

Ultra-High-Capacity Optical Communications and Networking

Program Solicitation

NSF 01-65

DIRECTORATE FOR ENGINEERING

DIVISION OF ELECTRICAL AND COMMUNICATIONS SYSTEMS

DIVISION OF BIOENGINEERING AND ENVIRONMENTAL SYSTEMS

DIRECTORATE FOR COMPUTER AND INFORMATION SCIENCE AND ENGINEERING

ADVANCED NETWORKING INFRASTRUCTURE AND RESEARCH

DIVISION OF COMPUTER-COMMUNICATIONS RESEARCH

FULL PROPOSAL DEADLINE(S): May 7, 2001



NATIONAL SCIENCE FOUNDATION



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- **To Locate NSF Employees:** (703) 292-5111

SUMMARY OF PROGRAM REQUIREMENTS

GENERAL INFORMATION

Program Title: Ultra-High-Capacity Optical Communications and Networking

Synopsis of Program: The National Science Foundation (NSF), through its Divisions of Electrical and Communications Systems (ECS) and Bioengineering and Environmental Systems (BES) of the Engineering Directorate and the Divisions of Advanced Networking Infrastructure and Research (ANIR) and Computer-Communications Research (C-CR) of the Directorate for Computer & Information Science & Engineering announce an Initiative on Ultra-High Capacity Optical Communications and Networking. This focused initiative seeks high-risk/high-return proposals of novel concepts in photonic devices, fiber communication systems and advanced networks. The emphasis will be on enabling technologies critical to the continued growth of high-capacity optical communications and networking systems into the next decade. DARPA plans to participate in the reviews and identify proposals of mutual interest and may provide co-funding for programs of high quality that meet their programmatic and relevancy requirements. The reviews and panels will be conducted by NSF, utilizing the NSF merit review process. All awards will be made by NSF, and will be subject to NSF terms and conditions.

Cognizant Program Officer(s):

- Fil Bartoli, Program Director, ENG/ECS, telephone: (703) 292-8339, e-mail: fbartoli@nsf.gov.
- Rajinder Khosla, Acting Division Director, ENG/ECS, telephone: (703) 292-8339, e-mail: rkhosla@nsf.gov.
- Lawrence Goldberg, Senior Engineering Advisor, ENG/ECS, telephone: (703) 292-8339, e-mail: lgoldber@nsf.gov.
- Leon Esterowitz, Program Director, ENG/BES, telephone: (703) 292-7492, e-mail: lesterow@nsf.gov.
- Aubrey Bush, Division Director, CISE/ANIR, telephone: (703) 292-8950, e-mail: abush@nsf.gov.
- Taieb Znati, Senior Program Director, ANR, CISE/ANIR, telephone: (703) 292-8949, e-mail: tznati@nsf.gov.
- Kamal Abdali, Acting Division Director, CISE/C-CR, telephone: (703) 292-8910, e-mail: kabdali@nsf.gov.
- John Cozzens, Program Director, SPS, CISE/C-CR, telephone: (703) 292-8912, e-mail: jcozzens@nsf.gov.

- Rodger Ziemer, Program Director, CR, CISE/C-CR, telephone: (703) 292-8918, e-mail: rziemer@nsf.gov.
- David Honey, Deputy Director, DARPA/MTO, telephone: (703) 696-0232, e-mail: dhoney@darpa.mil.
- M. W. Maeda, Program Manager, DARPA/ITO, telephone: (703) 696-2255, e-mail: mmaeda@darpa.mil.

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

- 47.070 --- Computer and Information Science and Engineering
- 47.041 --- Engineering

ELIGIBILITY INFORMATION

- **Organization Limit:** Proposals may be submitted by U.S academic institutions in support of single investigators or small interdisciplinary groups of 2 to 3 investigators.
- **PI Eligibility Limit:** Only one proposal may be submitted by a Principal Investigator. A Principal Investigator for one proposal may be a co-Principal Investigator on one other proposal. Applicants for small group awards should contact one of the Program Directors listed in this document prior to proposal submission to clarify the appropriateness of the contemplated group proposal.
- **Limit on Number of Proposals:** None

AWARD INFORMATION

- **Anticipated Type of Award:** Standard or Continuing Grant
- **Estimated Number of Awards:** 10-15
- **Anticipated Funding Amount:** \$5.5M, subject to availability of funds, to cover Standard or Continuing Grants of up to three years duration beginning in FY 2001.

PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

- **Full Proposals:** Standard Preparation Guidelines
 - Standard GPG Guidelines apply.

B. Budgetary Information

- **Cost Sharing Requirements:** Cost Sharing is not required.
- **Indirect Cost (F&A) Limitations:** Not Applicable.

- **Other Budgetary Limitations:** Other budgetary limitations apply. Please see the full program announcement/solicitation for further information.

C. Deadline/Target Dates

- **Letters of Intent (*optional*):** None
- **Preliminary Proposals (*optional*):** None
- **Full Proposal Deadline Date(s):** May 7, 2001

D. FastLane Requirements

- **FastLane Submission:** Full Proposal Required
- **FastLane Contact(s):**
 - FastLane user support services, fastlane@nsf.gov.

PROPOSAL REVIEW INFORMATION

- **Merit Review Criteria:** National Science Board approved criteria apply.

AWARD ADMINISTRATION INFORMATION

- **Award Conditions:** Standard NSF award conditions apply.
- **Reporting Requirements:** Standard NSF reporting requirements apply.

TABLE OF CONTENTS

SUMMARY OF PROGRAM REQUIREMENTS

I. INTRODUCTION

II. PROGRAM DESCRIPTION

III. ELIGIBILITY INFORMATION

IV. AWARD INFORMATION

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

B. Budgetary Information

C. Deadline/Target Dates

D. FastLane Requirements

VI. PROPOSAL REVIEW INFORMATION

A. NSF Proposal Review Process

B. Review Protocol and Associated Customer Service Standard

VII. AWARD ADMINISTRATION INFORMATION

A. Notification of the Award

B. Award Conditions

C. Reporting Requirements

VIII. CONTACTS FOR ADDITIONAL INFORMATION

IX. OTHER PROGRAMS OF INTEREST

I. INTRODUCTION

Optical communications has enjoyed almost unprecedented growth and success in the commercial sector, and has been a major contributor to our nation's economic growth. The growth in communications has outpaced the performance of digital semiconductor systems, which according to Moore's law has doubled every 18 months. Still, the high inherent bandwidth of optical fibers is just beginning to be exploited. Although optical communications is thriving commercially, research investments have become increasingly short-term, and longer-term high-risk research is necessary to sustain the growth in information transfer capacity.

Increasing the total capacity in optical communications and networking will require new materials and devices, and new concepts for the basic transmission media. Growth in transmission data rates will necessitate new modulation techniques. New wide-band modulators and amplifiers operating between 1200-1700 nm will need to be developed to exploit increased fiber bandwidth. Adaptive devices such as filters, gain and power equalizers, and dispersion compensators will be of increasing importance. Integrated optical circuits and packaging remain a challenge. There will be a need for greater functionality on a chip, possibly requiring large functional chips with on-board hybrid technologies. Optical intra-chip connections may improve on-chip electronic performance. New high-speed electronics may be needed to keep pace with the optical bandwidth increases.

More functions will be transferred to the optical layer. Advanced processing will be invoked to achieve fast reconfigurable networks. New network paradigms will be needed, involving restructuring the periphery to extend all-optical techniques and optical switching from the backbone deep into the local area. This has implications for new devices and techniques including optical switches, data formats, and new networking protocols. One network issue involves the optical-wireless interface and techniques to provide wireless access over the full optical bandwidth. While breakthroughs are anticipated from individual investigators, interdisciplinary groups will become increasingly important in this area. It is expected that the research supported and stimulated under this initiative will also impact the NSF-wide Initiatives on Information Technology Research (ITR), Nanoscale Science and Engineering (NSE), and the Twenty-First Century Workforce.

II. PROGRAM DESCRIPTION

This initiative will emphasize forward-looking, high-impact research relating to optical communications and networking, with the goal of assuring continued growth in data capacity in optical communications and networking systems throughout the next decade. It is envisioned that research will be carried out by single investigators, or small interdisciplinary groups that generate new concepts and approaches stimulated by the interaction of diverse disciplines. Proposals offering incremental advances of existing technologies are discouraged. Research should focus on critical enabling technologies for long-term growth. Such research might include concepts for all-optical networking, novel technologies for significantly increasing the optical fiber communications bandwidth, schemes to achieve higher spectral efficiency, the optical-wireless interface, and new networking paradigms accounting for both higher usage rates and the impact of the optical communications medium on higher layer protocols. Proposals should discuss effective ways in which education and outreach to underrepresented groups is integrated within the research program.

TOPICAL AREAS

Some of the materials, device, systems, and networking topical challenges that will be addressed by this initiative include but are not limited to:

1. High-speed all-optical networks employing advanced switching schemes, architectures, and protocols.
2. Seamless hybridization and integration of microwave wireless signals with the optical backbone.
3. Next-generations of optoelectronic materials and devices that will fuel future capacity and functionality revolutions, such as photonic crystals, nonlinear processors, and advanced integration and packaging.
4. Identification of future shifts in optical communications beyond current technologies for erbium-doped fiber amplifiers (EDFAs) and wavelength-division multiplexing (WDM).
5. Fundamental advances to achieve greater than 300-nm-wide useful spectral bandwidth.
6. Technologies that will help achieve greater than 50-terabit/s in a single optical fiber, with resulting system capacities.
7. Tradeoffs to optimize the network architecture for ultra-wideband and heterogeneous traffic.
8. Powerful coding and modulation tools and techniques to achieve better spectral efficiency; identification of fundamental limitations.
9. Optical-electronic interface for greater than 40-Gbit/s/channel systems.

III. ELIGIBILITY INFORMATION

The categories of proposers identified in the [Grant Proposal Guide](#) are eligible to submit proposals under this program announcement/solicitation.

IV. AWARD INFORMATION

The awards made under this initiative will be up to \$350,000 for a single investigator and up to \$700,000 for a small interdisciplinary group, for a duration of up to three years. Small interdisciplinary groups may be from the same institution or from different institutions, and should demonstrate substantial program enhancement resulting from the interaction of diverse disciplines. It is anticipated that the total funds available from NSF for this initiative will be approximately \$5.5 million. Estimated program budget, number of awards and average award size/duration are subject to the availability of funds and the quality of proposals.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal:

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 Web Site at: <http://www.nsf.gov/cgi-bin/getpub?nsf012>. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 or by e-mail from pubs@nsf.gov.

Proposers are reminded to identify the program solicitation number (NSF 01-65) in the program announcement/solicitation block on the NSF Form 1207, *Cover Sheet For Proposal to the National Science Foundation*. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost sharing is not required in proposals submitted under this Program Solicitation.

Other Budgetary Limitations: Total award amount will be up to \$350,000 for a single investigator and up to \$700,000 for a small interdisciplinary group, for a duration of up to three years.

C. Deadline/Target Dates

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

Full Proposals by 5:00 PM local time: May 7, 2001

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this Program 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 1-800-673-6188.

Submission of Signed Cover Sheets. The signed copy of the proposal Cover Sheet (NSF Form 1207) must be postmarked (or contain a legible proof of mailing date assigned by the carrier) within five working days following proposal submission and be forwarded to the following address:

National Science Foundation
DIS – FastLane Cover Sheet
4201 Wilson Blvd.
Arlington, VA 22230

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.

Proposals will be reviewed against the following general review criteria established by the National Science Board. Following each criterion are potential considerations that the reviewer may employ in the evaluation. These are suggestions and not all will apply to any given proposal. Each reviewer will be asked to address only those that are relevant to the proposal and for which he/she is qualified to make judgements.

What is the intellectual merit of the proposed activity?

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

Principal Investigators should address the following elements in their proposal to provide reviewers with the information necessary to respond fully to both of the above-described NSF merit review criteria. NSF staff will give these elements careful consideration 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.

A summary rating and accompanying narrative will be completed and signed 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.

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.

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 will be able to tell applicants whether their proposals have been declined or recommended for funding within six months for 95 percent of proposals. The time interval begins on the proposal deadline or target date or from the date of receipt, if deadlines or target dates are not used by the program. 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 its 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 Web site at http://www.nsf.gov/home/grants/grants_gac.htm. Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (301) 947-2722 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 Web site 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 Web site 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.

Within 90 days after the expiration of an award, the PI also is required to submit a final project report. Approximately 30 days before expiration, NSF will send a notice to remind the PI of the requirement to file the final project report. Failure to provide final technical reports delays NSF review and processing of pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

NSF has implemented an electronic project reporting system, available through FastLane. 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 Ultra-High-Capacity Optical Communications and Networking should be made to:

- Fil Bartoli, Program Director, ENG/ECS, telephone: (703) 292-8339, e-mail: fbartoli@nsf.gov.
- Rajinder Khosla, Acting Division Director, ENG/ECS, telephone: (703) 292-8339, e-mail: rkhosla@nsf.gov.
- Lawrence Goldberg, Senior Engineering Advisor, ENG/ECS, telephone: (703) 292-8339, e-mail: lgoldber@nsf.gov.
- Leon Esterowitz, Program Director, ENG/BES, telephone: (703) 292-7492, e-mail: lesterow@nsf.gov.
- Aubrey Bush, Division Director, CISE/ANIR, telephone: (703) 292-8950, e-mail: abush@nsf.gov.
- Taieb Znati, Senior Program Director, ANR, CISE/ANIR, telephone: (703) 292-8949, e-mail: tznati@nsf.gov.
- Kamal Abdali, Acting Division Director, CISE/C-CR, telephone: (703) 292-8910, e-mail: kabdali@nsf.gov.
- John Cozzens, Program Director, SPS, CISE/C-CR, telephone: (703) 292-8912, e-mail: jcozzens@nsf.gov.
- Rodger Ziemer, Program Director, CR, CISE/C-CR, telephone: (703) 292-8918, e-mail: rziemer@nsf.gov.
- David Honey, Deputy Director, DARPA/MTO, telephone: (703) 696-0232, e-mail: dhoney@darpa.mil.
- M. W. Maeda, Program Manager, DARPA/ITO, telephone: (703) 696-2255, e-mail: mmaeda@darpa.mil.

For questions related to the use of FastLane, contact:

- FastLane user support services, fastlane@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](http://www.nsf.gov/home/ebulletin), which is updated daily on the NSF web site 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) (<http://www.nsf.gov/home/cns/start.htm>) to be notified of new funding opportunities that become available.

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) funds research and education in most fields of science and engineering. Awardees are wholly responsible for conducting their project activities and preparing the results for publication. Thus, the Foundation does not assume responsibility for such findings or their interpretation.

NSF welcomes proposals from all qualified scientists, engineers and educators. The Foundation strongly encourages women, minorities and persons with disabilities to compete fully in its programs. In accordance with Federal statutes, regulations and NSF policies, no person on grounds of race, color, age, sex, national origin or disability shall be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving financial assistance from NSF (unless otherwise specified in the eligibility requirements for a particular program).

Facilitation Awards for Scientists and Engineers with Disabilities (FASSED) 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 program announcement/solicitation for further information.

The National Science Foundation has Telephonic Device for the Deaf (TDD) and Federal Information Relay Service (FIRS) capabilities that enable individuals with hearing impairments to communicate with the Foundation about NSF programs, employment or general information. TDD may be accessed at (703) 292-5090, FIRS at 1-800-877-8339.

The National Science Foundation is committed to making all of the information we publish easy to understand. If you have a suggestion about how to improve the clarity of this document or other NSF-published materials, please contact us at plainlanguage@nsf.gov.

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.

Pursuant to 5 CFR 1320.5(b), 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, Information Dissemination Branch, Division of Administrative Services, National Science Foundation, Arlington, VA 22230, or to Office of Information and Regulatory Affairs of OMB, Attention: Desk Officer for National Science Foundation (3145-0058), 725 17th Street, N.W. Room 10235, Washington, D.C. 20503.

OMB control number: 3145-0058.