

# NSF/EPRI Collaboration on "Water for Energy"- Advanced Dry Cooling for Power Plants

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## PROGRAM SOLICITATION

NSF 13-564



National Science Foundation

Directorate for Engineering  
Division of Chemical, Bioengineering, Environmental, and Transport Systems



Electric Power Research Institute

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

August 19, 2013

## IMPORTANT INFORMATION AND REVISION NOTES

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A revised version of the *NSF Proposal & Award Policies & Procedures Guide (PAPPG)*, [NSF 13-1](#), was issued on October 4, 2012 and is effective for proposals submitted, or due, on or after January 14, 2013. Please be advised that the guidelines contained in [NSF 13-1](#) apply to proposals submitted in response to this funding opportunity. Proposers who opt to submit prior to January 14, 2013, must also follow the guidelines contained in [NSF 13-1](#).

Please be aware that significant changes have been made to the PAPPG to implement revised merit review criteria based on the National Science Board (NSB) report, [National Science Foundation's Merit Review Criteria: Review and Revisions](#). While the two merit review criteria remain unchanged (Intellectual Merit and Broader Impacts), guidance has been provided to clarify and improve the function of the criteria. Changes will affect the project summary and project description sections of proposals. Annual and final reports also will be affected.

A by-chapter summary of this and other significant changes is provided at the beginning of both the [Grant Proposal Guide](#) and the [Award & Administration Guide](#).

*Please note that this program solicitation may contain supplemental proposal preparation guidance and/or guidance that deviates from the guidelines established in the [Grant Proposal Guide](#).*

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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**Program Title:**

Solicitation on Advanced Dry Cooling for Power Plants

**Synopsis of Program:**

The Directorate of Engineering at the National Science Foundation (NSF) and the Electric Power Research Institute (EPRI) have established a collaboration to jointly address the critical problem of water usage and consumption in power plant cooling. The "water-for-energy" issue is an important piece of the Energy-Water nexus. The goal of this collaboration is to leverage the complementary missions of applied research and commercialization (EPRI) and fundamental research and education (NSF) to foster enabling research and technology development that will lead to significant reductions or elimination of the use of water for cooling power plants.

Through this joint collaboration, NSF and EPRI jointly solicit proposals with transformative ideas that meet the detailed requirements in this solicitation.

**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.*

- Sumanta Acharya, National Science Foundation, telephone: (703) 292-7494, email: [sacharya@nsf.gov](mailto:sacharya@nsf.gov)
- Jessica Shi, Electric Power Research Agency, telephone: (650) 855-8516, email: [jshi@epri.com](mailto:jshi@epri.com)

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

- 47.041 --- Engineering

## Award Information

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**Anticipated Type of Award:** Continuing Grant

**Estimated Number of Awards:** 5 to 10

**Anticipated Funding Amount:** \$6,000,000

Funding (total) available under this solicitation is \$6 million (subject to availability of funds) distributed in FY2013, 2014, 2015 and/or 2016. Individual awards may range from \$200,000 to up to \$700,000 max per year for up to three years.

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

## Eligibility Information

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### Organization Limit:

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.

### PI Limit:

The PI(s) must be full time faculty determined by the submitting organizational academic institutions. Projects can be collaborative and collaborations with industry and relevant costs for their participation is allowed. However, the primary funds under this award must be directed to the academic institution.

### Limit on Number of Proposals per Organization:

None Specified

### Limit on Number of Proposals per PI: 1

The PI and co-PI may participate in only one proposal submitted under this solicitation. It is the responsibility of the submitting institution to insure that the PI and all co-PIs are participating in only one proposal. If more than one proposal is submitted by the PI or co-PI, NSF reserves the right to return without reviewing the last proposal received or all proposals received from the PI or co-PI.

## Proposal Preparation and Submission Instructions

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### A. Proposal Preparation Instructions

- **Letters of Intent:** Not Applicable
- **Preliminary Proposal Submission:** Not Applicable
- **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](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](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide))

### B. Budgetary Information

- **Cost Sharing:**

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

**EPRI Cost Sharing Requirements:** EPRI awards may require cost sharing and will be negotiated separately by EPRI.
- **Indirect Cost (F&A) Limitations:** Not Applicable
- **Other Budgetary Limitations:** Not Applicable

### C. Due Dates

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

August 19, 2013

## Proposal Review Information Criteria

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**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

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**Award Conditions:** Standard NSF award conditions apply.

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## I. INTRODUCTION

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In the last few years, there have been increasing concerns about the availability of clean water, and efforts have ramped up to reduce water consumption, explore water purification and improving technology to make use of dirty/brackish water. In the energy sector, water is used to extract oil and gas, to cool power plants, to generate hydroelectricity, and in other energy-related applications such as oil and gas refining, and in growing biomass. Clearly, water for energy use is a significant source of water consumption in the United States and overseas, and is a major socio-economic issue of contemporary interest.

In the U.S. power generation industry, steam-electric plants account for approximately 40% of the nation's total freshwater withdrawals and approximately 3% of the nation's total freshwater consumption. Power plants rely on condensers that use either once-through cooling, recirculating wet-cooling towers, or air-cooling to condense the steam discharge from the turbine. The rate of water use in power-stations with recirculating wet cooling systems, currently estimated to be 42% of the U.S. steam power plants, may not be sustainable at some locations across the country. Further, thermal discharges from once-through cooling, used in 43% U.S. steam power plants, face increasing regulatory challenges. Therefore developing cost effective options for reducing water use for power plant cooling has emerged as a widespread national need.

Because the National Science Foundation (NSF) and Electric Power Research Institute (EPRI) have long invested in research and development in cooling technologies, NSF and EPRI have developed a collaboration to jointly support research to develop advanced cooling systems that minimize or eliminate the use of water.

The collaboration seeks to exploit the complementary missions of (i) research and development for NSF, and (ii) deployment and commercialization for EPRI to develop the critical understanding and technology improvements that will dramatically reduce or eliminate the use of cooling water for steam condensers in power plants. Proposals that explore such water-conserving technologies and their scientific underpinnings are sought through this solicitation.

## II. PROGRAM DESCRIPTION

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A potential approach toward eliminating or dramatically reducing water use in steam condensation is to use air-cooled steam condensers or to use hybrid technologies.

Air cooled steam condensers (installed in only 1% of U.S. steam plants) are a water-efficient option but can have up to a 10% power production penalty on hot days, and up to five times higher capital costs compared to current cooling tower and water cooled surface condenser systems.

Air-cooled condensers (ACC) used in practice typically have a steam-header feeding a large number of gravity driven finned-tubes for the condensate that drain into water pipes at the bottom. Large fans are used to circulate air past the finned-condenser tubes. Besides the cost and the power-production penalty, other drawbacks of air-cooled condensers are the large footprint of the condenser and their typical dimensions including the fan size. Banks of such condensers are used depending on the thermal loads.

Innovations in air-cooled condensers and alternative dry cooling technologies are needed to reduce penalties, size and capital costs. These innovations must be accompanied by fundamental studies and improvements in our understanding.

We seek innovative, "out of the box", and game changing early stage dry cooling ideas and concepts to significantly increase the air-side heat transfer coefficient, to dramatically reduce the steam condensation temperatures of the currently used air cooled condensers and to develop more efficient, cost effective, and compact alternative dry cooling solutions for power plant steam

condensation.

- In proposing innovations, the requirements of the power plant cooling industry must be kept in mind, specifically the steam flow rates, the heat loads, and the operating pressures and temperatures. The PIs must make the case that while their proposed ideas are rooted in advances in engineering science and technology, their ideas will be scalable to the utility-scale requirements. Specifically, ideas are sought that may do the following (as a general guideline):
- Reduce steam condensation temperature significantly (from about 22°C-30°C above the ambient temperature currently).
- Improve air/fin side heat transfer coefficient ( $h$ ) significantly e.g., two to three times (current values of  $h$  are typically 50 W/m<sup>2</sup>/K) without significant increase of ACC size and fan power consumption
- Improve steam side heat transfer coefficient significantly. Ideas proposed should be practical for use in the ACC environment, and should quantify benefit towards the overall goals of reducing footprint, costs and other penalties associated with ACC.
- Reduce size and footprint of the condenser tubes and the ACC significantly. This may require understanding the steam condensation behavior in micro-channels, and how to maintain high  $h$ -values over the entire length of the tube.
- Alternative dry cooling solutions including hybrid-options to further reduce steam condensation temperature, operation cost, and footprint.

The proposed research can focus on any one or more of the specific processes associated with the ACC. The project narrative must include information on the state of the art, competing technologies and their shortcomings, and how the proposed innovation/research will provide an improvement over the current state of the art. The project narrative must also include a discussion on the potential impact of the research on power plant cooling, and the feasibility/risks/challenges of the technology including the environmental and operational impacts. In discussing the relevance of the proposed research to the utility industry, it is recommended that the project narrative should include detailed specifications (e.g., flow rates, cooling capacity, pressure, temperature, quality, size, energy input, heat transfer coefficients etc.) where possible.

Collaborations between researchers that are doing fundamental research in ACC or hybrid cooling with those that focus on applied research and have appropriate facilities for testing successful ideas are encouraged. In these cases, if the PIs are at different institutions, submission of separately submitted collaborative proposals is required. See [GPG Chapter II.D.4.b](#) for information about submission of a collaborative proposal from multiple organizations.

In all cases, the proposal budget should include costs for travel to an annual PI's review meeting. The PI or an alternate must attend the annual review meeting. The date and location of the meeting will be announced well in advance of the review meeting. Prior to the review meeting, a technical summary report and power point presentation that will be made at the meeting will be required. These details will be provided prior to the meeting.

Information about the currently used air cooled condensers, cooling tower cooling systems, and EPRI's Technology Innovation Water Conservation program can be found at

<http://www.epri.com/abstracts/pages/productabstract.aspx?ProductID=00000000001025771&Mode=download>

### III. AWARD INFORMATION

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The total program is estimated to be \$6,000,000, distributed in FY 2013, 2014, 2015 and/or 2016, pending availability of funds.

Individual awards may range from \$200,000 to up to \$700,000 max per year for up to three years. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds. Average award size is expected to be in the \$300,000 per year range.

NSF and EPRI may independently make awards following a common review panel and subsequent programmatic evaluations done independently by NSF and EPRI.

NSF will offer grants to research proposals that develop fundamental and translational research and EPRI will contract research that aims to develop engineering solutions and perform feasibility studies. Proposals can be slanted towards the more fundamental aspects (of greater interest to NSF) or the engineering solutions/applied technology aspect (of greater interest to EPRI) or preferably combine both aspects in a phased manner. Where the proposal aims to combine the aspects of fundamental research and applied technology development the tasks associated with each aspect of the work should be clearly delineated as "Fundamental" and "Applied", and the respective roles of the PIs, their tasks and the timeline and coordination should be clearly explained. **In these cases, if the PIs are at different institutions, submission of separately submitted collaborative proposals is required. See [GPG Chapter II.D.4.b](#) for information about submission of a collaborative proposal from multiple organizations.** Based on the review process, NSF and EPRI will decide on which awards to select for award by each organization. Where the individual proposal or the collaborative proposal has interests from EPRI, the PI will be asked to re-submit the proposal to EPRI for their administrative processing. In these cases, EPRI may require a cost-sharing from the PI's institution and their collaborators. For proposals supported by NSF, no cost-sharing is required or allowed. Both organizations will jointly manage the project reviews. All NSF awards will be made via a Continuing Grant mechanism while EPRI awards will be negotiated separately by EPRI via a contract mechanism.

### IV. ELIGIBILITY INFORMATION

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#### Organization Limit:

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.

#### PI Limit:

The PI(s) must be full time faculty determined by the submitting organizational academic institutions. Projects can be collaborative and collaborations with industry and relevant costs for their participation is allowed. However, the primary funds under this award must be directed to the academic institution.

#### Limit on Number of Proposals per Organization:

None Specified

#### Limit on Number of Proposals per PI: 1

The PI and co-PI may participate in only one proposal submitted under this solicitation. It is the responsibility of the submitting institution to insure that the PI and all co-PIs are participating in only one proposal. If more than one proposal is submitted by the PI or co-PI, NSF reserves the right to return without reviewing the last proposal received or all proposals received from the PI or co-PI.

#### Additional Eligibility Info:

Proposals may be submitted by a single organization or a group of organizations consisting of a lead organization in collaboration with one or more partner organizations. Only U.S. academic institutions with significant research and degree-granting education programs in disciplines normally supported by NSF are eligible to be the lead organization. Principal investigators are encouraged to form synergistic collaborations with industry. For interaction with industry, the GOALI mechanism (Grant Opportunities for Academic Liaison with Industry) may be used. Alternatively, subcontracts to industrial collaborators may be employed.

Collaborations between researchers that are doing fundamental research in ACC or hybrid cooling with those that focus on applied research and have appropriate facilities for testing successful ideas are encouraged. In these cases, if the PIs are at different institutions, submission of separately submitted collaborative proposals is required. See [GPG Chapter II.D.4.b](#) for information about submission of a collaborative proposal from multiple organizations.

## V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

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### A. Proposal Preparation Instructions

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**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](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](mailto: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](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](mailto: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.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

**Important Proposal Preparation Information:** FastLane will check for required sections of the proposal, in accordance with *Grant Proposal Guide* (GPG) instructions described in Chapter II.C.2. The GPG requires submission of: Project Summary; Project Description; References Cited; Biographical Sketch(es); Budget; Budget Justification; Current and Pending Support; Facilities, Equipment & Other Resources; Data Management Plan; and Postdoctoral Mentoring Plan, if applicable. If a required section is missing, **FastLane will not accept the proposal.**

Please note that the proposal preparation instructions provided in this program solicitation may deviate from the GPG instructions. If the solicitation instructions do not require a GPG-required section to be included in the proposal, insert text or upload a document in that section of the proposal that states, "Not Applicable for this Program Solicitation." Doing so will enable FastLane to accept your proposal.

### B. Budgetary Information

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#### Cost Sharing:

**NSF Cost Sharing Requirements:** Inclusion of voluntary committed cost sharing is prohibited

**EPRI Cost Sharing Requirements:** EPRI awards may require cost sharing and will be negotiated separately by EPRI.

#### Budget Preparation Instructions:

EPRI may have additional budget preparation requirements at the award stage. Proposals that are funded by EPRI may have EPRI cost sharing requirements.

In all cases, the proposal budget should include costs for travel to an annual review meeting by the PI or an alternate. Prior to the

review meeting, a technical summary report and power point presentation that will be made at the meeting will be required. These details will be provided prior to the meeting.

## C. Due Dates

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

August 19, 2013

## D. FastLane/Grants.gov Requirements

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- **For Proposals Submitted Via FastLane:**

Detailed technical instructions regarding the technical aspects of preparation and submission via FastLane are 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](mailto: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.

**Submission of Electronically Signed Cover Sheets.** The Authorized Organizational Representative (AOR) must electronically sign the proposal Cover Sheet to submit the required proposal certifications (see Chapter II, Section C of the Grant Proposal Guide for a listing of the certifications). The AOR must provide the required electronic certifications within five working days following the electronic submission of the proposal. Further instructions regarding this process are available on the FastLane Website at: <https://www.fastlane.nsf.gov/fastlane.jsp>.

- **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://www07.grants.gov/applicants/app\\_help\\_reso.jsp](http://www07.grants.gov/applicants/app_help_reso.jsp). In addition, the NSF Grants.gov Application Guide provides additional technical guidance regarding 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](mailto: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.

## VI. NSF Proposal Processing and Review Procedures

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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/](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 [Empowering the Nation Through Discovery and Innovation: NSF Strategic Plan for Fiscal Years \(FY\) 2011-2016](#). 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 core strategies 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 provide abundant opportunities where individuals may concurrently assume responsibilities as researchers, educators, and students, and where all can engage in joint efforts that infuse education with the excitement of discovery and enrich research through the variety of learning perspectives.

Another core strategy in support of NSF's mission is broadening 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

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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 to the above NSF criteria for evaluating proposals, reviewers will be asked to evaluate the proposal also on the following categories.

Impact to the power plant cooling industry, and specifically to efficiency, size and energy requirements

- Feasibility
- Economic potential in terms of cost and space in 10 to 20 years
- Risks on environmental and operational impacts
- Respondent's capabilities and related experience
- Realism of the proposed plan and cost estimates

PIs must therefore include discussions specific to the above evaluation criteria while adhering to the requirements stated in the GPG

[http://www.nsf.gov/publications/pub\\_summ.jsp?ods\\_key=gpg](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg)

## B. Review and Selection Process

Proposals submitted in response to this program solicitation will be reviewed by Panel Review.

The review process and panel will be administratively managed by NSF. Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The NSF and EPRI Program Officers assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation to their respective management teams.

At NSF, 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. For proposals of interest to EPRI, a similar process will be followed by the EPRI Program Officer.

NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, 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.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding by NSF will be forwarded to the Division of Grants and Agreements for review of business, financial, and policy implications and 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.

For proposals recommended for funding by EPRI, after the administrative approval process is completed, EPRI will contact the prospective awardee(s) to begin contract negotiations.

## VII. AWARD ADMINISTRATION INFORMATION

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### A. Notification of the Award

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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

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An NSF award consists of: (1) the award letter, 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 letter; (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 letter. 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](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](mailto: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](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).

### C. Reporting Requirements

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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](http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag).



## VIII. AGENCY CONTACTS

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*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:

- Sumanta Acharya, National Science Foundation, telephone: (703) 292-7494, email: [sacharya@nsf.gov](mailto:sacharya@nsf.gov)
- Jessica Shi, Electric Power Research Agency, telephone: (650) 855-8516, email: [jshi@epri.com](mailto:jshi@epri.com)

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: [fastlane@nsf.gov](mailto: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](mailto:support@grants.gov).

## IX. OTHER INFORMATION

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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, "My NSF" 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. "My NSF" also is available on NSF's website at <http://www.nsf.gov/mynsf/>.

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

## ABOUT THE NATIONAL SCIENCE FOUNDATION

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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.

### About the Electric Power Research Institute (EPRI)

The Electric Power Research Institute, Inc. (EPRI, [www.epri.com](http://www.epri.com)) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

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](mailto: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  
Division of Administrative Services  
National Science Foundation  
Arlington, VA 22230

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