U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND SCIENCE EDUCATION

HEARING CHARTER

The Merit Review Process:
Ensuring Limited Federal Resources are Invested in the Best Science

Tuesday, July 26, 2011
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

1. Purpose

On Tuesday, July 26, 2011, the Subcommittee on Research and Science Education will hold a hearing to examine the merit review grant award process and its effect on federally funded scientific research, in an effort to understand the strengths and potential weaknesses of the process.

2. Witnesses

Dr. Cora Marrett, Deputy Director, National Science Foundation

Dr. Keith Yamamoto, Vice Chancellor for Research, University of California San Francisco

Dr. Nancy Jackson, President, American Chemical Society

Dr. Jorge José, Vice President for Research, Indiana University

3. Overview

- A number of federal agencies, from the Department of Energy to the National Institutes of Health and the National Science Foundation, use various types of peer or merit review to evaluate proposals and make recommendations to award federal funds.

- The National Science Foundation (NSF) has three funding mechanisms: grants, cooperative agreements, and contracts. NSF makes merit-based grant awards to researchers, educators, and students. In Fiscal Year 2010 (FY10), NSF received 55,542 proposals and awarded 12,996 grants, a 23 percent funding rate. Fifty percent of its budget was devoted to new and continuing grants.[1]

- Approximately 96 percent of NSF grant proposals are evaluated through an external review process, commonly known as the NSF merit review process. The process utilizes subject matter experts to review proposals through the mail, in-person at a panel review, or through a

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[1] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.7
[2] Early-concept Grants for Exploratory Research (EAGER) are two-year awards for up to $300,000. These awards support the

combination of both (early-concept grants, rapid response grants, and small conferences and workshops are evaluated through an internal merit review process).

- The NSF merit review process evaluates proposals based on two criteria, intellectual merit and broader impacts. A National Science Board Task Force is currently examining the two criteria and a report is forthcoming. Since 2007, NSF has also been promoting potentially transformative concepts through additional language added to the intellectual merit criteria.

4. Background

Federal funding is disbursed in a number of ways, including through contracts, cooperative agreements and *grants*. The process by which many federal agencies evaluate potential grant awards is often termed merit or peer review. This process can take several different forms or utilize different processes; however, in general, it requires that the grant proposals be reviewed and evaluated by subject matter experts not associated with the proposal.

The National Science Foundation (NSF) uses grants for the majority of its funding disbursements. There are two basic grants. A standard award has a duration of typically 1-5 years, but is fully funded in the first fiscal year. A continuing grant, also for a multi-year project is provided in annual increments. The first year of funding for a continuing grant comes with a statement of intent to continue the funding with continuing grant increments (CGIs) through completion of the project, but the continuation is contingent on whether NSF deems satisfactory progress, availability of funds, and the receipt and approval of annual reports.

Cooperative agreements are used when the project requires substantial agency involvement like research centers and multi-user facilities.

Percentage of NSF Awards by Funding Mechanism

CATEGORY	2003	2004	2005	2006	2007	2008	2009	2010
Standard Grants	25%	25%	23%	25%	26%	28%	44%	37%
New Continuing	16%	14%	14%	13%	14%	13%	8%	13%
CGIs and Supplements	26%	28%	29%	28%	26%	26%	18%	18%
Cooperative Agreements	25%	24%	24%	23%	22%	23%	21%	23%
Other*	9%	9%	10%	11%	11%	11%	9%	9%

*Includes contracts, fellowships, interagency agreements, and IPA agreements
Source: NSF Enterprise Information System 12/22/10. Percentages may not sum to 100 due to rounding.

NSF utilizes an internal merit review process for a fraction of its grant awards, including the Early-concept Grants for Exploratory Research (EAGER) and Grants for Rapid Response Research (RAPID).[2] However, the bulk of NSF funded grants are evaluated through an external grant review process, known as the NSF merit review process.
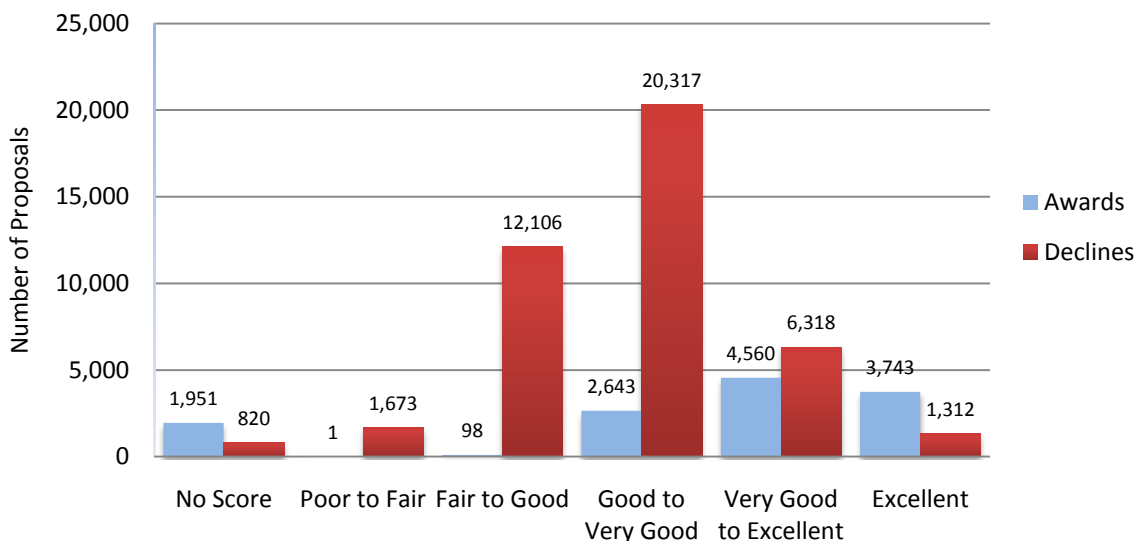*NSF Merit Review Process*

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[2] Early-concept Grants for Exploratory Research (EAGER) are two-year awards for up to $300,000. These awards support the early stages of work on potentially transformative research ideas or approaches. Grants for Rapid Response Research (RAPID) are one-year awards for up to $200,000. These awards support quick-response research, or research having a severe urgency with regard to availability of data, facilities, or equipment.

Grant proposals are required to be submitted electronically. NSF program officers ensure each proposal has been assigned to the correct office for review and determine the appropriate level of review (internal or external). Proposals are returned without being reviewed if they do not comply with NSF regulations, including separately addressing the intellectual merit and broader impacts criteria.

Program officers choose proposal reviewers and panel members from an NSF database of over 300,000 reviewers. They can also recruit reviewers based on literature searches, professional activities, and other reviewer recommendations. In addition, they also screen all reviewers for potential conflicts-of-interest and provide guidance and instructions.

Reviewers provide comments by mail or through the meeting of a panel session (these are most often in-person but panelists may also meet virtually). Once reviewers return comments, or a panel convenes, program officers are responsible for synthesizing comments and recommending the award or decline of each proposal. Reviewers provide narratives and categorical ratings which the program officer takes into account. An "Excellent" rating does not guarantee the award of funding. In FY 2010, 3,743 proposals that received an average review of "Excellent" were funded and 1,312 were not, and 4,560 proposals that received an average review of "Very Good to Excellent" were funded while 6,318 were not.[3]

Distribution of Average Reviewer Ratings for Awards and Declines, FY 2010

Source: NSF Enterprise Information System 10/01/10

The Division Director reviews the program officer's recommendations and then passes them on to the Division of Grants and Awards, who vets the eligibility of the awardee, negotiates any necessary changes, and disburses the award. The Director's Review Board reviews any award in excess of 2.5 percent of the awarding Division's budget. The National Science Board (NSB)

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[3] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.32

must approve any award in excess of $3 million dollars, or one percent or more of the awarding Directorate's prior year current plan, whichever is greater.

All those who submitted proposals receive notification as to whether or not an award will be made. Those to whom funding was declined receive copies of the reviews as well as information on the number of grants awarded and the number of proposals in each category. If a proposal is declined, the proposer may ask the program officer for further clarification. If he is still unsatisfied, he may make a reconsideration request to the relevant Assistant Director and a second request to the Deputy Director. (See Appendix A for the NSF Flow Chart.)

Types of Review

Proposals submitted to the merit review system are reviewed in three ways. Through "mail-only" reviews, proposals are sent to reviewers who are asked to submit written comments to NSF. Through "panel-only" reviews, reviewers serve on in-person (or virtual) panels to discuss reviews and provide advice to the program officer. Additionally, some proposals receive a combination of mail and panel review, which can take place in a number of ways.

There is value in each type of review. Mail review allows for better matching between the expertise of reviewers and proposals. Panel review allows for interplay between reviewers in the evaluation of proposals and the integration of different perspectives in the review of proposals. According to NSF, "Using panels in the review process tends to reduce proposal processing time (time-to-decision), compared to mail-only reviews. For example, in FY10, 78 percent of all proposals reviewed by panel-only were processed within six months, compared to 72 percent for mail + panel and 55 percent for mail-only.[4]" While in-person panels are most common, "virtual panels" are being convened more often. Virtual panels allow reviewers to participate from remote locations using interactive technology. The combination of mail and panel reviews "is used frequently because it combines the in-depth expertise of mail review with the comparative analysis of panel review.[5]"

The Program Officer

NSF program officers are made up of permanent (54 percent) and non-permanent (46 percent) employees,[6] all are subject matter experts in the areas they manage with advanced degrees or credentials. "Some non-permanent program officers are "on loan" as "Visiting Scientists, Engineers, and Educators" (VSEEs) for up to three years from their host institutions. Others are supported through grants to the home institutions under the terms of the Intergovernmental Personnel Act (IPA)."[7] These "rotators" ensure that new and fresh scientific ideas and specialties come through the Foundation and help to prevent institutional or innovative stagnation. One drawback, however, is the loss of institutional knowledge when a rotator leaves and the challenge of frequently bringing new rotators up to speed on NSF policies and processes.

The Foundation expects program officers to administer balanced portfolios and requires them to utilize the advice and expertise of the proposal reviewers while assessing proposals in terms of each portfolio. In order to create a balanced portfolio, program officers are expected to additionally

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[4] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.29
[5] Ibid.
[6] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.34
[7] Ibid.

evaluate proposals for a number of criteria, including, but not limited to: geographic distribution; novel approaches to significant research questions; capacity building in a new and promising research area; potential impact on the development of human resources and infrastructure; and NSF core strategies, including integration of research and education, broadening participation, and promoting partnerships.[8]

Merit Review Criteria

Since initial approval in 1997, every NSF grant proposal has been reviewed based on two merit review criteria, intellectual merit and broader impacts. While additional consideration may be given for a number of reasons including special requirements of the program, intellectual merit and broader impacts remains the cornerstone of the NSF merit review process.

> Intellectual Merit. 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, original, or potentially transformative concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?

> Broader Impacts. 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?[9]

The America COMPETES Reauthorization Act of 2010 expands the broader impacts criteria to include activities to achieve the following goals: 1) increase the economic competitiveness of the United States; 2) development a globally competitive STEM workforce; 3) increase participation of women and underrepresented minorities in STEM; 4) increase partnerships between academia and industry; 5) improve pre-K-12 STEM education and teacher development; 6) improve undergraduate STEM education; 7) increase public scientific literacy; and 8) increase national security.

In February 2010, the NSB reconstituted the Task Force on Merit Review. The Board charged the Task Force with "examining the two Merit Review Criteria and their effectiveness in achieving the goals for NSF support for science and engineering research and education."[10]

In June 2011, after a year of review, NSB and NSF put out a call for public comment (closed July 14, 2011) on proposed revisions to the merit review criteria. The proposed changes

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[8] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.26
[9] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.21-22
[10] NSB Task Force on Merit Review, http://www.nsf.gov/nsb/committees/tskforce_mr_charge.jsp

maintain the themes of intellectual merit and broader impacts while establishing key principles of the merit review criteria. The proposed changes include the identification of national goals which every NSF project should seek to advance, including, but not limited to: the increased economic competitiveness of the United States; the increased participation of women, persons with disabilities, and underrepresented minorities in STEM; the increased public scientific literacy and public engagement with science and technology; and increased national security. (See Appendix B for the complete proposal.)

Potential Challenges

While the NSF merit review process is widely considered the most effective of its type for the awarding of federal funding, there are existing challenges to be considered in an effort to strengthen the process. Questions remain about the way in which scientific priorities are established and whether the process is truly supporting innovative research and researchers. Below are some additional challenges:

- Transformative Research – Research that questions existing science often faces additional hurdles when facing review by scientific researchers in that field, especially during lean economic times as experts favor more conservative funding approaches. Since 2007, NSF has been working to ensure transformative research is considered appropriately and such proposals are provided an opportunity to compete through the merit review process, including adding explicit language in the intellectual merit criteria for transformative concepts. EAGER grants are intended to be used, in part, to fund potentially transformative ideas for which there is little to no preliminary data and, as such, would fare poorly in the standard merit review process. NSF has also incorporated efforts to encourage transformative research in its training of program officers and reviewers. It is also experimenting with modifications in the review process to help identify transformative proposals. Are these efforts working? Is there more to be done, within the process, to encourage transformative science?

- Ensuring a Pipeline for U.S. Students by Encouraging New Principal Investigators – New Principal Investigators (PIs) often do not have the same level of experience or access to resources that established PIs have, both considerations included as part of the intellectual merit criteria. In FY10, new PIs submitted 21,545 proposals and received 3,620 awards, a funding rate of 17 percent; prior PIs were funded at a rate of 28 percent.[11] A strong system properly encourages new investigators to participate in the scientific arena in order to ensure a pipeline for U.S. student participation in scientific endeavors. The Faculty Early Career Development (CAREER) Program offers specific funding opportunities for new PIs to help in this endeavor, but is this enough? Does the merit review process encourage the participation of new PIs?

- Parity for Institutions – Institutions that are not regular grant recipients do not always have the same resources or proficiencies as those institutions that consistently receive federal funding. "For FY10, the average funding rate was 26 percent for the top 100 Ph.D.-granting institutions (classified according to the amount of FY10 funding received). In comparison,

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[11] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.8
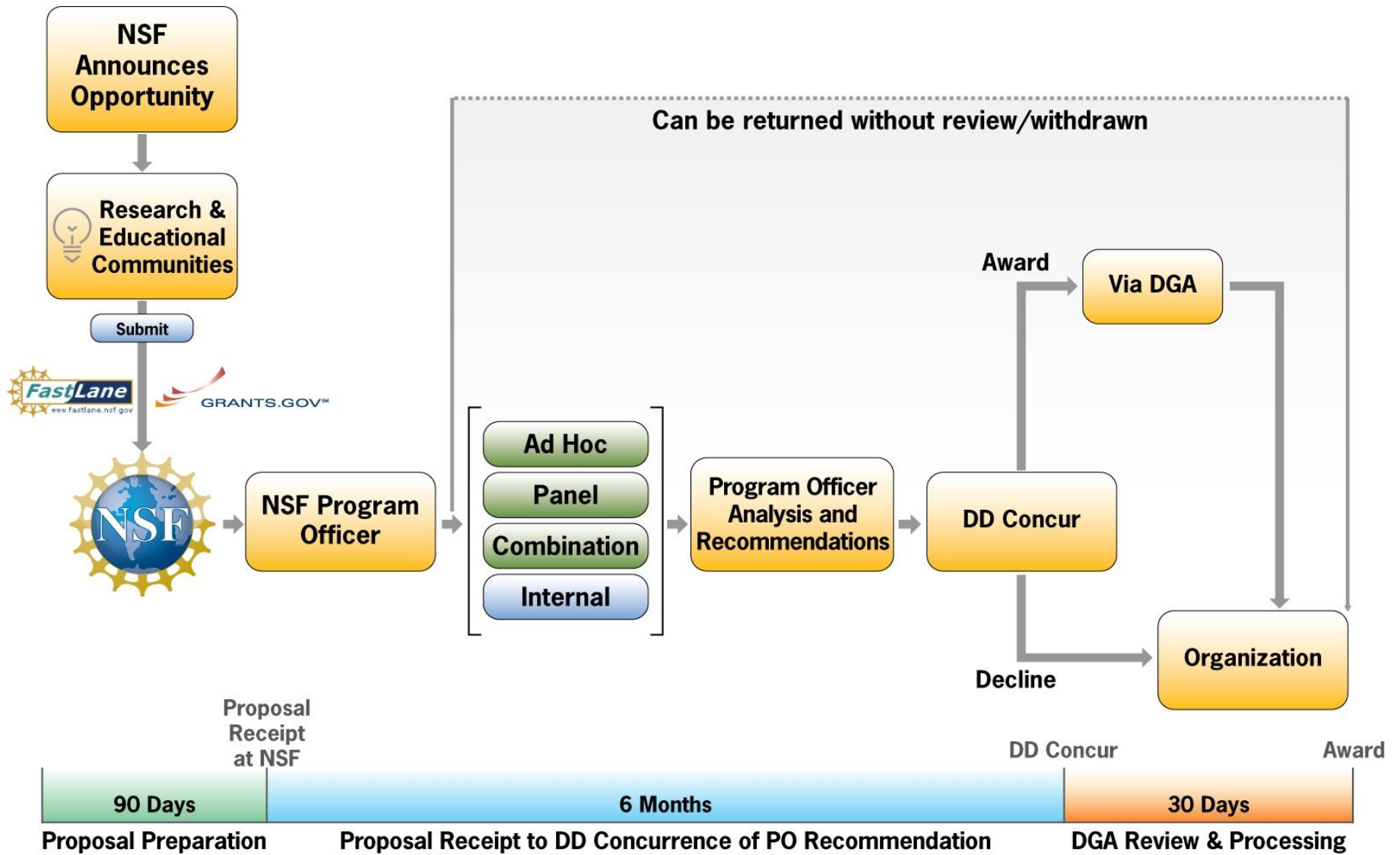
the rate was 17 percent for Ph.D.-granting institutions that are not in the top 100 NSF-funded category.[12]"   Are those institutions, not regularly in receipt of federal funding, encouraged to submit grant proposals and participate in the merit review process?

- <u>Multidisciplinary Review</u> – As NSF seeks to grow its multidisciplinary projects, the merit review process must consider the management of reviews that incorporate a combination of scientific disciplines in order to fund the strongest multidisciplinary proposals. Is the current process able to effectively encourage and evaluate multidisciplinary projects?

In all, the merit review process must continue to balance these challenges with the inherent need to fund the strongest science.

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[12] Report to the National Science Board on the National Science Foundation's Merit Review Process Fiscal Year 2010, p.10-11

APPENDIX A: NSF Merit Review Process Flow Chart

APPENDIX B: Merit Review Principles and Criteria*

The identification and description of the merit review criteria are firmly grounded in the following principles:

1. All NSF projects should be of the highest intellectual merit with the potential to advance the frontiers of knowledge.
2. Collectively, NSF projects should help to advance a broad set of important national goals, including:
   o Increased economic competitiveness of the United States.
   o Development of a globally competitive STEM workforce.
   o Increased participation of women, persons with disabilities, and underrepresented minorities in STEM.
   o Increased partnerships between academia and industry.
   o Improved pre-K–12 STEM education and teacher development.
   o Improved undergraduate STEM education.
   o Increased public scientific literacy and public engagement with science and technology.
   o Increased national security.
   o Enhanced infrastructure for research and education, including facilities, instrumentation, networks and partnerships.
3. Broader impacts may be achieved through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by the project but ancillary to the research. All are valuable approaches for advancing important national goals.
4. Ongoing application of these criteria should be subject to appropriate assessment developed using reasonable metrics over a period of time.

Intellectual merit of the proposed activity

The goal of this review criterion is to assess the degree to which the proposed activities will advance the frontiers of knowledge. Elements to consider in the review are:

1. What role does the proposed activity play in advancing knowledge and understanding within its own field or across different fields?
2. To what extent does the proposed activity suggest and explore creative, original, or potentially transformative concepts?
3. How well conceived and organized is the proposed activity?
4. How well qualified is the individual or team to conduct the proposed research?
5. Is there sufficient access to resources?

Broader impacts of the proposed activity

The purpose of this review criterion is to ensure the consideration of how the proposed project advances a national goal(s). Elements to consider in the review are:

1. Which national goal (or goals) is (or are) addressed in this proposal? Has the PI presented a compelling description of how the project or the PI will advance that goal(s)?
2. Is there a well-reasoned plan for the proposed activities, including, if appropriate, department-level or institutional engagement?
3. Is the rationale for choosing the approach well-justified? Have any innovations been incorporated?
4. How well qualified is the individual, team, or institution to carry out the proposed broader impacts activities?
5. Are there adequate resources available to the PI or institution to carry out the proposed activities?