

Designing Materials to Revolutionize and Engineer our Future (DMREF)

PROGRAM SOLICITATION

NSF 14-591

REPLACES DOCUMENT(S):

NSF 14-020



National Science Foundation

Directorate for Mathematical & Physical Sciences
Division of Materials Research
Division of Chemistry
Division of Mathematical Sciences

Directorate for Engineering
Division of Civil, Mechanical and Manufacturing Innovation
Division of Electrical, Communications and Cyber Systems
Division of Chemical, Bioengineering, Environmental, and Transport Systems

Directorate for Computer & Information Science & Engineering
Division of Advanced Cyberinfrastructure
Division of Computing and Communication Foundations
Division of Computer and Network Systems
Division of Information & Intelligent Systems

Submission Window Date(s) (due by 5 p.m. proposer's local time):

January 05, 2015 - January 29, 2015

IMPORTANT INFORMATION AND REVISION NOTES

This document replaces Dear Colleague Letter [NSF 14-020](#).

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide (PAPPG)* (NSF 15-1). The PAPPG is consistent with, and, implements the new Uniform Administrative Requirements, Cost Principles, and Audit Requirements for Federal Awards (Uniform Guidance) (2 CFR § 200). NSF anticipates release of the PAPPG in the Fall of 2014 and it will be effective for proposals submitted, or due, on or after December 26, 2014. Please be advised that proposers who opt to submit prior to December 26, 2014, must also follow the guidelines contained in NSF 15-1.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Designing Materials to Revolutionize and Engineer our Future (DMREF)

Synopsis of Program:

DMREF is the primary program by which NSF participates in the [Materials Genome Initiative \(MGI\) for Global Competitiveness](#). MGI recognizes the importance of materials science to the well-being and advancement of society and aims to "deploy advanced materials at least twice as fast as possible today, at a fraction of the cost." DMREF integrates materials discovery, development, property optimization, and systems design and optimization, with each employing a toolset to be developed within a materials innovation infrastructure. The toolset will synergistically integrate advanced computational methods and visual analytics with data-enabled scientific discovery and innovative experimental techniques to revolutionize our approach to materials science and engineering.

Accordingly, DMREF will support activities that accelerate materials discovery and development by building the fundamental knowledge base needed to design and make materials with specific and desired functions or properties from first principles. This will be accomplished by understanding the interrelationships of composition, structure, properties, processing, and performance. Achieving this goal will involve modeling, analysis, and computational simulations, validated and verified through sample preparation, characterization, and device demonstration. It will require new data analytic tools and statistical algorithms; advanced simulations of material properties in conjunction with new device functionality; advances in predictive modeling that leverage machine learning, data mining, and sparse approximation; data infrastructure that is accessible, extensible, scalable, and sustainable; the development, maintenance, and deployment of reliable, interoperable, and reusable software for the next-generation design of materials; and new collaborative capabilities for managing large, complex,

heterogeneous, distributed data supporting materials design, synthesis, and longitudinal study.

The multidisciplinary character of this effort dictates the involvement of programs in the NSF Directorates of Mathematical and Physical Sciences, Engineering, and Computer and Information Science and Engineering. Three or four year awards totaling \$500,000 – 1,500,000 for the award period are anticipated. To cover the breadth of this endeavor, it is expected that proposed projects will be directed by a team of at least two Senior Personnel with complementary expertise.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Almadena Chtchelkanova, CISE/CCF, 1115N, telephone: (703) 292-8910, email: achtchel@nsf.gov
- Eugene C. Gartland, MPS/DMS, 1025 N, telephone: (703) 292-2279, email: egartlan@nsf.gov
- Daniel Katz, CISE/ACI, 1270N, telephone: (703) 292-2254, email: dkatz@nsf.gov
- Alexis Lewis, ENG/CMMI, 545S, telephone: (703) 292-2624, email: alewis@nsf.gov
- Amnon J. Meir, MPS/DMS, 1025 N, telephone: (703) 292-2189, email: ajmeir@nsf.gov
- William Olbricht, ENG/CBET, 565S, telephone: (703) 292-2563, email: wolbrich@nsf.gov
- Timothy Patten, MPS/CHE, 1055S, telephone: (703) 292-7196, email: tpatten@nsf.gov
- Dimitris Pavlidis, ENG/ECCS, 525N, telephone: (703) 292-2216, email: dpavli@nsf.gov
- John Schlueter, MPS/DMR, 1065N, telephone: (703) 292-7766, email: jschluet@nsf.gov
- Sylvia Spengler, CISE/IIS, 1125S, telephone: (703) 292-8930, email: sspengle@nsf.gov
- Ralph Wachter, CISE/CNS, 1175N, telephone: (703) 292-8950, email: rwachter@nsf.gov

Applicable Catalog of Federal Domestic Assistance (CFDA) Number(s):

- 47.041 --- Engineering
- 47.049 --- Mathematical and Physical Sciences
- 47.070 --- Computer and Information Science and Engineering

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 18 to 25

The number of awards will depend on the availability of funds and the quality of the proposals.

Anticipated Funding Amount: \$22,000,000

Anticipated funding amount is pending availability of funds.

These funds will be partitioned among the participating Divisions, each of which will support proposals reviewed in that Division. Proposals on topics situated at the boundaries between two or more Divisions may be co-reviewed by those Divisions. Such proposals, if highly ranked, will be eligible for co-funding by those Divisions.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI:

No individual may appear as Senior Personnel (PI, Co-PI, Faculty or Other Senior Associate) on more than one DMREF proposal submitted in response to this solicitation. In the event that an individual exceeds this limit, any DMREF proposal submitted to this solicitation with this individual listed as Senior Personnel after the first DMREF proposal is received at NSF will be returned without review. No exceptions will be made.

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals funded or concurrently under consideration by NSF or to proposals previously declined by NSF and not substantially revised. Proposals not satisfying this condition will be returned without review.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
 - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
 - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide).

B. Budgetary Information

- **Cost Sharing Requirements:** Inclusion of voluntary committed cost sharing is prohibited.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. proposer's local time):
January 05, 2015 - January 29, 2015

Proposal Review Information Criteria

Merit Review Criteria: National Science Board approved criteria. Additional merit review considerations apply. Please see the full text of this solicitation for further information.

Award Administration Information

Award Conditions: Standard NSF award conditions apply.

Reporting Requirements: Standard NSF reporting requirements apply.

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I. INTRODUCTION

DMREF is the primary program by which NSF participates in the [Materials Genome Initiative \(MGI\) for Global Competitiveness](#). MGI recognizes the importance of materials science to the well-being and advancement of society and aims to "deploy advanced materials at least twice as fast as possible today, at a fraction of the cost." DMREF integrates materials discovery, development, property optimization, and systems design and optimization, with each employing a toolset to be developed within a materials innovation infrastructure. The toolset will synergistically integrate advanced computational methods and visual analytics with data-enabled scientific discovery and innovative experimental techniques to revolutionize our approach to materials science and engineering.

II. PROGRAM DESCRIPTION

DMREF seeks to promote activities that significantly accelerate materials discovery and development by building the fundamental knowledge base needed to progress towards designing and making materials with specific and desired functions or properties from first principles. Also of interest is research that seeks to advance fundamental understanding of materials across length and time scales to elucidate the effects of microstructure, surfaces, and coatings on the properties and performance of materials and devices. The DMREF goal is to control material properties through design. This is to be accomplished by understanding the interrelationships of composition, processing, structure, properties, performance, and process control. The approach envisioned to achieve this goal involves modeling, analysis, and computational simulations, validated and verified through measurement, experimentation, or device demonstration. This requires new data analytic tools and statistical algorithms; advanced simulations of material properties in conjunction with new device functionality; advances in predictive modeling that leverage machine learning, data mining, and sparse approximation; data infrastructure that is accessible, extensible, scalable, and sustainable; the development, maintenance, and deployment of reliable, interoperable, and reusable software for the next-generation design of materials; and new collaborative capabilities for managing large, complex, heterogeneous, distributed data supporting materials design, synthesis, and longitudinal study.

The program will support efforts that span researchers in materials science, chemistry, mathematics, computer science, and engineering, thereby bridging Program and Divisional interests. Proposal review will be coordinated and funded by NSF Programs and Divisions, as appropriate. The complexity and challenge of activities addressed by this initiative require a transformative approach to discovering and developing new materials, predicting and optimizing properties of materials, and informing the design of material systems. Accordingly, the proposed research must be a collaborative and iterative process wherein theory guides computational simulation, computational simulation guides experiments, and experiments further guide theory. Strategies must be included in the proposed research to advance synthesis/growth/processing techniques, characterization/testing methodology, and theory/data/computation/simulation approaches needed to develop predictive computational models.

This collaborative and iterative process will require a team of PIs with the requisite expertise. Accordingly, it is expected that proposed projects will be directed by a team of at least two Senior Personnel with complementary expertise. The proposal must provide a plan for enhanced data management that ensures transparency, data sharing, and open source software, including an explicit statement of which open source license(s), if applicable, will be used. While not required, ties with industry, national laboratories, engineering partners, or other organizations are encouraged. If there are strong collaborations with industry, please see the [Grant Opportunities for Academic Liaison with Industry \(GOALI\)](#) program solicitation, which can be used in conjunction with this effort. Collaborative Proposals involving two or more academic institutions may also be appropriate ([Grant Proposal Guide](#), Chapter II, Section.D.4). Because this DMREF approach emphasizes an integrated approach to materials research, cross-disciplinary educational activities are encouraged, as are public outreach activities.

NSF will support DMREF through well-coordinated activities involving the Directorates of Mathematical and Physical Sciences (MPS), Engineering (ENG), and Computer and Information Science and Engineering (CISE). Within MPS, the Divisions of Chemistry (CHE), Materials Research (DMR), and Mathematical Sciences (DMS) will participate. The Divisions of Civil, Mechanical, and Manufacturing Innovation (CMMI), Electrical, Communication and Cyber Systems (ECCS), and Chemical, Bioengineering, Environmental and Transport Systems (CBET) in ENG will participate. Within CISE the Divisions of Advanced Cyberinfrastructure (ACI), Computing and Communication Foundations (CCF), Computer and Network Systems (CNS), and Information and Intelligent Systems (IIS) will participate. Awards are expected to total between \$500,000 - \$1,500,000 for a duration of three or four years.

DMREF proposals must be submitted in response to this DMREF program solicitation. At least one participating NSF Division must be selected from the drop-down list in FastLane as the Unit of Consideration. The first Unit of Consideration selected must be the participating NSF Division aligned most closely with the topic of the proposal. Additional Units of Consideration aligned with the proposal may also be selected. Proposals must be submitted during the applicable submission window (5 January through 29 January 2015). The title of the proposal must begin with "DMREF:" (or **DMREF: GOALI:**, if applicable) followed by the project title.

Adherence to these requirements will guide NSF Program Officers in establishing an appropriate review for the proposal. This information will be used for guidance in identifying appropriate panels, but will not necessarily reflect the Division that will ultimately process the proposal. Proposals reviewed in a given Division will typically compete for funding allocated by that Division to support the DMREF program, but it is anticipated that proposals on topics situated at the boundaries between two or more Divisions may be co-reviewed by those Divisions. Such proposals, if highly ranked, will be eligible for co-funding by those Divisions.

Special Instructions for Proposals Selecting the Division of Mathematical Sciences (DMS) as the First Unit of Consideration

In addition to the mathematical and statistical modeling and analysis that occur in the interactions among experiments, models, and simulations, DMREF topics of special interest to DMS include, but are **not** limited to:

- Optimization of design in complicated, high-dimensional state spaces;
- Effective data mining methods to uncover relationships important for predictive modeling and design (e.g. between microstructure and bulk properties, or among composition, processing, and bulk properties);
- First-principles understanding of materials;
- Data-analytic tools and the interplay between data and predictive modeling; and
- Challenges presented not only by multiscale issues, but also by the problem of rapidly making use of differences between theory, new experimental data, and new simulation results to revise the theory, reformulate the simulation models and methods, and develop new experiments

This example is similar to data assimilation and data fusion problems encountered elsewhere, but here the possibilities offered by better data and closely coupled iteration create new opportunities for theoretical and algorithmic advances in mathematics and statistics.

Participants interested in selecting DMS as the first Unit of Consideration are strongly encouraged to confer with the cognizant DMS Program Officer listed above.

Special Instructions for Proposals Selecting the Division of Advanced Cyberinfrastructure (ACI) as the First Unit of Consideration

DMREF proposals of specific interest to the Division of Advanced Cyberinfrastructure must deal with problems in the range of issues described above and will be evaluated based on the extent that they:

- Contribute to development and deployment of comprehensive, integrated, sustainable, and secure cyberinfrastructure at the national or international scale;
- Have an effective cyberinfrastructure impact with clearly defined benefits across multiple research disciplines;
- Promote the transition from basic research to effective practice; and
- Build on existing or upcoming ACI investments, as well as major cyberinfrastructure investments from other parts of NSF.

Participants interested in selecting ACI as the first Unit of Consideration are strongly encouraged to confer with the cognizant ACI Program Officer listed above.

III. AWARD INFORMATION

Awards totaling \$500,000 to \$1,500,000 for periods of three or four years are anticipated. The budget must be commensurate with the scope of the project and thoroughly justified in the proposal.

Anticipated funding amount is pending availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI:

No individual may appear as Senior Personnel (PI, Co-PI, Faculty or Other Senior Associate) on more than one DMREF proposal submitted in response to this solicitation. In the event that an individual exceeds this limit, any DMREF proposal submitted to this solicitation with this individual listed as Senior Personnel after the first DMREF proposal is received at NSF will be returned without review. No exceptions will be made.

Proposals submitted in response to this solicitation may not duplicate or be substantially similar to other proposals funded or concurrently under consideration by NSF or to proposals previously declined by NSF and not substantially revised. Proposals not satisfying this condition will be returned without review.

Additional Eligibility Info:

All DMREF proposals must involve at least two Senior Personnel (PI, Co-PI, Faculty or Other Senior Associate) to ensure that all aspects of the project (synthesis/growth/processing, characterization/testing, theory/data/computation/simulation) are adequately covered by relevant expertise. These partnerships may occur either in a proposal from a single institution or in a Collaborative Research proposal involving two or more institutions.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.5 of the Grant Proposal Guide provides additional information on collaborative proposals.

See Chapter II.C.2 of the [GPG](#) for guidance on the required sections of a full research proposal submitted to NSF. Please note that the proposal preparation instructions provided in this program solicitation may deviate from the GPG instructions.

The standard Grant Proposal Guide or NSF Grants.gov Application Guide instructions for proposal preparation apply, with the following modifications.

Cover Page:

- **Program Solicitation Number.** FastLane users: Select the DMREF program solicitation number shown at the beginning of this solicitation from the drop-down menu. Grants.gov users: The program solicitation will be pre-populated by Grants.gov on the NSF Grant Application Cover Page.
- **Unit of Consideration.** At least one participating NSF Division from the drop-down list in FastLane must be selected as the Unit of Consideration. The first Unit of Consideration selected must be the participating NSF Division aligned most closely with the topic of the proposal. Additional Units of Consideration aligned with the topic of the proposal may also be selected. Grants.gov users should refer to Section VI.1.2. of the NSF Grants.gov Application Guide for specific instructions on how to designate the NSF Unit of Consideration. For assistance in determining which Division(s) to choose, refer to the NSF [Guide to Programs](#), which provides descriptions of NSF's research-supporting programs.
- **Proposal Title.** The proposal title must begin with "DMREF:" followed by an informative project title. Proposals submitted by different institutions as a collaborative group must have the identical title that begins with the designation "DMREF: Collaborative Research:".
- **Collaborative Proposals.** All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. All proposals in a collaborative group must select the same Units of Consideration in the same sequence. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on Collaborative Proposals.
- **Senior Personnel.** All DMREF proposals must involve at least two Senior Personnel (PI, Co-PI, Faculty or Other Senior Associate) to ensure that all aspects of the project (synthesis/growth/processing, characterization/testing, theory/data/computation/simulation) are adequately covered by relevant expertise. These partnerships may occur either in a proposal from a single institution or in a Collaborative Research proposal involving two or more institutions.

Compliance with these Cover Page specifications is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing or result in the proposal being returned without review.

Project Summary: The final line of the Overview portion of the Project Summary must be a list of no more than five key words preceded by the phrase or heading **Key Words**.

Project Description: The Project Description must include a brief description of the management plan for the collaboration preceded by the phrase or heading **Management Plan**.

Single Copy Documents:

- **Required:** A single, alphabetically ordered list of all persons with whom the Senior Personnel have a Conflict of Interest (COI) and the professional affiliation of each such person. For current purposes Senior Personnel have a COI (a) with any former graduate or postdoctoral advisee, (b) with any person with whom they have published or collaborated within the past 48 months, (c) with any person with whom they have co-edited a journal, compendium, or conference proceedings in the past 24 months, (d) with any former graduate advisor, and (e) with any person who was a postdoctoral advisor within the past five years.
- **Optional:** Suggested Reviewers and Reviewers Not to Include.

Single Copy Documents are used by NSF staff, but are not available to reviewers.

Supplementary Documents:

- For proposals involving collaborations with researchers not listed as co-PIs, proposers should include letters confirming the collaborations. The letters must be very brief and contain no statements of support or reference. Details about collaborative work to be done under this project should be included within the 15 pages of the Project Description, not in the letter(s) of collaboration.

B. Budgetary Information

Cost Sharing: Inclusion of voluntary committed cost sharing is prohibited.

Budget Preparation Instructions:

The NSF DMREF Management Team will schedule a meeting of DMREF PIs annually in the Washington, DC, area. Proposal budgets should include funds to support the attendance of at least one PI or co-PI each year.

C. Due Dates

- **Submission Window Date(s)** (due by 5 p.m. proposer's local time):

January 05, 2015 - January 29, 2015

Proposals must be submitted by 5:00 p.m., proposer's local time, on January 29, 2015.

D. FastLane/Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: <http://www.grants.gov/web/grants/applicants.html>. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in the GPG as [Exhibit III-1](#).

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is 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.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. ([GPG Chapter II.C.2.d.i.](#) contains additional information for use by proposers in development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including [GPG Chapter II.C.2.d.i.](#), prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
 - a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
 - b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

Additional Solicitation Specific Review Criteria

In addition, the following criteria will be used:

- Does the proposed research use collaborative processes with iterative feedback between tasks? Materials synthesis/growth/processing, materials characterization/testing, and theory/data/computation/simulation components of the research must all interact to improve each other and enhance project outcomes.
- Is the proposed work likely to lead to significant advances in all components of the project, including materials synthesis/growth/processing, materials characterization/testing, and theory/computation/simulations?
- Does the proposed work help accelerate materials discovery and development by building the fundamental knowledge base needed to progress toward designing and making materials with specific, desired functions or properties?
- Does the proposed work provide access to its outputs, including publications, software, and data, with clear identification of what license(s) will be used?

B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will be completed and submitted by each reviewer. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF strives to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. Large or particularly complex proposals or proposals from new awardees may require additional review and processing time. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director acts upon the Program Officer's recommendation.

After programmatic approval has been obtained, the proposals recommended for funding will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications. After an administrative review has occurred, Grants and Agreements Officers perform the processing and issuance of a grant or other agreement. Proposers are cautioned that only a Grants and Agreements Officer may make commitments, obligations or awards on behalf of NSF or authorize the expenditure of funds. No commitment on the part of NSF should be inferred from technical or budgetary discussions with a NSF Program Officer. A Principal Investigator or organization that makes financial or personnel commitments in the absence of a grant or cooperative agreement signed by the NSF Grants and Agreements Officer does so at their own risk.

Once an award or declination decision has been made, Principal Investigators are provided feedback about their proposals. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers or any reviewer-identifying information, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process).

B. Award Conditions

An NSF award consists of: (1) the award notice, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award notice; (4) the applicable award conditions, such as Grant General Conditions (GC-1)*; or Research Terms and Conditions* and (5) any announcement or other NSF issuance that may be incorporated by reference in the award notice. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). Within 90 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Almadena Chtchelkanova, CISE/CCF, 1115N, telephone: (703) 292-8910, email: achtchel@nsf.gov
- Eugene C. Gartland, MPS/DMS, 1025 N, telephone: (703) 292-2279, email: egartlan@nsf.gov
- Daniel Katz, CISE/ACI, 1270N, telephone: (703) 292-2254, email: dkatz@nsf.gov
- Alexis Lewis, ENG/CMMI, 545S, telephone: (703) 292-2624, email: alewis@nsf.gov
- Amnon J. Meir, MPS/DMS, 1025 N, telephone: (703) 292-2189, email: ajmeir@nsf.gov
- William Olbricht, ENG/CBET, 565S, telephone: (703) 292-2563, email: wolbrich@nsf.gov
- Timothy Patten, MPS/CHE, 1055S, telephone: (703) 292-7196, email: tpatten@nsf.gov
- Dimitris Pavlidis, ENG/ECCS, 525N, telephone: (703) 292-2216, email: dpavlidis@nsf.gov
- John Schlueter, MPS/DMR, 1065N, telephone: (703) 292-7766, email: jschluet@nsf.gov
- Sylvia Spengler, CISE/IIS, 1125S, telephone: (703) 292-8930, email: sspengle@nsf.gov
- Ralph Wachter, CISE/CNS, 1175N, telephone: (703) 292-8950, email: rwachter@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

IX. OTHER INFORMATION

The NSF website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this website by potential proposers is strongly encouraged. In addition, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF [Grants Conferences](#). Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website at https://public.govdelivery.com/accounts/USNSF/subscriber/new?topic_id=USNSF_179.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this mechanism. Further information on Grants.gov may be obtained at <http://www.grants.gov>.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

Facilitation Awards for Scientists and Engineers with Disabilities provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See Grant Proposal Guide Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090 and (800) 281-8749, FIRS at (800) 877-8339.

The National Science Foundation Information Center may be reached at (703) 292-5111.

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding

grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

To get the latest information about program deadlines, to download copies of NSF publications, and to access abstracts of awards, visit the NSF Website at <http://www.nsf.gov>

- **Location:** 4201 Wilson Blvd. Arlington, VA 22230
- **For General Information**
(NSF Information Center): (703) 292-5111
- **TDD (for the hearing-impaired):** (703) 292-5090
- **To Order Publications or Forms:**
Send an e-mail to: nsfpubs@nsf.gov
or telephone: (703) 292-7827
- **To Locate NSF Employees:** (703) 292-5111

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, [NSF-50](#), "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and [NSF-51](#), "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Office of the General Counsel
National Science Foundation
Arlington, VA 22230

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