

# High Performance Computing System Acquisition: Towards a Petascale Computing Environment for Science and Engineering

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## Program Solicitation

NSF 05-625

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**National Science Foundation**

Office of Cyberinfrastructure

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

February 10, 2006

and the last business day in November 2006 and annually thereafter.

November 30, 2006

December 05, 2007

November 28, 2008

## REVISION NOTES

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In furtherance of the President's Management Agenda, NSF has identified programs that will offer proposers the option to utilize Grants.gov to prepare and submit proposals, or will require that proposers utilize Grants.gov to prepare and submit proposals. Grants.gov provides a single Government-wide portal for finding and applying for Federal grants online.

In response to this program solicitation, proposers may opt to submit proposals via [Grants.gov](http://Grants.gov) or via the [NSF FastLane](#) system. 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.3 of the Grant Proposal Guide provides additional information on collaborative proposals.

## SUMMARY OF PROGRAM REQUIREMENTS

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### General Information

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**Program Title:**

Leadership-Class System Acquisition - Creating a Petascale Computing Environment for Science and Engineering

**Synopsis of Program:**

NSF's five-year goal for high performance computing (HPC) is to enable petascale science and engineering through the deployment and support of a world-class HPC environment comprising the most capable combination of HPC assets available to the academic community. By the year 2010, the petascale HPC environment will enable investigations of computationally challenging problems that require computing systems capable of delivering sustained performance approaching  $10^{15}$  floating point operations per second (petaflops) on real applications, that consume large amounts of memory, and/or that work with very large data sets. Among other things, researchers will be able to perform simulations that are intrinsically multi-scale or that involve the simultaneous interaction of multiple processes.

HPC Resource Providers - those organizations willing to acquire, deploy and operate HPC systems in service to the broad science and engineering research and education community - play a key role in the provision and support of a national HPC environment. With this solicitation, NSF requests proposals from organizations willing to serve as HPC Resource Providers, and who propose to acquire and deploy a new, and/or upgrade an existing, HPC system.

Competitive HPC systems will:

- Enable researchers to work on a range of computationally-challenging science and engineering applications;
- Incorporate reliable, robust system software essential to optimal sustained performance; and
- Provide a high degree of stability and usability.

A robust and effective HPC acquisition process, driven by the requirements of the science and engineering research and education community, is one of the key elements of NSF's HPC strategy. System performance on an appropriate set of benchmarks will thus be a key factor in system selection. These benchmarks are designed to capture the salient attributes of those science and engineering applications placing the most stringent demands on the systems to be provisioned. The performance requirements and benchmarks for this competition will be posted on the NSF web-site at <http://www.nsf.gov/div/index.jsp?div=OCI> by November 10, 2005.

Up to two awards will be made as a result of this competition.

**Cognizant Program Officer(s):**

- Stephen Meacham, HPC Program Director, 1145 S, telephone: (703) 292-8970, fax: (703) 292-9060, email: [smeacham@nsf.gov](mailto:smeacham@nsf.gov)
- Jose Munoz, Deputy Office Director/Senior Scientific Advisor, 1145 S, telephone: (703) 292-8970, fax: (703) 292-9060, email: [jmunoz@nsf.gov](mailto:jmunoz@nsf.gov)

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

- 47.080 --- Office of Cyberinfrastructure

**Award Information**

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**Anticipated Type of Award:** Cooperative Agreement

**Estimated Number of Awards:** 1

**Anticipated Funding Amount:** \$30,000,000 available annually.

**Eligibility Information**

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**Organization Limit:**

Proposals may only be submitted by the following:

- U.S. institutions of higher education and Federally Funded Research and Development Centers are eligible to apply as Resource Providers. It is recognized that FFRDCs may be positioned to make unique contributions to the HPC environment important to academic researchers. Hence for the

purposes of this solicitation, NSF will consider acquiring and deploying new, or upgrading existing, HPC systems at FFRDC sites. However, proposing organizations must assure that open access to the HPC systems deployed will be provided to researchers from the broad range of science and engineering fields supported by NSF.

**PI Limit:**

None Specified

**Limit on Number of Proposals per Organization: 1**

An organization may submit only one proposal in each funding cycle.

Collaborative projects may **only** be submitted as a single proposal in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the submitting organization.

**Limit on Number of Proposals per PI:**

None Specified

**Proposal Preparation and Submission Instructions**

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**A. Proposal Preparation Instructions**

- **Letters of Intent:** 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/bfa/dias/policy/docs/grantsgovguide.pdf/>)

**B. Budgetary Information**

- **Cost Sharing Requirements:** Cost Sharing is not required under this solicitation.
- **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. proposer's local time):

February 10, 2006

and the last business day in November 2006 and annually thereafter.

November 30, 2006

December 05, 2007

## 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:** Additional award conditions apply. Please see the full text of this solicitation for further information.

**Reporting Requirements:** Additional reporting requirements apply. Please see the full text of this solicitation for further information.

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## I. INTRODUCTION

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What are the three-dimensional structures of all of the proteins encoded by an organism's genome and how does structure influence function, both spatially and temporally? What patterns of emergent behavior occur in models of very large societies? How do massive stars explode and produce the heaviest elements in the periodic table? What sort of abrupt transitions can occur in Earth's climate and ecosystem structure? How do these occur and under what circumstances? If we could design catalysts atom-by-atom, could we transform industrial synthesis? What strategies might be developed to optimize management of complex infrastructure systems? What kind of language processing can occur in large assemblages of neurons? Can we enable integrated planning and response to natural and man-made disasters that prevent or minimize the loss of life and property? These are just some of the important questions that researchers wish to answer using state-of-the-art High-Performance Computing (HPC) systems.

Science and engineering research and education enabled by state-of-the-art HPC tools have a direct bearing on the Nation's

competitiveness. If investments in HPC are to have long-term impact on basic research problems of national need, then HPC resources must deliver high performance capability to a wide range of science and engineering applications.

By 2010, it is anticipated that academic researchers will be able to access a rich mix of HPC systems that:

- deliver sustained performance in the 10 teraflops to 2 petaflops range on a variety of science and engineering codes;
- are integrated into a national cyberinfrastructure environment; and,
- are supported at national, regional and/or campus levels.

In this scenario, it is likely that NSF will directly support several systems delivering sustained performance in the 50 to 200 teraflops range across a broad range of science and engineering research applications, and at least one system capable of exceeding one petaflops of sustained performance on the most computationally-challenging research codes.

## II. PROGRAM DESCRIPTION

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The purpose of this solicitation is to generate proposals from Resource Provider organizations who are committed to the acquisition and deployment of balanced HPC systems that will contribute to the development of the HPC environment described in the *Introduction*. In future competitions, these systems will be upgraded or complemented by the acquisition of additional HPC systems that may be optimized for particular classes of science and engineering research problems. However, this competition emphasizes the provision of a well-balanced system that delivers high levels of performance for many different types of science and engineering applications.

Competitive HPC systems will:

- Enable researchers to work on a range of computationally-challenging science and engineering applications at the frontiers of research;
- Incorporate reliable, robust system software essential to optimal sustained performance; and
- Provide a high degree of stability and usability.

For the purposes of this solicitation, an acquisition may include: *computing hardware*, including processors, caches (if present) and main memory, inter-connects, I/O sub-system(s); *local on-line storage* of sufficient size to support science and engineering research applications that use the full extent of the computing hardware; *archival storage* of a size appropriate to a system of the scale proposed; a wide-area *network connection*; any other hardware typical of a modern supercomputing system; *system software* including, one or more operating systems, one or more file systems, a set of compilers and run-time libraries that, at a minimum include a Fortran, C and C++ compiler and support the OpenMP API, software libraries that support access to the full memory model of the system proposed including one that offers a standard MPI interface, standard operating system and mathematical libraries, debugging and program development tools, system administration and job scheduling software, user accounting software, any other software typical of a modern supercomputing system; either dedicated nodes or small satellite systems that provide for interactive access, job preparation and staging, and system management.

Information on NSF's system performance requirements and benchmarks is posted at <http://www.nsf.gov/div/index.jsp?div=OCI>. The submission of benchmark results or estimated benchmark results is required as part of each proposal. The ability of proposed systems to meet any estimated benchmark results included in proposals will be made a requirement in subsequent awards, with funding contingent on meeting the estimated benchmark performance (see *Section VII.B. Award Conditions* of this solicitation for more information).

Detailed information on the format to be followed in each proposal submitted in response to this solicitation is provided in *Section V., Proposal Preparation and Submission Instructions*.

Proposals submitted in response to this solicitation should be focused on the provisioning of HPC systems as a service to the science and engineering research and education community. Proposals that request support for HPC research will be deemed ineligible and returned without review.

It is anticipated that NSF will receive questions about the solicitation from prospective proposers between the release of the solicitation and the deadline for proposals. Answers to questions that may be of general interest to prospective proposers will be posted on a "Frequently Asked Questions" page accessible through <http://www.nsf.gov/div/index.jsp?div=OCI>.

Prospective proposers are encouraged to check this page periodically for updates.

The system(s) deployed as a result of this solicitation will become part of the portfolio of resources supported by NSF for shared use by the broad science and engineering research and education community. Accordingly, the system(s) will

complement the capabilities currently provided by existing NSF Resource Provider sites. Allocations for use of the system(s) will be made through the Large and Medium Resource Allocation Committees (LRAC and MRAC) or their successors. It is anticipated that the system(s) deployed will be made available to users as part of the TeraGrid (for more information on TeraGrid, see [www.teragrid.org](http://www.teragrid.org)).

NSF expects to hold HPC acquisition competitions annually. Solicitation requirements, including performance benchmarks, may be customized for each competition.

### III. AWARD INFORMATION

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**Anticipated Type of Award:** Cooperative Agreement.

**Estimated Number of Awards:** 1, to be made in October of the year following the proposal deadline, subject to availability of funds.

**Anticipated Funding Amount:** Total of \$30,000,000 for acquisition and deployment available annually, subject to the availability of funds. Project durations should be for up to 5 years. An acquisition associated with the upgrade of an existing system is permissible. Each award will support the acquisition and deployment of hardware, system software, and core software libraries, and the personnel costs associated with the acquisition and deployment of the proposed system, including acceptance testing. Each proposal may be for an acquisition that occurs in one step near the beginning of the award period or for an acquisition that is deployed in phases during the award period. User support and operating costs for each deployed HPC system will be provided in a separate funding action.

### IV. ELIGIBILITY INFORMATION

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**Organization Limit:**

Proposals may only be submitted by the following:

- U.S. institutions of higher education and Federally Funded Research and Development Centers are eligible to apply as Resource Providers. It is recognized that FFRDCs may be positioned to make unique contributions to the HPC environment important to academic researchers. Hence for the purposes of this solicitation, NSF will consider acquiring and deploying new, or upgrading existing, HPC systems at FFRDC sites. However, proposing organizations must assure that open access to the HPC systems deployed will be provided to researchers from the broad range of science and engineering fields supported by NSF.

**PI Limit:**

None Specified

**Limit on Number of Proposals per Organization: 1**

An organization may submit only one proposal in each funding cycle.

Collaborative projects may **only** be submitted as a single proposal in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the submitting organization.

**Limit on Number of Proposals per PI:**

None Specified

**Additional Eligibility Info:**

**Organization Limit:** U.S. institutions of higher education and Federally Funded Research and Development

Centers are eligible to apply as Resource Providers. It is recognized that FFRDCs may be positioned to make unique contributions to the HPC environment important to science and engineering researchers. Hence for the purposes of this solicitation, NSF will consider acquiring and deploying new, or upgrading existing, HPC systems at FFRDC sites. However, proposing organizations must assure that open access to HPC systems will be provided to researchers from the broad range of science and engineering fields supported by NSF.

**PI Eligibility Limit:** None specified

**Limit on Number of Proposals:** An organization may submit only one proposal in each funding cycle.

## 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 [pubs@nsf.gov](mailto:pubs@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/bfa/dias/policy/docs/grantsgovguide.pdf>). 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 [pubs@nsf.gov](mailto:pubs@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.3 of the Grant Proposal Guide provides additional information on collaborative proposals.

Exceptions to guidelines in the GPG or NSF Grants.gov Application Guide follow.

- The page limit for the Project Description section of the proposal is **35 pages**.
- There is no page limit for the Budget Justification section.
- Certain information other than that described in the GPG should be submitted as Supplementary Documents (see below for details).
- Collaborative efforts may **only** be submitted as a single proposal, in which a single award is being requested. The involvement of partner organizations should be supported through sub-awards administered by the proposing Resource Provider organization.

The Project Description must include the following six sections:

- **HPC System Specification**
- **HPC System Performance on Science and Engineering Applications**
- **HPC System Reliability and Usability**
- **Implementation, Project Management, and Risk Mitigation**
- **Quality of the Physical Infrastructure**
- **Effective User Support and Projected Operating Costs**



Information to be provided in each section is described below.

## HPC System Specification

Specify the HPC system to be acquired and deployed. Where a system will be upgraded, describe the existing system and details of the proposed upgrade. Include a detailed description of any aspects of the proposed system that are likely to influence the performance of science and engineering research codes. Parameters to be considered include total number of processors, speed and architecture of individual processors, number of processors sharing the same access to memory, amount of memory, size and number of caches (if present), inter-processor and inter-node bandwidth and latency, communications topology, amount of secondary storage, amount of archival storage, I/O sub-system, file system(s), operating system(s), compiler(s), debugging tools, performance measurement tools, system administration tools. If the system includes any specialized hardware or software to facilitate checkpointing and checkpoint-restart of large jobs, or performance monitoring, please describe this.

If appropriate, describe how the proposed system is scalable beyond the size proposed for this acquisition or otherwise upgradable in ways that will improve system performance. The existence of a clear upgrade path beyond the system proposed to this competition is not a requirement.

Describe how the proposed system complements and adds value to the portfolio of major HPC systems currently supported by NSF as national resources. Orthogonality to systems currently supported by NSF is not a requirement.

Describe how the compute engine, local disk, and longer term mass storage systems will be integrated.

Describe any vendor-supplied hardware or software support for measuring application and system performance.

## HPC System Performance on Science and Engineering Applications

Provide a detailed analysis of the performance of the proposed system on a benchmark suite representative of science and engineering applications. This analysis should include actual results or estimated results for a set of benchmarks that are posted on the NSF web-site <http://www.nsf.gov/div/index.jsp?div=OCI>. System performance on an additional set of benchmarks identified by the proposing organization may also be provided. The system performance on an appropriate set of performance benchmarks will be a factor in the selection of the system(s) to be installed. ***The actual results or estimated results of any benchmarks used should be submitted in the "Supplementary Documents" section of the proposal.***

The benchmarks provided by NSF should be run "as is." Minor changes in code in order to get the benchmarks to compile and/or run are permitted but should be described in the proposal. In addition, the modified version of the benchmark source code or execution scripts must be posted to a secure ftp site hosted by the proposing organization and accessible to NSF staff on the day following the proposal deadline date. In addition, at the discretion of the proposing organization, the benchmarks provided by NSF may also be run in a form in which the source code has been optimized by the proposer or vendor. If an optimized form of one or more of the NSF benchmarks is run, and/or if benchmarks other than those provided by NSF are used in addition to the NSF benchmarks, then detailed descriptions of the benchmark or code modifications, the results of the benchmark run, and copies of the version of the source code and execution scripts that were used in running the benchmark, must also be made available at the same secure ftp site on the day following the proposal deadline date. Any libraries with which the benchmarks were linked should be supplied to the HPC Resource Provider as part of the project requirements.

Benchmarks may be run on existing or prototype systems of the same design as proposed, or estimated by well-justified extrapolation from analogous systems. In addition, proposers may choose to require vendors to demonstrate further the ability to support the research needs of the broad community of potential users by including performance data for a variety of specific applications. The choice of applications should be justified in terms of their scientific merit and their ability to characterize the potential of a system. Since optimizing system design for a particular set of applications can influence the architecture and "balance" of a system, the features of applications influencing the configuration of the proposed system should be fully explained.

If one of the benchmarks specified by NSF or by the proposing organization fails to run or cannot be run, a description of the reasons for this must be included. Benchmarks should be run on a system that corresponds to what will be delivered if the proposal is successful. Any estimated benchmark performance results should be based on a well-justified extrapolation from analogous systems. It is anticipated that demonstrated ability to achieve any benchmark results or other measures of performance provided in the proposal, whether actual or estimated, will be required as a performance metric for formal acceptance of the delivered system.

In addition to providing benchmark results, describe: the time required to boot the full system from a cold start; the maximum amount of main memory that will be available to users; and, the time required to exchange the contents of this portion of main



memory with local disk storage (both load and store).

Describe the degree to which the system is designed such that codes of the classes represented in the benchmarks can be expected to scale to large fractions of the total system, and provide relevant justification.

### **HPC System Reliability and Usability**

Describe the availability of system software and tools to effectively use the computational capabilities of the system hardware. It is vital that basic system services be sufficient for users and system managers to accomplish their work. Describe how the proposed system will respond to these needs. System software features of particular importance include the operating system or systems, the file system or systems, compilers (including Fortran, C, C++, and support for the OpenMP API), message-passing libraries, other libraries (including standard system and mathematical libraries), debugging tools, application tuning tools, performance monitoring tools, system administration and resource management, job scheduling and accounting.

Describe the job mix that the Resource Provider expects to represent the usage of the system for science and engineering research applications, as well as jobs associated with system operation and maintenance. This should include applications that scale to a large fraction of the system, as well as smaller jobs, and should include a mix of durations. It is anticipated that one of the performance requirements included in the award document will be that, in production mode, when averaged over one month, 95% of jobs submitted to the system should complete without having to be resubmitted as a result of a failure in the hardware or system software, including failures as a result of a compiler failing to correctly implement code that complies with the relevant language standard. Include an analysis of the reliability of the proposed system and the reasons that the proposed system can be expected to meet this performance requirement.

The award instrument will include a performance requirement on the availability of the system. NSF requires that, when averaged over a month, the system should be unavailable as a result of scheduled and unscheduled maintenance no more than 5% of the time. Accordingly, provide an analysis of the reasons that the proposed system can be expected to meet this performance requirement.

### **Implementation, Project Management, and Risk Mitigation**

Provide a detailed implementation plan and corresponding performance metrics for acquiring and deploying the proposed system. A detailed month-by-month schedule should be provided. It is expected that, by the May 31 following the date of the award, at least a significant portion of the system or of the first planned phase of the system will be deployed and operating in full production mode.

The system acquired will be integrated into NSF's existing cyberinfrastructure program. Within this context, describe which elements of the proposed system will be integrated into the TeraGrid (<http://www.teragrid.org>) and what steps such integration will require.

Provide details on the sub-contract(s) with the relevant HPC vendor(s) that describe the contractual terms of the acquisition.

Describe the availability of experts to address any system integration problems that arise as the system is deployed. This expertise may be provided by the proposing Resource Provider and/or by other vendor, academic or government partners. Proposers should make clear their previous associations, if any, with these partners. The breadth of knowledge, depth of interaction, and technical abilities of partners will be considered in the review process. This knowledge and expertise is particularly important in supporting advanced programming paradigms (e.g. compilers for parallel environments, problem solving environments), tools (e.g. performance visualization, parallel debuggers) and system elements (e.g. parallel file systems).

Describe user access to the system during the deployment phase and prior to system acceptance, including during testing.

Describe the experience of the proposing organization in the management of awards of this scale and the resources that would be available to manage an award. Describe the experience of the proposing organization in the management of large sub-contracts to vendors for the acquisition of HPC systems. Describe the resources that would be available to manage any such sub-contract issued under an award made as a result of this solicitation.

Provide a detailed risk mitigation plan, identifying both technical and management risks as well as strategies to mitigate such risks.

### **Quality of the Physical Infrastructure**

Describe the physical facility that will house the proposed system and any schedule implications of the provision of computer-

ready space, including floor space, power, cooling, fire suppression, and any other emergency equipment, for the system and its supporting hardware. Include a description of the physical security that will be provided. Include a description of the expected power and heat budgets of the proposed system and explain how these will be managed. Describe the expected impacts of power interruptions and how these will be managed. Please provide an analysis of the implications of a sudden loss of power to, or catastrophic failure of, either the computing, storage or primary cooling systems and describe what emergency systems will be required to minimize damage to personnel and equipment. Briefly describe the degree to which the physical environment will be compatible with possible system growth through future upgrades. Note that the capability to accommodate future upgrades is not a requirement.

Describe the present external network connectivity and any plans for modifying this. Ideally, by the May 31 following the date of the award, there will be two independent high bandwidth (of at least 10 gigabit/second each) network connections between the Resource Provider site and one or more appropriate national networks.

High-performance applications are expected to produce many terabytes of data. Describe how these data will be handled, how data integrity will be maintained, what backup and contingency procedures and schedules will be provided and how will they be implemented.

### **Effective User Support and Projected Operating Costs**

Provide a plan for user support that includes a description of the anticipated requirements of the science and engineering research community, a description of how resources will be allocated, and any other operational details likely to have an impact on user access or usage of the proposed system. Describe the number and anticipated qualifications of the types of personnel that will be involved with the provision of user support. In addition, describe the user training opportunities that will be made available. Describe the expected availability of dedicated time on the system for both science and engineering applications and systems testing, and what fraction of system resources will be consumed in moving users on and off the system, or reconfiguring it for dedicated use.

Describe the experience of the proposing organization in operating HPC systems. Include a description of whether operational support was provided on a 24/7 basis or was provided on a more limited basis. Please describe the number and type of users, the types of computation performed, and the nature of the user support provided. Describe the processes used to evaluate management performance, determine user needs, and evaluate user satisfaction.

Describe the qualifications of the Principal Investigator(s) with regard to her or his ability to manage a project of this size and complexity, and to manage a resource with a large number of external users.

Provide an analysis of the projected annual operating costs of the proposed system for a period of four years, including the cost of providing user support. Detailed operating cost estimates should include a maintenance contract for 4 years whose fully burdened cost does not exceed one half of one percent per month of the total acquisition cost, the cost of power and physical security, the cost of network connectivity from the location of the system to the TeraGrid, and costs associated with leasing machine room space, if necessary. Provide an estimate of the costs associated with the number of FTEs necessary to maintain 24/7 operations of the proposed system. Provide an estimate of the costs associated with the number of FTEs necessary to provide effective user support. Estimate the costs and personnel required to maintain operation of the system within the TeraGrid and address any issues anticipated with supporting the current TeraGrid core software stack (see <http://www.teragrid.org> for details) or any other aspects of participating in the TeraGrid.

Include a more detailed explanation of the budget for user support and operating costs ***in the Supplementary Documents section of the proposal (this should not exceed 5 pages). Information provided will be used to help NSF assess the operating cost-performance attributes of the proposed system.***

Describe any other factors that are anticipated to have an impact on the Total Cost of Ownership of the proposed system.

### **Proprietary information**

Proposals containing patentable ideas, trade secrets, privileged or confidential commercial or financial information, disclosure of which may harm the proposer, should be clearly marked where appropriate in the proposal and labeled with the following legend:

"The following is (proprietary or confidential) information that (name of proposing organization) requests not be released to persons outside the Government, except for purposes of review and evaluation."

Note that proposals submitted to this solicitation will be reviewed by a group of experts that include people who are not U.S. Government personnel.

## Supplementary Documents

Proposals should include the following sections as Supplementary Documents :

- Actual or estimated performance benchmark results as described in Section V.A. *System Performance on Science and Engineering Applications* of this solicitation. This section should not be used to continue discussion or analysis of the merits of the resource provider, vendor or vendors, or system.
- Detailed Projected Operating Costs as described in Section V.A. *Effective User Support and Projected Operating Costs* of this solicitation. This **should not exceed 5 pages**.
- A list of all institutions and companies involved in the project.
- A single, alphabetically ordered list of all people, in the academic or professional computing community, who have collaborated with (within the last 48 months), or have been a Ph.D. advisee or advisor of, any of the personnel involved in the proposed project. In this list, please include, next to the name of each conflicted individual, that individual's institution or company and the name of the project member with whom he or she has the conflict of interest. It is not necessary to list, as collaborators, personnel who are employees of an institution or company involved in the project.
- **Letters of endorsement should not be included in proposals.** Letters of commitment from individuals who are described in the Project Description as involved in the project in a senior capacity but who are not members of the lead proposing organization, or from representatives of institutions or organizations collaborating with the lead institution, are allowable. As described in the Grant Proposal Guide, Section II.C.2.j, such letters of commitment should be included in the Supplementary Documents section and do not count toward overall page limits. If letters of endorsement are included, NSF may choose to return the proposal without review.

## B. Budgetary Information

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**Cost Sharing:** Cost sharing is not required under this solicitation.

### Other Budgetary Limitations:

Each proposal should be for the acquisition and deployment of a single HPC system for which the project costs total no more than \$30,000,000. An acquisition associated with the upgrade of an existing system is permissible. Each award will support the acquisition and deployment of hardware, system software, and core software libraries, and personnel costs associated with system acquisition and deployment, including acceptance testing. Detailed budgetary information should be provided in the Budget Justification section of the proposal.

Each proposal may be for an acquisition that occurs in one step near the beginning of the award period or for an acquisition that is deployed in phases during the award period.

User support and operating costs for the proposed HPC system will be provided in a separate funding action.

## C. Due Dates

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

February 10, 2006

and the last business day in November 2006 and annually thereafter.

November 30, 2006

December 05, 2007

November 28, 2008

## 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. The Grants.gov's Grant Community User Guide is a comprehensive reference document that provides technical information about Grants.gov. Proposers can download the User Guide as a Microsoft Word document or as a PDF document. The Grants.gov User Guide is available at: <http://www.grants.gov/CustomerSupport>. 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 and, if they meet NSF proposal preparation 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 who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the 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 with the proposer.

### **A. NSF Merit Review Criteria**

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All NSF proposals are evaluated through use of the two National Science Board (NSB)-approved merit review criteria: intellectual merit and the broader impacts of the proposed effort. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two NSB-approved merit review criteria are listed below. The criteria include considerations that help define them. These considerations are suggestions and not all will apply to any given proposal. While proposers must address both merit review criteria, reviewers will be asked to address only those considerations that are relevant to the proposal being considered and for which the reviewer is qualified to make judgements.

#### **What is the intellectual merit of the proposed activity?**

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

#### **What are the broader impacts of the proposed activity?**

How well does the activity advance discovery and understanding while promoting teaching, training, and

learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

Examples illustrating activities likely to demonstrate broader impacts are available electronically on the NSF website at: <http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf>.

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

#### ***Integration of Research and Education***

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

#### ***Integrating Diversity into NSF Programs, Projects, and Activities***

Broadening opportunities and enabling the participation of all citizens -- women and men, underrepresented minorities, and persons with disabilities -- 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.

#### **Additional Review Criteria:**

Proposals for this solicitation will also be subject to the additional review criteria described below. These criteria parallel specific sections in the Project Description.

- **Meeting the Needs of the Most Computationally-Challenging Science and Engineering Applications.** How well does the system proposed match the requirements of the science and engineering research and education community for HPC resources and services? Can the proposed system provide the necessary computational capability required to generate new, breakthrough, science and engineering discoveries? Where benchmark results have been estimated, are these estimates credible?
- **System Reliability and Usability.** Are the system and the operation of the system likely to provide a robust, reliable, high-productivity computational environment for users? Assess the commitment of the vendor or vendors to meet the agreed performance goals and to provide post-acquisition support. Does the environment in which the system will be embedded include adequate capability for the remote analysis of output from high-end computations?
- **Implementation, Project Management and Risk Mitigation.** Is there an adequate procedure for ensuring that the proposed system will be available for use by the science and engineering research and education community? Does the proposing organization have the capability to manage the award and any associated sub-contracts? Does the PI have the capability to manage the project? Is the detailed implementation plan for acquisition and deployment adequate and realistic? Are the plans for integration into the TeraGrid and the associated costs reasonable? Does the proposing organization and its partners have the expertise to meet any challenges likely to be encountered while deploying the complete system (including data storage, communications and core software environment) and bringing it to production status? Has there been a reasonable assessment of potential risks and does the proposal include an adequate risk management strategy?
- **Quality and Availability of the Physical Infrastructure.** Are the physical facilities described by the proposing organization adequate to accommodate the system proposed?
- **Effective User Support.** What are the qualifications and experience of the PI and the proposing organization in regard to managing a resource for national use and providing effective user support?
- **Total Cost of Ownership.** Are the budget and roster of personnel for operations and user support adequate and reasonable? Assess the total cost of ownership of the proposed HPC system. Is this reasonable in light of the advances in science and engineering likely to result?

## **B. Review and Selection Process**

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

In addition to panel and/or mail review, a subset of proposals may be subject to site visit review. If site reviews are used it is anticipated that these would occur in the February or March following the proposal deadline.

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. 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 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 date of receipt. 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 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.

## 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 Federal Demonstration Partnership (FDP) 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/general\\_conditions.jsp?org=NSF](http://www.nsf.gov/awards/managing/general_conditions.jsp?org=NSF). Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from [pubs@nsf.gov](mailto:pubs@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).

#### Special Award Conditions:

Awards made as a result of this competition will include performance requirements and metrics for the proposed systems. An awardee will include terms and conditions in any subcontract agreement to address schedule and performance expectations and the impact of delays in delivery.

### 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 before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after expiration of a grant, the PI also is required to submit a final project report.

Failure to provide the required annual or final project reports will delay NSF review and processing of any future funding increments as well as any pending proposals for that PI. 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 FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational) publications; and, other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete.

Additional reporting requirements apply, will be negotiated with the Resource Provider prior to award, and will be incorporated into the special terms and conditions of the award.

## VIII. AGENCY CONTACTS

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General inquiries regarding this program should be made to:

- Stephen Meacham, HPC Program Director, 1145 S, telephone: (703) 292-8970, fax: (703) 292-9060, email: [smeacham@nsf.gov](mailto:smeacham@nsf.gov)
- Jose Munoz, Deputy Office Director/Senior Scientific Advisor, 1145 S, telephone: (703) 292-8970, fax: (703) 292-9060, email: [jmunoz@nsf.gov](mailto:jmunoz@nsf.gov)

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).
- Priscilla L. Bezdek, Program and Technology Specialist, 1145 S, telephone: (703) 292-8962, fax: (703) 292-9060, email: [pbezdek@nsf.gov](mailto:pbezdek@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, MyNSF (formerly the Custom News Service) 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 Regional 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. MyNSF 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 40,000 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 Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

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

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

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

The National Science Foundation promotes and advances scientific progress in the United States by competitively awarding grants and cooperative agreements for research and education in the sciences, mathematics, and engineering.

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

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

## PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

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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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