps most importantly, that lessons learned from previous competitions are effectively incorporated into future competitions. This individual would serve as NSF's "corporate memory" for competitions and could help assure consistency of approach and policy for the Foundation.

- NSF should compare its review, renewal and recompetition policies and practices with those of other federal agencies that fund research and development to benchmark its policies and practices against those of other agencies while retaining those features that foster NSF's unique mission.

## **I. INTRODUCTION AND GOALS OF A RECOMPETITION**

NSF should consider adopting a statement of its goals and philosophy regarding the re-competition of major research facilities. Such a statement might include some of the elements below, which the Subcommittee inferred from the materials we were given:

- Ensure the highest quality science and engineering research
- Ensure the availability of state-of-the-art research facilities and instrumentation to American scientists and engineers
- Provide research opportunities to enhance the education of future generations of scientists and engineers
- Sustain our nation's international leadership in science and engineering, and
- Ensure effective, efficient and responsive management of these facilities.

In addition, NSF should consider adopting a statement of principles to guide review and recompetition, which may include the following:

NSF believes the best science and engineering research comes from rigorous competition and peer review of proposals seeking funding for science and engineering research. In keeping with this belief, NSF seeks to ensure the competitiveness of its facilities and the delivery of high quality services to national user communities. NSF will fulfill these objectives by:

- conducting rigorous reviews of the quality of science and engineering programs, as well as the effectiveness and efficiency of the management, at each facility
- assessing the satisfaction of the user communities with the management of each facility
- conducting recompetitions in a manner that takes into account the unique characteristics of each facility
- completing such recompetitions in a timely and efficient manner.

To assist in accomplishing recompetitions in a manner that is viewed by the affected scientific or engineering community as having integrity, NSF should consider defining the characteristics of the terms “renewal” and “recompetition,” as well as the circumstances in which it will use one approach or the other.

## **II. LESSONS LEARNED FROM PAST COMPETITIONS**

The charge to the Subcommittee asked us to examine “how past competitions of NSF facilities have worked and any lessons to be learned from this analysis.” In carrying out this examination we benefitted from the testimony and written submissions from users, operators, and managers of facilities that have actually undergone recompetition. No presenter identified an NSF recompetition that resulted in a completely negative outcome, although only a handful of cases were discussed in detail and most case histories were anecdotal in nature and presented by the ‘winners’ in competitions. One recompetition, NHMFL, gave highly positive results. Most recompetitions were judged by users and the current facilities managers to be at least mildly positive in their effects on user science and/or facility management, e.g. UNOLS, NNIN, NEES. One (which did not ultimately change the management structure) was judged neutral, UCAR.

For the cases where recompetitions were conducted, facility-specific complexities were involved; however, these cases describe (with one exception) facilities where recompetition was actually viable, and motivated by concerns about management that could not be resolved by other means. There may be even more complex facilities where cost-benefit analysis would indicate that recompetition should be less frequent or more strategically timed.

Many challenges to effective recompetition were advanced, some of which were significant; e.g., necessity of establishing a level playing field, complexities of renegotiating international agreements, and overall costs to NSF, the incumbent, prospective competitors and the user and reviewer communities – costs not just in dollars, but also in the time and effort of key personnel. Complications which bear upon the decision to recompute and the overall effort involved are discussed in later sections.

### **Benefits observed from previous recompetitions**

We note that a regular, thorough, renewal review has been the conventional process for facilities not deemed to be encountering major problems. We consider here benefits that are above and beyond those anticipated from such a review.

Excellent facilities shine under normal reviews, and hence the incremental benefits from recompetition of such facilities are expected to be marginal. Well-performing incumbents are also likely to excel in recompetition, which makes it much harder to find non-incumbents willing to compete with them and thus to conduct an effective recompetition. However, when scientific or management problems had been identified that precipitated recompetition, various tangible benefits were demonstrated:

- Existing management was improved or refreshed, or new management was established.
- Identification and elimination of weaker components of facilities e.g. two nodes in NNIN, and an NEES site. In principle it should have been possible to achieve this via the regular renewal process; this has occurred for other facilities.
- Promotion of visionary, longer-range thinking and strategic planning. Again, these should be possible via renewal, provided the renewal review is thorough, critical and not pro forma.
- Development of new scientific and technical collaborations. Some aspects may be possible via renewal, but are likely to be more significant during recompetition.
- Addition of new methodologies, deletion or scale-back of old technologies. Renewals typically involve some updating or upgrading of capabilities, but major shifts of technologies are likely to be better effectuated by recompetition.
- Extra leverage achieved with host institutions due to competitive concerns about possible competitor cost-sharing.
- Despite fears to the contrary, scientific operations continued to run effectively during the recompetition process, as long as it was not unduly protracted.

The fact that these benefits were derived during recompetitions of facilities that were in trouble tends to bias net effects in a positive direction. Many benefits do not appear to require the context of recompetition to achieve, as long as renewal processes are conducted with critical, demanding criteria. It is apparent that significant benefits were achieved by the renewal process alone for many facilities. However, these benefits were not sufficiently documented to allow valid comparison with benefits achieved by recompetition.

### **Costs of recompetition**

The testimony was largely anecdotal, but categories of cost were consistently invoked:

- For NSF personnel, recompetition requires substantially more work than renewals to ensure effective competition, e.g. soliciting multiple bidders, managing facility subcontracts, international relationships, community relations in order to ensure a “level field”.
- Unsuccessful competitors have clearly lost time and resources.
- Costs for the successful competitor are hard to determine but may be recoverable through the management fee or other routes. NSF may end up paying for the bid and proposal costs.
- Human time consumed in reviewing multiple proposals (versus single proposal renewal), panel work, external reviewer work, NSF management, liability assessment, legal issues. Frequent competitions tax the external reviewers, all of whom already have many competing demands on their time.

- Recompetition shifts resources from science to administration, both at NSF and in the facilities themselves.
- Some - but not all - costs may be mitigated by an effective pre-recompetition proposal process.
- Science operations and effectiveness are potentially harmed when recompetitions are unduly protracted (i.e. >1 year).

Again, the absence of information about the costs of conducting such recompetitions does not allow us to accurately gauge the costs involved. Surprisingly, the internal costs to NSF itself were not available to the Subcommittee. Accounting for the incremental costs of recompetition versus renewal remains fragmentary and anecdotal. These costs multiply with the number of competitors, but also with the added NSF efforts for recompetition overall.

Clearly the costs are significant, but the lack of hard data makes sensible cost-benefit analysis difficult. It would be useful to assess the cost of recompetitions relative to renewals.

NSF should establish procedures to collect and analyze data on the impact of recompetitions (e.g. time/effort associated with recompetition, direct and indirect costs associated with recompetition) including NSF's internal costs, costs to the incumbent facility managers, costs to competitors, and costs associated with the volunteer labor of facility scientists, external reviewers and the user community.

#### **Adverse effects observed from recompetitions, to be avoided where possible**

- Efforts to level the playing field can modify facility procedures and complicate sensitive arrangements (university, international, operational, etc.) critical to effective functioning of the facility.
- Relative to renewals, recompetitions result in disengagement between the facility and NSF for an extended period of time prior to and during the recompetition. The imposed "blackout period" of reduced interaction between facility management and NSF program managers during a recompetition represents a real change in NSF/incumbent interactions for one year or longer. This "blackout" is not experienced during renewals.
- Excessive attention to ensuring competitive bids could require increases in management fees to attract for-profit competitors, with little user scientific or management gain. This has occurred during DOE recompetitions of their national security labs.
- The incumbent may defer long-term decisions and investments in the facility and may experience heightened anxiety by its staff before and during a recompetition. It is unclear whether negative effects of deferral and anxiety are more severe during recompetition than during renewal.

- If good facility management cannot hope for, and to a reasonable extent depend on, renewals of their contracts as the reward for good performance, they will be less likely to commit their own resources to the effort, and may be less likely to concern themselves with demonstrating the best possible performance, especially for the long-term benefit of the facility. Elimination of the possibility of a renewal of a facility award deprives NSF of a powerful motivating tool.

### **III. CONSIDERATIONS THAT SHOULD GO INTO A RECOMPETITION DECISION**

The primary decision about whether to renew or recompute the management of a facility should be based on a thorough review of the value of the facility to (a) advance fundamental or applied scientific knowledge, and (b) foster innovation and broader impacts on research, education and society at large. The value and merits of the facility, laboratory or observatory should be informed by experts in the scientific fields served by the facility, by experienced users of the facility, and by other stakeholders who can provide an objective evaluation of the significance of research undertaken there. Studies of the future, broad directions of scientific and engineering disciplines undertaken by the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine should be taken into account. NSF's decision may also consider the value of the facility relative to the merits of other potential facilities and/or research programs.

Once NSF has decided that the scientific area represented by a facility and its users is of high value and that NSF intends to continue its support, then the second decision arises: should NSF solicit a non-competitive renewal proposal from the current facility operator i.e. the incumbent? Or, should NSF proceed with a competitive renewal, i.e., a recompetition where multiple proposals from the incumbent and new competitors are solicited and reviewed?

The following is a summary of considerations that should go into the decision to undertake a non-competitive renewal or a recompetition:

1. Is it feasible to recompute the facility (i.e., to change the awardee)?  
Notwithstanding the potential benefits of an open competition, there are situations where it would be extremely difficult, costly or ill-conceived to change the awardee. Examples include the following:
  - a. A facility may have too many encumbrances for it to be practically or economically feasible to conduct an effective recompetition. Examples of possible encumbrances are included in Section 4. In cases where significant encumbrances preclude recompetition in the near term, NSF may decide on a non-competitive renewal that includes the requirement that the incumbent eliminate specified encumbrances in order to facilitate a future recompetition.
  - b. Where a facility is still under construction or has not yet achieved steady operations, it may be impossible to properly evaluate the basis for recompetition, and/or be extremely counter-productive to conduct a

recompetition. In such cases, recompetition should be deferred for a specified period or until certain milestones are met.

2. Has NSF clearly defined its goals for recompetition (see Section I)? Until and unless NSF can clearly articulate what it hopes to accomplish via a recompetition, it should not embark on one. Once the goals of a recompetition are clear, these goals should be reflected in the request for proposals, and in the criteria to be used to evaluate the proposals. These goals may include one or more of the following:
  - a. More effective leadership and vision in research, education, and outreach
  - b. Technical improvements to the facility, including equipment and operating procedures to better acquire, store and access research data
  - c. Managerial and procedural aspects of site operations that will facilitate more effective use of the facility by the research community and continual enhancements to maintain a state-of-art facility
    - a. Improved financial and business processes to ensure cost-effective operations and effective fiduciary oversight by NSF and other partners
    - b. Improved relationships with research partners and users that will enhance both the facility itself and research conducted at the facility
    - c. Contributions by the site's lead institution, that may include direct financial support for the facility and its operations and in-kind contributions, such as buildings/real estate, faculty and research staff support, etc.
    - d. Renewal of the supporting infrastructure and/or the research equipment itself to enhance the research capabilities of the facility.
  
2. Past performance of the incumbent facility operator, as evaluated by surveys, review visits and site audits, should be a major factor in deciding whether a recompetition is warranted. The following is a summary of performance measures that should be considered:
  - a. Satisfaction of the research community, including past and current users of the facility, potential new users from the research community, and others in the community whose research, education and/or outreach is affected by the facility. User surveys must be carefully designed to obtain a representative sample. Confidentiality is important. For example, early career scientists may be reluctant to openly contradict senior colleagues who could influence their careers. Nevertheless the views of those early career scientists are valuable: they represent the future of the facility, and arguably have the most to gain from its continued success.
  - b. Scientific output of the facility, as judged by specific accomplishments and the broader impact on research in the field
  - c. Efficiency of the facility, in terms of the volume of use and outcomes relative to the support costs



- d. Business operations, including adherence to best practices for office operations, accounting and personnel management, and responsiveness to information and audit requests from NSF and other oversight agencies
  - e. Vision of the leadership team and responsiveness to seek out opportunities to enhance the capabilities of the facility and the overall scientific research enterprise
3. Encumbrances that may create significant obstacles to changes in the facility management and operators should be identified and evaluated. Some encumbrances may be significant enough to preclude effective recompetition of the facility until they are mitigated or removed. When NSF desires to have a recompetition, it should work with the facility operator to mitigate the encumbrances. The following are examples of encumbrances that can arise:
- a. International agreements related to land rights or ownership outside the United States and/or cooperative operating agreements with other governments or organizations. For example, AURA is explicitly recognized in legislation approved by the Chilean Parliament, thus giving AURA special legal status within Chile.
  - b. Co-ownership of real estate or other property (supporting infrastructure and/or research equipment) with other partners, including universities, government agencies, or other organizations.
  - c. Intellectual property that belongs to the current operator and may not be transferable.
  - d. Data, records, and other management information that may become lost or inaccessible due to change of operators.
  - e. Labor agreements, pensions, and other outstanding liabilities between the current operator and current or retired staff and other stakeholders.
  - f. Investments by state governments, local governments, or other agencies in a facility or its operations that may be lost with a change in operators and/or relocation of a facility.
  - g. Shared facilities where NSF provides only a portion of the support for a facility and a change in operator may result in loss of critical operational support by other partners.
  - h. The number of management and technical staff that would turn over due to a change in operator and how this would affect continued operation of the facility.
  - i. Original agreements that NSF has made or implied to the operator regarding the intended timeframe of the operating agreement, and any subsequent agreements that the operator has made to its partners, staff, subcontractors, etc.

4. Potential for meaningful recompetition: Before entering into a recompetition NSF should, to the extent possible, have confidence that there will be two or more competitors who will submit viable proposals. NSF should strive to make the recompetition attractive and to minimize factors that would dissuade potential competitors from participating. That is, NSF must strive to “level the playing field”. Factors that can inhibit a meaningful competition include the following:
  - a. Existing encumbrances, such as those mentioned previously, can pose a significant obstacle to attracting competitors. Significant existing encumbrances should be addressed either by eliminating the encumbrances prior to the competition or by outlining, in the competition RFP, the known encumbrances and NSF’s expectations for how these should be handled.
  - b. NSF should convey a positive message to the research community and potential competitors to explain its intentions and solicit interest for the competition. This should include its plans and expectations for continued operation of the facility beyond the current cooperative agreement, e.g., the potential funding profile for the facility.
  - c. The emergence or viability of competing proposals may be severely hindered where the current operator is a consortium that represents a majority of the research community. Where such situations exist, NSF may explore ways to ensure that competing proposers have viable options for engaging the research community as part of their recompetition bid.
  - d. The length of time since the last competition for a facility, together with the rationale behind the recompetition, are likely to be significant factors in how receptive the research user community and potential competitors are to the recompetition. Based on testimony from users and from facility management, the Subcommittee identified a widespread consensus that the length of time between competitions should not be fixed, but instead, should be based on the specific circumstances at a facility. While five years is generally viewed as too short a time between recompetition,<sup>1</sup> there may be circumstances where this short a time is warranted due to significant, widely perceived shortcomings with the current operator. On the other hand, while 10 years is not an unreasonable timeframe for recompetitions, the timing of recompetitions should not be automatic but should take into consideration any unique circumstances that could adversely affect major research projects, facility upgrades, or continuing operations.
  - e. Ideally, there would be demonstrated interest in a recompetition by multiple competitors before the recompetition is announced. NSF should explore strategies to ascertain such interest before committing itself to a recompetition. Such interest may become apparent through surveys or

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<sup>1</sup> Preparation for a recompetition typically begins two or three years before the end of the award period. In the case of a recompetition after only five years, not enough time has elapsed to demonstrate improvements the awardee has proposed to implement; e.g., an enhanced user base. See also Executive Summary: Findings

meetings with the research community about the current facility operations. Where possible (recognizing appropriate legal and ethical bounds), NSF might also seek input from knowledgeable individuals in the research community on the likelihood that there will be competitive proposals.

- f. Conducting a recompetition when there are no likely or possible bidders or when it is difficult for the community to see how NSF could make an award to anyone other than the incumbent should if at all possible be avoided. An ineffective recompetition would not merely waste time and money but create significant cynicism among the larger community about the motives of NSF in conducting competitions. This could have a broader and highly negative impact.
5. In addition to the general points raised above, there may be abnormal issues and risks that could affect the decision and/or timing on undertaking a recompetition. A few examples of the types of issues that may be relevant and significant to the decision follow:
- a. Political – To the extent that local and state governments provide significant support for a facility (e.g., matching financial or in-kind support for operations), there may be factors related to timing of recompetition that trigger renegotiations of local and state support during sensitive political budgeting cycles, which could reduce existing levels of state or local support for the facility.
  - b. Major research projects and/or facility upgrades – There may be situations where the success of large multi-year research projects and/or major upgrades to a facility would be put in jeopardy by an impending recompetition and potential change in facility management and operations. Such cases would not preclude recompetition, but could influence its desirable timing.
  - c. Personnel – There may be situations where personnel changes at a site (e.g., a new manager coming on board) may impact decisions about the timing of a recompetition.

In summary, the decision process to conduct a non-competitive renewal or to recompute a facility should begin only after NSF has made the decision to continue its support for a facility, based on its scientific merits. Then, the decision about whether to conduct a non-competitive renewal or to recompute a facility should be a deliberate one that weighs the potential benefits of an effective recompetition against the tangible and intangible costs of holding that recompetition. Regardless of the costs, important triggers for recompetition include (a) dissatisfaction with facility capabilities or operations by the user community, (b) a stagnant user community that is unresponsive to critical review of facility operations, and (c) significant inefficiencies that adversely affect operating costs.

Beyond these performance-based triggers, it is probably appropriate to recompete facility cooperative agreements every 10 to 15 years so as to foster new vision. The Subcommittee recommends that 20 years be the maximum period for which a facility is supported without recompetition.

#### **IV. RECOMMENDATIONS CONCERNING THE PROCESS OF RECOMPETITION**

In the previous section we discussed the considerations and procedures leading to a decision to recompete. Once such a decision has been made, NSF needs a well-defined process for large facility recompetitions that is general to the entire Foundation and that is made known to facility managers (incumbents) and potential competitors, on which progress can be reported to the NSB. Elements that should be considered for the NSF process include:

1. Assigning to one person at NSF the responsibility to manage the process for all recompetitions of major facilities. The Subcommittee recognizes that the recompetition of a major facility is a significant undertaking requiring the effort and expertise of many individuals. Nevertheless, or perhaps because of this, we believe that the NSF would benefit from a designated “recompetition manager” whose responsibility would be to work with the program office responsible for each facility competition to ensure that competition goals are articulated clearly, realistic schedules are developed and met, communication strategies are put in place, legal and policy issues are recognized early, and perhaps most importantly, that lessons learned from previous competitions are effectively incorporated into future competitions. This individual would serve as NSF’s “corporate memory” for competitions and could help assure consistency of approach and policy for the Foundation.
2. Identifying goals for the specific competition (see III.2).
3. Convening a recompetition team composed of the Program Officer (or Officers) concerned, representatives of the Division of Contracts and Grants, the General Counsel’s office, the Recompetition Manager and others as appropriate. The team should assign roles and responsibilities, set accountability standards for each member of the team, and determine ways to conduct an efficient and effective recompetition in a timely manner.
4. Announcing a timetable for each element of the recompetition in advance and adhering to it.
5. Ensuring that the recompetition process is as transparent as possible. The incumbent facility manager and the user community must know the schedule in advance, and the incumbent facility manager and all potential competitors must be informed of what will be required of them during recompetition.
6. Specifying in advance of the details of the peer review and evaluation process.
7. Identifying the criteria to be used to determine the selection of the successful bidder.

8. Using all the tools available to minimize the advantage to incumbents. See Section III.5 above.
9. Developing mechanisms to ensure that the time period between the announcement of a recompetition and the final award is as short as possible.
  - a. Long periods between announcement and award create substantial stress and uncertainty on facility management and staff and may result in loss of staff or difficulties in hiring new staff.
  - b. Since NSF must naturally distance itself to a considerable degree from the incumbent facility management during recompetition, it is important that this time period be as short as possible
  - c. The time period should be short enough that the award occurs before the expiration of the current award.

## V. SOME SITE-SPECIFIC CONSIDERATIONS

NSF's major research facilities comprise an extremely varied set of institutions. Each has special considerations that should be taken into account in any recompetition. In this section we consider the special character of five classes of facilities.

**International facilities:** Large facilities increasingly have significant international partners. The partnerships take various forms. Some facilities are located outside the U.S.; some have significant foreign technical contributions; and in some, the NSF is a minority partner. The organization and management of these large international facilities are very different from each other. In recompeting large international facilities, the NSF needs to take into account their many unique intricacies.

We have found no fundamental issues for existing international facilities that make their recompetition impossible, although there are issues that make it more difficult. To minimize the disruption internationally, the intent to re compete a facility in the future needs to be taken into account up front when negotiating and developing the partnership agreements. Some of the special issues for recompeting large international facilities that we have identified include those listed below:

- Which entity should be the legal entity signing the partnership? If it is the initial awardee, then a new partnership agreement would have to be made with a new contractor. This could generate a significant barrier to recompetition. We recommend that the legal entity be the NSF, acting on behalf of the initial awardee.
- Are there special considerations to be taken into account to maintain U.S. responsibility regarding retention of employees, or assuring continuity of these responsibilities?

- Which entity owns or leases land, owns equipment, etc.? How should this capital investment be taken into account in recompetition?
- Scientific data, software, etc. need to be made available for smooth transition to a new facility manager.
- Arrangements with international partners often involve working relationships with individuals who are an important part of successful collaborations and these elements need to be considered in making changes in management.
- The timing of any recompetition needs to take into account when it makes the most sense for the overall international project, and when it will be least disruptive to international partners.

**Multiple-site facilities:** Several major facilities involve multiple, geographically distributed sites. In some cases, the overall facility management coordinates the overall program of independent subfacilities, like ships or fabrication facilities, while other cases involve scientifically distributed projects like NEON.

We found no fundamental issues preventing recompetition of such multiple-site facilities. The unavoidable duplication of infrastructure and personnel at multiple sites typically makes their operations costs higher than for single site facilities. There can also be mitigating advantages to multiple-site facilities that directly involve a number of local institutions and government representatives.

In considering recompetition of multiple-site facilities, an important management challenge is to implement a cost-effective facility that minimizes unnecessary duplication of infrastructure where possible.

**Big science projects:** For the purposes of this report, “big science” is defined by three projects in the current NSF portfolio: LIGO, ICECUBE, and the Large Hadron Collider’s U.S. instruments ATLAS and CMS. These are targeted experiments in which large teams pursue a few, well-defined scientific goals, in contrast to general-purpose laboratories or observatories which support a wide range of experiments or observations, often conducted by separate, small teams of users or even individuals.

Complex and focused experiments such as LIGO and ICECUBE require sufficient time to build, test, and operate before recompetition is feasible. Patience and flexibility are needed to build a stable staff and to commission instruments that will achieve the science goals. Regular management reviews should be undertaken during this commissioning stage. A plan should be devised in advance that defines a timetable for construction, debugging, and initial operations which could then lead to recompetition for the management.

LIGO and the LHC are both international projects and, thus, carry the same complications as other international facilities. In planning a recompetition, sensitivity to international staffing, international agreements and contracts, scientific data distribution, etc. is required.

The somewhat shorter and finite duration of some of these experiments may also differentiate these big science experiments from facility-class operations that typically operate for decades. This may influence the timing of recompetition.

With the above issues taken into consideration, we find it feasible to undertake recompetitions of the management of these big science projects.

**Consortium-operated facilities:** There is a range of sizes of consortia in the NSF facilities portfolio, which offer individual challenges that will need to be considered in recompetitions. One size does not fit all in considering the unique issues with facilities operated by consortia. Large consortia such as UCAR and IRIS, each with over 100 members, face the challenge of communicating effectively with the broad spectrum of their membership. Small consortia, such as NEON with 30 members, may communicate more directly with their members, but may not represent all interested parties and scientific perspectives across the discipline.

All consortia need to have transparency and concrete metrics for engagement with members. Consortia must be able to demonstrate open communication with a cross-section of its membership so NSF can be confident that potential problems with management or effectiveness of the organization are identified within the consortium membership and if appropriate, brought to the NSF's attention. Serious flaws in communication could be key in triggering a recompetition.

Large consortia offer interesting potential challenges for recompetitions since the incumbent facility management may involve all major U.S. academic players in a particular discipline. This both limits the potential bidders in a recompetition and poses a conflict of interest for most potential reviewers. Special efforts may be required to encourage bidders from within or outside the consortium. A two-step process involving a draft RFP or a pre-proposal may be an effective tool to survey potential bidders and to assist NSF in its approach to recompetitions. NSF should avoid attempts to break up a broad-based consortium that manages a facility merely for the purpose of facilitating a recompetition, as this will likely have negative impacts on the scientific users. Likewise, some consortia manage more than one related facility (e.g. AUI for Alma and NRAO, and AURA for Gemini and Cerro Tololo Observatories) and the NSF should take fully into account the effectiveness resulting from the sharing of people and services at a common site when considering recompetition for such facilities.

**University-based facilities:** Recompetitions of university-based NSF facilities presents certain unique challenges. In most cases, the facilities are highly integrated into the university administrative and academic structure, and the university usually makes a substantial contribution to both initial costs and ongoing operations of the facility. In return, the university reaps the prestige of having an important research facility on campus, their faculties have easy and regular access to the facility as well as the enhanced opportunity of interacting with outside researchers who make use of the facility, and the

facility offers excellent educational opportunities for both graduate students and often, undergraduates. NSF and, by extension the federal taxpayer, benefits from cost sharing by the university.

There are at least three mechanisms by which NSF can routinely maintain and enhance the quality and control the costs of university-based facilities. The main mechanism is the occasion of the renewal of the cooperative agreement between the university and NSF. If the university is underperforming in its management of the facility, NSF has various options ranging from steps to address specific problems to a decision not to renew the agreement. (The latter may result in the discontinuation of the facility altogether if, for example, the science has moved on and the facility is obsolete. Re-location of the facility to another university campus may occur; or it may be reconstituted as a non-university-based facility on the same site.) A second mechanism is available through the routine science and management reviews that NSF conducts regularly for all its facilities.

Recompetition is the third mechanism that NSF could use to maintain a high level of scientific productivity and management efficiency for its university-based facilities. In this case, it would be highly unusual for a recompetition to result in a complete disenfranchisement of the university from the facility. That would eliminate most incentives for the university to host the facility and would result in highly problematic separation of university-owned equipment from NSF-owned property. A more likely outcome of recompetition might transfer management from the university to a consortium structure in which the university would presumably be a major member. In structuring recompetition of university-based facilities, NSF must take into account the various incentives for the university to continue to host the facility as well as possible benefits that might accrue from an altered management structure and possible cost-sharing from any additional partners in the management of the facility.



### **Members of the ad hoc subcommittee on recompetition:**

1. **William R. Frazer** – Subcommittee Chair. University of California Provost, emeritus.
2. **Barry C. Barish** – Linde Professor of Physics, emeritus, California Institute of Technology. Member, National Science Board (NSB) 2003-2009.
3. **Jack Burns** – Professor in the Department of Astrophysical and Planetary Sciences at the University of Colorado (CU) in Boulder. He is also Vice President Emeritus for Academic Affairs and Research for the CU System.
4. **Gregory G. Deierlein** – J. A. Blume Professor of Engineering, and Director, John A. Blume Earthquake Engineering Center, Dept. of Civil & Env. Engineering, Stanford University,
5. **Margaret S. Leinen** – Associate Provost for Marine and Environmental Initiatives and Executive Director, Harbor Branch Oceanographic Institute, Florida Atlantic University. NSF Assistant Director for Geosciences, 2000-2007.
6. **Keith Moffat** – Louis Block Professor of Biochemistry & Molecular Biology, The University of Chicago; Deputy Provost for Research, 2002-10
7. **Bruce B. Darling** – Vice President for Laboratory Management, University of California.
8. **Arthur P. Ramirez** - Dean, Baskin School of Engineering, and Professor of Electrical Engineering and Professor of Physics, University of California at Santa Cruz.
9. **Adam M. Dziewonski** - Frank B. Baird, Jr. Research Professor of Science, Department of Earth and Planetary Sciences, Harvard University.
10. **Thorne Lay** – Distinguished Professor, Earth and Planetary Sciences Department, and Director, Center for Studies of Imaging and Dynamics of the Earth, University of California at Santa Cruz.
11. **Kerry A. Emanuel** – The Cecil and Ida green Professor Atmospheric Science at the Massachusetts Institute of Technology.
12. **L. Devon Streit** - Associate Director, Office of Laboratory Policy and Evaluation, Department of Energy. (Member of the NSF Business and Operations Advisory Committee.)

