

PFE: Research Initiation in Engineering Formation (PFE: RIEF)

PROGRAM SOLICITATION

NSF 20-558

REPLACES DOCUMENT(S):

NSF 17-514



National Science Foundation

Directorate for Engineering
Engineering Education and Centers

Full Proposal Deadline(s) (due by 5 p.m. submitter's local time):

November 10, 2020

Second Tuesday in November, Annually Thereafter

IMPORTANT INFORMATION AND REVISION NOTES

Language was added to clarify the intended audience of prospective PIs for this solicitation. Expectations about the mentoring component of this program were clarified.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 20-1), which is effective for proposals submitted, or due, on or after June 1, 2020.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

PFE: Research Initiation in Engineering Formation (PFE: RIEF)

Synopsis of Program:

The PFE: Research Initiation in Engineering Formation (PFE: RIEF) program has two goals: 1) Support research in the Professional Formation of Engineers (PFE), and 2) Increase the community of researchers conducting PFE research. PIs are expected to have little or no experience conducting social science or education research. PFE: RIEF is not intended for established researchers in engineering education or other social science fields to initiate new projects. Those researchers should consider the Research in the Formation of Engineers program (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505681).

The NSF Engineering (ENG) Directorate has launched a multi-year initiative, the Professional Formation of Engineers, to create and support an innovative and inclusive engineering profession for the 21st Century. Professional Formation of Engineers (PFE) refers to the formal and informal education and value systems by which people become engineers. It also includes the ethical responsibility of practicing engineers to sustain and grow the profession. The engineering profession must be responsive to national priorities, grand challenges, and dynamic workforce needs; it must be equally open and accessible to all.

Engineering faculty possess both deep technical expertise in their engineering discipline and the primary responsibility for the process of professional formation of future engineers. As such, engineering faculty are in a unique position to help address critical challenges in engineering formation. The Professional Formation of Engineers: Research Initiation in Engineering Formation (PFE: RIEF) program enables engineering faculty who are renowned for teaching, mentoring, or leading educational reform efforts on their campus to develop expertise in conducting engineering education research.

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.

- Jumoke Ladeji-Osias, telephone: (703) 292-7708, email: jladejio@nsf.gov

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

- 47.041 --- Engineering

Award Information

Anticipated Type of Award:

Standard Grant or Continuing Grant

Estimated Number of Awards:

15

Anticipated Funding Amount:

\$3,000,000

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

The PFE: RIEF program is designed to expand the community of engineering faculty equipped to conduct research in professional formation of engineers. At least one (co) PI must be a member of an engineering department AND not have received engineering education or professional formation funding through EEC in the last three years.

Submissions from faculty with active disciplinary research programs, or faculty seeking a shift in their research focus, are especially encouraged. The program is not intended to create an additional funding channel for researchers with expertise in social science or education research; such researchers should apply to the Research in the Formation of Engineers program (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505681), or other related NSF opportunities.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

There are no restrictions or limits.

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* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - Full Proposals submitted via Research.gov: *NSF Proposal and Award Policies and Procedures Guide* (PAPPG) guidelines apply. The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.
 - 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: https://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:**

Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

November 10, 2020

Second Tuesday in November, Annually Thereafter

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria. Additional merit review criteria 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

Engineering faculty have deep understanding of their technical fields and the primary responsibility for educating future engineers. Engineering faculty have used novel classroom techniques or developed programs to enhance the education of their students, develop interest in engineering at the K12 level, and inform the public. Many of these faculty are interested in gathering evidence for the effectiveness of these practices or understanding the factors that affect their students' learning. The Professional Formation of Engineers: Research Initiation in Engineering Formation (PFE: RIEF) program is designed to provide these faculty with the opportunity to conduct this research while at the same time being mentored on social science research approaches. The intent is that by completing a PFE: RIEF project, engineering faculty will be prepared to take a stronger leadership role in research on the professional formation of engineers, thus expanding the community of engineering education researchers. An award under PFE: RIEF is one possible pathway toward securing research funding from the RFE program.

The Professional Formation of Engineers: Research Initiation in Engineering Formation (PFE: RIEF) solicitation is a funding opportunity in the Engineering Directorate's (ENG) multi-year initiative, the Professional Formation of Engineers, established to create and support an innovative and inclusive engineering profession for the 21st Century.

Professional Formation of Engineers (PFE) refers to the formal and informal processes and value systems through which people become engineers. It also includes the ethical responsibility of practicing engineers to sustain and grow the profession in order to improve quality of life for all peoples. Processes of formation are holistic, carefully attending to how knowledge and identity interrelate in the larger context of one's career and life.

Professional Formation includes, but is not limited, to:

- Introductions to the profession at any age;
- Acquisition of deep technical and professional skills, knowledge, and abilities in both formal and informal settings/domains;
- Development of outlooks, perspectives, ways of thinking, knowing, and doing;
- Development of identity as an engineer and its intersection with other identities; and
- Acculturation to the profession, its standards, and norms.

Research is welcome that considers the construction of engineering knowledge, engineering identity, and the engineering profession, as well as interventions that expand the boundaries of each of these.

Professional formation occurs within a complex system that includes formal classrooms; informal settings such as maker spaces (hands-on, do-it-yourself environments where community members gather to create, invent, and learn); co-curricular activities; industry experiences (including co-ops and internships); community-based learning experiences; as well as early career (co-op or internship) work, research experiences, mentor/mentee, and sponsor/sponsee relationships, etc. To facilitate such activities, engineers must understand and navigate this complex system for successful professional formation and practice. They must oversee and participate in developing and maintaining this system, with smooth and clear pathways to and through the profession. Pathways may include, but are not limited to, formal and informal education, apprenticeship, credentialing, and licensure.

Engineering formation activities serve societal needs by supporting an innovative and inclusive engineering profession for the 21st Century. Challenges facing the engineering profession require new ideas about how to reshape processes of professional formation in multiple areas, such as:

1. Advancing holistic engineering formation. The US labor market requires a sufficient number of talented and well educated US engineers with outlooks, perspectives, and ways of thinking, knowing, and doing appropriate for professional practice across economic sectors. These include not only technical competence but also twenty-first century skills, "T-shaped" skills, critical thinking, creativity, intercultural competencies, entrepreneurship, and mindsets supporting sustainability. These competencies relate to several ABET-identified learning outcomes, including abilities to analyze social context in both historical and contemporary settings; to communicate effectively in listening, speaking, writing, and visual representation; to engage effectively in diverse teams; to reflect and act ethically; to engage in lifelong learning; and to design in context. Creating greater opportunities and preparation for engineers to engage interdisciplinary endeavors, especially in relation to complex sociotechnical systems (e.g., electric power grid; food-water-energy systems; telecommunications systems; machine learning and robotics; healthcare system; etc.) will enable the future workforce to adapt to changes in national priorities and emergent technologies.
2. Diversifying pathways to and through engineering. Research projects that align with this theme explore how engineering programs can create alternative pathways for students with a broad range of backgrounds, interests, and experiences; investigate how informal or real world experiences germane to engineering-such as military service or being a "maker" - serve as pathways to engineering; identify engineering norms of knowing, thinking, and doing that reflect and perpetuate climates and cultures of inequality, including but not limited to normative masculinities, heteronormativities, whiteness, and able-bodiedness in the profession; develop effective strategies to reshape these norms in ways that increase opportunities for engineers from groups traditionally underrepresented in engineering, including those with disabilities, as well as engineers from underserved or non-traditional backgrounds; develop engineering identities and processes of acculturation to the profession that are compatible with intersecting non-normative identities; or investigate how to fundamentally restructure courses, curricula, or programs to substantially boost student success, especially for under-represented populations, including those with disabilities, and veterans. Research on approaches that lower barriers for students to transfer into or between engineering programs, from other majors or community colleges for example, is also sought.
3. Exploring citizen engineering, credentialing and expertise. Research in this area explores how to build capacity within communities and the general public to make well-informed decisions about engineering priorities; develop processes for engineers and the public to collaboratively define, ideate, and implement creative solutions related to major sociotechnical challenges in society; explores the relationships among credentialing, expertise, and formation of engineers, developing new methods to assess, credential, and accredit engineering formation; characterizes how credentials are valued and interpreted in different settings; considers alternatives for obtaining professional credentials or expertise at manageable cost and time invested.
4. Developing engineering-specific theories of how engineers are formed. Theories on development of engineering epistemologies and identities, and methodologies to characterize different aspects of professional formation processes at the level of individuals, groups, institutions, and in society at large.
5. Understanding how change in engineering formation processes travels, translates, transfers, diffuses, and/or scales. This topic includes studies on how to improve the translation of engineering formation research to practice or scale innovations to have systemic impact. This topic also supports activities that inform engineering formation efforts and investments or spawn new research.

These, and many other challenges in the professional formation of engineers, require expertise in both engineering and the social sciences to understand the issues and develop solutions. The PFE: RIEF program specifically targets those individuals who are passionate educators and/or have technical disciplinary research programs, allowing them to build from this base to develop wider innovations in the professional formation of engineers grounded in engineering education research.

II. PROGRAM DESCRIPTION

A wide range of research topics related to the Professional Formation of Engineers can be addressed in PFE: RIEF proposals; the emphasis of PFE: RIEF is on initiating research projects in professional formation of engineers rather than supporting research on any specific topic. PFE: RIEF projects should combine engineering approaches with those from learning and cognitive sciences, engineering education, social sciences, and related fields in synergistic ways and enable engineering faculty to develop expertise in engineering education research.

PFE: RIEF awards are intended to expand the community of engineering faculty conducting research related to professional formation of engineers.

Possible outcomes commensurate with the goals of this program are:

- Support engineering faculty in developing expertise in professional formation of engineers.
- Increase the number of faculty and universities who will initiate projects and programs in research on professional formation of engineers.

The intent of the PFE: RIEF program is to expand the community of engineering faculty conducting research related to engineering formation rather than to create an additional funding channel for researchers with social science expertise.

III. AWARD INFORMATION

Anticipated Type of Award: Continuing Grant or Standard Grant

Estimated Number of Awards: 15

Anticipated Funding Amount: \$3,000,000

Estimated program budget, number of awards and average award size/duration are subject to the availability of funds.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Institutions of Higher Education (IHEs) - Two- and four-year IHEs (including community colleges) accredited in, and having a campus located in the US, acting on behalf of their faculty members. Special Instructions for International Branch Campuses of US IHEs: If the proposal includes funding to be provided to an international branch campus of a US institution of higher education (including through use of subawards and consultant arrangements), the proposer must explain the benefit(s) to the project of performance at the international branch campus, and justify why the project activities cannot be performed at the US campus.
- Non-profit, non-academic organizations: Independent museums, observatories, research labs, professional societies and similar organizations in the U.S. associated with educational or research activities.

Who May Serve as PI:

The PFE: RIEF program is designed to expand the community of engineering faculty equipped to conduct research in professional formation of engineers. At least one (co) PI must be a member of an engineering department AND not have received engineering education or professional formation funding through EEC in the last three years.

Submissions from faculty with active disciplinary research programs, or faculty seeking a shift in their research focus, are especially encouraged. The program is not intended to create an additional funding channel for researchers with expertise in social science or education research; such researchers should apply to the Research in the Formation of Engineers program (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505681), or other related NSF opportunities.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

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

There are no restrictions or limits.

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 FastLane, Research.gov, or Grants.gov.

- 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 Proposal & Award Policies & Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 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 Research.gov: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the *NSF Proposal and Award Policies and Procedures Guide* (PAPPG). The complete text of the PAPPG is available electronically on the NSF website at: https://www.nsf.gov/publications/pub_summ.jsp?ods_key=papppg. Paper copies of the PAPPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 or by e-mail from nsfpubs@nsf.gov. The Prepare New Proposal setup will prompt you for the program solicitation number.
- 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: https://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) 292-8134 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 FastLane or Research.gov. PAPPG Chapter II.D.3 provides additional information on collaborative proposals.

See PAPPG Chapter II.C.2 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 PAPPG instructions.

Guidelines for PFE: RIEF Proposal Preparation

The focus of the PFE: RIEF program is enabling engineering faculty who are passionate about teaching, mentoring, or leading educational reform efforts on their campus to initiate collaborative partnerships in engineering education research related to the professional formation of engineers. Please follow the instructions given in the PAPPG in preparing your proposal. Given the focus of the PFE: RIEF program on faculty development and cross-disciplinary collaboration, PFE: RIEF proposals also need to include the following information in the Project Description:

- **Problem Definition:** PFE: RIEF projects should be motivated by, and clearly state, a perceived problem in engineering formation which requires insights, expertise, and/or theory from engineering and social science or humanities disciplines. The proposal should pose research questions that will be formally investigated during the project and which are informed by and address gaps in the literature. The research questions and research design should also be informed by an appropriate theoretical framework, and can be developed with consultation from the engineering education research mentor.
- **Research Design:** Explain in detail how you will answer your research questions. Elements of the research design should include sampling, data collection, and data analysis methods.
- **Evaluation:** Evaluation refers to monitoring of the research process to ensure that the project stays on track. The evaluation plan should include both formative and summative evaluation. An evaluator external to the PI's organization is not required, but the evaluator should not be an individual who is involved in the research activities. Potential evaluators include faculty with evaluation expertise at the PI's institution, an institutional evaluation office, or an advisory board of experts.
- **PI Mentoring Plan:** Since the intent of the PFE: RIEF program is to expand the community of researchers in the professional formation of engineers, there should be a mentoring plan by which the engineering faculty PI will learn how to conduct engineering education or social science research. Mentor(s) should provide feedback to the engineering faculty PI, guiding that PI in both knowledge acquisition and conducting the research for the project. Details of the mentoring plan should be explicitly described in the proposal, including: communication frequency and modality, topical areas for mentorship (specific research methods or other components relevant to the research), and a plan to monitor the health and effectiveness of the mentorship relationship.
- **PI Motivation and Future Plans:** Provide background on the PI's relevant expertise and/or experience facilitating engineering formation processes. Describe any current and ongoing efforts to improve the professional formation of engineers that are being undertaken by the PI, particularly those related to mentoring, introducing future engineers to professional skills and engineering practice, instilling values and professional ethics, or acculturating future engineers to the profession. Describe how this project will connect the PI's prior experiences to future PFE research. Activities to be undertaken during the project—such as acquisition of preliminary data, professional development, or exploratory research—should lead to formulation of ongoing research projects. Future projects should lead to competitive grant applications to NSF at the conclusion of the PFE: RIEF award. Describe how the planned activities will lay the groundwork for, or be incorporated into, future research in areas including professional formation and other areas of interest to NSF. A specific goal of the PFE: RIEF program is to broaden the range of faculty who submit to EEC programs in the future.

The title of PFE: RIEF proposals should begin with "Research Initiation:".

Please be aware that engineering education research projects involving human subjects must receive approval from the proposer's Institutional Review Board (IRB) before funds will be awarded.

Also note that EEC sponsors grantee meetings at which PIs are encouraged to present results from their projects.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

Maximum award amount is \$200,000. Maximum award duration is 24 months.

C. Due Dates

- **Full Proposal Deadline(s)** (due by 5 p.m. submitter's local time):

November 10, 2020

Second Tuesday in November, Annually Thereafter

D. FastLane/Research.gov/Grants.gov Requirements

For Proposals Submitted Via FastLane or Research.gov:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: <https://www.fastlane.nsf.gov/a1/newstan.htm>. To prepare and submit a proposal via Research.gov, see detailed technical instructions available at: https://www.research.gov/research-portal/appmanager/base/desktop?_nfpb=true&_pageLabel=research_node_display&_nodePath=/researchGov/Service/Desktop/ProposalPreparationandSubmission.html. For FastLane or Research.gov user support, call the FastLane and Research.gov Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov or rgov@nsf.gov. The FastLane and Research.gov Help Desk answers general technical questions related to the use of the FastLane and Research.gov systems. 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: <https://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 or Research.gov may use Research.gov 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 acknowledgment 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 PAPPG Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: https://www.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 *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*. 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. (PAPPG 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 PAPPG 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

- Extent to which the project will expand the community of engineering education researchers: Reviewers will consider the prior experience of the engineering faculty PI. It is expected that the PI will have little or no experience conducting education or social science research. Development of new curricula or education programs does not count as social science research experience, although extensive work evaluating such programs does.
- Merit of the mentoring plan: Reviewers will consider the extent to which the mentoring plan is clear, well thought out, and practical for developing the research capabilities of the PI, the qualifications of the mentor(s) at providing the necessary mentoring, and the extent to which the

mentoring plan will provide the PI with the skills and abilities needed to conduct independent research in engineering education.

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 generally be completed and submitted by each reviewer and/or panel. 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 https://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-8134 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 *Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

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 no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 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 Proposal & Award Policies & Procedures Guide* (PAPPG) Chapter VII, available electronically on the NSF Website at https://www.nsf.gov/publications/pub_summ.jsp?ods_key=pappg.

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:

- Jumoke Ladeji-Osias, telephone: (703) 292-7708, email: jladeji@nsf.gov

For questions related to the use of FastLane or Research.gov, contact:

- FastLane and Research.gov Help Desk: 1-800-673-6188
FastLane Help Desk e-mail: fastlane@nsf.gov.
Research.gov Help Desk e-mail: rgov@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](#).

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 <https://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 (FASSED) provide funding for special assistance or equipment to enable persons with disabilities to work on NSF-supported projects. See the *NSF Proposal & Award Policies & Procedures Guide* Chapter II.E.6 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 <https://www.nsf.gov/>

- **Location:** 2415 Eisenhower Avenue, Alexandria, VA 22314
- **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) 292-8134
- **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 [System of Record Notices](#), NSF-50, "Principal Investigator/Proposal File and Associated Records," and NSF-51, "Reviewer/Proposal File and Associated Records." 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
Policy Office, Division of Institution and Award Support
Office of Budget, Finance, and Award Management
National Science Foundation
Alexandria, VA 22314

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