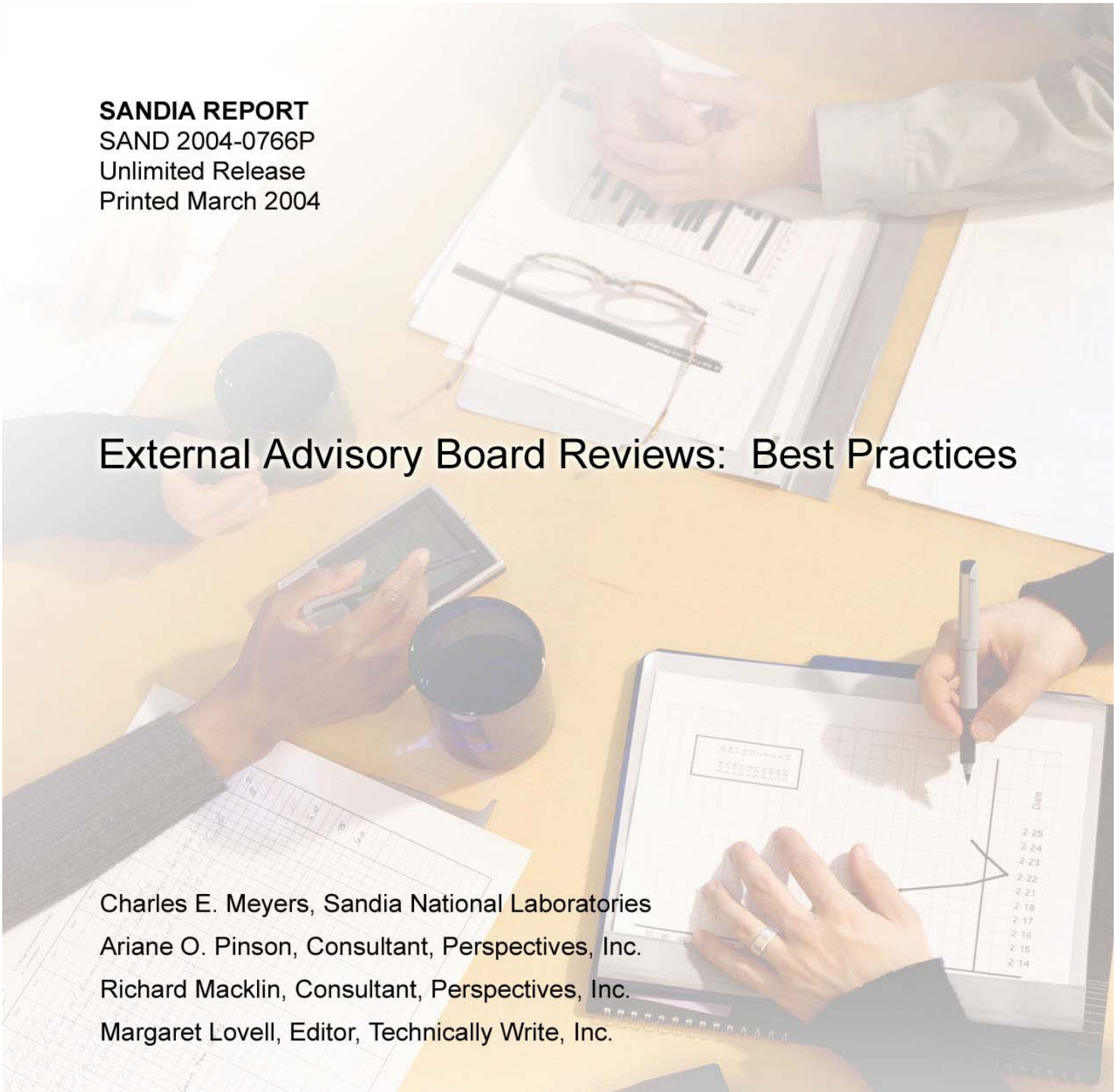
SANDIA REPORT
SAND 2004-0766P
Unlimited Release
Printed March 2004



External Advisory Board Reviews: Best Practices

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL84000.

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

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Abstract

Our purpose is to provide a single source of information and experience that both new and experienced users of technical external advisory boards can rely on to conduct actionable and successful reviews.

External reviews are widely recognized as the most effective means for assessing a program's relevance, quality, performance, and facilities. However, lack of guidance and benchmarks often result in reviews of variable quality and utility to the programs being assessed.

This guide is based on activities from five Sandia external program reviews, federal agency research review processes including NAS, NSF, NIH, and NASA, and federal agency and private industry guidance.

The guide provides direction to external advisory review committee members, and to staff whose job it is to brief the advisory boards, by outlining the best practices with respect to such reviews and providing a list of suggested questions to be addressed by the review committee.

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Executive Summary

Peer reviews have been a cornerstone of research management at Sandia for almost two decades. External Advisory Board reviews are generally recognized as the best way to evaluate applied and basic research programs while they are in progress because they provide an objective assessment of mission relevance, research quality, and technical merit. External Advisory Board review committees evaluate all aspects of research at Sandia, from individual research projects to the entire research program.

External reviews assess programs on four criteria.

• RELEVANCE	Why the research and development (R&D) activity is important and appropriate in terms of both scientific merit and Sandia's mission.
• QUALITY	The technical and scientific merits of programs and projects.
• PERFORMANCE	The management of projects with respect to achieving milestones and meeting the budget.
• FACILITIES OPERATIONS	The quality, appropriateness, and availability of research facilities for a program's R&D goals.

An important source of variability in external review content is a lack of review guidelines. The goal of this report is to provide these guidelines. The following are guidelines based on an assessment of best practices in external reviews of Sandia programs and programs at other federal institutions.

- Prior to the review committee meeting, the program staff should provide the review committee with a description of the program, including goals, milestones, metrics, budgets, oversights, and self-assessment procedures. New review committee members should receive information on prior review committee recommendations and a description of any actions taken by the program to follow the recommendations. Information Provided to the Review Committee

- The program staff should request that the review committee address specific questions during the review process. The *Potential External Review Committee Questions* included in this report provide guidance for developing review-specific questions. Examples of External Review Committee Questions

- The review committee should assess each program with respect to relevance, quality, performance, and facilities operations. The committee should focus special attention on the uniqueness of the program, its potential impact, and known redundancies with both other internal and any external projects and programs. Review Committee Program Assessment

- The review committee's comments should tie to specific program areas and be supported with quantitative and qualitative data relating to performance assessments. It is helpful for the review committee to provide separate comments on each research or technology area. Review Committee Report Organization

External Advisory Board reviews that observe these guidelines not only provide important feedback to project and program managers, but also become an important source of information for Sandia-wide assessments of internal science and technology investments.

A summary chronology of the steps recommended in this report, including page references for each step, is presented on the following page.

CHRONOLOGY	EVENT	SUPPLIER
Prior to Review	**Initiate Review by:** • Providing committee with program description (Refer to pg. 7) • Providing committee with review-specific questions (Refer to pg. 8)	**Program Staff**
During Review	**Assess program for:** • Relevance • Quality • Performance • Facilities Operations (refer to pg. 5)	**Review Committee**
Following Review	Prepare report with quantitative and qualitative data to support assessment (refer to pg. 11)	**Review Committee**

Introduction

All scientific enterprises are based on trust (National Academy of Sciences 1995). Scientists trust that published results are valid, and society trusts that researchers are honest and unbiased in their description of the world. At all levels of science, peer review is the central process for guaranteeing the honesty and accuracy of research. Peer reviews minimize the influence of individual subjectivity in interpreting research results and encourage researchers to be critical and objective in evaluating their own conclusions, methods, and techniques.

External peer reviews are the most robust means for evaluating research. Reviewers from other institutions bring to the review process knowledge, experience, and perspectives different from those represented by the scientists in a single laboratory or program. These qualities enable external reviewers to identify program shortcomings, flawed techniques, and strategic pitfalls that might not be apparent to program staff. External reviews also allow a research program and its scientific results to be evaluated in the broader context of advances in research, technology, and methods occurring at other institutions.

As recently summarized by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy (DOE/EERE) Peer Review Task Force (2003):

> ***Peer review is essential in providing robust, documented feedback to [program managers]. In-depth knowledge about the quality and effectiveness of current projects and programs is absolutely essential in designing future programs and/or enhancing existing efforts. Peer review also provides management with independent confirmation of the effectiveness of its programs.***

The necessity of external reviews is recognized by the federal government and mandated by the Government Performance and Results Act (GPRA) of 1993. This act requires all federal agencies to annually evaluate and report on the results of their activities, and to annually produce a strategic plan, a performance plan, and a performance report. Detailed tools for conducting federal program assessments have been provided in the Office of Management and Budget's Program Assessment Ratings Tool (PART) (Online). A definition of a peer review is provided in the EERE Peer Review Task Force 2003 document:

> ***A critical, formal, and documented evaluation process using objective criteria and qualified and independent reviewers to make a judgment of the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects.***

Sandia National Laboratories routinely conducts external reviews of its Science & Technology (S&T) areas and of several individual technical and engineering research programs. External peer reviews have been a cornerstone of research management at Sandia for almost two decades. External reviews are generally recognized as the best way to evaluate applied and basic research programs while they are in

progress (Feller 2002; Hamel and Prahalad 1994; Marburger and Daniels 2002; National Academy of Sciences 1999, 2000; Prahalad and Hamel 1990) because they provide an objective assessment of mission relevance, research quality, and technical merit. External review committees evaluate all aspects of research at Sandia, from individual research projects to the entire research program.

The goal of external peer reviews at Sandia is to assess the following criteria.

- **Relevance** – Relevance refers to why the R&D program or project is important and appropriate. The R&D program or project should have a clearly articulated plan, with clear goals and priorities and requests for funding. The societal benefits of the research must be articulated, and the mechanisms for evaluating proposed programs and program results must also be clearly stated. At Sandia, relevance assessments include evaluating program goals and management, technical approaches, and connectivity to the outside world; ensuring that the science and technology continues to focus on cutting-edge advances not duplicated at other institutions; and evaluating the fit of programs and projects to Sandia's missions.

- **Quality** – Quality assessment is the determination of the technical and scientific merits of programs and projects. Programs must also clearly articulate the mechanisms that they use to assess the quality of proposed programs and program results.

- **Performance** – R&D program managers must be able to monitor and document how well the program is performing. Program inputs must be documented annually, output and outcome measures and schedules must be set, and decision points for continuation, redirection, and termination must be made explicit. R&D programs must be able to justify how funds are allocated to ensure quality R&D.

- **Facilities Operations** – Facilities operations refers to the quality and appropriateness of research facilities. Facilities operations must be evaluated with respect to adequacy of the technology for the existing and proposed R&D; the level of funding to maintain and acquire new equipment; the knowledge, skills, number, and availability of support staff; and the plan for sharing the facility among researchers and projects.

Ideally, an External Advisory Board review of a program identifies improvements to that program and helps program participants obtain their desired objectives. In most cases, a review that is both intensive and extensive maximizes its usefulness. Details, such as program budgets and the performance of specific research groups, should be addressed along with progress toward program goals. While it is the purpose of the review committee to provide guidance, it is the program participants' responsibility to provide the review committee with all the information that they need to evaluate the program.

The reviews not only can provide important feedback to project and program managers, but also can become an important source of information for Sandia-wide assessments of internal science and technology investments. Of the review committee

reports examined for this study, some provided detailed feedback and clearly actionable recommendations; others provided little in the way of feedback beyond general comments and few actionable recommendations. No two reviews addressed the same set of questions.

This report provides External Advisory Board review committee guidelines drawn from the best practices of external review committee reports, grant application guidelines, and the experiences of Sandia S&T executives. These guidelines should be tailored to the specific needs of individual programs and projects, taking into account a program's or project's budget, research output, management structure and complexity, stage of technology development or commercial readiness, stakeholder participation, and input needed to support management decisions (EERE Peer Review Task Force 2003).

Best Practice Guidelines for External Review Committees

These are the best practices identified in the five external review committee reports, the three guidelines for grant applications, and the additional input provided by the S&T Directors and Deputies. Detailed discussions of the committee reports and the guidelines can be found in the appendices.

INFORMATION PROVIDED TO THE REVIEW COMMITTEE

Prior to the review committee meeting, the program staff should provide the review committee with a description of the program, including goals, milestones, metrics, budgets, oversights, and self-assessment procedures. New review committee members should receive information on prior review committee recommendations and a description of any actions taken by the program to follow the recommendations. Review committee members can benefit from:

- a briefing on the logistical details of the review process at Sandia; including background information on Sandia, capabilities, organization and management, review timeline, length of review, agenda, committee caucus time vs. presentations, close-out, follow-up reviews, committee development, membership and organization, the standard practice regarding costs and payments, and executive management support.

- copies of previous program reviews so that they can evaluate a program's progress over time. The committee would also be able to assess how well a program has addressed concerns raised in prior reviews.

- information on the different levels of program organization and on the levels of organizational review at Sandia, which range from the reviews of specific research projects to the Science & Technology External Advisory Board review of S&T as a whole. This organizational information enables review committee members to understand how the program, and their review of the program, fits in with other efforts at Sandia.

- a briefing that covers the frequency of reviews of different kinds of programs at Sandia. Review frequencies are tied to a program's size, scope, and the relative amount of basic vs. applied research (see Figure 1, below). In general, reviews of the entire research program at Sandia are conducted about every 10 years, basic research programs are reviewed every 3 to 5 years, and applied research is reviewed annually. Engineering, technical, and industrial research, particularly projects with an emphasis on producing a specific marketable service or product, are reviewed semiannually or even quarterly.

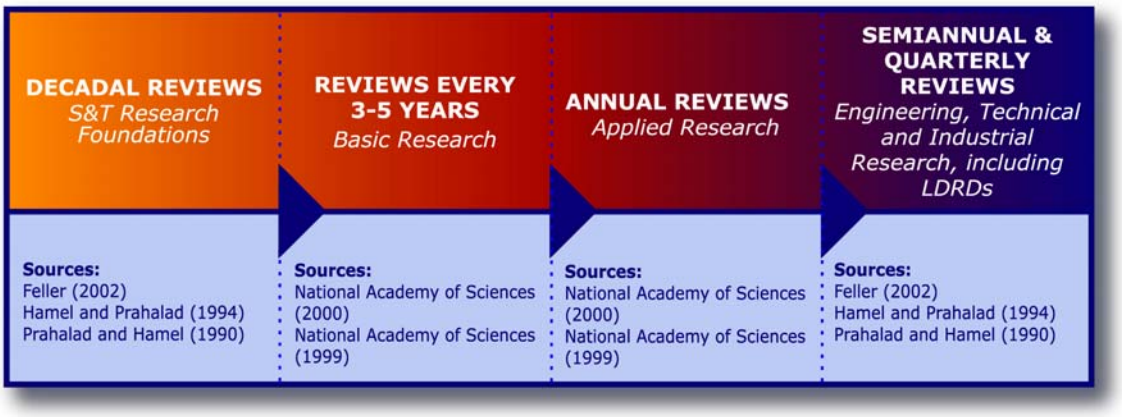

Figure 1: Research programs and review frequency spectrum.

EXAMPLES OF EXTERNAL REVIEW COMMITTEE QUESTIONS

The program staff should request that the review committee address specific questions during the review process. The *Potential External Review Committee Questions* included in this report provide guidance for developing review-specific questions on the criteria of relevance, quality, performance, and facilities operations.

Relevance

- Are the program goals well articulated? Are they focused on what could be important and compelling achievements? Are these goals achievable within the proposed timeframe?
- Is there a good fit between the program's research foci and Sandia's missions? Within Sandia, who are the major and minor customers among the Strategic Management Units (SMUs), Centers, and other research units? What feedback has the program received from these users regarding the quality and utility of the products provided? How might the fit to the mission and SMUs be improved?
- Has the fit between this program and other federal programs been evaluated? With which major external research programs is there significant redundancy and how might the program be re-focused to reduce or eliminate this redundancy?
- How can the program achieve better recognition as a national asset? What additional steps should program participants take to heighten the national visibility of this program's accomplishments?
- Are there collaboration opportunities to fill technology gaps and/or accelerate the progress of research?
- What changes are needed to program management that would assist the program in meeting its goals?

Quality of R&D

The following questions could be addressed for the program as a whole, as well as for each major research area within the program. The reviewers should be asked to support

assessments with specific examples and quantitative data as appropriate, assess the relative magnitude of strengths and weaknesses, and provide recommendations for improvement that are both specific and actionable.

- Are the technical activities in science, technology, and engineering outstanding in quality? What are the strengths and weaknesses of the program as a whole and of specific research areas?
- Are the approaches to overcoming the barriers to success promising? Are there potentially better methodologies or solutions to the challenges?
- Is the research being published in major journals at an acceptable rate? Are research results being presented at national conferences in a regular and timely fashion?
- How has this program moved to protect its intellectual property? What patent areas have been identified? What intellectual property claims have been filed? Is the rate of filing of intellectual property claims acceptable?

Performance

- Have the program participants identified and prioritized the major barriers to success? Have specific metrics been established for each major barrier (milestone)?
- Of the key technical milestones, which have been met and which remain? Of the remaining milestones, which can be considered "significant barriers" to achieving the program goals and which relate to performance improvements?
- Are the program's assumptions with respect to internal capabilities and goals accurate? Does the program have adequate resources on task? Is the budget sufficient to reach the program's goals?
- What major grant sources, major federal initiatives, program announcements, and other funding sources have program participants identified? Which ones will be targeted in the near-, middle-, and long-term? Are there other funding sources that have not been considered?
- Have problems identified by previous review committees been addressed? How have program goals and scope been adjusted in light of the recommendations of previous review committees?
- What specific steps are recommended to improve the quality of the science, technology, and engineering activities in this program?

Facilities Operations

- Are the available facilities and equipment adequate for the program's R&D? Is the budget sufficient for maintaining the facilities and equipment?
- Will new equipment or facilities have to be purchased? Is the budget and timeline for such purchases adequate given the R&D milestones established by the program?
- Are the facilities adequately staffed? Are staff knowledgeable and experienced in the area of the program's R&D? Are they available for sufficient time and in sufficient numbers to support the program's research?

- Are facility resources shared appropriately among projects and programs? Is the method for allocating the resources among projects and programs suitable? Is the program's access to the facilities appropriate in time and quantity to enable the program to successfully reach its R&D milestones?

REVIEW COMMITTEE PROGRAM ASSESSMENT

The review committee should assess each program with respect to relevance, quality, performance, and facilities operations. The committee should focus special attention on the uniqueness of the program, its potential impact, and known redundancies with both other internal and any external projects and programs.

- Receive and review summary information concerning milestones, metrics, budgets, oversights, and self-assessment procedures prior to the review committee meeting. Quantitative and qualitative data should be included in the summary information, as appropriate.

- Assess program management and goals, technical merit and research quality, and external connections between the program and federal, state, public, and private institutions.

- Throughout, support broad statements with more specific observations.

- Provide specific and actionable recommendations aimed at improving program performance.

- Evaluate research areas with respect to both past performance and future research directions.

- As appropriate, be cognizant of recommendations made at prior review committee meetings.

- Include an evaluation of the adequacy of the program resources and budget for achieving stated program goals. The proposed cost should be assessed with respect to both the proposed activity and the funds available.

- As appropriate, assess the fit to Sandia's missions.

- Understand that review criteria must be somewhat flexible to allow reviewers to use slightly different criteria for assessing different kinds of programs and different stages of program development. For example, intellectual property claims and technical publications may not be good metrics for a Laboratory Directed Research and Development (LDRD) project in its first year.

- Assess the relative magnitude of strengths and weaknesses, in order to provide perspective on the relative importance of each comment.

- As needed, make suggestions to the program participants for improving future presentations.

REVIEW COMMITTEE REPORT ORGANIZATION

The review committee's comments should tie to specific program areas and be supported with quantitative and qualitative data relating to performance assessments. It is helpful for the review committee to provide separate comments on each research or technology area.

- Reports begin with a bulleted summary of the conclusions reached. The summary conclusions are rich in specific technical detail and in directions for management of the project.

- The executive summary provides both a short overview of the committee findings plus all of the recommendations for program improvement made by the committee throughout the report.

- The introduction clearly states the questions addressed by the review committee.

- Include a list of the review committee members, their affiliations and, possibly, their area of expertise.

- Where appropriate, reviews are organized into three key areas: management and goals; technical achievements; and outreach activities. Comments in each area are followed by specific recommendations for improvement.

- The technical achievements section is organized by research area and technology category. Comments on each area are clearly organized and conclude with specific recommendations for improving the performance in this area. The comments on each research or technology area are organized into three categories: strengths and accomplishments; concerns and problem areas; and recommendations.

A table summarizing major program strengths, weaknesses, opportunities, and recommendations provides a powerful "take-away" summary of the key points of the review. An example of a summary table is included in Appendix A, the Border Grand Challenge External Advisory Board report. Summary Table

Methodology

The content and organization of eight external review reports and other documents were used to determine the characteristics of an ideal External Advisory Board review committee report. The methods that produced these characteristics are identified below as the "best practices" evident in the reports. A summary outline of each report is also included.

Sources of data used in the determination of review best practices include the following. [Click on the links to go to the appendices for more detailed information about each source.]

- **Border Grand Challenge:** *Grand Challenge: A Systems Approach to Defending Our Borders, External Advisory Board Report: January 15, 2003.* [Best practices, summary outline, Summary Table]

- **Pulsed Power Science & Technology:** *Pulsed Power Peer Review Committee Report, SAND2002-3317.* October 2002. [Best practices, summary outline]

- **Engineering Sciences Research Foundation:** *Letter to Thomas Bickel, Chair, Engineering Sciences Research Foundation, from Charbel Farhat, Professor and Chair, Department of Aerospace Engineering Sciences and Director, Center for Aerospace Studies, University of Colorado at Boulder*, October 10, 2002; supplemented by *Engineering Sciences Research Foundation External Review,* August 26-28, 2002: *Panel Outbrief* [presentation]. [Best practices, summary outline]

- **Computation, Computers, Information, and Mathematics (CCIM):** *2002 External Technical Review, Computation, Computers, Information, and Mathematics (CCIM), Center 9200* [presentation]. [Best practices, summary outline]

- **Sandia Science & Technology External Advisory Board (STEAB):** *Science & Technology External Advisory Board Review.* November 6-8, 2002. [Best practices, review criteria]

- **National Science Foundation (NSF):** *Grant Proposal Guide (NSF 03-2).* October 2002. [Best practices, review criteria]

- **National Institutes of Health (NIH):** *Review Guidelines*, Section A. "Guidelines For Study Section Reviewers and Chairs." March 4, 2003. [Best practices, review criteria]

- **National Aeronautics and Space Administration (NASA):** *National Aeronautics and Space Administration: Guidebook For Proposers Responding To A NASA Research Announcement (NRA)*. January 2003 (w/errata dated 01/31/03). [Best practices, review criteria]

Guidance on the conduct of external reviews of federal agencies and programs was also obtained from:

- **Office of Science and Technology Policy, and the Office of Management and Budget:** *Memorandum for the heads of Executive Departments and Agencies*, John H. Marburger, III, and Mitchell Daniels. May 30, 2002.

- **National Academy of Sciences:** *Implementing the Government Performance and Results Act for Research: A Status Report*, National Academy Press. 2001

- **National Academy of Sciences:** *Evaluating Federal Research Programs: Research and the Government Performance and Results Act*, National Academy Press. 1999.

- **National Aeronautics and Space Administration:** *Guidebook For Proposers Responding To A NASA Research Announcement (NRA)*. January 2003 (w/errata dated 01/31/03).

- **National Institutes of Health:** *Review Guidelines*. March 4, 2003.

- **National Science Foundation:** *Grant Proposal Guide (NSF 03-2)*. October 2002.

- **EERE Peer Review Task Force:** *Peer Review Guide Based on a Survey of Best Practices in Peer Review*, review draft. June 12, 2003.

A complete list of all sources consulted and their citations may be found in the reference list at the end of this document.

At the conclusion of the initial research portion of this project, the best practices identified in each report were consolidated and organized into two groups:

- Best practices relating to report content.

- Best practices relating to report organization.

The two sets of best practices were developed into a set of guidelines for conducting an external review of a program or project at Sandia. The guidelines include a sample question set that could serve as an outline for presentations to external review committees as well as a potential guideline for review committee reports.

A draft of this report was sent out for comment to Science & Technology Directors and Deputies, and others at Sandia. These reviewers identified additional best practices based on their on-the-ground experiences. These additional best practices focused on information needed by review committee members in order to conduct effective reviews. The initial research and this valuable feedback were combined into this final version of the *External Advisory Board Reviews: Best Practices* report.

We wish to recognize the following reviewers who supplied comments for this report: William Camp, Timothy Cohen, Alton Romig, Jr., Marion Scott, Richard Steichen, Steve Thompson, Kenneth Washington, and Suzanne Weissman.

Appendix A: Border Grand Challenge EAB Report (January 2003)

This appendix outlines the Border Grand Challenge External Advisory Board report *Grand Challenge: A Systems Approach to Defending Our Borders, External Advisory Board Report: January 15, 2003*. The section begins with a summary of the best practices of the review board in preparing the report, followed by a summary outline of the report itself. Throughout the summary outline, the focus is on what the reviewers did, not on the information that they discovered.

The content of the review is conditioned by the newness of the research project. The Border Grand Challenge (GC) is in the process of trying to narrow its research scope and describe the problems to be addressed.

BEST PRACTICES IN THE BORDER REPORT

The best practices of this report that were included in developing the guidelines were:

- The report provides a clear articulation of the problems addressed by the reviewers.
- The report begins with a summary of the conclusions reached. The summary conclusions, presented in bulleted form, are rich in specific technical detail and in directions for management of the project.
- The report concludes with a summary table of the Border Grand Challenge program strengths, weaknesses, opportunities, and recommendations.

SUMMARY OUTLINE OF THE BORDER REPORT

The Border Grand Challenge External Advisory Board considered five key questions regarding the progress of the Border Grand Challenge.

- Are our program goals focused on what could be important and compelling achievements?
- Do we have the right resources on task?
- What other collaboration opportunities to fill technology gaps and/or accelerate our progress should we be aware of?
- Have we identified and prioritized the right major barriers to success?
- Are our assumptions of strong internal capabilities, coupled with a unique set of goals, correct?

Prior to addressing each of these questions, the report presents a summary of the conclusions that the Board reached. The summary conclusions are presented in bulleted form. The conclusions address specific research goals and technologies, for example the

MOR sensor, as well as critical research challenges, such as the fit between Sandia's MOR technology and the facial recognition challenge, and overall program goals, for example, the need to plan a concrete demonstration of the Border simulation. The summary of conclusions also includes the need to focus the research more narrowly and to establish a "vision" for the project.

The report then addresses each of the five key questions articulated in the introduction.

1. Are our program goals focused on what could be important and compelling achievements?

In this section, the reviewers focused on the potential significance of the Grand Challenge and how this could be leveraged for future funding opportunities, for example, the Defense Advanced Research Projects Agency (DARPA). It outlined the major challenges facing the Border Grand Challenge, including both research/technology difficulties and ethical and moral problems to the deployment of the technology. The section, however, did not provide any sort of detail about the technical and research challenges.

2. Do we have the right resources on task?

This section summarized the readiness of the team to take on the Border Grand Challenge, focusing on the team's "demonstrated experience and capabilities." However, the availability of and need for new facilities was not addressed. The link between the Grand Challenge goals and the team's experience and capabilities was not made.

3. What other collaboration opportunities to fill technology gaps and/or accelerate our progress should we be aware of?

This section identified potential research collaborators as well as potential "outreach" opportunities with the National Institute of Standards and Technology (NIST), the International Organization for Standardization (ISO), and at various conferences (an Institute of Electrical and Electronics Engineers [IEEE] International Workshop, a Card-Tech/Secure-Tech Expo). The committee identified potential government funding opportunities at DARPA, the National Institute of Justice (NIJ), and the National Infrastructure Simulation and Analysis Center (NISAC). Other government contacts were also identified. Although institutions and contacts at the institutions were identified, the report did not clearly articulate links to specific Border Grand Challenge objectives.

4. Have we identified and prioritized the right major barriers to success?

The question was answered only in part, citing the need for more groundwork in identifying the Border Grand Challenge scope before the question can be fully addressed.

5. Are our assumptions of strong internal capabilities, coupled with a unique set of goals, correct?

The question was not answered, except to assert that the scale of the proposed simulation is bold, and the challenges very significant.

Summary Table Example

Here is the Summary Table from the Border Grand Challenge External Advisory Board report. This format can be an effective "take-away" for summarizing the findings of review committees.

Strengths	Weaknesses
• Level of Simulation: Intriguing, creative, valuable • Sandia experience in Security, especially ability to examine: - Applied technologies - Flow of incoming traffic - Border Porosity - Proposed safeguards • MOR sensor attributes	• Description of the problems to be addressed by the Border simulation is unclear; it is also unclear who are the target agency customers and how they would specifically use the tool • Proposed development of three technology areas with sufficient budget for only one • Difficult to make the connection between Mod/Sim and tech development unless the simulation is used to discover which technologies are suited to solve Border problems
Opportunities	**Recommendations**
• Possibly tap into related work at NISAC and LANL's TransSim studies • Relate to existing models such as Border Wizard, PORTSIM, or airport models • Federal Agency networking and committee/conference possibilities - see main body of report	• Redefine the scope and vision of this project – on external retreat, if necessary • Establish metrics of success and effectiveness • Focus on the strongest, most likely long-term user of this tool, integrate their needs into the project and bring them into the EAB • Meet again in May 2003 to assess new goals and revised plan

Appendix B: Pulsed Power Peer Review Committee Report (October 2002)

This appendix summarizes and outlines the most recent external advisory board review of the Pulsed Power Science & Technology area, entitled *Pulsed Power Peer Review Committee Report, SAND2002-3317, October 2002.* The section begins with a summary of the best practices of the review board in preparing the report, followed by a summary outline of the report itself. Throughout the summary outline, the focus is on what the reviewers did, not on the information that they discovered.

BEST PRACTICES OF THE PULSED POWER REPORT

The best practices of this report that were included in developing the guidelines were:

- The committee was familiar with prior reviews and asked if prior review recommendations had been carried out or acted upon.

- Throughout, the reviewers supported their critiques with data relating to specific program research and technology. Both qualitative and quantitative data supported critique and commentary on existing programs and future plans.

- In each section, the reviewers provided specific and actionable recommendations aimed at improved management of the Pulsed Power Center and the allocation of resources among researchers at the Center, at Sandia, at other national laboratories, and at other institutions. The committee provided recommendations for the further development of existing technologies, along with recommendations for new research directions for Center scientists to pursue.

- The Executive Summary included a short overview of the committee findings, plus all of the recommendations for program improvement made by the committee throughout the report.

SUMMARY OUTLINE OF THE PULSED POWER REPORT

The review is divided into four sections.

1. Self-assessment Criteria: Quality

Reviewers evaluated the quality of technical activities in science, technology, and engineering.

- The committee conducted a campaign-by-campaign assessment of the quality of the research being performed, with an eye towards the scientific merit of the advances.

- For each campaign, a summary of its research goals and accomplishments was provided, along with critical evaluation of the successes and failures since the last

review. The committee also evaluated future research directions for each major technology area within each campaign.

- All comments were specific to particular technology advances and research accomplishments. Unsupported statements of a general nature were avoided.

- The section ended with a list of specific recommendations by the committee (A.6 Quality Committee Recommendations, p. 25). The recommendations were specific to technologies being advanced under each campaign, such as:

  - "We recommend that the relative priorities of the double-ended and dynamic hohlraums be re-evaluated to ensure that adequate resources are devoted to obtain maximum benefit from the impressive results showing the creation of a thin, uniform shock wave produced in dynamic hohlraum experiments."

  - "We recommend that the Program study low-to-moderate hohlraum temperature "foot" physics, in collaboration with other labs as was discussed in the last review and recommended by the Garwin Committee."

2. Self-assessment Criteria: Programmatic Performance and Planning

In this section, the committee addressed the quality of near-term planning, the fit between research objectives and customer requirements, and long-term planning. A key issue for this criterion was developing a better means to manage access to the facility by Sandia scientists working outside of this research area, as well as for scientists at Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), and at universities.

- The section considered the three areas of programmatic performance, management, and planning.

- The reviewers evaluated programmatic performance from the perspectives of management and technical achievement. The ability of the program to meet or exceed specific benchmarks was addressed and concrete examples were provided.

- Management performance was evaluated for its ability to apportion resources among researchers, to encourage high-quality innovative and high-risk research, and to work together as a team.

- The committee evaluated near- and intermediate-term planning with respect to the allocation of resources among research personnel, both at Sandia and other laboratories.

- Long-term planning was evaluated for alignment to the long-term goals articulated by the previous review committee, and as determined by the Pulsed Power Center. Special attention was paid to positioning key facilities, especially the ZR facility, with respect to other federal facilities to avoid perceived duplication and consequent funding declines.

- The committee made specific recommendations in the areas of programmatic performance and planning. The recommendations provided a clear path-forward for the Pulsed Power committee to take action. Sample recommendations included:

    - "We recommend that a user group or groups be established, the purpose of which should be to help set priorities within given resources. (This is a reprise of a Garwin Committee recommendation.) It is also suggested that the Program continue the practice of allocating certain fractions of facility time to the laboratories to use as their internally set priorities determine, but reserve about 20-25 percent of all tests for allocation by the user groups as a result of peer-reviewed brief proposals. Users group(s) allocation recommendations might be sent to [the Department of Energy/National Nuclear Security Administration] DOE/NNSA for approval to insulate against complaints of inequitable distribution of shots."

    - "We recommend that Sandia's Pulsed Power Program maintain its experimental program on the Z-machine to the maximum extent possible throughout the implementation of Z-refurbishment."

    - "We recommend that Sandia look carefully at the possibility of being able to handle Special Nuclear Materials [SNM] on its facilities, but should invest money in hardware only when there is a compelling demand and the safety of such operation is assured."

3. Self-assessment Criteria: Relevance

This section assessed the fit between Sandia's Pulsed Power Science & Technology and national needs, including DOE/NNSA missions, with special attention to basic science, energy production, and national security. The review was divided into four research areas: dynamic materials properties under extreme conditions; inertial confinement fusion and high yield (ICF/HY); high-energy-density science, radiation transport, and radiography; and radiation effects science and hostile environments.

- For each research area, the technologies and research were summarized and a critical evaluation provided.

- For each research area, the reviewers provided specific recommendations in the areas of management and research. For example:

    - "We recommend that the Program further explore with LLNL and LANL the feasibility to sustain a jointly supported experimental program on the Z-accelerator to perform dynamic high-pressure experiments on SNM."

    - "We recommend that the Program pursue ICF/HY to provide quantitative and cost data for a potential DOE/NNSA decision in the FY2008 era on a machine and program capable of ICF/HY."

- The committee identified cross-cutting issues in a separate subsection, after the discussion and recommendations for each research area. Cross-cutting issues included academic alliances (expanding, continuing), the development of next-generation pulsed power capabilities, and shot-allocation on pulsed power facilities.

4. Comments on specific issues raised by the Pulsed Power Center Director during the Pulsed Power Program Peer Review held May 7-9, 2002.

The Pulsed Power Center Director came to the Pulsed Power Program Peer Review of May 7-9, 2002 with specific questions to be addressed by the review committee. These questions focused on key programmatic issues related to improving the visibility of the Center as a unique national asset. These questions show that the Center Director is concerned with the external visibility of the Center to both researchers and federal agencies charged with funding the Center. The Pulsed Power Center Director raised four questions:

- How can we achieve better recognition of our facilities as a national asset?

- Pulsed Power provides complementary capability to Omega today and National Ignition Facility (NIF) in the future. How can we reduce/avoid destructive competition?

- How can we overcome "mission creep" concerns felt by other labs?

- How can we balance the need to maintain the vitality of Pulsed Power Science with the need to impact near term Stockpile Stewardship deliverables?

Appendix C: Engineering Sciences Research Foundation External Review (October 2002)

The source for this appendix is the October 2002 External Review of the Engineering Sciences Research Foundation (ESRF), which has two components.

- A letter to Thomas Bickel, Chair, Engineering Sciences Research Foundation, from Charbel Farhat, Professor and Chair, Department of Aerospace Engineering Sciences and Director, Center for Aerospace Studies, University of Colorado at Boulder, dated October 10, 2002. Professor Farhat is the chair of the ESRF external review board.

- The Engineering Sciences Research Foundation External Review, August 26-28, 2002: Panel Outbrief [presentation]

The outbrief presentation is a summary of the letter contents. This study focuses on the content of the letter.

BEST PRACTICES OF THE ENGINEERING REVIEW LETTER

The best practices of this letter that were included in developing the guidelines were:

- The letter included a clear statement of the questions asked to the review committee.

- The letter was at its best when its commentary was supported by reference to specific research areas and issues.

- The review committee members specifically requested that they be given more information, including data that addressed milestones, metrics, budgets, oversights, and self-assessment procedures, prior to the meeting. Having access to such data would give the reviewers more information and result in a more-detailed assessment of the ESRF program.

SUMMARY OUTLINE OF THE ENGINEERING REVIEW LETTER

The letter addressed four questions posed to the review committee by the leaders of the Engineering Sciences Research Foundation.

- What is the technical quality of the research?

- Is the research relevant to Sandia's mission?

- How well is the research managed?

- How well is the research connected to the external community?

The letter answered the four questions and provided a set of technical, managerial, and organizational recommendations.

1. What is the technical quality of the research?

The technical quality of the research was compared to academic research funded by the National Science Foundation (NSF) and the timeliness of the research was assessed.

2. Is the research relevant to Sandia's mission?

The tie between ESRF research and Sandia's nuclear weapons mission was examined, although details of the fit to specific Strategic Business Units were not assessed. The letter identified specific research areas where the fit was particularly good. Concerns were raised regarding the relative emphasis placed on some research areas in ESRF at the expense of others.

3. How well is the research managed?

This section of the letter addressed briefly on the major collaborations and the attitude of the staff towards the project. A positive feeling among staff was identified.

4. How well is the research connected to the external community?

The committee considered the external connections, mentioning only the Memorandum of Understanding (MOU) with NSF by name. Concern was raised about the paucity of links to other laboratory missions (non-proliferation, energy, and emerging threats).

5. Recommendations

The committee made specific recommendations on technical issues, managerial issues, and review process issues. Concerns were raised regarding:

- The importance of Chem/Bio as an emerging technology and the importance of looking for pre-competitive opportunities with industry;
- The involvement of managers in fund-raising vs. research;
- Increasing the frequency of reviews so that project feedback would be timelier; and
- The need for more information to be disseminated to the review committee prior to the meeting, including quantitative data.
    - "…the panel members feel that they can be better prepared for the review process if the written input they are given prior to each meeting is more condensed, written at a higher level, and addresses milestones, metrics, budgets, oversights, and self-assessment procedures. They recommend [having] all project leaders comment explicitly on the review criteria during their presentations."

Appendix D: Computation, Computers, Information, and Mathematics (CCIM)

The source for this appendix is the August 2002 external review presentation: *2002 External Technical Review, Computation, Computers, Information, and Mathematics (CCIM), Center 9200*.

BEST PRACTICES OF THE CCIM REPORT

The best practices of this report that were included in developing the guidelines were:

- The review was organized by research area and technology category. This allowed researchers to easily identify comments specifically directed at their research areas.
- The comments were clearly organized, beginning with overview comments, then comments by research area, and closing with a recommendations section.
- Comments on each application, algorithm, and platform addressed both past performance and future research directions.
- The reviewers identified research areas where the fit to Sandia's missions was not clear.
- For each platform, the comments were organized into three categories: strengths and accomplishments, concerns and problem areas, and recommendations. This was a strong and clear way of organizing the comments.
- The comments showed an awareness of comments and recommendations made by previous review committees, and assessed progress towards the resolution of these issues.
- In several places, the reviewers suggested that feedback from technology users at Sandia (specifically Center 9100 analysts) would provide useful information for assessing the value of CCIM products.

The reviewers provided suggestions for improving future presentations, such as the inclusion of budget/effort summary tables along with clearly summarized information on the status of each project in terms of its overall goals, resource availability, and its relationship to other research efforts at Sandia and elsewhere.

SUMMARY OUTLINE OF THE CCIM REPORT

The report contained five major sections.

1. Introductory Comments

The introductory comments stressed how impressed the review committee was with the quality of research undertaken in this area, the uniqueness of this research endeavor, and its connections to other research areas both in Sandia and outside of Sandia.

2. Applications

In this section, the reviewers made specific comments on the main applications areas, including ALEGRA MHD, EMU, XYCE, TOWHEE, FASTRAM, and PREMO.

- Although many comments were not supported by specific detail, the committee was explicit about what information they would like to receive in the future and about future directions for the applications. For example:
    - "The panel would like to hear a discussion of perceived advantages [of EMU] over other approaches, such as SPH & MPM."
    - "We did not see how [TOWHEE] feeds into SNL's needs – understand fits into energy (chemistry) area – perhaps that is its niche?"
- The section ended with a series of recommendations that were comparatively specific in nature. For example:
    - "We would like to see where the money for V&V is being invested."
    - "We would like to see evidence of Tim Trucano's probabilistic approach to validation be incorporated."
    - "For next year, we would like to hear about the progress made in stochastic modeling."

3. Algorithms

In this section, the reviewers included comments on the main algorithms being developed at CCIM, including ASCI algorithms, Automated Multilevel Substructuring, Computational Biology, ZOLTAN, Large-scale PDE Constrained Optimization, and Verification and Validation algorithms.

- In many cases, the reviewers provided specific comments about what they found to be promising future directions for research.
- Problems of focus and fit to Sandia's missions were identified in several algorithm research areas. The fit with other research areas at Sandia was also a concern for some areas.

4. Platforms

In this section, reviewers commented on the platforms being developed at Sandia, including: Red Storm, CPlant, PetaFLOPS architecture research, and Visualization.

- For each platform, the comments were organized into three categories: strengths and accomplishments, concerns and problem areas, and recommendations.

- The recommendations for each platform area provided specific actions and research directions to be taken that would advance the CCIM program.

- The section ended with a series of general recommendations concerning the platforms work at Sandia. In this section, future research directions were reiterated. Also, a great deal of concern was raised over a perceived lack of "vision" at CCIM, and the resulting long-term negative consequences for CCIM and Sandia.

    - "The committee expresses total disbelief in the lack of vision represented by the computational requirements projections and observes that this not only compromises SNL's ability to accomplish their mission …[but also]… the nation's ability [to] develop both advanced engineering techniques and advanced IT capabilities."

    - "Given the broad scope of activities at CCIM, the demands of those activities, and the understandable and deserved promotions from within this group, the panel feels that all 2nd level manager positions must be filled, promptly."

5. General Observations

This section focused on the relationship between information technology (IT) in the labs and in the nation.

- The report summarized platform improvement recommendations.

- Shortcomings between the U.S. supercomputing efforts and those in other nations were identified.

- The committee addressed the need for a realistic evaluation of computational needs.

- Short-term and long-term goals were identified.

- The reviewers provided advice to the CCIM staff on the content of future presentations.

Appendix E: Science & Technology External Advisory Board Review (November 2002).

This appendix summarizes the criteria for review established by Sandia's Science & Technology External Advisory Board (STEAB), presented in the publication *Science & Technology External Advisory Board Review, November 6-8, 2002*.

BEST PRACTICES OF THE STEAB REPORT

The best practices of this report that were included in developing the guidelines were:

- The key questions and sub-questions were identified in the front of the document.
- The key questions were focused and well-crafted to address the fit between Sandia's research and its mission and the relationship between Sandia's research and the newly formed Department of Homeland Security (DHS).
- Beneath the first two lead questions were a series of sub-questions. These sub-questions served to clarify the lead questions and to lead the STEAB member to solicit specific kinds of data in the review of their science and technology (S&T) area.

STEAB REVIEW CRITERIA (CHARTER AND CHARGE TO BOARD)

This section presents the contents of the chapter of the STEAB review entitled "Charter and Charge to Board." These were the specific questions STEAB was asked to address in reviewing the S&T areas at the November 2002 meeting.

1. Is Sandia's S&T well positioned to support current and future Laboratory mission(s)?
    a. Does Sandia have a clear vision and strategy for aligning its S&T with mission needs?
    b. Are the elements of Sandia's S&T portfolio well integrated?
    c. Is Sandia's annual investment in S&T sufficient for the challenges of today and tomorrow?
    d. Are there S&T capability areas in which Sandia should emphasize future investment, or others in which future investment be curtailed?
    e. Does Sandia's recapitalization rate on capital equipment meet industry standards?
    f. Considering the spectrum from basic science, through development, to applied technology; in general, is Sandia's investment allocation along this spectrum appropriate?

2. Do Sandia's management strategies maintain and assure the alignment of S&T within Sandia's mission(s)?

a. What changes would you recommend in the way Sandia makes strategic decisions that affect S&T investments?

b. Do S&T management processes lead to desired outcomes?

c. Is the S&T leadership well executed?

d. What other best practices should Sandia consider to improve S&T at Sandia?

3. If STEAB feels an integral role for Sandia with the Department of Homeland Security is appropriate, how can Sandia help DHS gain unfettered access to Sandia capabilities?

Appendix F: National Science Foundation Grant Review Criteria

The National Science Foundation (NSF) has issued specific guidelines regarding the review criteria for grant applications. These guidelines are spelled out in Chapter 3, Section A: Review Criteria, in NSF's *Grant Proposal Guide (NSF 03-2)*, issued October 2002 (online).

BEST PRACTICES OF NSF GRANT REVIEW CRITERIA

The best practices of this report that were included in developing the guidelines were:

- The focus is on two key areas: intellectual merit and the broader impacts of the proposed activities.
    - Under the subheading "intellectual merit," the proposal is evaluated for the relevancy of the project to advancing knowledge in a particular field, the qualifications of the proposer to carry out the proposed activity are assessed, and the viability of the research plan.
    - Under "broader impacts," the questions focus on the participation of students and minorities, the development of facilities for research *and* education, plans for the dissemination of the results, and the benefits to society of the proposed research.
- The reviewer is provided with specific questions to address in the review to ensure that specific areas of concern to NSF are addressed in each review.

NSF GRANT REVIEW CRITERIA

These are the criteria set forth by NSF.

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

What are the broader impacts of the proposed activity?

How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities,

instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

NSF staff will give careful consideration to the following in making funding decisions.

Integration of Research and Education

One of the principal strategies in support of NSF's goals is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the diversity of learning perspectives.

Integrating Diversity into NSF Programs, Projects, and Activities

Broadening opportunities and enabling the participation of all citizens, women and men, underrepresented minorities, and persons with disabilities, are essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

Appendix G: National Institutes of Health Center for Scientific Review Grant Review Criteria

At the National Institutes of Health (NIH), the initial review of grants is done by review committees at the Center for Scientific Review. NIH's criteria for a written review of grant applications is laid out in the document *Review Guidelines*, Section A. "Guidelines For Study Section Reviewers and Chairs," published March 4, 2003, available online. Additional guidelines are provided by grant type in the same document.

BEST PRACTICES OF NIH GRANT REVIEW CRITERIA

The best practices of this report that were included in developing the guidelines were:

- The review criteria are flexible, allowing reviewers to use slightly different criteria for assessing different kinds of research projects. For example, the written critique instructions include the statements "Do not insist on a hypothesis-driven approach if the research is sound and will move the field forward" and "Focus is important, especially for new investigators."

- Reviewers are asked to assess the relative magnitude of strengths and weaknesses, which provides some perspective on the degree to which assessment of the grant application should be affected by each critique.

- The reviewers are asked to favorably weight sound research that moves a field forward over high-risk research.

NIH GRANT REVIEW CRITERIA

The review guidelines are detailed in the following two sections from *Review Guidelines* [emphasis added].

- The Written Critique: Consider all aspects of the application. Do not describe the investigator's plans; rather make evaluative statements about the strengths and weaknesses based on criteria described elsewhere. A strong application will contain good ideas, address important issues, and generate confidence that the investigator(s) will make a significant impact. Do not insist on a hypothesis-driven approach if the research is sound and will move the field forward. Focus is important, especially for new investigators. Avoid emphasizing minor technical details, making tutorial comments, or redesigning the investigator's experiments. Put the requirement for preliminary data in perspective such that bold new ideas, young investigators, and risk taking are encouraged rather than stymied. Be concise; longer reviews are not necessarily better. Sample critiques are less than 2 pages long. Where possible, try to put the strengths and weaknesses in perspective by indicating their relative magnitude. Do not consider issues outside of scientific merit in your critique such as current or past funding levels or personal situations of the investigator.

- Scoring: Priority scores range from 1.0 (highest priority) to 5.0 (lowest priority). Use your judgment in weighing the relative importance of each criterion. An application does not need to be strong in all categories to be judged likely to have a major scientific impact. For example, an investigator may propose to carry out important work that by its nature is not innovative, but is essential to move a field forward. An application of average strength relative to other applications ordinarily reviewed by the study section should receive a score of 3.0, although the scoring behavior of individual study sections may vary. It is important to note that unacceptable designations in the areas of protection of human subjects from research risk or inclusion of gender, minorities, or children should be reflected in the priority score. Be consistent and remember that you are welcome to discuss scoring issues with the SRA and/or the Chair. It may be helpful in spreading the scores to rank the applications assigned to you for any given meeting in order of scientific merit.

Appendix H: National Aeronautics and Space Administration Grant Review Criteria

The National Aeronautics and Space Administration's (NASA) criteria for a written review of grant applications is laid out in the document *National Aeronautics And Space Administration: Guidebook For Proposers Responding To A NASA Research Announcement (NRA)*, issued January 2003 (w/errata dated 01/31/03), available online.

BEST PRACTICES OF NASA GRANT REVIEW CRITERIA

The best practices of this report that were included in developing the guidelines were:

- The review equally emphasizes intrinsic merit, relevance to NASA objectives, and cost. The failure of a proposal to receive high marks in any one of these areas is sufficient cause for the proposal to be rejected.
- Reviewers are also given specific review criteria for each solicitation area.
- Reviewers are asked to assess the fit between a proposal and review criteria independently of other proposals; comparisons between competing proposals are discouraged.
- The realism of the proposed cost is assessed both with respect to the proposed activity and to the funds available.

NASA GRANT REVIEW CRITERIA

The review guidelines are spelled out in the following section from *the Guidebook.*

C.2 Evaluation Criteria [Ref.: Appendix B, Part (i)]

As a general rule, the evaluation criteria in Appendix B, Part (i), of this Guidebook, as amended below by the words in italics, will apply to all NRA's [NASA Research Announcement] released by NASA, although they may be augmented and/or amended in each NRA [emphasis in original]:

(i). Evaluation Factors.

(1) Unless otherwise specified in the NRA, the principal elements (of approximately equal weight) considered in evaluating a proposal are its intrinsic merit, its relevance to NASA's objectives, and its cost. *The failure of a proposal to be rated highly in any one of these elements is sufficient cause for the proposal to not be selected*.

(2) Evaluation of a proposal's relevance to NASA's objectives includes the consideration of the potential contribution of the effort to NASA's mission *as expressed in its most recent NASA strategy documents and the specific objectives and goals given in the solicitation to which the proposal is submitted*.

(3) Evaluation of intrinsic merit includes consideration of the following factors:

(i) Overall scientific or technical merit of the proposal and/or unique and innovative methods, approaches, concepts, or advanced technologies demonstrated by the proposal;

(ii) Offeror's capabilities, related experience, facilities, techniques, or unique combination of these which are integral factors for achieving the proposal's objectives;

(iii) The qualifications, capabilities, and experience of the proposed principal investigator, team leader, or key personnel critical in achieving the proposal objectives; and

(iv) Overall standing among similar proposals and/or evaluation against the state-of-the-art.

(4) Evaluation of the cost of a proposed effort shall include the realism and reasonableness of the proposed cost, and *the comparison of that proposed cost to* available funds. *Low cost, while desirable, does not offset the importance of realism and reasonableness of the proposed budget*."

Note that the NASA Research Announcement itself provides the focused, program-specific objectives that will define precisely what is meant by the term "relevance" in items (1) and (2) above. The evaluation forms that are provided to reviewers will generally list (perhaps in abbreviated form) all criteria for which their opinion is requested. Reviewers are instructed to judge each proposal against the stated evaluation criteria and *not* to compare proposals to which they have access, even if they propose similar objectives. Only the NASA Program Officer may make binding comparisons of proposals during the process of developing the recommendation for selection.

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