Nanoscale Science and Engineering Education (NSEE)

Program Solicitation
NSF 03-044

National Science Foundation
Directorate for Biological Sciences
Directorate for Computer and Information Science and Engineering
Directorate for Education and Human Resources
Directorate for Engineering
Directorate for Geosciences
Directorate for Mathematical and Physical Sciences
Directorate for Social, Behavioral, and Economic Sciences
Office of International Science and Engineering

Preliminary Proposal Due Date(s) ***(required):***

November 17, 2003

[A] Centers for Learning and Teaching - NCLT
[B] Informal Science Education - NISE
[C] Instructional Materials Development - NIMD

NOTE: Preliminary proposals are not required for NUE

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

November 17, 2003

[D] Nanotechnology Undergraduate Education - NUE

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[A] Centers for Learning and Teaching - NCLT
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SUMMARY OF PROGRAM REQUIREMENTS

Program Title:

Nanoscale Science and Engineering Education (NSEE)

Synopsis of Program:

This solicitation represents a comprehensive effort on the part of the National Science Foundation (NSF) to enhance nanoscale science and engineering education. Its goals are to form strong partnerships between researchers in science and engineering and those in science education; to develop effective strategies and interventions for integrating nanoscale science and engineering that will inform other emerging areas of science and engineering, into formal education in grades 7-16; and to increase public awareness of advances in nanoscale research and technology and their impact on society. Among the activities that will be supported are doctoral programs in science education, the development of instructional materials and courses for adoption and implementation in classrooms, grades 7-16, and research on the cognitive and implementation aspects of the educational interventions. The goals are carried out through partnerships involving institutions with the requisite expertise in nanoscale science and engineering and in education.

A related program solicitation, *Nanoscale Science and Engineering* (NSF 03-043), is focused on fundamental research in emerging areas of nanoscale science, engineering, and technology. This related solicitation contains three components: *Nanoscale Interdisciplinary Research Teams (NIRT); Nanoscale Exploratory Research (NER);* and *Nanoscale Science and Engineering Centers (NSEC).* Other research and education projects in nanoscience and engineering will continue to be supported in the relevant programs and divisions.

To attain the overarching program goals, NSEE encompasses four independent components:

- ***[A] Centers for Learning and Teaching (NCLT):*** Centers are intended to create educational leadership for emerging areas of science and engineering by creating doctoral programs, representing collaborations of researchers in nanoscale science and engineering, education, and cognitive and behavioral sciences. Other objectives are to define and implement a research agenda focused on the learning and teaching necessary to introduce nanoscale science and engineering into classrooms at age-appropriate levels, and to develop strategies for providing effective teacher and faculty development.

- ***[B] Informal Science Education (NISE):*** This national effort is intended to foster public awareness and understanding of nanoscale science and engineering through development of media projects (film, radio, television) and exhibits.

- ***[C] Instructional Materials Development (NIMD):*** This effort is intended to support development and rigorous testing of prototype instructional materials that promote student learning and interest in nanoscale science, engineering, and technology concepts and that show promise for large-scale adoption and implementation in some or all of the grades 7-12.

- ***[D] Nanotechnology Undergraduate Education (NUE):*** This effort continues an existing program to introduce nanoscale science and technology through a variety of interdisciplinary approaches into undergraduate education, particularly in the first two collegiate years.

NOTE. These four components are related to existing programs at NSF. Those organizations with an interest in more than one component must submit separate preliminary proposals (where required) and full proposals for each component of interest.

WORKSHOP FOR POTENTIAL APPLICANTS

In view of the highly interdisciplinary nature of this initiative, both within science and engineering and among those disciplines and education, NSF is planning a workshop for potential applicants. The workshop will be held at NSF beginning at 5:00 P.M. Sunday, September 28 and ending in the early afternoon Tuesday, September 30, 2003. Primary workshop goals are: (1) to provide information about existing projects in research and education related to nanoscale science and engineering, as well as projects in education of the type envisioned for this initiative; (2) to present a vision of the nature of the cooperation and synergy between the community engaged in research in nanoscale science and engineering and the community engaged in research and development in education; (3) to provide opportunities for members of these communities to begin to form partnerships; and (4) to provide an understanding of the evaluation of the NSEE program, in which all grantees will be required to participate. The workshop will include presentations by representatives from NSF-supported centers engaged in nanoscale research and outreach activities, Principal Investigators (PIs) from education projects with goals similar to those articulated in this solicitation, and evaluators of education projects. Participants are expected to cover their own travel and subsistence expenses. Those with an interest in participating in this workshop should register by 5:00 p.m. (registrant's local time) August 25, 2003. Details will be available through the Web site, http://www.nsf.gov/nano/NSEE. Every attempt will be made to accommodate those registered on or before that date.

Cognizant Program Officer(s):

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- Barry Van Deman, *Informal Science Education (NISE)*, Section Head, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5124, fax: (703) 292-9044, email: bvandema@nsf.gov

- Gerhard L. Salinger, *Instructional Materials Development (NIMD)*, Program Director, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5116, fax: (703) 292-9044, email: gsalinge@nsf.gov

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- Mary F. Poats, *Nanotechnology Undergrad Education (NUE),* Program Director, Directorate for Engineering, Division of

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

- 47.074 --- Biological Sciences
- 47.070 --- Computer and Information Science and Engineering
- 47.076 --- Education and Human Resources
- 47.041 --- Engineering
- 47.050 --- Geosciences
- 47.049 --- Mathematical and Physical Sciences
- 47.075 --- Social, Behavioral and Economic Sciences

Eligibility Information

- **Organization Limit:** The lead institution for all components of this solicitation **must** be a U.S. institution. Foreign institutions may be included as partners.
- **PI Eligibility Limit:** None Specified.
- **Limit on Number of Proposals:** None Specified.

Award Information

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 40 to 49 -

  [A] NCLT - 2
  [B] NISE - up to 3
  [C] NIMD - up to 4
  [D] NUE - up to 40

- **Anticipated Funding Amount:** $11,850,000 total funding, pending availability of funds.

  [A] NCLT - $6,000,000
  [B] NISE - $750,000
  [C] NIMD - $1,100,000
  [D] NUE - $4,000,000

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Preliminary Proposals:** Submission of Preliminary Proposals is required. Please see the full text of this solicitation for further information.
- **Full Proposal Preparation Instructions:** This solicitation contains information that supplements the standard Grant Proposal Guide (GPG) proposal preparation guidelines. Please see the full text of this solicitation for further information.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is Specialized. Please see the full text of this solicitation for further information.
- **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

- **Preliminary Proposals *(required)* :**
  November 17, 2003

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Proposal Review Information

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

Award Administration Information

- **Award Conditions:** Standard NSF award conditions apply.
- **Reporting Requirements:** Additional reporting requirements apply. Please see the full text of this solicitation for further information.

TABLE OF CONTENTS

I. INTRODUCTION

One nanometer (one billionth of a meter) is a magical point on the dimensional scale. Nanostructures are at the confluence of the smallest of human-made devices and the largest molecules of living systems. Nanoscale science and engineering here refer to the fundamental understanding and resulting technological advances arising from the exploitation of new physical, chemical, and biological properties of systems that are intermediate in size, between isolated atoms and molecules and bulk materials, where the transitional properties between the two limits can be controlled. During the last few years, novel structures, phenomena, and processes have been observed at the nanoscale (from a fraction of nanometer to about 100 nm) and new experimental, theoretical and simulation tools have been developed for investigating them. These advances provide fresh opportunities for scientific and technological developments in nanoparticles, nanostructured materials, nanodevices, and systems.

Nanotechnology is the creation and utilization of functional materials, devices, and systems with novel properties and functions that are achieved through the control of matter, atom-by-atom, molecule-by-molecule, or at the macromolecular level. A revolution has begun in science, engineering and technology, based on the ability to organize, characterize, and manipulate matter systematically at the nanoscale. Far-reaching outcomes for the 21st century are envisioned in both scientific knowledge and a wide range of technologies in most industries, healthcare, conservation of materials and energy, biology, environment and education. Nanoscale Science and Engineering (NSE) underpin innovations in critical areas ranging from manufacturing to medicine.

The interdisciplinary nature of NSE involves all of the sciences and engineering. Its economic, environmental, social, and ethical dimensions require careful study as well. These interactions create important opportunities and challenges for education at the middle school, high school, and undergraduate levels (i.e., grades 7-16). If citizens are to understand and appreciate the potential for nanoscale science and engineering, it is imperative that our schools offer scientifically accurate and developmentally appropriate learning opportunities in the relevant disciplines and that ways be found to collaborate across disciplines and to transcend traditional boundaries. This, in turn, requires that the science education leaders and science teachers have not only a deep understanding of nanoscale science and engineering, but also an appreciation for the challenges of learning about related social and ethical implications of nanotechnology.

The Nanoscale Science and Engineering Education (NSEE) initiative provides funding for four types of projects that will explore educational challenges of this new field and generate practical ways of introducing nanotechnology into middle school, secondary, and undergraduate education and to the public at large. Joining research in education with emerging research in nanoscale science and engineering creates opportunities for new interdisciplinary teaching strategies, for understanding and enhancing science literacy, for preparing the 21st century workforce in these fields, and for engaging the interest and broadening the vision of science, engineering, and technology for a diverse group of talented students.

II. PROGRAM DESCRIPTION

This Solicitation covers work under four program components. Descriptions and review criteria for each component follow.

[A] CENTERS FOR LEARNING AND TEACHING IN NANOSCALE SCIENCE AND ENGINEERING (NCLT) COMPONENT

The Centers for Learning and Teaching in Nanoscale Science and Engineering (NCLT) component represents broad-based efforts for integrating advances in nanoscale science and engineering into education, grades 7-16. Centers will experiment with innovative approaches to such integration; conduct research on the conditions under which such integration is effective; and develop doctoral

programs in science education focused on these objectives. Support will also be provided for developing faculty and teacher leaders with expertise in integrating these emerging areas of science and engineering into grades 7-16 education and for conducting research on the efficacy of such integration. Centers should have a specific disciplinary focus on nanoscale science and engineering and should serve as models and resources that support the introduction of relevant concepts and applications into middle school, secondary, and undergraduate classrooms, nationwide. NCLT projects must involve partnerships that include institutions with strong research programs in nanoscale science and engineering, institutions with strong education research programs, and at least one institution that grants doctoral degrees in related STEM education fields, and other relevant educational partners, grades 7-16. These other partners may include state education agencies, two- and four-year colleges and universities, school districts, professional societies, government laboratories, private foundations, informal science education institutions, business and industry, and other public and private organizations (whether for profit or nonprofit).

NCLT Goals

Nanoscale science and engineering is inherently interdisciplinary with extensive applications for 21st century society. Centers must include diverse stakeholders who can traverse traditional boundaries within and among disciplines and organizations. They must incorporate disciplinary expertise in nanoscale science and engineering together with that from the cognitive sciences, educational research, teacher and faculty development, and educational materials design and implementation. NCLT projects are expected to focus on understanding and facilitating the integration of emerging research in nanoscale science and engineering into educational practice. The NCLT component is intended to result in a broad-based, systemic approach to enriching the curricula and the workforce, grades 7-16, by infusing scientific advances into classrooms.

Centers must address three equally important goals: create national leadership for advancing nanoscale science and engineering education, develop the instructional workforce, and research national issues critical to STEM education. The three goals must inform one another and support the Centers' major research foci. Specifically, the goals are:

- **Develop a diverse cadre of national STEM education leaders focused on the emerging field of nanoscale science and engineering:** Centers must provide basic and advanced education for doctoral and post-doctoral students who specialize in adapting and adopting emerging technologies into STEM education; provide the expertise for assessing and/or evaluating educational innovations; conduct research on STEM teaching and learning; inform development of the next generation of curricular and professional development materials that incorporate key ideas and concepts inherent in nanoscale science and engineering; and/or guide future directions in both formal and informal STEM education.

- **Provide professional development to teachers, grades 7-12, and undergraduate faculty:** Centers should create exemplary strategies and resources for developing educational leaders, fully grounded in the disciplines and scientific processes of nanoscale science and engineering. These educators should participate in the testing, development, and implementation of related educational materials. Dissemination of these strategies and resources are intended to accelerate the introduction of nanoscale science and engineering concepts into classrooms, grades 7-16.

- **Conduct research on issues related to integrating advances in nanoscale science and engineering into middle school through undergraduate curriculum:** NCLT focuses on nanoscale science and engineering which currently has limited education exposure. Centers should therefore conduct research on how to incorporate nanoscale science and engineering into classrooms. The research should investigate strategies for identifying age-appropriate topics; developing educational experiences and materials that embed these topics into curricula; and scaling and sustaining these efforts. It is anticipated that Center research should inform future efforts in other emerging areas of science and engineering.

Center activities should build on what is already known as effective strategies and existing educational and disciplinary research bases. They should provide opportunities for doctoral and post-doctoral students to gain the knowledge and skills necessary to educate the next generation of 7-12 teachers and undergraduate faculty capable of bringing advances in science into the education system. NCLTs are expected to draw on the expertise of major NSF-supported nanoscale science and engineering research centers and networks; to provide relevant education expertise to strengthen their education outreach activities; and to disseminate the products of their efforts to the education community nationally on an on-going basis.

NCLT Project Description

The project description for Centers for Learning and Teaching in Nanoscale Science and Engineering (NCLT) proposals should address the following critical components:

a. Focus. NCLTs are expected to develop strategies for meeting the professional development needs of the prospective and current instructional workforce, grades 7-16, and to provide STEM education professionals -- through doctoral, post-doctoral, and internship opportunities -- expertise in emerging areas of nanoscale science and engineering research. Because the purpose of NCLT is to change the educational system, the development of teachers and undergraduate faculty should be an ongoing activity of collaborating institutions, and integral to the Centers' programs of study for undergraduates, graduate students, and interns.

NCLT projects are expected to be a resource for, and learn from, the education outreach efforts of other nanoscale science and engineering research projects, e.g., *Nanoscale Science and Engineering Centers* (NSEC), *National Nanofabrication Users Network* (NNUN), *Network for Computational Nanotechnology* (NCN), *Science and Technology Centers* (STC), *Materials Research Science and Engineering Centers* (MRSEC), and *Engineering Research Centers* (ERC). NCLT projects are encouraged to form partnerships with one or more of these research centers (a listing can be found at: www.nsf.gov/nano).

NCLT projects should have, or be able to develop, the capability to carry out basic research on the learning of the complex, interdisciplinary ideas associated with nanoscale science and engineering. It is expected that the foundation for this research will be developed through gathering and evaluating extant educational materials, exemplars, models, and resources from both the efforts mentioned above, as well as from other sources. An important contribution of the NCLTs is to organize, study, reshape, adapt, and augment the existing knowledge base and resources in meeting the objectives of this effort.

b. Coverage. Centers must focus on understanding and facilitating the integration of nanoscale science and engineering into education practice. Centers may expand this focus to include the implications of advances in nanoscale science and engineering for technology education. Each Center must exhibit a comprehensive plan for integrating advances in nanoscale science and engineering research into the entire education spectrum relevant to this solicitation. The research agenda must also encompass issues across the grades 7-16 spectrum; however, a Center could place special emphasis on a particular grade band. Proposals must provide the rationale for this emphasis and clearly articulate the area of national need being addressed, as well as expectations for the Center's contribution to the body of knowledge on STEM teaching and learning.

Centers should be a fully cooperative effort among and, as appropriate, within institutions. In addition to higher education institutions, Centers may leverage the expertise of state or local education agencies, school districts, government laboratories, business and industry, and international institutions, as appropriate. Within the Center, at least one U.S. partner must grant doctoral degrees in related STEM education. Doctoral students, post-doctoral students, and interns might pursue different parts of their education at different institutions and/or Centers in order to develop specialized expertise. At least one partner must be a school district or a collection of schools (e.g., specialized schools).

c. Doctoral, Post-Doctoral, and Internship Programs: Doctoral, post-doctoral, and internship programs for this interdisciplinary effort could recruit from university teacher educators; scientists and engineers; curriculum developers; district- or state-level supervisors and coordinators; lead teachers; informal science educators; assessment specialists; education administrators; and others. Proposals should describe programs of studies for these individuals and clearly delineate the type of degree (Ph.D. or Ed.D.). Innovative ways to involve the Center's collaborative partners are strongly encouraged.

Doctoral programs and post-doctoral education at these Centers should impact both content preparation and quality of the STEM education infrastructure. Proposals should include clear statements of focus, indicating the backgrounds and experiences that are required for entrance and discussing how the program of study might be adapted for applicants with varying backgrounds. Programs of study should, for example: (1) provide rich opportunities to conduct research, development, and assessment studies in STEM learning and teaching; (2) provide in-depth experiences relevant to K-12 STEM education for doctoral and post-doctoral students and interns coming from STEM disciplines; and (3) provide rich education and learning experiences in the disciplines for doctoral and post-doctoral students, as well as interns, from education backgrounds.

d. Educator Component. Centers may employ a wide range of strategies to integrate new areas of science and engineering into education, including professional development of the prospective and current instructional workforce, grades 7-16; internships; or some combination of these and other approaches. Centers may develop or revise Master's programs, providing coursework and laboratory experiences for teachers, grades 7-12, to assist them in acquiring knowledge and understanding of nanoscale science and engineering. Centers should provide opportunities for professionals to apply their developing knowledge in realistic settings; provide extensive mentoring; and help develop a broad network to support them after the program of study is complete. Educators at all levels will be assisted in learning content and related instructional strategies in cooperation with scientists and engineers. Educational experiences should go beyond standard courses or generic professional development, be based on national standards, and include effective pedagogy for adult learning. Innovative ways of providing ongoing support for Center participants are encouraged.

e. Recruitment Strategies. Center proposals must present clear plans for recruiting highly qualified candidates (e.g., teachers, doctoral and post-doctoral students, faculty, interns) into its programs. Of particular interest are creative approaches for recruiting individuals with strong disciplinary backgrounds and for expanding diversity of the STEM education workforce. Proposals should describe how these strategies build on existing efforts that have been demonstrated to be effective.

f. Research Component. Proposals must articulate an overarching research agenda that addresses the Center's focus and links to both the doctoral education and educator efforts. Basic research should be conducted on the age-appropriate learning of the complex, interdisciplinary ideas associated with nanoscale science and engineering. Centers should develop effective strategies for communicating innovations, new instructional developments, and research findings to important stakeholders in relevant education and disciplinary communities in order to extend the impact of their work.

g. Institutionalization. Proposals must include plans for ensuring continuation of various aspects of the Centers after NSF support ends. In particular, doctoral and educator programs need to be institutionalized. The collaborating institutions should archive resources developed by the Center and provide plans for continuing support for educators in adopting and adapting these resources.

h. Evaluation. Centers are required to conduct formative and summative evaluation of the educator, doctoral, post-doctoral, and internship components. The evaluation plans must describe evidence to be used in ensuring that Centers' goals are being met; identify indicators, benchmarks, and relevant data; evaluation techniques to be used; and a timeline for the evaluation process. Evaluations should be designed to document the impact on students, teachers, undergraduate faculty, and graduate students, in addition to the impact on institutional environments. They should also document the effectiveness of its strategies for transforming classroom instruction and informing issues related to state/district curricula adoption and implementation, grades 7-12 (if appropriate). Proposed Centers must commit to cooperating with an NSF third-party evaluation (funded independently by NSF), which will include a longitudinal study of impact. Centers will be responsible for providing requested data to multiple program evaluators.

i. Dissemination. The proposal should include strategies for communicating activities and outcomes of the Center to relevant education and research communities, including professionals in NSF-supported STEM research centers responsible for education outreach, both during and after the project.

j. Relationship to other Projects supported by NSF. Proposed Centers may include partners from major NSF-supported nanoscale science, engineering, and technology projects, (e.g., *Nanoscale Science and Engineering Centers* (NSEC), *National Nanofabrication Users Network* (NNUN), *Network for Computational Nanotechnology* (NCN), *Science and Technology Centers* (STC), *Materials Research Science and Engineering Centers* (MRSEC), *Engineering Research Centers* (ERC)), or large-scale education projects (e,g., the *Advanced Technology Education Centers, Math and Science Partnership* projects). Proposals should carefully delineate plans to avoid duplication of effort and should provide strategies for cooperation. Details should be given for linking the NCLT research agenda to the work of other projects. Of particular concern is the need for coherence in goals and effort of work with educational partners. Center proposals that include partner(s) playing a key role in an existing or proposed large-scale project must provide evidence of capacity to carry out the proposed work of both projects; of alignment among goals and strategies; and of management structures that further the goals of both projects without inhibiting the attainment of the goals of each.

[B] INFORMAL SCIENCE EDUCATION IN NANOSCALE SCIENCE AND ENGINEERING (NISE) COMPONENT

NISE Goals

In response to NSF's focus on nanoscale science and engineering, the Informal Science Education (ISE) program encourages development of NISE projects to promote public understanding of nanoscale science and engineering concepts, scientific processes, and applications to society. The purpose of these efforts is to ensure that the public is kept abreast of advances in the field. Projects can include, but are not limited to, television programs, films, and traveling exhibits, that are designed to reach broad audiences, to complement formal education, and/or to inform youth and their parents about opportunities for pursuing advanced study and careers. Projects must involve experts at the forefront of nanoscale science and engineering research, as well as those experienced in the design and implementation of relevant types of informal science education. This solicitation is intended to encourage partnerships among science centers and museums, universities, schools, and other institutions in which each contributes in its areas of expertise. Such collaboration should be evident in both the planning and implementation of the proposed project. All proposals to this solicitation must conform to the guidelines for the development of informal science education projects in the *Informal Science Education Program Solicitation (NSF 03-511).*

Proposals similar to those defined by this Solicitation cannot be simultaneously submitted to both the NSF Informal Science Education (ISE) program managed by the Division of Elementary, Secondary, and Informal Education; see http://www.ehr.nsf.gov/esie/programs/ise/ise.asp.

NISE Project Description

NISE projects must have strong intellectual merit with a firm basis in nanoscale science and engineering and demonstrate the capacity for broad impacts.

a. Exhibit Projects. ISE supports traveling and permanent exhibits. It is anticipated that exhibits will be visitor-centered, inquiry-based, and promote active learning. In addition to addressing the overall ISE narrative requirements (see NSF 03-511), proposals are expected to include the following information that relates specifically to the exhibit format: an exhibit walk-through from the visitor's perspective that highlights key design elements and visitor experiences; details about the exhibit's accessibility; logistics regarding the exhibit's traveling (if applicable); and evaluation procedures that will be implemented (including front-end, formative, and summative evaluation procedures.) [see: Dierking, Lynn D. and Pollock, Weny. (1998). *Questions and Assumptions: An Introduction to Front-End Studies in Museums*. Ann Arbor, MI: Mallow Lithographing, Inc. and, *User Friendly Handbook for Project Evaluation: Science, Mathematics, Engineering and Technology Education* (NSF 93-152, revised 2/96); http://www.ehr.nsf.gov/EHR/RED/EVAL/Handbook/handbook.htm.]

Where possible, projects are encouraged to include smaller versions of exhibits or exhibit components for dissemination to other venues, such as small museums and science centers, libraries, and community centers. To the extent feasible, and within professional museum and conservation standards, efforts should be made to ensure that exhibits are designed and fabricated using the most environmentally friendly materials and processes possible.

b. Media Projects. Media projects supported by the ISE program generally are designed for national distribution. If the content is especially relevant to a particular area of the country, media projects designed for regional broadcast can be supported. Viable proposals should include documentation of interest or commitment from a major national or, if appropriate, regional broadcast or cable outlet, or an indication of interest and distribution plan for a non-broadcast film.

Proposals for media projects must clearly describe the scope of the science and how it will be presented. In additional to an explanation of the program/series content and format in the body of a proposal, competitive submissions should generally include a treatment for one or more programs as a supplementary document. Similarly, proposals should include a plan for outreach that is designed to extend the learning experience of the target audience for the media component.

[C] INSTRUCTIONAL MATERIALS DEVELOPMENT (NIMD) COMPONENT

NIMD Goals.

In response to NSF's focus on nanoscale science and engineering, the Instructional Materials Development (IMD) program encourages creation and dissemination of a limited number of exemplary instructional materials on nanoscale science, engineering, and technology targeted at middle- and secondary-school levels. These materials should address one or more of the following goals:

- integrate nanoscale science and engineering concepts and applications into existing standards-based STEM instructional resources;
- create modular units and/or laboratory experiments that present nanoscale science and engineering concepts and applications in a real-world context;
- emphasize the interdisciplinary nature of science through nanoscale science and engineering examples and applications; and,
- emphasize core concepts in technology and connections between science and technology through nanoscale science and engineering examples and applications.

The materials should extend understanding of how science, mathematics, and technology standards developed by national professional organizations (American Association for the Advancement of Science, the National Research Council, the National Council for Teachers of Mathematics, and the International Technology Education Association) can be addressed through the study of cutting edge, interdisciplinary science. The proposal should describe how inherently interdisciplinary content can be used to help students learn key concepts in science and technology.

Projects should develop both instructional materials for students that include embedded assessment of student learning, as well as materials for teachers that facilitate their implementation. The materials should enable students to meet the following learning goals:

- recognize how size can make a difference in the properties of materials;
- appreciate the interdisciplinary nature of science and engineering;
- understand the relationship between science and technology;
- become familiar with nanoscale science and engineering content and careers;
- apply nanoscale concepts to relevant student experiences; and,
- explore technological, economic, and social implications of nanoscale science and engineering.

The NIMD component emphasizes development, dissemination, and implementation of instructional materials and assessments in STEM education, as well as research on their effectiveness. These materials should align with standards, reflect research on learning and teaching, and develop a coherent understanding of how disciplinary research is performed. The materials should be developed through collaboration of practicing researchers, educators, and teachers. External consultant(s) should evaluate the effectiveness of

versions of the materials following pilot and field trials, the results of which should be used to revise the materials where needed. The materials should also incorporate resources for the professional development of teachers.

For convenience, a summary from the IMD program solicitation is provided here. All proposals must conform to the full guidelines for developing instructional materials as described in the IMD Program Solicitation (NSF 03-524). Of particular importance are the Project Description and Additional Review Criteria sections found in the *Student Materials* Component of the IMD solicitation.

NIMD Project Description

Exemplary projects should contain the following elements, which should be addressed in the Project Description section of the proposal. Proposal reviewers will examine the extent to which these elements are effectively incorporated in the overall project plan.

a. Goals and Objectives. Describe the major goals for the project, as well as the anticipated outcomes for students and teachers.

b. Project Evaluation. Describe the evidence that will be accepted to determine the extent to which goals are achieved, as well as the evaluation strategies that will be used to obtain that evidence. Each major aspect of the project should be evaluated -- the development process, implementation, student learning, change in teacher practice, etc. Formative evaluation, designed to affect development efforts may be conducted by an internal evaluator. Summative evaluation should be conducted by an external evaluator.

c. Anticipated Products. Describe the materials to be produced (e.g., print, software, videos, CD-ROMs, scholarly publications, monographs), including the specific learning activities to be developed (laboratory experiments, student projects, assessments, etc.).

d. Rationale. Describe how proposed instructional materials will meet the learning goals for students and teachers with regard to scientific concepts central to nanoscale materials and devices. Describe how these materials relate to, and build upon, previous and ongoing efforts. Relevant literature should be referenced to indicate knowledge of disciplinary and pedagogical issues.

e. Work Plan. Explain how the instructional materials will be created (or revised), reviewed, pilot-tested, field-tested, evaluated, and published. A detailed plan, including a complete timeline that indicates who is responsible for each facet, helps reviewers understand the flow of work. Draft materials must be pilot-tested with master teachers; field-tests must include a broad range of teachers with diverse backgrounds who teach target student populations. It is expected that results of these trials will be used to inform revisions of the materials, and that both the results of the trials and the revisions will be submitted to NSF.

f. Content and Pedagogical Strategies. Describe how the instructional materials' content and pedagogical strategies align with standards developed by national professional organizations; how these materials will prepare and motivate students to pursue further study of STEM disciplines; and how the materials will account for potential differences in students' prior knowledge.

g. Assessment. Describe tools and strategies for student assessment to be included in the instructional materials. It is critical that embedded student assessments be clearly aligned with the desired student learning outcomes and be informed by the nationally developed standards in mathematics, science, and/or technology. Assessments should address both formative and summative aspects of learning.

h. Professional Development. Describe the products (e.g., print, CD-ROM, Web-based) to be produced that will support teachers and administrators in effectively implementing the materials with fidelity to the developer's intent. It is expected that teaching guides will accompany the student materials.

i. Caregiver and Community Involvement. Describe strategies for communicating to school boards, administrators, and educators how the materials will enhance learning of significant subject matter content and increase student interest in science, mathematics, and technology.

j. Dissemination and Implementation. Explain how information about the materials will be shared with professionals and practitioners in STEM education communities both during and after the project. Instructional materials typically will be published and distributed commercially, although in some instances "free" distribution (e.g., through a refereed and highly visible Web site) might be an appropriate outlet.

k. Personnel. Describe the expertise and experience of the key personnel. It is expected that the development team will include -- as active participants -- appropriate STEM researchers; cognitive scientists; STEM educators; classroom teachers; assessment, evaluation and research experts; technology experts; instructional technologists; and professional developers. The proposal should include a detailed description of the role and commitment level of each of the key personnel.

Proposals similar to those defined by this Solicitation may also be submitted to the NSF Instructional Materials Development (IMD) program managed by the Division of Elementary, Secondary, and Informal Education, see http://www.ehr.nsf.gov/esie/programs/imd/imd.asp . The same proposal, however, cannot be simultaneously submitted to both NIMD and the IMD program.

[D] NANOTECHNOLOGY UNDERGRADUATE EDUCATION (NUE) COMPONENT

NUE Goals

Advances in nanotechnology research provide new opportunities in undergraduate education. With their focus on imaging and manipulating the ultimate building block of matter - the atom - nanoscale science and engineering provide a multitude of new interdisciplinary teaching opportunities for engaging student interest and for broadening their vision of science, engineering, and technology. Nanoscale science and engineering thus permit new strategies for enhancing science literacy, preparing the workforce for emerging technologies, and attracting a diverse group of talented students to the workforce of tomorrow.

Nanoscale science and engineering provides creative opportunities for invigorating undergraduate education through new courses and research experiences. It blends chemistry, physics, biology, mathematics, computer science, materials science, geology, behavioral and social sciences, and/or engineering. As such, it provides new opportunities for faculty collaboration, both in teaching and in research, that cross traditional disciplinary departmental boundaries. Some examples of nanotechnology-based topics that can be introduced into the curriculum include scanning probe methods, nanotubes, bottom-up and top-down syntheses of nanoscale materials, self-assembly, nanobiotechnology, environmental aspects of nanotechnology, applications of nanotechnology to information technology, properties and fundamental phenomena in nanoscale materials, computational methods for modeling nanoscale materials, nanoscale devices, and the societal, ethical, economic and environmental implications of nanotechnology. See http://www.nsf.gov/nano and http://www.nanofab.psu.edu/education/nsf-nue-program.htm for additional examples.

NUE projects are intended to enable individuals, departments, programs, or campuses to integrate nanoscale science and engineering into their curricula. Integration could take the form of a new course or courses, or modification of existing courses so that a substantial portion of the course content is based on nanoscale science and engineering. Although proposals involving any part of the undergraduate curriculum are eligible, special emphasis is placed on first- and second-year undergraduate courses, given their pivotal role in influencing science literacy and career paths.

NUE emphasizes new approaches to undergraduate education through interdisciplinary collaborations. These collaborations could lead to, but are not limited to:

- new examples of introductory undergraduate STEM courses that are presented through the development of manuals and other written materials, software, laboratory and demonstration experiments, and web-based resources;

- development and dissemination of new teaching modules for nanoscale science and engineering that can be used in existing undergraduate STEM courses; and,

- incorporation of undergraduate research opportunities based on nanoscale science and engineering into the curriculum at any level, particularly during first- and second-year studies.

Proposals similar to those defined by this Solicitation may also be submitted to the NSF Course, Curriculum, and Laboratory Improvement (CCLI) program managed by the Division of Undergraduate Education, see http://www.ehr.nsf.gov/due/programs/ccli. The same proposal, however, cannot be simultaneously submitted to both NUE and the CCLI program.

NUE Project Description

The project description for NUE should contain the following components:

a. Goals and Objectives. The goals of the project should be stated clearly and concisely in relation to the goals of the NUE component.

b. Results of Prior NUE Support. In addition to results of prior support as required by the NSF *GPG*, institutions participating in prior NUE awards must describe the relationship of that award to this new proposal.

c. Detailed Project Plan. The project plan should be the longest section of the Project Description. It should include description of the project's features, clearly delineating the plan to introduce or enhance nanotechnology in the undergraduate curriculum. The plan should include:

- a background on the proposed project describing how it builds on nanoscale and/or pedagogical research;
- a statement describing the expected impact of the project on the undergraduate curriculum at the participating institution(s) and, if applicable, elsewhere;
- number and percentage of undergraduate students who would be impacted by the project at the participating institution(s), and the extent to which under-represented groups would be served;
- plans for institutionalization of projects; and
- references to required letter(s) of institutional and departmental commitments noted under *Supplementary Material* (see below).

d. Experience and Capability of the Principal Investigator(s). Briefly describe the experience and capability of the PI(s). Include a brief description of the rationale for including the specific faculty members and institutional units within the project. State the role of each and cite the expertise that each will contribute to the project.

e. Evaluation Plan. Describe criteria to be used in evaluating the quality and impact of the project, how the project's impact on student learning will be assessed, and the process for collecting and analyzing information at the applicant's institution or from others involved in testing of course materials developed. The following references may be helpful in designing the evaluation plan:

- User Friendly Handbook for Project Evaluation: Science, Mathematics, Engineering and Technology Education (NSF 93-152, revised 2/96). See: http://www.ehr.nsf.gov/EHR/RED/EVAL/Handbook/handbook.htm

- User Friendly Handbook for Mixed Method Evaluations (NSF 97-153). See: http://www.ehr.nsf.gov/EHR/REC/pubs/NSF97-153/start.htm

- Online Evaluation Resource Library. See: http://oerl.sri.com

- Field-tested Learning Assessment Guide (FLAG). See: http://www.wcer.wisc.edu/nise/CL1/flag/

f. Dissemination of Results. Describe plans to communicate the results of the project to other professionals in the STEM and education communities, both during and after the project. Describe the information or materials to be disseminated (e.g., computer presentations, laboratory manuals, software, multimedia materials); how the material will be made available to other institutions; the means of dissemination (e.g., faculty development workshops, journal articles, conference presentations, electronic networks, media); and the procedures for determining the success of the dissemination effort. Describe procedures to be used to maintain the quality and currency of any material developed, to provide support for faculty users, and to publicize the availability of materials.

Investigators are encouraged to use the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL), as part of their dissemination efforts, see http://nsdl.org. To ensure that educational materials can be indexed and cataloged within the appropriate collections of NSDL, standard metadata elements and tags should be embedded in web-based products, e.g. documents, animations, simulations, and modules. A variety of review and user annotation procedures are also under development as NSDL services. Information about metadata standards is available from the Dublin Core Metadata Initiative at http://dublincore.org and the NSDL Metadata Primer at http://metamanagement.comm.nsdlib.org/outline.html. The NSDL Communications Portal at http://comm.nsdlib.org provides updates of ongoing NSDL efforts and discussions.

g. Supplementary Material. Letter(s) describing commitment of institutional and academic department(s) signed by a senior academic officer (dean or above) with budget authority to implement the activities listed in the proposal (if awarded) must be included as a Supplementary Document. The letter(s) should be referenced in the Project Description and outline the school's and department's commitment to the project and how the project may effect a lasting change at the institution. If these signed statements are not included in the Supplementary Documents section of FastLane, the proposal will be returned to the Principal Investigator without review.

Because the NUE component does not require preliminary proposals, potential PIs are encouraged to contact the cognizant NSF program officer listed in this solicitation before submitting an NUE proposal. This will facilitate determining whether the proposed work is appropriate for NUE.

III. ELIGIBILITY INFORMATION

The categories of proposers identified in the Grant Proposal Guide are eligible to submit proposals under this program announcement/solicitation; however, the lead institution **must** be a U.S. institution. Foreign institutions may be included as partners. No additional restrictions apply to proposals submitted for NISE or NIMD. Below are Eligibility Requirements for NCLT and NUE:

[A] NCLT -- An institution or agency may submit only one NCLT proposal as the lead institution for the NSEE competition. No collaborative proposals will be supported. However, an institution or agency may be a partner on more than one NCLT proposal. Center proposals must involve partnerships of organizations with a scientific, engineering, and/or educational mission. Among these are universities, two- and four-year colleges, state and local education agencies, professional societies, government laboratories, business and industry, informal science centers, instructional materials development centers, private foundations, and/or other public and private organizations (whether for profit or nonprofit). Each Center must have one or more school district partners (or an appropriate group of schools, e.g., specialized schools), as well as a partner that is authorized to award doctoral degrees in an appropriate STEM education area.

[B] NISE -- No additional restrictions.

[C] NIMD -- No additional restrictions.

[D] NUE -- Proposals may be submitted by any U.S. academic institution having undergraduate programs in disciplines usually supported by NSF. Projects may be proposed by individual investigators or by groups from academic institutions. Synergistic collaboration among researchers and collaboration or partnerships with industry or government laboratories is encouraged when appropriate. NUE proposals involving more than one institution must be submitted as a single administrative package with the managing Principal Investigator (PI) from the lead institution. Only one proposal may be submitted by any institution as the lead institution with the following exception: An institution may submit a second proposal as the lead institution, if it is focused on the societal, ethical, economic and/or environmental implications of nanoscale science and technology; two proposals focused on these areas are not allowed.

IV. AWARD INFORMATION

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

[A] Centers for Learning and Teaching in Nanoscale Science and Engineering (NCLT):

- Anticipated Type of Award: Continuing Grant
- Estimated Number of Awards: up to two
- Anticipated Funding Amount: Expected FY 2004 funding is $6,000,000
- Estimated Award Size: Up to $3,000,000 per year for five years

[B] Informal Science Education in Nanoscale Science and Engineering (NISE):

- Anticipated Type of Award: Continuing Grant
- Estimated Number of Awards: up to three
- Anticipated Funding Amount: Expected FY 2004 funding is $750,000
- Estimated Award Size: Up to $500,000 per year, for up to five years

[C] Instructional Materials Development in Nanoscale Science and Engineering (NIMD):

- Anticipated Type of Award: Continuing Grant
- Estimated Number of Awards: up to four
- Anticipated Funding Amount: Expected FY 2004 funding is $1,100,000
- Estimated Award Size: Approximately $275,000 per year for up to five years

[D] Nanotechnology in Undergraduate Education (NUE):

- Anticipated Type of Award: Standard Grant for duration of two years
- Estimated Number of Awards: up to 40
- Anticipated Funding Amount: Expected FY 2004 funding is $4,000,000
- Estimated Award Size: Up to $100,000 total for two years

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Preliminary Proposals *(required):*

A preliminary proposal is required for **NCLT, NISE,** and **NIMD *only***. No preliminary proposal is required for NUE. A preliminary proposal provides NSF staff the opportunity to comment on a project's responsiveness to program goals and priorities, its potential to compete successfully with other proposals in the merit review process, and information that can contribute to strengthening the full proposal. This response is an advisory opinion only and full proposals may be submitted regardless of the program response.

Reviews are returned as expeditiously as possible, but in general no later than one month prior to the date for submission of a full proposal. Preliminary proposals must be submitted in FastLane no later than 5:00 PM local time on the preliminary proposal due date to be ensured the review required for submission of a full proposal. (Please Note: In FastLane, the preliminary proposal is referred to as preproposal.) The Project Description may not exceed six pages and must be single-spaced and written in 12-point type with one-inch margins.

Each preliminary proposal should include a Cover Page and a 100-word project summary that describes the major features of the project. This summary will be used to assign review of the proposals to individuals with appropriate expertise.

[A] Specific to NCLT Preliminary Proposals:

The project description for NCLT preliminary proposals should explain how the proposed Center will address the three goals articulated in the program solicitation, how these goals will be connected, and how the Center will be evaluated and managed. Additionally, it should identify the anticipated partners and describe their expected roles. No budget is necessary at this time.

[B] Specific to NISE Preliminary Proposals:

The project description for NISE preliminary proposals should sketch, in broad strokes, the essential features of the project including: (a) educational need, target audience, and plans to reach that audience; (b) major project goal(s); (c) content focus and project design; (d) evaluation plans; (e) key personnel and advisors; (f) dissemination plans; (g) linkages with formal education, if any; (h) budget requested from NSF; and (i) supplementary information, including percentage of total budget being sought from non-NSF funding sources, anticipated sources of other funding, and indication of how the project will be supported after the NSF award period, if applicable.

[C] Specific to NIMD Preliminary Proposals:

The project description for NIMD preliminary proposals should address the following: (a) goals or objectives of the project, (b) evidence to be accepted to demonstrate the extent to which the project achieves its goals, (c) anticipated products, (d) need for the project and relevant research, (e) essential features of the project and a work plan that describes how the project will be accomplished, (f) content and pedagogical strategies used, (g) evaluation plans (both formative to inform project development and summative to assess the effectiveness of the project with the target audience), and (h) dissemination plans. A cumulative budget (instead of yearly budgets) and a one-page budget justification page are required.

[D] NUE

No preliminary proposal is required for NUE.

Full Proposal Instructions:

Proposals submitted in response to this program announcement/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/cgi-bin/getpub?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.

Proposers' attention is directed to the recent NSF requirement that the two general review criteria, *Intellectual Merit* and *Broader Impact*, **must be** explicitly addressed in the project summary and project description of proposals.

[A] Specific to NCLT Full Proposals:

Proposals submitted in response to this program solicitation must be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide (GPG),* **except that the project description may be up to 20 pages**. Additional review criteria described below should be addressed when preparing a proposal. The Project Description for NCLT proposals may not exceed 20 single-spaced pages in 12-point type with one-inch margins. Submission by FastLane is required for both preliminary proposals (preproposals) and full proposals.

Proposers are required to identify the relevant proposal component, "**Centers for Learning and Teaching in Nanoscale Science and Engineering**", on the Cover Sheet in the block titled "For consideration by NSF organizational unit". The proposal title should begin with the component acronym **"NCLT"**.

[B] Specific to NISE Full Proposals:

Proposals submitted in response to this program solicitation must be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide (GPG).*

Additional review criteria described below should be addressed when preparing a proposal. **The Project Description for NISE proposals may not exceed 15 single-spaced pages in 12-point type with one-inch margins** . Submission by FastLane is required for both preliminary proposals (preproposals) and full proposals.

Proposers are required to identify the relevant proposal component, "**Informal Science Education in Nanoscale Science and Engineering"**, in the block titled "For consideration by NSF organizational unit". The proposal title should begin with component acronym: "**NISE** ".

[C] Specific to NIMD Full Proposals:

Proposals submitted in response to this program solicitation must be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide (GPG).*

Additional review criteria described below should be addressed when preparing a proposal.

Additional review criteria described below should be addressed when preparing a proposal. **The Project Description for NIMD proposals may not exceed 15 single-spaced pages in 12-point type with one-inch margins.** Submission by FastLane is required for both preliminary proposals (preproposals) and full proposals.

Proposers are required to identify the relevant proposal component, "**Instructional Materials Development in Nanoscale Science and Engineering"**, in the block titled "For consideration by NSF organizational unit". The proposal title should begin with component acronym: **"NIMD"**.

[D] Specific to NUE Full Proposals:

Proposals submitted in response to this program solicitation must be prepared and submitted in accordance with the general guidelines contained in the NSF *Grant Proposal Guide (GPG).*

Additional review criteria described below should be addressed when preparing a proposal. **The Project Description for NUE proposals may not exceed 15 single-spaced pages in 12-point type with one-inch margins.** Submission by FastLane is required for full proposals.

Proposers are required to identify the relevant proposal component, "**Nanotechnology in Undergraduate Education"**, in the block titled "For consideration by NSF organizational unit". The proposal title should begin with component acronym: **"NUE"**. For administrative purposes, all NUE proposals must be submitted via FastLane to CHE (contact Michael Clarke, mclarke@nsf.gov).

Requirement for *all* NSEE Full Proposals ([A], [B], [C], and [D]):

Proposers are reminded to identify the program announcement/solicitation number (03-044) in the program announcement/solicitation block on the proposal Cover Sheet. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost Sharing:

[A] NCLT:

Cost sharing at a level of 10 percent of the requested total amount of NSF funds is required of all NCLT proposals. The proposed cost sharing must be shown on line M on the proposal budget. Documentation of the availability of cost sharing must be included in the proposal. Proposers should not exceed the cost sharing level or amount identified in the solicitation.

Only items that would be allowable under the applicable cost principles, if charged to the project, may be included in the awardee's contribution to cost sharing. Contributions may be made from any non-Federal source, including non-Federal grants or contracts, and may be cash or in kind (see OMB Circular A-110, Section 23). It should be noted that contributions counted as cost sharing toward projects of another Federal agency may not be counted towards meeting the specific cost sharing requirements of the NSF award. All cost sharing amounts are subject to audit. Failure to provide the level of cost sharing reflected in the approved award budget may result in termination of the NSF award, disallowance of award costs and/or refund of award funds to NSF.

[B] NISE:

Cost sharing for NISE projects is not required. However, NSF will support only a portion of the total project budget for NISE projects. It is expected that NSF support will be leveraged with resources from other sources. The amount of NISE support depends largely on scope and size of the project. Generally, for exhibit projects, NISE will support up to *two-thirds* of a total project budget. For media projects (excluding large-format films), NISE will generally support up to *one-half* of the production costs and up to two-thirds of the costs of advisors, outreach, and evaluation. For large-format films, NISE will generally support up to *one-third* of the production costs and up to one-half of the costs of advisors, outreach, and evaluation. Typically, NISE does not support general operating expenses, facilities, capital development, or equipment costs (NISE will consider support for equipment intended for exhibits or for direct use by the informal learner, but not for equipment used by project staff to develop the project.).

[C] NIMD:

Cost sharing for NIMD projects is not required.

[D] NUE:

Cost sharing for NUE projects is not required.

Proposed Cost Sharing Documentation ([A] NCLT):

The proposed cost sharing must be shown on Line M on the proposal budget. Documentation of the availability of cost sharing must be included in the proposal. Only items which would be allowable under the applicable cost principles, if charged to the project, may be included as the awardee's contribution to cost sharing. Contributions may be made from any non-Federal source, including non-Federal grants or contracts, and may be cash or in-kind (see OMB Circular A-110, Section 23). It should be noted that contributions counted as cost-sharing toward projects of another Federal agency may not be counted towards meeting the specific cost-sharing requirements of

the NSF award. All cost-sharing amounts are subject to audit. Failure to provide the level of cost-sharing reflected in the approved award budget may result in termination of the NSF award, disallowance of award costs and/or refund of award funds to NSF.

Other Budgetary Limitations:

NCLT, NISE, and NIMD awards will be made as continuing grants for up to five years. It is possible that NCLT projects can be renewed for an additional 5 years.

NUE awards will be made as standard grants for a duration of 2 years.

Budget Preparation Instructions:

[A] NCLT:

NCLT awards will be made with an initial commitment of five years and a potential, maximum duration of ten years. NSF will review the progress and plans of each funded Center annually, prior to receiving continued NSF support. In the fourth year of operation, Centers may submit a renewal proposal for continued support; the renewal request will undergo merit review. The NCLT's achievements and future plans will be evaluated comprehensively to determine if it is meeting the goals and objectives as originally proposed. The goals and objectives of the NCLT program and the individual goals of the particular NCLT will guide the NCLT performance assessment. At the end of the second year of funding, Centers will be required to participate in a reverse site visit at NSF Headquarters. Funding beyond the second year will depend on a successful outcome of the reverse site visit. Projects should budget for the reverse site visit (up to five participants), as well as two meetings per year at NSF (up to two participants).

Support levels for graduate and post-doctoral students and interns may vary depending upon the academic background and/or teaching expertise of applicants. It is envisioned that some advanced students will be paid academic-year stipends (in accordance with local institutional rates) plus tuition and fee waivers, while experienced professionals from teaching or other fields may be remunerated in proportion to their current salaries (up to $35,000/ten months) plus tuition and fee waivers. Professional development activities for teachers may offer stipends of up to $100 per day; provide tuition and fee waivers for graduate credits; or provide support for substitutes to permit the release of teachers during the school day. Although proposals may request funds for the development of new graduate courses in STEM education, the cost of delivering such courses may not be covered.

[B] NISE: No additional budget preparation instructions.

[C] NIMD: No additional budget preparation instructions.

[D] NUE: No additional budget preparation instructions.

C. Due Dates

Proposals must be submitted by the following date(s):

Preliminary Proposals *(required):*

November 17, 2003

[A] Centers for Learning and Teaching - NCLT
[B] Informal Science Education - NISE
[C] Instructional Materials Development - NIMD

NOTE: Preliminary proposals are not required for NUE

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

November 17, 2003

[D] Nanotechnology Undergraduate Education - NUE

February 20, 2004

[A] Centers for Learning and Teaching - NCLT
[B] Informal Science Education - NISE
[C] Instructional Materials Development - NIMD

Related Program Solicitation: ***Nanoscale Science and Engineering (NSF)***, NSF 03-043.

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this announcement/solicitation through the FastLane system. Detailed instructions for proposal preparation and submission via FastLane are available at: http://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. The FastLane Help Desk answers general technical questions related to the use of the FastLane system. Specific questions related to this program announcement/solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this announcement/solicitation.

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. Proposers are no longer required to provide a paper copy of the signed Proposal Cover Sheet to NSF. Further instructions regarding this process are available on the FastLane Website at: http://www.fastlane.nsf.gov

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

Reviews of proposals submitted to NSF are solicited from peers with expertise in the substantive area of the proposed research or education project. These reviewers are selected by Program Officers charged with the oversight of the review process. NSF invites the proposer to suggest, at the time of submission, the names of appropriate or inappropriate reviewers. Care is taken to ensure that reviewers have no conflicts with the proposer. Special efforts are made to recruit reviewers from non-academic institutions, minority-serving institutions, or adjacent disciplines to that principally addressed in the proposal.

The National Science Board approved revised criteria for evaluating proposals at its meeting on March 28, 1997 (NSB 97-72). All NSF proposals are evaluated through use of the two merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

On July 8, 2002, the NSF Director issued Important Notice 127, Implementation of new Grant Proposal Guide Requirements Related to the Broader Impacts Criterion. This Important Notice reinforces the importance of addressing both criteria in the preparation and review of all proposals submitted to NSF. NSF continues to strengthen its internal processes to ensure that both of the merit review criteria are addressed when making funding decisions.

In an effort to increase compliance with these requirements, the January 2002 issuance of the GPG incorporated revised proposal preparation guidelines relating to the development of the Project Summary and Project Description. Chapter II of the GPG specifies that Principal Investigators (PIs) must address both merit review criteria in separate statements within the one-page Project Summary. This chapter also reiterates that broader impacts resulting from the proposed project must be addressed in the Project Description and described as an integral part of the narrative.

Effective October 1, 2002, NSF will return without review proposals that do not separately address both merit review criteria within the Project Summary. It is believed that these changes to NSF proposal preparation and processing guidelines will more clearly articulate the importance of broader impacts to NSF-funded projects.

The two National Science Board approved merit review criteria are listed below (see the Grant Proposal Guide Chapter III.A for further information). 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 he/she is qualified to make judgments.

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 and original 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?

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:

[A] NCLT:

In addition to the two NSB criteria described above, the following elements will be used by reviewers and NSF staff in evaluating all NCLT proposals:

Institutional Capacity. What involvement has the proposing institution and its partners had in substantial, high-quality STEM education programs? What is the expertise (education and disciplinary) of the faculty and staff who will have involvement with the program? How does it relate to their role in Center activities? What are the plans for institutionalizing the Center?

Project Design. How does the project integrate advances in nanoscale science and engineering, with its education goals? How does the design of the opportunities proposed for teachers, faculty, graduate and post-doctoral students, and interns reflect current understanding of high-quality professional development? Does the project design allow for differences in background knowledge and experience that participants will bring to the programs?

Impact. What is the likelihood that the activities will produce leaders who can impact STEM/NSE education? Will the recruitment and program activities enhance the diversity of the STEM workforce? What is the potential for the project to significantly strengthen the nation's formal and informal STEM instructional workforce, both at the K-12 and higher education levels?

Plan. What is the likelihood that the proposed project will achieve its goals? How will the plan improve the disciplinary content knowledge and instructional skills of STEM teachers and undergraduate faculty? Is the project informed by research in teaching and learning? Do proposed activities address and promote equity and diversity in the STEM workforce? Are plans for dissemination and sustainability adequate?

Cooperative Relationships. Are the working relationships among collaborating parties strong? How will collaborations be strengthened as the project progresses? How does the existence of the Center create appropriate synergies between STEM researchers and STEM education researchers and add value to the work of individual partners?

Research Agenda. Are the research findings of the Center used to inform and improve student learning and teaching practice in the Center's specific focus area of nanotechnology? Does the research add, in a coherent way, to the body of knowledge about STEM/NSE learning, teaching, assessment, relevant education policies, teacher preparation/professional development, uses of information technology, etc.? Will the research findings be disseminated in a comprehensive way? Will the research address issues of equity and diversity in STEM education?

Evaluation. Are project goals clearly stated and measurable? Is acceptable evidence of success stated? Is the evaluation likely to provide data on the impact of the project, e.g., the quality and rigor of the research conducted by the CNLT, participants' knowledge of content and/or pedagogy, the quality of instruction for students or teachers, the potential effectiveness of graduate students in strengthening the future STEM education infrastructure, and on improving K-12 student learning?

[B] NISE:

Proposals will be evaluated against the two National Science Board (NSB) merit review criteria: What is the intellectual merit of the proposed activity? And, what are the broader impacts of the proposed activity? For the NISE competition, these two criteria are defined as follows:

Intellectual Merit. NISE projects should be designed to provide rich and stimulating opportunities for informal learning. Through these activities, individuals of all ages, interests, and backgrounds should be given the opportunity to increase their appreciation, understanding, and use of STEM disciplines through examples derived from nanotechnology. NISE projects should be well conceived and organized; conducted by well-qualified individuals and teams; explore innovative concepts and applications; and advance knowledge across the informal education field.

Broader Impacts. NISE projects will reach large audiences and have significant regional or national impact. Projects should be not only attract and engage large and diverse audiences, but also actively seek to include underserved audiences, including projects that address critical needs for informal science education in less populated regions of the nation. All projects are expected to disseminate effective designs of educational materials in order to maximize their impact.

In addition, in making funding decisions, NSF staff will give careful consideration to the integration of research and education and integrating diversity into NSF programs, projects, and activities.

In addition to the two NSB criteria described above, the following elements will be used by reviewers and NSF staff in evaluating all NISE proposals:

Collaboration. Projects should encourage individuals and organizations to find new ways to work together to achieve their goals and contribute to society. Partnering should be strategic alliances that leverage

competencies of each partner to create value; alliances that can take many different forms; and that cross sectors, creating distinctive challenges, but also great opportunities.

Evaluation. Projects should include plans for rigorous evaluation, based on comprehensive quantitative and qualitative information, in order to document project impact, inform the field, and demonstrate potential for dissemination and replication. It is expected that NISE projects will include front-end, formative, and summative evaluation at a level commensurate with the nature and scope of the project. Evaluation plans should be consistent with the projects goals, and the summative evaluation should reflect the extent to which the intended outcomes and impacts are achieved for the target audiences.

Dissemination. NISE projects should include plans for dissemination to target audiences, including marketing strategies and commitments from participating organizations, venues, and media outlets. Projects should also contribute to enhancing the infrastructure of informal science education through activities such as publication, electronic networking, technical assistance, and professional development. NISE also encourages publication and sharing of summative evaluation reports with the field.

[C] NIMD:

In addition to the two NSB criteria described above, the following elements will be used by reviewers and NSF staff in evaluating all NIMD proposals. Under the criterion of *intellectual merit,* reviewers will address project goals and objectives, evaluation, anticipated products, rationale, work plan, content and pedagogical strategies, assessment, and personnel described under NIMD *Project Description*. Under the criterion of *broader impacts*, reviewers will address strategies for increased participation of underrepresented groups, professional development, caregiver and community involvement, and dissemination and implementation.

[D] NUE:

In addition to the two NSB criteria described above, the following elements will be used by reviewers and NSF staff in evaluating all NUE proposals:

- the extent to which creative, interdisciplinary approaches to nanotechnology undergraduate education are fostered;
- the likelihood that the project will engage students and faculty at participating institutions (and, if applicable, elsewhere) in undergraduate nanotechnology education;
- soundness of plans for project assessment, institutionalization, and dissemination beyond the faculty members involved in the proposal;
- potential impact on developing a diverse workforce and enhancing science literacy; and
- the scale of the potential impact.

B. Review Protocol and Associated Customer Service Standard

All proposals are carefully reviewed by at least three other persons outside NSF who are experts in the particular field represented by the proposal. Proposals submitted in response to this announcement/solicitation will be reviewed by Panel Review.

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.

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 Director. In addition, the proposer will receive an explanation of the decision to award or decline funding.

In most cases, proposers will be contacted by the Program Officer after his or her recommendation to award or decline funding has been approved by the Division Director. This informal notification is not a guarantee of an eventual 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.

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

A. Notification of the Award

Notification of the award is made to *the submitting organization* by a Grants Officer in the Division of Grants and Agreements. Organizations whose proposals are declined will be advised as promptly as possible by the cognizant NSF Program Division 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.A. for additional information on the review process.)

B. Award Conditions

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 (NSF-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 agreement awards also are administered in accordance with NSF Cooperative Agreement Terms and Conditions (CA-1). Electronic mail notification is the preferred way to transmit NSF awards to organizations that have electronic mail capabilities and have requested such notification from the Division of Grants and Agreements.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from pubs@nsf.gov.

More comprehensive information on NSF Award Conditions is contained in the NSF *Grant Policy Manual* (GPM) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/cgi-bin/getpub?gpm. The GPM is also for sale through the Superintendent of Documents, Government Printing Office (GPO), Washington, DC 20402. The telephone number at GPO for subscription information is (202) 512-1800. The GPM may be ordered through the GPO Website at http://www.gpo.gov.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the PI must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period.

Annual progress reports are required for all components of this Solicitation, as is participation in an NSF evaluation of the entire nanoscale education effort.

The NSEE effort is viewed as a prototype for introducing cutting-edge research into the educational system, from middle school through undergraduate levels. For this reason, efforts to integrate research and education through the NSE and NSEE solicitations will be subjected to rigorous program evaluation designed to assess the effectiveness and impact of the individual components described above, the education outreach efforts of NSF-supported centers conducting nanotechnology research, and the value-added of developing an educational infrastructure built on the combined expertise of the research and education communities.

Additional reporting requirements include:

[A] NCLT:

Centers will be required (1) to submit annual reports of progress, (2) to participate in a reverse site visit before the third year of funding, and (3) to participate in an NSF evaluation of the Centers for Learning and Teaching program. NCLTs will also be asked to provide data and relevant qualitative information to the NSF third-party evaluation of the entire nanoscale education effort. Subject to availability of funds, NSF will invest up to approximately $6 million in this program component in FY 2004 -- up to two Centers, each at up to $3 million annually. Anticipated date of awards: September 2004.

[B] NISE: Projects will be required to provide data and relevant qualitative information to the NSF third-party evaluation of the entire nanoscale education effort.

[C] NIMD: Projects will be required to provide data and relevant qualitative information to the NSF third-party evaluation of the entire nanoscale education effort.

[D] NUE: Projects will be required to provide data and relevant qualitative information to the NSF third-party evaluation of the entire nanoscale education effort.

For ALL NSEE Components:

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for the PI and all Co-PIs. 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. This system permits electronic submission and updating of project reports, including information on project participants (individual and organizational), activities and findings, 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.

VIII. CONTACTS FOR ADDITIONAL INFORMATION

General inquiries regarding this program should be made to:

- John (Spud) Bradley, *Centers for Learning and Teaching (NCLT),* Section Head, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5091, fax: (703) 292-9044, email: jbradley@nsf.gov

- Michael R. Haney, *Centers for Learning and Teaching (NCLT)*, Program Director, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5102, fax: (703) 292-9044, email: mhaney@nsf.gov

- Duncan E. McBride, *Centers for Learning and Teaching (NCLT)*, Section Head, Directorate for Education & Human Resources, Division of Undergraduate Education, 835 N, telephone: (703) 292-4630, fax: (703) 292-9015, email:

dmcbride@nsf.gov

- Mike Clarke, *Centers for Learning and Teaching (NCLT)*, Program Director, Directorate for Mathematical & Physical Sciences, Division of Chemistry, 1055 S, telephone: (703) 292-4967, fax: (703) 292-9037, email: mclarke@nsf.gov

- Barry Van Deman, *Informal Science Education (NISE)*, Section Head, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5124, fax: (703) 292-9044, email: bvandema@nsf.gov

- Gerhard L. Salinger, *Instructional Materials Development (NIMD)*, Program Director, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5116, fax: (703) 292-9044, email: gsalinge@nsf.gov

- Carole Stearns, *Instructional Materials Development (NIMD)*, Program Director, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5108, fax: (703) 292-9044, email: cstearns@nsf.gov

- Mike Clarke, *Nanotechnology Undergrad Education (NUE)* Program Officer, Directorate for Mathematical & Physical Sciences, Division of Chemistry, 1055 S, telephone: (703) 292-4967, fax: (703) 292-9037, email: mclarke@nsf.gov

- Duncan E. McBride, *Nanotechnology Undergrad Education (NUE),* Section Head, Directorate for Education & Human Resources, Division of Undergraduate Education, 835 N, telephone: (703) 292-4630, fax: (703) 292-9015, email: dmcbride@nsf.gov

- Mary F. Poats, *Nanotechnology Undergrad Education (NUE),* Program Director, Directorate for Engineering, Division of Engineering Education & Centers, 585 N, telephone: (703) 292-8380, fax: (703) 292-9051, email: mpoats@nsf.gov

For questions related to the use of FastLane, contact:

- Jeffrey S. Harris, Science Education Analyst, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-5103, fax: (703) 292-9044, email: jsharris@nsf.gov

- Sarita Shephard, Program & Technology Analyst, Directorate for Education & Human Resources, Division of Elementary, Secondary, & Informal Education, 885 S, telephone: (703) 292-7422, fax: (703) 292-9044, email: sshephar@nsf.gov

IX. OTHER PROGRAMS OF INTEREST

The NSF *Guide to Programs* is a compilation of funding for research and education in science, mathematics, and engineering. The NSF *Guide to Programs* is available electronically at http://www.nsf.gov/cgi-bin/getpub?gp. General descriptions of NSF programs, research areas, and eligibility information for proposal submission are provided in each chapter.

Many NSF programs offer announcements or solicitations concerning specific proposal requirements. To obtain additional information about these requirements, contact the appropriate NSF program offices. Any changes in NSF's fiscal year programs occurring after press time for the *Guide to Programs* will be announced in the NSF E-Bulletin, which is updated daily on the NSF Website at http://www.nsf.gov/home/ebulletin, and in individual program announcements/solicitations. Subscribers can also sign up for NSF's Custom News Service (http://www.nsf.gov/home/cns/start.htm) to be notified of new funding opportunities that become available.

Related Programs:

- Centers For Learning and Teaching (NSF 03-522)
- Informal Science Education (NSF 03-511)
- Instructional Materials Development (NSF 03-524)

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Facilitation Awards for Scientists and Engineers with Disabilities (FASED) provide funding for special assistance or equipment to enable persons with disabilities (investigators and other staff, including student research assistants) to work on NSF-supported projects. See the GPG Chapter II, Section D.2 for instructions regarding preparation of these types of proposals.

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 or (800) 281-8749
- **To Order Publications or Forms:**

  Send an e-mail to: pubs@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; 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 applicant 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 needing information as part of the review process or in order to coordinate programs; 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," 63 Federal Register 267 (January 5, 1998), and NSF-51, "Reviewer/Proposal File and Associated Records," 63 Federal Register 268 (January 5, 1998). 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 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 this burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to: Suzanne Plimpton, Reports Clearance Officer, Division of Administrative Services, National Science Foundation, Arlington, VA 22230.

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