Report by the Facilities Subcommittee of the National Science Foundation Business and Operations Advisory Committee

Following the May 1-2, 2006 Meeting of the Facilities Subcommittee

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Executive Summary

The Facilities Subcommittee (FS) of the NSF Business and Operations Advisory Committee met on May 1-2, 2006 at the National Science Foundation in Arlington, Virginia to discuss items provided in a meeting Charge to the subcommittee by NSF Chief Financial Officer and Director of the Office of Budget, Finance and Award Management, Thomas N. Cooley. The charge letter is included in this report as Appendix A. The Subcommittee was joined by a group of NSF-selected Facilities Operations Participants that have experience in the operations issues for large NSF scientific facilities. The participants were invited to join the meeting in order to provide directly applicable expertise to the subcommittee in its work. Following the meeting, the subcommittee refined the conclusions that were arrived at during the meeting, derived some specific recommendations and prepared this report for submission to the full Business and Operations Advisory Committee of NSF.

This report was submitted and presented to the NSF Business and Operations Advisory Committee at the Spring 2006 Meeting held on May 18-19, 2006 at NSF. Following a two-week comment period, this Facilities Subcommittee report was accepted and its conclusions and recommendations endorsed by the full Business and Operations Committee and transmitted to the NSF management.

The main topical focus of the subcommittee in the May 1-2 meeting, and in this report, was the manner in which NSF *operates* their large scientific facilities and how these operations are integrated with the facility construction period, the program of advanced R&D for scientifically productive facility evolution and the planning for eventual decommissioning and closeout of the facility. Another issue that occupied considerable attention during the meeting was assessment of the proper role of *risk management* for responding to large, time-uncertain equipment or plant failures in NSF facilities that suddenly require large cost outlays and how the NSF might address the funding impact of such events in a systematic and productive manner across the agency. The subcommittee systematically identified with the facilities operations participants, a '*best-practices'* management approach for addressing the various operations questions and issues posed in the NSF charge to the subcommittee.

From the discussion during the meeting, captured in the detailed written sections of this report, the subcommittee arrived at some *key conclusions* provided in the last section. To summarize its recommended responses to these key conclusions, the subcommittee provides a number of specific recommendations to the NSF management:

Recommendations of the Subcommittee:

1. It is recommended that NSF conduct *annual operations reviews* of large, NSF-led large operating facilities, preferably co-organized by the cognizant NSF program officer and the office of the Deputy Director for Large Facility Projects; these reviews should be conducted with the participation of outside expert peer consultants, and may or may not in the same forum, involve the assessment of the ongoing and future scientific program of the facility.
2. It is recommended that NSF collaborate with the lead sponsor of large operating facilities in which NSF has a non-leading operations role, to perform appropriate annual operations reviews of a suitable type for confirming the successful carrying out of NSF's role in the facility operations.
3. It is recommended that NSF institute in its large operating facilities, a systematic program of *formal risk assessment* to identify the potential cost and operations impacts of non-recurring events along with an assessment of their probability of occurrence.

4. It is recommended that NSF institute with its large operating facilities, a continuing program of assessment and planning for *Advanced R&D* that will enable these facilities to evolve with their scientific program and best meet the needs of the research community; the facility's program manager should be closely involved in the facility evolution and the supporting Advanced R&D planning.
5. It is recommended that NSF institute for its large operating facilities, a process for projecting the anticipated termination of the facility along with the costs and legal requirements of this action; this process should create and keep current, a plan for the *facility termination and closeout*.

The subcommittee concurs unanimously in the content of this report.

Main Report

Introduction

The NSF Business and Operations Advisory Committee decided in the fall of 2004 that it had a sufficient number of issues and questions to address about the NSF process of approving plus the actual construction performance of Major Research Equipment and Facilities Construction (MREFC) projects, that it decided to create a Facilities Subcommittee (FS) to study the issues and report to the full B&O Committee. The B&O Committee did not wish to address questions concerning the scientific mission of the facilities since this is the purview of the NSF Science Board. It did, however, conclude that many of the *project management topics* were definitely within its purview and would benefit by the formation of the FS. The subcommittee was formed and has reported twice to the full committee, once in the spring of 2005 and again in the fall of 2005. The members of the FS are listed in Appendix C of this report. In both cases, a written report of the subcommittee, responding to the topic-specific meeting Charge prepared by the NSF Office of Budget, Finance and Award Management (BFA), was accepted and endorsed by the full B&O Committee following minor requested edits of the reports. The two earlier subcommittee reports dealt largely with issues of project management in the construction phase and the relationship of these issues to the newly created NSF Deputy Director for Large Facility Projects (DDLFP) and the proper role of this BFA official to the construction projects and their management.

The present report derives from a consensus of the NSF BFA management and its B&O Committee that there were many facilities issues beyond the approval and construction of MREFC projects. Specifically, the pre-project preparation of scope, technologies and R&D funding as well as critical planning for the operations period, including its budgeting, were of at least comparable importance and were critical to the overall achievement of an optimum scientific program in the assistant directorates with large operating facilities. In the same discussions, the issue of facility decommissioning and closeout arose and it was apparent that little or no attention has been given to this issue in the NSF. A typical characterization of the full span of these related topics and issues is the 'cradle to grave' approach for planning all the phases of large facilities. It is now generally considered to be a *best practice* for NSF and facility management to address the full facility lifetime span starting with the construction period for new facilities and to initiate this kind of assessment and planning for already operating facilities. In this light, the BFA charged the FS to study and report on some questions that NSF sought advice and commentary on. The specific charge for the May 1-2, 2006 FS meeting is provided in Appendix A of the present report.

At the immediately preceding meeting of the FS, the BFA conveners proposed to include in the meeting, a small group of experts having relevant NSF *facilities construction project experience* in order to enhance the reach of the FS members and to broaden the experience base relevant to the issues under discussion. Following that meeting and its written report, the BFA managers and the FS members agreed that this addition to the discussion was very valuable and the same protocol was followed in the May 2006 meeting, but with a new group of NSF *facilities operations experts* chosen by the BFA managers following the solicitation of suggestions for expert participants from the FS. The Facilities Operations Participants who participated in the meeting are listed in Appendix D.

In all of the meetings of the FS so far, a relatively novel meeting structure was adopted by the FS in which there were no prepared formal presentations to the subcommittee. Instead, specific discussion topics taken directly from the meeting charge to the subcommittee were scheduled and the meeting

report derived from the substance of these discussions. The Agenda for the May 1-2, 2006 Meeting is provided as Appendix B of this report. In order to accurately capture in the written report, the remarks of the expert participants that were not subcommittee members, each participant was asked to submit a concise version of his or her remarks by email to the FS to ensure accurate recording of these views. These written contributions were held in confidence within the FS. The subsequent written report was drafted, edited and submitted by the entire subcommittee working together by exchange of written report drafts. The FS was pleased with this method of proceeding and continued it for the present report.

During the meeting, consideration of the discussion topics from the Agenda took place among the FS, the expert facilities operations participants and various NSF program managers that attended all or part of the meeting. Near the end of the meeting, all the participants in the meeting took time to identify the *key conclusions* that had been reached. Notes were taken by the FS chair and by other participants and the subsequent FS report relied upon these, together with written report text from FS members and some of the participants. The written report itself was created by the FS members and edited to produce a document that all FS members concurred in. Following completion of this written report, it was presented to the full B&O Committee at their May 18-19, 2006 Meeting at the NSF in Arlington. The submitted copy of the report was received by the B&O Committee and considered for adoption by the full Committee. Following a two-week comment period, the Facilities Subcommittee report was accepted and its conclusions and recommendations endorsed by the full Business and Operations Committee. The report is now transmitted to the NSF management for their use.

Discussion Topic 1 - NSF Oversight and Stewardship Roles in Large Facilities

The charge letter to the subcommittee from the NSF contains as bullets 1-3, the following questions for consideration and commentary by the subcommittee and the facilities operations participants: Bullet 1 - *"What do you see as the scope of NSF's oversight role of large facilities at the operations level? What role should the Large Facilities Office in BFA have in contributing to this oversight?"*; Bullet 2 – *"Is NSF effective at providing oversight, as distinguished from management, of operational large facilities? What can NSF do to improve mutual understanding of the respective roles, values, and objectives by NSF and its research community?"*; Bullet 3 – *"Do Cooperative Agreements provide sufficiently comprehensive directions to Awardee institutions in carrying out their stewardship roles of operating NSF-funded large facilities? If not, what should/could be changed?"* The subcommittee with the facilities operations participants discussed these questions during the meeting. The subcommittee then formulated the commentary that follows here for this written report.

With regard to Bullets 1 &2, there was a consensus that in the operations phase, the overall NSF oversight is adequate and has an appropriate scope in regard to the questions posed in the charge to the subcommittee. Because there is a wide spectrum of practices among the large NSF operating facilities, it should be noted that many of them are already operating in an effective management environment and their relations with the NSF program manager are good. In these cases, the reporting duties and responsiveness appear to meet the agency's needs and the oversight is adequate to maintain successful facilities operations as well as a timely evolution of the facility's capability to respond to future scientific challenges. As an example of a well-performing NSF facility, we append to this section of the report, some comments from a participating operating facility expert.

On the other hand, there are several areas where improvement is needed. The non-uniform practices, across the agency, for evaluating and overseeing large facilities in the several NSF directorates give rise to a somewhat questionable management posture for the agency as a whole. In this circumstance, the Large Facilities Office (LFO) could provide a valuable role in normalizing management *standards* across the agency, while not prescribing the *implementation* of the standards in a 'one size fits all' formulation. The subcommittee perceives that the involvement and influence of the LFO in the management of large facilities is small or non-existent at present, and that this circumstance is missing a significant opportunity for improving those large NSF facilities presently less well managed and overseen in their operations and facility evolution. A 'best practice' for the agency would be to pursue an appropriate level of involvement by the LFO in normalizing the standards for large facilities operations and evolution across the NSF.

We provide next, some general observations about the most important practice that the subcommittee identified for large facility operations oversight, namely the performance of annual operations reviews. The subcommittee consensus was clearly that annual external evaluation was healthy and valuable for the accountability for a federally funded operating facility. The way in which that is accomplished should be tailored for each situation to avoid adding undue excess burden. For example, if NSF is a non-leading partner, it could observe or participate in the lead partner's annual review or equivalent process. Since NSF operates facilities through operations contracts to and Cooperative Agreements with not-for-profit entities, often composed of academic or research institutions, the managing organization is able to provide or collaborate with NSF in a peer review external to the management of the facility that also satisfies the organization's due diligence as contract holder.

The LFO in BFA can play a complementary role to the NSF program officer in contributing to oversight of a facility operation, especially in assuring good and uniform *management standards* for

large facilities across the agency. It is crucial that scientific performance metrics and measures of research community satisfaction be developed within the NSF research division in close collaboration with the management of the facility. These facility-specific metrics and measures should implement the more general policy standards set by the NSF and assure that the standards are met. The facilities directors invited to participate in the subcommittee meeting generally felt that the NSF program officers in the scientific divisions were doing a very good job in providing management oversight. BFA can add the perspective of management efficiency in business and administrative services of the facility and assurance to NSF that its agency-wide management standards were being met. The LFO could provide significant value added by collecting and sharing best practices among large NSF facilities. Given the usual pressure to keep administrative overheads low within the facilities, LFO may also employ some limited resources to undertake benchmarking activities such as determining typical costs of facilities maintenance or competitive market values for key personnel using national searches. The extent to which LFO can provide such data could improve overall efficiency and provide a more sound basis for evaluation of functional efficiency of the facility.

A concern was raised over the request by NSF for data on performance on a very short notice. It is recognized that sometimes this is necessary but it can place a large administrative burden on facility staff. Perhaps this is an area were the collective experience across the foundation on performance metrics can help program managers plan for such data collection in a timely and organized manner. Facility management is helped if the facility managers are informed of the outcomes of data use.

Reporting requirements under some Cooperative Agreements are extensive (Quarterly and Annual Programmatic reports and Financial and Administrative reports). In addition, these requirements are often supplemented by requests for reports responding to Site Visit Evaluation reports which, depending on the type of facility, may double the number of reports required in any 12-month period. In view of the substantial sums of money involved, such reporting seems justifiable, but the potential burden on the facility should also be recognized. It is, therefore, recommended that, as far as possible, NSF standardize the reporting requirements using templates where possible to keep the reports brief and succinct.

Frequently, program plans are presented a year before the (often lower) facility budget levels are known. There is no apparent feedback path on what program elements need to be dropped. This leads the facility to appear to users to be making arbitrary choices when, in reality, the facility management is adjusting to budget reductions. Centers usually have little choice but to plan budget levels using the Presidents Budget Request as their only available guidance.

When considering the above comments, it is important to say that there are different approaches at both the directorate and program manager level across the NSF, and oversight ranges from comprehensive to perhaps sub-minimal. There is a clear role for the Large Facilities Office to ensure that all programs are exposed to and have the opportunity to use proven '*best practices*' as well as to assure that all facilities have an effective level of oversight appropriate to their size and mission. The Large Facilities Office can also help define clear facility oversight roles for the program managers, visiting committees, etc. across the agency. International partnerships for the management of large facilities operations where NSF is not the lead partner are a particular challenge from the perspective of the agency as it attempts to maintain a credible posture in the management of public funds. This situation has led to circumstances where it is not clear 'who is in charge'. Where NSF is clearly the lead funding agency, there can be substantial advantages. NSF, however, can be buffeted in an international consortium where it is not the lead sponsor. NSF facility program managers are key individuals under these circumstances and can operate most successfully as both proactive policemen

and program facilitators. The NSF program managers must be key players in facility operations oversight.

Bullet 3 addresses the issue of NSF Cooperative Agreements (CA). Again, there was a consensus that this is "something NSF does well". Cooperative Agreements seem to be good vehicles for providing the framework for Awardees to operate facilities. It remains true that, independent of the budget envelope for the long-term award totals, the actual award is adjusted annually and, because of the nature of the federal budget process, especially as it is must be implemented in the case of the NSF, quite late in each fiscal year. Nevertheless, it is important that the scope of work for the fiscal year be renegotiated formally after the amount of the annual award is settled so that NSF shares responsibility with the Awardee and facility management in the outcomes for the year. We also note that many current and future large astronomy projects involving NSF are complex partnerships that can involve private and state institutions and foreign entities. The subcommittee wishes to point out that such agreements need very clearly defined roles, responsibilities, and deliverables. Another observation is that the governance and management of a large facility should be structured so that, on one hand, the NSF has a share of influence proportional to its investment and, on the other, that the facility has an accountable and effective management structure that allows the managers to make the most cost effective decisions as free of partner political considerations as possible. Finally, we note that NSF aspires to a 'best practices' level of management performance and accountability and is exploring with this subcommittee practical ways of achieving that goal. If a facility operations partner is promising a deliverable at fixed price, on an agreed-upon schedule, to what degree can the other partners, such as NSF, demand reviews and specific practices? The mix of cultures, both public vs. private and US vs. foreign, can probably not be resolved with the same standards that NSF can apply to the activities over which it has more direct oversight or holds the lead sponsorship role in the collaboration.

The subcommittee believes that the CAs are clearly the proper place to define the oversight roles addressed above — a circumstance that implies a role for the Large Facility Office. There was some discussion of contracts vs. CAs in the meeting with no firm guidelines other than that contracts might be preferable when there are fixed deliverables and a mission that is not expected to evolve over time.

Among smaller issues discussed, a point was raised regarding the approval of Amendments to Cooperative Agreements: In this electronic age, Cooperative Agreements between NSF and the Awardee's Institution are not signed. Instead, the Awardee signifies acceptance of the terms and conditions when he/she first draws down funds against the Agreement. However, a similar opportunity does not exist for the Awardee in the event of amendments to the Agreement. Instead, the Awardee is invited to contact the Grants and Agreements Official or the Program Officer within 30 days with any questions. This approach seems to favor NSF and place the Awardee at a disadvantage. It is recommended that, at a minimum, NSF should send a draft of the terms and conditions of the proposed amendment to the Awardee, with a 30-day comment period, before the amendment is formally issued.

Cash flow can also be a serious issue for any facility. The BFA Chief Financial Officer, Tom Cooley, observed that the NSF culture does not allocate funding until the final authorized budget is known to NSF. NSF policy is to distribute 95-100% of the previous year's authorization. This allocation was 90-95% in FY2005, as the result of 1-5% across the board rescissions. But even in that case, NSF actually sent 90% out to the programs. Ultimately, the cash flow is in the hands of the program managers and there must be a close working relationship between CA awardees and these program managers. Expanding on this point, we note that it is essential that there be good stewardship of the facilities across the board from facility operations to science output. As stated above, this principle implies that facility program managers are key individuals that must be both policemen and facilitator.

It is in issues such as cash flow and science output that being a pro-active program manager facilitator comes to the fore.

Comments on the NSF Ocean Drilling Program:
"Over the course of NSF's history, the Foundation has managed large, complicated facilities within a science Directorate that have underpinned successful scientific research programs. From 1983 through 2003, NSF managed a state-of-the-art, dynamically positioned scientific ocean drilling vessel through a contract to Joint Oceanographic Institutions (JOI). The vessel, the JOIDES Resolution, sailed almost continuously over this period, and served as the scientific platform for 110 scientific expeditions of the Ocean Drilling Program, funded by a consortium of 23 Nations led by the US. During the course of the program, several first-order scientific outcomes were achieved. These include delineating all of the basic tenets of plate tectonic theory, determining and quantifying global environmental changes over the past 100 M.Y., including rapid climate changes and climate extremes, and discovery of methane hydrates and a vast deep biosphere of planetary scale.

Funding for the program, and hence the facility, was provided by 23 Nations. These funding contributions, which arrived at NSF throughout the year, mitigated the potential risk of funding cessation owing to the overdue appropriation of US funds.

The ship operated remotely for 20 years, ice edge to ice edge, in all of the world's oceans and was rarely in US waters. All of the planning, delivery of supplies, scientific equipment, other logistics, scientific and technical staff, etc. was planned and delivered by Joint Oceanographic Institutions and its subcontractors at Texas A&M and Columbia Universities. The facility was managed by JOI in close consultation with the leadership of the Ocean Sciences Directorate (OCE) and a robust international science advisory structure that provided input for science priorities as well as the scientific performance characteristics of the ship and shipboard laboratory facilities. Working together, OCE and JOI not only provided for nearly continuous operation of the scientific drilling vessel, but plans were made and then executed for two dry dock periods during which the ship was refurbished and inspected. Successful continuous operations required the careful planning for risk mitigation, including such issues as loss of drill string, loss of the ships dynamic positioning capability and other risks.

JOI operates under both a contract with the NSF for the US component of the Integrated Ocean Drilling Program and cooperative agreements for the US Science Support Program for Ocean Drilling and for the ORION program Office which supports planning for the Ocean Observatories Initiative. JOI believes that funding instruments have been useful in providing services and support for scientific research. JOI has found that the contract for the drilling vessel and other services within ODP has been important as the contract delineates the roles and responsibilities for both NSF and JOI and provides space within which JOI can operate mostly independently without intrusive, detailed oversight. Within this space, cost, schedule, and performance criteria were clear and well defined. Cooperative agreements on the other hand have proved useful for situations in which the services to be provided were not as clear and the circumstances affecting the nature and timing of services was more varied and required extensive discussions with NSF program managers." – Dr. Steve Bohlen, President of the Joint Oceanographic Institutions

Discussion Topic 2 - Risk Issues in Formulating Facilities Operating Budgets

The charge letter to the subcommittee from the NSF contains as bullet 4, the following questions for consideration and commentary by the subcommittee and the facilities operations participants: Bullet 4 - *"What process should be used to develop and assess the validity of a proposed operations budget? How should risks be factored into the proposed budget, especially in consideration of OMB Circular A-21[1], 'Cost Principles for Universities,' and OMB Circular A-122[2], 'Cost Principles for Non-profit Organizations,' which state, 'contributions to a contingency reserve or any similar provision made for events, the occurrence of which cannot be foretold with certainty as to time, intensity, or with an assurance of their happening, are unallowable.'."* The subcommittee with the facilities operations participants discussed this topic during the meeting. The subcommittee then formulated the commentary that follows here for this written report.

[1] See website URL, http://www.whitehouse.gov/OMB/circulars/a021/a021.html
[2] See website URL, http://www.whitehouse.gov/OMB/circulars/a122/a122.html

The Subcommittee considered the questions in the topical charge above, on the processes that should be used to develop and assess proposed operating budgets for large NSF facilities, specifically as these address the topic of cost risk for significant facility equipment and plant failures. The issue of assessing risk in the operations of large NSF facilities is closely connected to the issue of maintaining a management contingency or reserve to offset these risks as addressed in the OMB Circulars, A-21 and A-122 quoted in the charge. In this subject area, the subcommittee's view was that the issue of funding contingencies or emergency expenses must be approached realistically if NSF is to claim that it self-insures operational facilities with time-critical activities. Prudent management will undertake preventive maintenance for limited lifetime items and will hold planned major capital items until near the end of the fiscal year to allow for unforeseen failures with moderate (2-5% of annual budget) impacts. A failure that costs 25-100% of an annual operating budget cannot be handled by the facility; it cannot dismiss half its staff for a year to replace a piece of hardware. The question is, at what level can NSF hold agency-wide contingency of that dollar magnitude - Division, Directorate, or Foundation? By what process would such funds be dispensed? Since the events would be unique major failures, risk management analysis techniques would be in the realm of small number statistics, but less so if considered and mitigated across the entire NSF. A challenge is that the first event in a year could exhaust a single facility's fund, paralyzing that facility at the occurrence of a second event. Even at the Foundation level, it is possible that the funds would be spent out by the end of each fiscal year. If an NSF-wide self-insurance approach deliver cannot deliver realistic protection, commercial insurance could be considered as a funding backup.

In this light, the processes used by NSF to develop and assess operating budgets for large NSF facilities include an approach to incorporating the evaluation of risks inherent in these operations within the budgeting process. The following suggestions, if accepted, would require the preparation of operating instructions for all such Foundation facilities to achieve the purposes outlined.

The preparation of a proposed budget for an operating facility is an annual affair. The validity of such a proposed budget can first of all be tested against the budgets approved and their utilization in past years. In doing this, due consideration must be given to the fact that these budgets are, in reality, the summation of estimated costs for a list of activities that the operation is responsible to conduct, personnel costs and burdens that the operation must employ and a variety of general and special costs that are characteristic for this and similar operations. While the list of items being estimated here are '*known-knowns*', the costs associated with them are not precisely known, and that is why the term "estimated" is used here to describe the costs presented. These costs are estimated or projected for

known events and activities that are planned to occur in the future year. They are not actual costs that can only be provided in a following audit of past events and activities. And, since they are estimated costs, they cannot be held to the standard of being actual costs. They must be seen to be inherently subject to the uncertainly of the estimating process. A good estimator will come close to the actual value of the projected costs. But a good estimator will always seek to project his/her estimate adequate to cover the likely actual costs.

The uncertainty in projecting cost estimates of future known performance or events is well understood by those who make estimates. The precise labor hours required to produce a particular piece of work or product, typically cannot be determined with absolute certainty. The actual hours required can be affected by many local or unanticipated circumstances. Therefore, the estimator, knowing this, will provide the estimate for the hours required with an allowance to accommodate this uncertainty. The known labor rates that are applied to the labor hours will be based on certain assumptions of the labor grades and thus pay rates and associated employee benefits that are likely to apply to the type of work and the skill levels required. Again, the skilled estimator will consider the likely mix of labor force and associated rates to be involved and calculate a labor cost that will include the uncertainly of the process involved.

Similar estimating processes will be employed in determining the value of estimated costs for the known materials to be used and the known services that are expected to be required by the operating organization. And, since this hypothetical operation for which an estimated operating budget is being prepared, is in the business of performing scientific research, the recognized inherent uncertainties associated with the processes of discovery and confirmation are expected to apply.

As the facilities provided for this scientific research activity are utilized, they will require routine cleaning, maintenance and minor repair. How much of each will be required in a given year will be included in this estimate. The experienced estimator will use such analysis methods as parametric analysis, looking back at the past year, and/or trend analysis to arrive at the estimated amount and cost of such cleaning, maintenance and routine repairs for the year in question. The result is an estimate and it will inherently reflect some reasonable level of uncertainty about the future and future needs.

The entire development of a proposed operating budget, covering all the known needs and requirements, when done by a skilled and experience estimator, will represent the best values for the costs of all the known, expected activities and staff for the coming year. The estimate will reflect in its numbers, the uncertainties inherent in attempting to accurately reflect the expected cost of known future events. If the budget does reflect all such information, then it is a good budget submission. It contains all the known-knowns regarding the facility operations. While the expert estimator will ask for a small contingency to cover “those things we forgot” or that could not have been anticipated (an unexpected need to replace a major air-conditioning plant, for example), it is the current policy of the government, as expressed in the OMB circulars quoted in the charge above, that a simple contingency to cover such items, is an unallowable cost item if explicitly included in the budgeting process.

Looking further at the budgeting process, there are operational issues that this budget does not address. What’s to be done here with the ‘*known-unknowns*’? Known-unknowns are such items as the roof that has an expected useful lifetime but, as that time period approaches, already has some minor leaks. Full roof replacement is a relatively large cost item that would not fit into the routine cleaning, maintenance and minor repair budgets. It’s a major cost in the realm of an operating budget, but it is not yet a known-known. It is unknown just when the roof must be replaced. The same can be said for such items as air conditioning compressors, electrical transformers and switch gear, road repair and resurfacing, and audio-visual and IT equipment and systems within the facility. There are many such

items in a large facility. When these items require replacement or major repair, they become major draws on the operating budget. But the operating budget to be submitted cannot include a contingency, as noted above, that would otherwise be a suitable source of funds to cover such known-unknown events. So what can be done to protect the operation and the Foundation from the potential facility down time that such events could cause?

It could be argued that, because such events are anticipated to require attention at *some* point in time (but the point in time for each is unknown), the Foundation, as the holder of all such assets developed under its programs, would be well advised to hold a "rainy-day" fund (for lack of a better name) which could be drawn upon by a facility, under its Cooperative Agreement, when the unknown time of such an event becomes known by actually occurring.

To initiate such a risk-averaging program in the annual budgeting process, as an attachment to, but not an included part of, the budget submission, the facility management should be asked to provide an expected total cost for repair or replacement of each of the major facility operational items that have defined useful lives and the date when the manufacturer, supplier or suitable expert indicates that this date would be reached. It would also be possible to have this information included in the form of an accounting accrual amount for each year, leading to the accrual of the full repair or replacement sum on or about the date of the expected useful life. In this way, the Foundation, looking to the highest level in the agency's funding from Congress, could include in its funds management, a pool of funds that could be accessed through proper application and justification, to carry out the timely repairs or replacement of these major items throughout the NSF complex. Whatever the path chosen, an orderly and predictable future for the timely replacement of essential assets for the many operating research facilities that exist under the mantle of the NSF should be provided.

All this could well be a part of a more formal Condition Assessment and Asset Management Plan approach to operating the enterprise. Such CAAMP systems are currently in use elsewhere in the government and provide timely insight for planning and preparing for repair and replacement of assets whose useful life is expiring. Such a system would also fit with the following suggestion.

Looking further into the management of the major facility responsibilities, the following suggestions are made. The final consideration in budgeting for operations of the major scientific and research facilities of the Foundation should consider the uninsured and unfunded risk basis for the ongoing facilities. These are typically risks that are always there, to one degree or another. In the context of this report, such risks may be characterized as the '*unknown-unknowns*' and may be best identified and described with the use of a Risk-based presentation. These are such things as "Acts of God", i.e. tornadoes, hurricanes, floods, earthquakes, volcanic eruptions, forest fires, etc. with the added insight of the impacts and damages to be expected at the various NSF facilities from such credible, albeit unpredictable by location and timing, events. There may also be special risk considerations. For these, the information about the definition of how great the risk, and what the impact and duration are, is important. Such occurrences might include the actions of a Native American council to cut off the power supply or the source of water to a facility. Or the risk might arise from civil unrest, pirate threats on the high seas, or a terrorist attack. A number of these risks could be the subject of a comprehensive insurance program for a global organization; but because the Foundation is, in-effect, self-insured as an institution of the federal government, an appreciation of the risks covered under that self-insurance should be an important piece of management information.

These are but a few examples of the range of unknown-unknown risks that, in a well-run business, would be identified by the individual site, and then described, quantified to the degree available, and the mitigation measures described that are available to minimize the impacts and costs. It may be

appropriate for the Foundation to have a work-up of the risk exposures that its assets represent for the purposes of planning and discussions within the government. Such information could be provided as a component of each facility's annual operating budget submission. It would not go forward with the operating budget submission, but would be used by NSF to develop the Foundation Risk Profile and to provide a basis for planning and sharing mitigation measures from one site that could be effective in reducing another site's operational risk exposure.

An example of the form that such a risk-based analysis and presentation might take is provided in the Excel-based Chart attached as Appendix E. The format and instructions to be addressed by each facility should be fairly well structured to allow Foundation management an efficient means to compare, group and sum-up its agency-wide risk exposures and to identify effective mitigation measures as might be used by other facilities, all as may be useful to management.

Discussion Topic 3 – Effective Scientific Productivity and Lifetime Issues

The charge letter to the subcommittee from the NSF contain as bullets 5 and 7, the following questions for consideration and commentary by the subcommittee and the facilities operations participants: Bullet 5 - *"Are there steps that NSF can take to improve its assessment processes that ascertain the state of facility performance? How can oversight encourage maximum scientific productivity, and how will NSF know it is achieving it? Are there new approaches that should be examined that would be especially helpful in the assessment of the operation of large distributed facilities, including those that have a very large software component that must be sustained?"*; Bullet 7 - *"What considerations should be addressed in projecting the facility's operational lifetime and what provisions should be addressed for projected facility closeout?"* The subcommittee with the facilities operations participants discussed these topics during the meeting. The subcommittee then formulated the commentary that follows here for this written report.

The management role of the NSF Deputy Director for Large Facilities Projects (DDLFP) is to provide templates of best practices for the assessment of facility performance. There was general agreement among the meeting participants that this assessment should include thorough, periodic peer review of *facilities operations*, and to distinguish this review from the assessment of the direction and effectiveness of the *scientific program* of the facility (which is separately assessed by scientific peer review). *Self-evaluation*, as now carried out by some NSF facilities managers, has an appropriate and useful role for internal performance assessment but is *not sufficient* or a substitute for, periodic facility performance assessment utilizing peer reviews by panels of well-qualified experts. All cooperative agreements that fund operations should incorporate appropriate metrics for success to guide these reviews. In a number of cases, NSF is not the sole or even the lead source of operating funds and other stakeholders perform the primary oversight. In such cases NSF does not need to take full responsibility for assessment, but may wish to be a participant in the lead sponsor's review process at an appropriate level.

Software is a large effort and budget component of operations activities in a broad range of facilities. The associated activities and procurements require careful planning and budgeting and, in recent times, this issue has received increased attention. Extensive use of mock-data-challenges (the detailed simulation of the facility instrumentation's production and characterization of raw data, together with the planned handling of this data and its distribution and analysis in the collaboration) has been successful on many projects during facility construction as an effective way to prepare for the software and computing phase of operations. Nevertheless, the software component requires continuous maintenance and upgrade during the operations phase in most MREFC-funded projects and must be carefully projected and planned for by facility management. One problem that seemed to be a concern within the discussion group at this meeting was turnover of software staff. The subcommittee notes this issue but has no particular advice to offer.

There was general agreement in the subcommittee and meeting participants that issues and costs of decommissioning and closeout of facilities should be initially addressed during the construction phase of all major NSF facilities projects. These costs are real but, in competition with funding for new projects, they are not likely to attract sufficient support in the construction phase to develop reliable estimates and to keep these estimates current throughout the lifetime of the operating facility. The NSF should explore an effective oversight mechanism, possibly initiated by the DDLFP, to deal with this issue and provide NSF with the appropriate level of planning for these future impacts and expenses. The fact that the lifetime of a given facility may be highly uncertain is not an excuse for ignoring the question or for tracking the costs during the facility operations period.

Discussion Topic 4 – Funding Balance Between Operations and Advanced R&D

The charge letter to the subcommittee from the NSF contains as bullet 6, the following question for consideration and commentary by the subcommittee and the facilities operations participants: Bullet 6 - *"Are there oversight mechanisms that would better inform NSF of the funding relationship between concurrent operational and advanced R&D activities conducted under the same award? NSF needs to be able to understand how to sustain adequate operational funding for a facility when variable levels of total facility funding are encountered, without 'robbing Peter to pay Paul'."* The subcommittee with the facilities operations participants discussed this question during the meeting. The subcommittee then formulated the commentary that follows here for this written report.

The operations stage of a facility lifecycle covers the use of the facility for its intended purpose. The facility managers are responsible for ensuring that the facilities are operating efficiently and cost-effectively, and for pursuing modest and intermediate scale technical enhancements to maintain the state-of-the-art research capabilities of the facilities. As a result of these scientific mission capability enhancements, the facilities evolve so that they can continue to address the research questions that motivated the original facility construction investment. The need for continuing advanced R&D to enable productive facility evolution is addressed in the original agreements and it is expected that R&D is included as a component of operations. The amount of advanced R&D for a given facility is dependent on a number of factors including the potential value of enhancements viewed in the wider scope of scientific capability and competitiveness in that field of research, together with the evolving scientific interests of the facility's own research community.

The relationship between concurrent operations and advanced R&D activities is part of the more general question concerning the appropriate level of funding for facility operations. It is essential that the NSF program staff be sufficiently engaged in facility oversight activities to understand priorities, risks and consequences, and value to the research community from various facility operations funding levels. The Cooperative Agreement between NSF and the institution responsible for operating the facility should define the primary mechanism of NSF oversight. An annual operations review, charged by the NSF program office and carried out by a peer group, will provide an appropriate level of oversight and provide the information needed to evaluate past performance and determine future funding levels, including advanced R&D.

The subcommittee recognizes that the management of any given facility, and to a somewhat lesser extent the regular users of that facility, will plan and operate as though the facility will go on operating and being improved and updated indefinitely. This may or may not be a valid projection as the scientific circumstances of the facility and its scientific reach evolve but it is certain that without any investment in advanced R&D, the competitiveness of the facility will decline. For this reason, the subcommittee feels that an aggressive interest must be maintained in the opportunities for advanced R&D by the facility's management and, perhaps even more important, by the NSF program officer who, in addition to his/her facilities oversight duties, is also responsible for looking ahead to the general health of that scientific field and evaluating and projecting the potential future value and contributions that this particular facility will make to that field. We suggest that the evaluation of each large NSF facility in its yearly operations reviews include a section on the plans for advanced R&D and relate these plans to the anticipated evolving mission of the facility.

Key Conclusions and Recommendations

The discussion topics on the Agenda engendered a number of *key conclusions*, generally along the lines of commentaries by the participants combined into agreed-upon observations that resulted in the key conclusions reported below. The bullet points in the formal charge to the subcommittee contained a total of 12 specific questions. In each of the topical sections above, these questions are addressed and the subcommittee's responses supplied. The related key conclusions enumerated here emerged from the discussion sessions and were identified as key conclusions near the end of the meeting.

Key Conclusions of the Subcommittee:
Most of the NSF facilities managers are perceived to be satisfied with NSF oversight and believe that it is working; some small points were noted about reporting categories and deadlines but these were not major issues. The subcommittee, in collaboration with the facilities operations participants and NSF staff members, identified some key conclusions during the latter part of the meeting, refined them for this report and presents them here. The key conclusions are provided in no specific priority order:

1. Large Operating Facilities of the NSF require substantial oversight in the form of (at least) *annual expert peer reviews of the facility operations* conducted by the NSF; these reviews should include outside expert consultants acting as agency advisers; the Deputy Director for Large Facilities projects should collaborate with the Program Officer in planning and conducting these reviews.
2. Large operating facilities in which NSF is not the lead sponsor should also have annual operations reviews as prescribed by the lead sponsor in which NSF participates at an appropriate level of involvement and, in which reviews, NSF issues and concerns are substantially addressed.
3. The assessment of the scientific program and the future scientific direction of a large NSF facility is distinguishable from the review of facilities operations and may take place by other means and at other times; however, the plan for *advanced R&D* by the facility and its role in facility evolution should be included as part of the annual operations review.
4. *Self assessments* of large facilities operations can have significant value for the managers of the facilities but this type of internal assessment cannot take the place of NSF-organized, peer reviews with outside expert consultants.
5. The software and computing function in large facilities operations is important and growing; the use of '*mock data challenges*' (detailed simulations of the facility's incoming data stream, its distribution and analysis), starting early in the construction period and continuing into the operations period, is an important indicator of the adequacy of the software and computing planning for the facility and its future evolution.
6. The issues of *facility termination and closeout* at the end of the facilities' scientifically competitive life are important to identify and plan for; annual review of an evolving plan for the decommissioning and disposal of the facility assets and environmental obligations needs to be systematically considered as part of the facilities operations mission.
7. The perceived Office of Management and Budget strictures against the identification of a contingency reserve in operations budgets to mitigate against potential future large-cost risks in large NSF facilities (OMB Circulars A-21 and A-122) represents an issue in which the interpretation of OMB guidance will need intense further study; the subcommittee did not arrive at a definitive position on the best practices to follow on this issue.
8. The introduction of a disciplined risk analysis methodology for identifying the significant risks for rare or time-uncertain large cost impacts in the operation of NSF large facilities is a *best practice* for such facilities; the subcommittee urges the NSF to introduce and practice such a cost risk methodology in the mitigation and analysis of the risk circumstances of its large operating facilities.

9. In the process of creating and amending Cooperative Agreements (CA) between NSF and institutional managers of large facilities, the terms and conditions in the agreements need to be well understood and agreed to by both parties; in the case of CA amendments, the agreement process needs to be tightened up so that both parties are aware of and explicitly agree to the terms and conditions in the amendments.
10. The NSF needs to develop an effective process and workable protocol for funding *Advanced R&D* in the context of an ongoing operating facility; there is an essential tension between the needs of an operating program and the need to prepare for the facility evolution with new technologies and facility capabilities.

From the key conclusions above and discussion of the associated issues, the subcommittee offers some recommendations to NSF management that we feel support a best-practices management approach.

Recommendations of the Subcommittee:

1. It is recommended that NSF conduct *annual operations reviews* of large, NSF-led large operating facilities, preferably co-organized by the cognizant NSF program officer and the office of the Deputy Director for Large Facility Projects; these reviews should be conducted with the participation of outside expert peer consultants, and may or may not in the same forum, involve the assessment of the ongoing and future scientific program of the facility.
2. It is recommended that NSF collaborate with the lead sponsor of large operating facilities in which NSF has a non-leading operations role, to perform appropriate annual operations reviews of a suitable type for confirming the successful carrying out of NSF's role in the facility operations.
3. It is recommended that NSF institute in its large operating facilities, a systematic program of *formal risk assessment* to identify the potential cost and operations impacts of non-recurring events along with an assessment of their probability of occurrence.
4. It is recommended that NSF institute with its large operating facilities, a continuing program of assessment and planning for *Advanced R&D* that will enable these facilities to evolve with their scientific program and best meet the needs of the research community; the facility's program manager should be closely involved in the facility evolution and the supporting Advanced R&D planning.
5. It is recommended that NSF institute for its large operating facilities, a process for projecting the anticipated termination of the facility along with the costs and legal requirements of this action; this process should create and keep current, a plan for the *facility termination and closeout*.

Appendix A – Facilities Subcommittee Charge Letter from NSF

OFFICE OF BUDGET, FINANCE & AWARD MANAGEMENT

March 6, 2006

Dr. Tom Kirk
Brookhaven National Lab
P.O. Box 5000, Mail Stop 510F
Upton, NY 11973-5000

Dear Dr. Kirk:

I would like to convene a third meeting of the NSF's Business and Operations Advisory Committee's Subcommittee on Facilities to meet this Spring, prior to the full Business and Operations Advisory Committee meeting, scheduled for May 18-19, 2006. Toward this end, we have agreed with the Subcommittee members to hold this meeting on Monday, May1 and Tuesday, May2, 2006 at NSF, starting at 1:00 pm on May 1.

It would be very helpful if the next Facilities Subcommittee meeting could focus on NSF policies and procedures, as described in NSF's "Facilities Management and Oversight Guide" and "Guidelines for Planning and Managing the MREFC Account" for conducting oversight of the business aspects of operational large facilities. The format used for the last Subcommittee meeting proved very successful, and resulted in valuable interactions between the Subcommittee, NSF staff, and community representatives involved in planning and constructing large facilities. Mark and I would like to continue with that format, and propose to invite a representative sample of individuals from operational facilities and NSF-funded FFRDC's. The meeting should result in the subcommittee offering recommendations on how NSF can improve its oversight processes for operational large facilities. These recommendations should be presented to the full Business and Operations Advisory Committee in May. The recommendations should also be provided as a written report, to be publicly available on the NSF web site following review and acceptance of the report by the Business and Operations Advisory Committee.

Mark and I would be grateful for any suggestions you and the other members of the Subcommittee may have regarding potential participants who would be able to comment on the strengths and weaknesses of current NSF management practices for operational oversight of facilities. NSF will assist the Subcommittee by providing logistical support and travel funds for the Facilities Subcommittee and participants from the research community. The meeting will be held at NSF and will be open to all interested parties.

Suggested topics for discussion by participants in the meeting are:

- What do you see as the scope of NSF's oversight role of large facilities at the operation level? What role should the Large Facilities Office in BFA have in contributing to this oversight?
- Is NSF effective at providing oversight, as distinguished from management, of operational large facilities? What can NSF do to improve mutual understanding of the respective roles, values, and objectives by NSF and its research community?
- Do Cooperative Agreements provide sufficiently comprehensive direction to Awardee institutions in carrying out their stewardship roles of operating NSF-funded large facilities? If not, what should/could be changed?
- What process should be used to develop and assess the validity of a proposed operations budget? How should risks be factored into the proposed budget, especially in consideration of OMB Circular A-21, "Cost Principles for Universities," and OMB Circular A-122, "Cost Principles for Non-profit Organizations," which state, "contributions to a contingency reserve or any similar provision made for events, the occurrence of which cannot be foretold with certainty as to time, intensity, or with an assurance of their happening, are unallowable."
- Are there steps NSF can take to improve its assessment processes that ascertain the state of facility performance? How can oversight encourage maximum scientific productivity, and how will NSF know it is achieving it? Are there new approaches that should be examined that would be especially helpful in the assessment of the operation of large distributed facilities, including those that have a very large software component that must be sustained?
- Are there oversight mechanisms that would better inform NSF of the funding relationship between concurrent operational and advanced R&D activities conducted under the same award? NSF needs to be able to understand how to sustain adequate operational funding for a facility when variable levels of total facility funding are encountered, without "robbing Peter to pay Paul."
- What considerations should be addressed in projecting the facility's operational lifetime and what provisions should be addressed for projected facility closeout.

My staff and I would be happy to work with you to ascertain the availability of individuals to participate in this meeting, assist with travel arrangements, and organize any other supporting activities that are required. Thanks again for your continued efforts in support of the Business and Operations Advisory Committee and NSF.

Sincerely,

(Original signed by T. Cooley)

Thomas N. Cooley
Chief Financial Officer and
Director, Office of Budget, Finance and
Award Management

Cc;
Mark Coles

Appendix B – Facilities Subcommittee Meeting Agenda

Meeting Agenda
NSF Business and Operations Committee
Facilities Subcommittee Meeting
May 1-2, 2006
NSF Room 470, Arlington, Virginia

Monday, May 1:

1:00 pm Welcome and Charge from NSF - Tom Cooley, NSF CFO
1:15 pm Introductions and Meeting Plan - Tom Kirk, Facilities Subcommittee Chair
1:30 pm Opening Comments from Research Facilities Operations Participants (see Note 0)
2:15 pm Coffee Break
2:30 pm Topical Discussion 3 – Effective Scientific Productivity and Lifetime Issues (see Note 3)
3:30 pm Topical Discussion 2 – Risk Issues in formulating facilities operating budgets (see Note 2)
4:30 pm General Discussion and Suggestions for Added Topics
5:00 pm Adjourn

Tuesday, May 2:

8:30 am Topical Discussion 1 – NSF Oversight and Stewardship Roles in Large Facilities (see Note 1)
9:30 am Topical Discussion 4 – Funding Balance between operations and advanced R&D (see Note 4)
10:30 am Coffee Break
10:45 am Other Topical Discussions (if needed) or General Discussions and Conclusions
12:00 pm Luncheon Break
1:30 pm General Discussions and Conclusions (Cont.)
2:30 pm Identification of Key Conclusions
3:30 pm Coffee Break
4:00 pm Subcommittee Executive Session
5:00 pm Adjourn

We ask that succinct versions of general and topical comments from the Research Facilities Operations Participants be supplied by email to the Subcommittee for consideration in our written report, either before the meeting or within a few days after. The email address for distribution to the Subcommittee is tkirk1@gmail.com ; all email submissions will be held in confidence within the Subcommittee.

Note 0 General comments not specific to the identified 'Topical Discussions' can be made at this time.
Note 1 From the NSF Charge Letter: Bullet 1 - *"What do you see as the scope of NSF's oversight role of large facilities at the operations level? What role should the Large Facilities Office in BFA have in contributing to this oversight?"* Bullet 2 – *"Is NSF effective at providing oversight, as distinguished from management, of operational large facilities? What can NSF do to improve mutual understanding of the respective roles, values, and objectives by NSF and its research community?"* Bullet 3 – *"Do Cooperative Agreements provide sufficiently comprehensive directions to Awardee institutions in carrying out their stewardship roles of operating NSF-funded large facilities? If not, what should/could be changed?"*
Note 2 From the NSF Charge Letter: Bullet 4 - *"What process should be used to develop and assess the validity of a proposed operations budget? How should risks be factored into the proposed budget, especially in consideration of OMB Circular A-21[1], "Cost Principles for Universities," and OMB Circular A-122[2], "Cost Principles for Non-profit Organizations," which state, "contributions to a contingency reserve or any similar provision made for events, the occurrence of which cannot be foretold with certainty as to time, intensity, or with an assurance of their happening, are unallowable."*

[1] See website URL, *http://www.whitehouse.gov/OMB/circulars/a021/a021.html*

[2] See website URL, *http://www.whitehouse.gov/OMB/circulars/a122/a122.html*

Note 3 From the NSF Charge Letter: Bullet 5 - *"Are there steps that NSF can take to improve its assessment processes that ascertain the state of facility performance? How can oversight encourage maximum scientific productivity, and how will NSF know it is achieving it? Are there new approaches that should be examined that would be especially helpful in the assessment of the operation of large distributed facilities, including those that have a very large software component that must be sustained?"* Bullet 7 – *"What considerations should be addressed in projecting the facility's operational lifetime and what provisions should be addressed for projected facility closeout?"*

Note 4 From the NSF Charge Letter: Bullet 6 - *"Are there oversight mechanisms that would better inform NSF of the funding relationship between concurrent operational and advanced R&D activities conducted under the same award? NSF needs to be able to understand how to sustain adequate operational funding for a facility when variable levels of total facility funding are encountered, without 'robbing Peter to pay Paul'."*

Appendix C – Facilities Subcommittee Membership

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Appendix D – Facilities Operations Participants
NSF Facilities Subcommittee May 1-2, 2006 Meeting
Invited Facilities Operations Participants - ATTENDING

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Appendix E – Risk Assessment Chart (Spreadsheet-Based)

RISK REGISTRY FORM (Example for Discussion) (YEAR OF ESTIMATE:)					
ITEM No,	DESCRIPTION OF RISK & NATURE OF LOSS	LIKELIHOOD OF OCCURRENCE	CONSEQUENCE OF OCCURRENCE & COSTS	MITIGATION PLANS/STRATEGY	MITIGATED COSTS

NOTE: The entries for each heading should be prepared following the Instructions provided by the Foundation. All costs reported should be in year of estimate dollars. Footnotes are encouraged where an understanding of the underlying risk, consequences, and mitigations may be important to the Foundation.