

Engineering Research Centers (ERC)

Partnerships in Transforming Research, Education and Technology

PROGRAM SOLICITATION

NSF 09-545

REPLACES DOCUMENT(S):
NSF 07-521



National Science Foundation
Directorate for Engineering
Engineering Education and Centers

Letter of Intent Due Date(s) (required) (due by 5 p.m. proposer's local time):

May 15, 2009

Preliminary Proposal Due Date(s) (required) (due by 5 p.m. proposer's local time):

July 15, 2009

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

February 09, 2010

For Invited Non-energy Topic Full Proposals

May 05, 2010

For Invited Sustainable Energy Topic Full Proposals

REVISION NOTES

NSF is currently in negotiations with the U.S. Department of Energy (DOE) to form a partnership in support of ERC awards that are focused on sustainable energy systems. As a result of this developing partnership, the original full proposal deadline date has been revised and there now will be two full proposal deadlines to address the anticipated changes in the merit review schedule for the two sets of proposals (energy and non-energy). For additional information, please see the ERC program webpage at: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5502.

1. It is anticipated that approximately \$13,000,000 is expected to be available to support at least two and up to four new Gen-3 ERCs in the Fall of 2010 with year one start-up budgets each of up to \$3,250,000, year two budgets of up to \$3,500,000, year three budgets of up to \$3,750,000 and years four and five budgets of up to \$4,000,000 each, pending satisfactory annual performance and availability of funding. The actual number of ERCs funded will depend on the scale and scope of the proposed Centers, the availability of funds, and the quality of the proposals submitted.
2. The lead university and no more than four domestic partner universities may join in a long-term partnership to form, support, and sustain an ERC. The lead and each of the partner universities will contribute to the research, university and pre-college education and innovation missions of the ERC. These partners will be committed to support and sustain the ERC through cost sharing and the involvement of the Dean of Engineering in the ERC's Council of Deans. The level of funding of the lead and partner universities through time will depend upon their role in the ERC and their performance. At least one but no more than three partnerships are required with foreign universities for both research and education that adds value to the ERC and the foreign partner. These partners will be funded by foreign sources or non-NSF sources if the ERC proposal receives an award. See Section II.B.2. for further information on the institutional configuration of the ERC.
3. Academic cost sharing is required of the lead university and domestic partner university(ies). It must be identified in the invited full proposal and is an eligibility criterion for the full proposal. Cost sharing will not be identified in the preliminary proposal. See the cost sharing requirements information in Section V.B. "Budgetary Information" for further information on academic cost sharing. For the lead university, in the full proposal this commitment to cost sharing must be augmented by an additional commitment to headquarters space for the ERC per requirements in II.B.8.d. The headquarters space must be located on the campus of the lead university.
4. Firms, and as appropriate for the topic, state or local government agencies who would be users of the results, are required to commit to membership at the preliminary proposal and the invited full proposal stages. Financial commitments are not required at the preliminary proposal stage. However, the invited full proposal must demonstrate commitments for cash and in-kind support. Upon award, these firms/agencies must provide membership fees in cash and in-kind and may provide additional cash support for sponsored projects, additional in-kind support, etc.
5. States may provide a commitment for financial support to enhance the impact of the ERC on local economic development or infrastructure, depending on the focus of the ERC, but this support is not required.
6. A lead university can receive only one ERC award through this solicitation.

7. Depending upon the quality of proposals and the available budget, at least two and up to four awards will be made in the following topic areas:

- Complex, Coupled Physical Civil Infrastructure Systems under Stress;
- Energy Systems for a Sustainable Future; and
- Transformational Engineered Systems - Open Category with Topic Chosen by the Proposing ERC Team.

Note, proposals that focus on the innovation process itself as an engineered system are not appropriate.

General guidance on the topic areas is provided in Section II.B.1.a in the solicitation.

8. Please be advised that the *NSF Proposal & Award Policies & Procedures Guide (PAPPG)* includes revised guidelines to implement the mentoring provisions of the America COMPETES Act (ACA) (Pub. L. No. 110-69, Aug. 9, 2007.) As specified in the ACA, each proposal that requests funding to support postdoctoral researchers must include a description of the mentoring activities that will be provided for such individuals. Proposals that do not comply with this requirement will be returned without review (see the PAPP Guide Part I: *Grant Proposal Guide* Chapter II for further information implementation of this new requirement). For ERC proposals there is an expanded mentoring requirement. See Section II.B.8.e of this solicitation.
9. A PI may be identified as Center Director on only one proposal.
10. Preliminary proposals are limited to 15 pages including all figures, tables and charts. This page limit is extended by the length of the Table of Academic and other Participants, Scientific Advisory Board, and Industrial and Practitioner Members (see section V.A.(4.a.))

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Engineering Research Centers (ERC)
Partnerships in Transforming Research, Education and Technology

Synopsis of Program:

The goal of the Generation Three (Gen-3) Engineering Research Centers (ERC) Program is to create a culture in engineering research and education that links discovery to technological innovation through transformational fundamental and engineered systems research in order to advance technology and produce engineering graduates who will be creative U.S. innovators in a globally competitive economy. These ERCs will be at the forefront as the U.S. competes in the 21st century global economy where R&D resources and engineering talent are internationally distributed. Recognizing that optimizing efficiency and product quality are no longer sufficient for U.S. industry to remain competitive, these ERCs will optimize academic engineering research and education to stimulate increased U.S. innovation in a global context. They will develop this culture of discovery and innovation through a symbiotic relationship between academic researchers, small innovative firms, larger industrial and practitioner partners, and organizations devoted to entrepreneurship and innovation. In essence this solicitation requires that the efforts be devoted to creating, developing, and enhancing capacities in ERCs from transformational fundamental research to technology commercialization and creating a continuous pipeline in engineering education from middle school to graduate studies.

In order to achieve this, Gen-3 ERCs will:

1. Advance discovery and build bridges from science-based discovery to technological innovation to realize transforming engineered systems.
2. Partner with foreign universities and provide unique opportunities for research and learning collaboration that will prepare U.S. engineering graduates for leadership in innovation in a global economy.
3. Form teams of faculty and students who are diverse and talented individuals who will prepare diverse and talented domestic and international graduates who can function in a global world where research, design and production efforts cross national borders.
4. Function with transforming engineering education programs that rest on partnerships with pre-college institutions to attract students to engineering and strategically impart in engineering graduates the capacity to create and exploit knowledge for technological innovation.
5. Function with partnerships with industry and other users, organizations devoted to stimulating entrepreneurship and innovation at the local level, and small firms engaged in the ERC's research program to speed translation of research results to innovation.

Cognizant Program Officer(s):

- Lynn Preston, Leader of the Engineering Research Centers (ERC) Program and Deputy Division Director (Centers), Division of Engineering Education and Centers (EEC), 585N, telephone: (703) 292-5358, fax: (703) 292-9051, email: lpreston@nsf.gov
- Deborah Jackson, Program Director, Engineering Research Centers, Division of Engineering Education and Centers (EEC), 585N, telephone: 703-292-7499, fax: 703-292-9051, email: djackson@nsf.gov
- Barbara Kenny, Program Director, Engineering Research Centers, Division of Engineering Education and Centers (EEC), 585, telephone: (703) 292-4667, fax: (703) 292-9051, email: bkenny@nsf.gov

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

- 47.041 --- Engineering

Award Information

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards:

4

Depending upon availability of funds, at least two and possibly four new ERC awards will be made.

Anticipated Funding Amount: \$13,000,000 (approximately) is expected to be available to support at least two and up to four new Gen-3 ERCs, with approximately two in the Fall of 2010 and two in FY 2011 with year one start-up budgets each of up to \$3,250,000, year two budgets of up to \$3,500,000, year three budgets of up to \$3,750,000, and years four and five budgets of up to \$4,000,000 each, pending satisfactory annual performance and availability of funding. NSF support will be augmented by academic cost sharing and financial and in-kind support provided by member firms, and for certain topic areas, these members would include state and local government agencies. Additional support from states and other sources is desired, but not required.

Eligibility Information

Organization Limit:

Proposals may only be submitted by the following:

- Only U.S. universities with undergraduate, masters, and doctoral engineering programs with the breadth and depth appropriate to support the vision may submit proposals as the lead university. Proposals must be submitted by the lead university. Separately submitted collaborative proposals are not acceptable and will be returned without review.

Other Organizational Requirements:

ERC Proposals must meet all of the following organizational requirements or they will be returned without review:

- Commitments for lead and partner university cost sharing and industrial/government agency financial support must be included in the invited full proposal but not in the preliminary proposal.
- The number of domestic partner universities is limited to the lead university plus up to four domestic partner universities. The lead or one of the domestic partner universities must be a university that serves students predominantly underrepresented in engineering and science in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities).
- At least one but no more than three foreign universities are required to be partners in research and education and post-award their support must be provided by foreign governments or other non-NSF sources.
- The ERC must partner with middle and high schools in pre-college education.
- The ERC must partner with local level organizations devoted to stimulating entrepreneurship and innovation and must include a plan for the support of start-up firms to carry out translational research through the ERC's research program. These firms should not be identified in the proposal stages.

PI Limit:

The Center Director must be a tenured faculty member in an engineering department at the lead university or may hold a joint appointment in an engineering department at the lead university. The Director's doctoral degree must be in engineering or an associated field of science; if the latter, she/he must have substantial career experience in engineering and a joint appointment in an engineering department at the lead university.

Limit on Number of Proposals per Organization:

There is no limit on the number of proposals to be submitted by a lead university and there is no limit on the number of ERC partnerships a partner university may join. A lead university can only receive one ERC award through this solicitation.

Limit on Number of Proposals per PI:

A PI may be identified as Center Director on only one proposal.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Submission of Letters of Intent is required. Please see the full text of this solicitation for further information.
- **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 deviates from the standard NSF Proposal and Award Policies and Procedures Guide, Part I: 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

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):
May 15, 2009
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):
July 15, 2009
- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):
February 09, 2010
For Invited Non-energy Topic Full Proposals
May 05, 2010
For Invited Sustainable Energy Topic Full Proposals

Proposal Review Information Criteria

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

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

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I. INTRODUCTION

Gen-3 Engineering Research Centers (ERC) build on two generations of achievement of 40 successful ERCs funded through ERC solicitations between 1985 and 2006. At the request of the White House and the National Academy of Engineering, the ERC program was established in 1984 to develop a new interdisciplinary culture in engineering research and education in partnership with industry to strengthen the competitiveness of U.S. industry. The goal was to educate new generations of engineers who would be capable of integrating fundamental knowledge across disciplines to advance systems-level technology. The first generation of 18 successful ERCs, established between 1985 and 1990, focused on next-generation technological systems and the expansion of design and manufacturing in

the academic engineering experience. The second generation of 22 successful ERCs, established from 1994 to 2006, focused on transformational engineered systems with the potential to transform industrial processes and product lines, became more multi-university in configuration, included pre-college education, and focused on significantly increasing the diversity of their faculty and students. Both generations of these ERCs functioned with sustained partnerships with industry and practitioners to bring knowledge of industrial and professional practices and needs to academe and speed the translation of their research into useful products, processes, and services. These partnerships have educated thousands of ERC engineering graduates who have proven to be more effective in advancing technology in industry.

The beginning of the 21st century finds the U.S. again faced by economic challenges and opportunities; but in a different context - a more broadly based global economy, increased global competitiveness, and declining U.S. student interest in careers in science and engineering. There have been a series of major publications analyzing the position of the U.S. economy in the world economy and raising a significant call for action:

- Engineering Research and America's Future, Committee to Assess the Capacity of the U.S. Engineering Research Enterprise, National Academy of Engineering (NAE), Washington, DC, 2005;
- The Engineer of 2020, NAE, 2004 and Educating the Engineer of 2020, NAE, 2005;
- Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future, National Research Council/COSEPUP, Washington, DC, 2005;
- Innovate America: National Innovation Initiative Final Report, Council on Competitiveness, Washington, DC, 2005; and
- The World is Flat: A Brief History of the Twenty-First Century, Thomas L. Friedman, Farrar, Straus, and Giroux, New York, 2005.

These and other publications, such as The America Competes Act of 2007, point to the following challenges and opportunities:

- Increase the capacity of U.S. society for creative innovation because optimizing efficiency and product quality is not enough to successfully compete in the 21st century;
- Support a culture of innovation through a symbiotic relationship between research, commercialization, and life-long skill development;
- Build bridges from science-based discovery to technological innovation by creating wholly new fields at the interface of science and engineering research;
- Stimulate diverse domestic and international talent to pursue engineering careers in the U.S.;
- Transform engineering education to impart the capacity to create and exploit knowledge for technological innovation;
- Build partnerships in engineering education between pre-college institutions and universities; and
- Produce engineering graduates who can compete in a global world where design and production efforts cross national borders.

The Gen-3 ERC program is designed to address these needs. The core key features of Gen-3 ERCs, as presented below, rest on the proven capacity of ERCs to contribute to U.S. competitiveness, augmented by new features that strengthen the role of ERCs and universities to innovation to address these challenges (see the full program description). The Gen-3 ERCs, through partnerships with member firms, small R&D firms engaged in translational research, local level partners devoted to stimulating entrepreneurship and innovation, and foreign university partners will be positioned to produce engineering graduates who will thrive as innovators in a highly competitive, global economy.

The first class of Gen-3 ERCs to undertake this mission were awarded in 2008. These are:

1. NSF Engineering Research Center for Integrated Access Networks (CIAN), University of Arizona (<http://www.cian-erc.org>)
2. NSF Engineering Research Center for Biorenewable Chemicals (CBIRC), Iowa State University (<http://www.cbirc.iastate.edu/index.asp>);
3. NSF Engineering Research Center for Revolutionizing Metallic Biomaterials, North Carolina Agricultural and Technology University (<http://erc.ncat.edu/>);
4. NSF Engineering Research Center for Future Renewable Electric Energy Delivery and Management (FREEDM) Systems, North Carolina State University (<http://www.freedm.ncsu.edu/>); and
5. NSF Engineering Research Center for Smart Lighting, Rensselaer Polytechnic Institute (<http://smartlighting.rpi.edu>).

The October 6, 2008 NSF Press Release announcing these new Engineering Research Centers can be found at: http://www.nsf.gov/news/news_summ.jsp?cntn_id=112313&org=ENG&from=news .

II. PROGRAM DESCRIPTION

A. Goal and Key Features of Generation Three (Gen-3) ERCs

The goal of the Gen-3 Engineering Research Centers Program is to create a culture that links scientific discovery to technological innovation through transformational engineered systems research and education to advance technology and produce engineering graduates who will be creative innovators in a global economy.

To achieve this goal, Gen-3 ERCs will have the following key features:

- Guiding strategic vision for a transformational engineered system and the development of an innovative, globally competitive engineering workforce;
- Partnerships with foreign universities to add value in research and education;
- Strategic, discovery and systems motivated cross-disciplinary research program, including small firms engaged in translational research;
- Education program strategically designed to produce creative, innovative engineers by engaging students in all phases of the research and innovation process;
- Long-term partnerships with middle and high schools to bring engineering concepts to the classroom and increase enrollment in college-level engineering degree programs;
- Partnerships for technology transfer and innovation with member firms and local level organizations devoted to stimulating entrepreneurship and speeding technological innovation;
- Capable and diverse leadership, faculty, and student teams committed to the vision, with effective management systems; and
- Multi-university configuration enabled by a long-term cross-institutional commitment to support and sustain the ERC and facilitate and foster the cross-disciplinary team, its innovation, mentoring, and diversity goals.

These ERCs will require the following infrastructure to succeed:

- A multi-university configuration comprised of an eligible lead university and no more than four domestic partner universities, joined in a long-term partnership to form, support, and sustain the ERC (See Section II.B.8.e);
- Leadership, financial and management systems to develop, operate, and sustain the ERC during its NSF funding life and beyond;
- Effective cross-institution collaboration among faculty and students through shared resources (e.g., shared data, experimentation, simulations, and testbeds), and shared programs of education, enabled by the cyberinfrastructure;
- Effective academic policies that sustain and reward the ERC's cross-disciplinary, global culture of the ERC, its goals for technological innovation, and the role of its faculty and students in mentoring and pre-college outreach; and
- Financial and in-kind cost sharing support from the lead and partner universities and membership fees from industry/practitioner organizations to augment NSF support to demonstrate a partnership with NSF to enable the ERC to achieve its goals and to sustain the ERC after graduation from NSF support. Additional support from states and other sources is desired, but not required. See the cost sharing requirements information in Section V.B. "Budgetary Information" for further information.)

B. Guidance Regarding Gen-3 Key Features:

Since the Gen-3 ERCs have not operated long enough to develop a set of best practices for the features that are unique to these ERCs, NSF expects each proposing team to develop new modes to effectively realize the Gen-3 key features. Best practices for Gen-2 ERCs are a useful starting point regarding the core features of Gen-2 and Gen-3 ERCs and can be found in the "Best Practices Manual" at http://www.erc-assoc.org/manual/bp_index.htm. This manual was developed by faculty, staff, and students from ongoing ERCs funded between 1994 and 2003.

1. Systems Vision:

a. **Vision Areas:** The approximately four anticipated awards will be funded in the following areas:

- Complex, Coupled Physical Civil Infrastructure Systems under Stress;
- Energy Systems for a Sustainable Future; and
- Transformational Engineered Systems - Open Category with Topic Chosen by the Proposing ERC Team.

Note, proposals that focus on the innovation process itself as an engineered system are not appropriate.

The following general guidance is provided regarding the first three topics:

Complex, Coupled Physical Civil Infrastructure Systems under Stress

An ERC focusing on this area would undertake a complex coupled engineered systems approach that supports the sustainability of an urban/suburban community or region. It is expected that interaction and complex interdependencies of the physical systems with economic and societal systems will be addressed in a way that transforms the current state of the art. Infrastructure systems such as, but not limited to, lifelines, transportation networks, and communications should be addressed. These physical systems are coupled to each other and to economic, societal, environmental and political systems in complex ways that are not well understood. These subsystems are under increasing stress in the U.S. due to a variety of causes. As a result the urban/suburban physical infrastructure system is at risk of not sustaining the continued economic prosperity of the U.S. and providing a sustainable human living environment and resulting in socially unacceptable levels of service delivery. Stressors whether transient or permanent, static or dynamic shall be identified and their influence on the functionality and sustainability of engineered system shall be addressed. The ERC will develop advanced methods and advanced info-structures by which such coupled complex systems can be analyzed and managed under dynamic and extreme conditions.

The goal is to join investigators from a range of engineering and science fields along with public decision makers responsible for the management, maintenance, construction, regulation and operation of these systems. The result will be knowledge that will transform the development of technology, tools, and decision systems to enable wholly new approaches to refreshing, rehabilitating, and managing the systems in a synergistic way to provide reliable, functional, safe and secure, and sustainable infrastructure systems in a regional context.

Energy Systems for a Sustainable Future

To sustain the U.S. economy and the environment, an ERC funded in this area would focus on providing transformational engineered systems that would enable households, communities, and/or regions to function more effectively with a combination of renewable and non-renewable energy sources that are used to conserve energy and reduce the impact on the environment. Because of its engineered system focus and its ability to address the complexity of this issue across a range of disciplinary perspectives, the goal of an ERC funded in this area is to add value and impact in ways that are not achievable through support from other parts of NSF and the Department of Energy. The result would enable a transformational contribution to sustainability of the U.S. economy over time through the exploration of innovative, high-risk, high-payoff technologies. Such an ERC would rest on the assumption that to be viable, the U.S. economy must rely on a broad base of energy sources, both renewable and resource-limited. To be effective the teams would include a combination of engineers and scientists including environmental and economic scientists.

Open Topic - Transformational Engineered Systems

An ERC funded in this area must be motivated by a vision for a transformational engineered system that does not overlap the systems visions called for by the first two topic areas.

b. **Vision Guidance:** Given the vision area guidance in 1.a, a prospective ERC team should develop a ten-year vision for advances in an emerging and potentially revolutionary or transforming engineered system(s) with the potential to significantly change current practices, establish wholly new industries, or

public sector services. The systems vision should provide an opportunity for national economic growth or contribute to the solution of a major societal problem that has a national, and perhaps an international impact. The vision should be positioned at the cusp of emerging discoveries in science and engineering. Visions that focus on incremental advances to current practices will not be competitive. An engineered system is a combination of components that work in synergy to collectively perform a useful function. That system can be a service delivery system, a technology system, or an infrastructure system. Part of the complexity of engineered systems research derives from integrating factors that represent their use in products or services, factoring in their impacts on the environment, society or the human body, as appropriate to the system chosen. This complexity should be factored into the development of the vision and the strategic research plan.

If this analysis reveals that a significant fraction of the ten-year time frame for the research would be spent on basic/fundamental research before enabling and systems technology could be undertaken, the topic is not suitable for an ERC.

While high quality research on one or more of the enabling technological components of the system will be required to realize the functionality of the system, a focus on the individual components without their integration into an engineered system is not appropriate for an ERC.

Additionally, proposers should avoid focusing on an engineered system that is too closely aligned with those of ongoing or recently graduated ERCs or other Centers supported by NSF, other Federal agencies, or state governments. If the proposal is relevant to the research mission of another Federal Agency, the vision section of the preliminary and invited full proposals must include a justification of the value added by the proposed ERC over the project/centers already funded by that agency or called for in solicitations from those agencies already released at the time of submission of the preliminary proposal and the invited full proposal. If the proposing team is derived largely from the team involved in a graduated NSF or other agency funded center or one that would have graduated from NSF or other agency support by the time the ERC would be funded, the vision chosen should reflect a significantly different vision to warrant an additional NSF investment. In that case, the difference must be specifically addressed in the proposal.

Descriptions of ongoing ERCs and access to their web sites can be found at <http://www.erc-assoc.org/centers.htm>. Descriptions of other NSF-funded centers where engineering research plays a significant role, such as Industry/University Cooperative Research Centers (IUCRCs), Nanoscale Science and Engineering Centers (NSECs), Science and Technology Centers (STCs), Science of Learning Centers (SLCs), Materials Research Science and Engineering Centers (MRSECs), can be found by searching the NSF website at <http://www.nsf.gov>. Descriptions of the five new ERCs awarded in 2008 are available on the NSF web site at: http://www.nsf.gov/news/news_summ.jsp?cntn_id=112313&org=ENG.

2. ERC Configuration:

- a. **Domestic Universities:** The number of domestic partner universities is limited to the lead university plus up to four domestic partner universities. The lead and each of the partner universities must be committed to an integrated configuration to fulfill the research, university and pre-college education, and innovation goals of the ERC.

The lead and partner domestic universities will be committed to support and sustain the ERC through real and in-kind cost sharing and the involvement of the Dean of Engineering in the ERC's Council of Deans. Evidence of this cost sharing must not be provided in the preliminary proposal, but is required for the invited full proposal. The level of funding of the lead and partner universities through time will depend upon their role in the strategic plans and their performance. The lead or one of the domestic partners must be a university that serves students predominantly underrepresented in engineering and science in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities).

While not required, there may be one or two affiliated faculty each from a few other universities/colleges. These faculty do not have to have a long-term commitment to the Center and these universities/colleges are not considered partners and are not required to cost share. These universities are termed "universities providing affiliated faculty." In addition, staff from federal laboratories may participate in an ERC, but NSF funds may not support their effort. The contributions of these affiliated faculty or federal laboratory personnel may be in research, education, and/or innovation.

- b. **Foreign Universities:** One of the goals of the ERC Program is to provide an opportunity for domestic students and faculty to collaborate in a globally connected university research and education environment to strengthen the ERC, provide new opportunities for innovation, and to enable its graduates to work effectively in a globally connected economy. Thus, it is required that the ERC include at least one but no more than three foreign universities as partners in research and education, carrying out projects under the ERC's strategic plan that add value to the ERC in research and education. It is critical that the goals, interests, and intellectual resources of the foreign partner(s) complement those of the U.S. investigators and contribute significant value in both research and education to the ERC.

The foreign university, its government, or other non NSF sources will provide funds for this partnership. This funding for the foreign faculty and students to work at their home university as ERC partners, carrying out projects under the ERC's strategic plan, is expected to be in place during the first year of operation of the Center, if the proposal is awarded. Foreign students (not a U.S. citizen or permanent resident) matriculated in U.S. degree programs or on a post doc appointment, or foreign faculty serving on a visiting faculty appointment to the lead or one of the U.S. partner universities may be supported by U.S. funds. However, Research Experiences for Undergraduates (REU) funds may not be used to support foreign students.

- c. **Other Organizations Carrying out the ERC's Mission:** The ERC also will include pre-college educational institutions and local level organizations devoted to stimulating entrepreneurship and innovation. See the Section II.6. and II.7.b. for more information on these partnerships.

3. Strategic Research Plan: An ERC must have a strategic research plan motivated by the systems vision and

positioned to advance the state of the art. The objective of the strategic plan is to define the characteristics of the system and how it is expected to function, the barriers in the way of realizing the vision through analysis of the state of the art and practice, and a critical path of fundamental and enabling technology research and testbeds needed to explore and test the system through proof-of-concept testbeds.

The strategic plan is dynamic over time and will evolve with the progress of the Center and the field. Since the focus will be on emerging, highly speculative technological opportunities, the ultimate implementation at the systems level may be uncertain at this time. Nevertheless, initial systems goals and requirements, specific knowledge gaps, technology goals and deliverables, and barriers to achieving these goals should be preliminarily identified, understanding that they will evolve in depth and sophistication over time. If this analysis reveals that a significant fraction of the ten-year time frame for the research would be spent on basic/fundamental research before enabling and systems technology research could be undertaken, the topic is not suitable for an ERC. However, this statement should not be construed to mean that ERCs are focused on applied research, rather they contain a portfolio of fundamental research and research focused on exploring and realizing enabling and systems technology.

The systems goals and barriers motivate and guide the selection of proposed research projects, testbeds, and the role of small firms in carrying out translational research through the research program to speed innovation. The testbeds enable proof-of-concept inquiries of enabling and systems-level technologies to test the new ideas/components and their relationships in an environment that simulates their intended application. Small, innovative firms will be included in the research program with ERC funds at the appropriate time to carry out translational research to strategically speed innovation. The role of the small firms in the research program should be strategically planned to team staff from these firms with the ERC's faculty and students. The quality of the strategic plan and its execution through an integrated research program, as presented in the proposal, will be a key selection factor in the ERC competition.

The proposal must include a conceptual diagram using a customized version of the ERC Program's Three-Plane Strategic Planning Chart. The proposed strategic plan diagram must show how the systems goals of the ERC drive and integrate its major research goals and testbeds to address key barriers to realize the systems-level vision. This chart is available at <http://www.erc-assoc.org>.

In addition, the proposal must include a ten-year milestone chart indicating the critical paths through key research projects and testbeds to achieve the major research goals and deliverables. There is no preferred model for this chart; however, it should be presented in a format that clearly indicates the points of integration. A linear Gant chart without points of interface is not effective. More clarity of milestones is expected for the first five years.

- 4. Research Program:** The research program of an ERC merges the fundamental research culture of academe and the technology and product-development culture of industry. Deliverables include both long-term contributions to fundamental knowledge and technology and nearer-term results to meet industry's impending needs. The research program is cross-disciplinary in nature, encouraging teaming between faculty and students of different laboratories and disciplines. The projects are organized into thrusts focused on each of the major research goals. Synergies within and across thrusts are necessary to achieve the goals of the ERC and testbeds play a critical role in integrating the research and exploring the realities of enabling and systems-level technology. It should be understood that ERC testbeds are not expected to approach the product and process realization stages found in industry, but rather their role in an ERC is for proof-of-concept to explore the technology and speed technology transfer. Often, they generate new research directions when barriers are more difficult to surmount than anticipated.

In the project-level descriptions in the research section of the proposal, provide a few examples of the fundamental barriers the research will address and the approaches to be taken to address them in the context of known results and theory to demonstrate that the desired results constitute breakthroughs and are attainable in ten years.

The research program will form collaborations of the best faculty and students working in fields that support the vision. It will integrate engineering disciplines with physical, materials, and natural science disciplines; and depending on the system(s) chosen, it will include computer science, medicine, social, economic, and decision sciences to achieve the vision of the Center.

The research program will integrate discovery and innovation for all faculty and students to complement the discovery aspects of each person's research. The innovation efforts of the ERC will play a leading-edge role in bridging the gap between the discovery and successful product commercialization or service delivery in the private/public sector. A key player in that process is the small, start-up business sector. At the appropriate stage of the research, the research program will support these small start-up firms to carry out translational research in teams including faculty and students, to speed the research results of the ERC to innovation. This will provide the opportunity for the ERC's students at all levels to work with members of these small firms in the ERC's laboratories to assure they learn about the innovation process as a part of their degree activities. If the topic proposed would lead to an innovation in service delivery or professional practice, as opposed to a technology product, small firms or other organizations contributing to enhancing innovations in these services and speeding their use in practice should be engaged in the place of technologically-focused start-up firms.

In later stages, the research program also should include support for technical staff to work with students and faculty to build the systems testbeds to transition the enabling and systems technology research to early-stage prototypes.

The ERC's research teams will be supported by appropriate research equipment and facilities, shared data, shared experimentation, and shared simulations or testbeds. These should be supported by the cyberinfrastructure to facilitate collaboration across space and time.

The research program will include graduate and undergraduate students from the domestic partner universities in core activities. This undergraduate participation will be augmented by a summer Research Experiences for Undergraduates (REU) program that supports a diverse group of students from universities/colleges outside the lead and partner universities. The ERC will budget for the REU program using its base budget (at least \$42,000 per year not including indirect costs). Post-award, the ERC should submit a proposal to the NSF REU program solicitation for a full site award from that

program to fully support the ERC's REU program or augment support from the base budget efforts. If the ERC does not receive an REU site award, it will continue to use its base budget to support this program.

5. **University Education Program:** The ERC will have a strategically designed university education plan with a driving hypothesis of how to nurture and develop graduates who are adaptive and creative innovators with the capacity to advance fundamental knowledge and create and exploit that knowledge to advance innovation in a global economy. The ERC will propose an education strategic plan that describes the activities that will be included in the education program to impart these characteristics in ERC students to test the ERC's educational hypothesis. The activities will be carried out in collaboration with the domestic and foreign partnering universities' education programs.

The education program must be structured to develop engineering graduates at the B.S., M.S. and Ph.D. levels. The education program also will develop course materials derived from the ERC's research, and if needed in the field, new degree programs, options, or certificates identified on transcripts.

The education program will include a formative and summative assessment plan to monitor progress and impacts to improve the program through time and assess its long-term impacts. Given the projected ten-year life span of the Center, it is expected that longitudinal data will be collected and assessments of the impact of the education program will be carried out. Because of this, Institution Review Board approval for research involving human subjects will have to be obtained. The education team may need to be supported by faculty with backgrounds in research on engineering education, innovation, and educational assessment. The quality of the educational plan will be judged on the quality of the vision for the future graduates and the innovative nature of the educational plan, and the quality of the assessment plan.

6. **Pre-college Education Program:** The pre-college education program of the ERC will form long-term partnerships with a manageable number of pre-college institutions (middle through high school) that are committed to including engineering concepts in the pre-college classroom. The goal is to stimulate student interest in engineering careers and increase the diversity of domestic students studying engineering at the college level. The partnership will involve the pre-college and university administrators, faculty, and students. The lead and each of the partner universities will have pre-college partners. However, the total number should be limited as the purpose is to develop intensive and long-term relationships. One goal is to involve pre-college teachers in the ERC's research to enable them to develop course modules to bring engineering concepts into the classroom to inform pre-college students about engineering and stimulate them to choose engineering degree programs in community colleges, colleges, and universities. In addition, pre-college students will be involved in the ERC's educational activities and some promising high school students from these institutions will be offered an ERC Young Scholars research opportunity within the ERC's research program to carry out research in the Center's laboratories, mentored by its students. Students will receive a certificate of completion for the Young Scholar's program.

It is expected that the ERC's faculty and students will participate in the full scope of the pre-college education program and their mentoring efforts will be recognized and rewarded by their home institutions.

The pre-college program will include a Research Experience for Teachers (RET) program using the ERC's base budget (at least \$42,000 per year not including indirect costs) to support teachers from the ERC's pre-college partner schools. Post-award, the ERC should submit a proposal to the Directorate for Engineering RET solicitation for a site award from that program to fully support the ERC's RET program or augment support from the base budget efforts. If the ERC does not receive an RET site award, it will continue to use its base budget to support this program.

The pre-college program will have an assessment component to determine whether its goals are being met. This assessment program will be formative and summative and is expected to adopt best practices in program implementation and assessment already developed by ongoing NSF-funded and other pre-college education programs.

The preliminary and invited full proposals will include letters from the partner administrators of the selected pre-college institutions indicating their commitment to participate.

7. **Industrial/Practitioner Members and Innovation Partners:**

- a. **Members:** The ERC's industrial/practitioner membership program will be strategically designed to optimize innovation and speed commercialization/utilization of ERC advances through member firms and as appropriate, user agencies or hospitals. Through this program, the ERC will take the lead role in bridging discovery to successful product commercialization and utilization. The Gen-3 ERC will include as members a mix of sizes of firms and, as appropriate, for the field, it will include practitioner organizations such as government agencies or hospitals. It will recognize the important role of domestic small member firms in transforming high-risk research into successful commercial products for the U.S. economy.

The membership program will be a shared program of industrial/practitioner collaboration that serves the ERC as a whole. The members will provide guidance on strategic planning, research opportunities, education, the role of innovation within the ERC, and will help guide the translation of ERC research into innovation as discussed below. It is also expected that industry/practitioners will contribute to the ERC's research and education program by providing knowledge of manufacturing, product design, or the practices involved in service delivery, and help establish the culture of innovation and a global experience required for its students and faculty.

Given the field, the ERC will strategically determine the right types of industrial/practitioner members needed to assume the essential risks involved in advancing discoveries to technological innovations that impact products and services. It is expected that there will be a mix of small, medium, and large firms (both domestic and foreign). The mix will depend upon the field. The inclusion of member practitioner organizations, such as hospitals or local government agencies, would depend upon the systems focus of the ERC.

ERCs are required to have industry/practitioner members that pay membership fees.

Preliminary proposals are not required to demonstrate financial commitment by industry/practitioner members. However, by the invited full proposal stage, NSF expects the level of industrial support from firms committed to ERC membership if an award is made, to demonstrate strong industry interest in membership in the proposed ERC and commitment to financial support. There are no requirements for the numbers of memberships or levels of support as judgments of sufficiency vary by field.

The Gen-3 ERC's industrial/practitioner membership program will be governed by an ERC-wide membership agreement that defines the scope and function of the ERC's partnership with industry/practitioners and the ERC's Intellectual Property (IP) policies. Guidance on effective agreements and IP policies is available in the ERC Best Practices Manual in the chapter focused on industrial collaboration. For Gen-3 ERCs, it is advised that the IP policies be developed to facilitate the Gen-3 innovation model and be flexible in recognizing IP jointly developed by faculty in different universities or that are developed by joint industry and university research.

The ERC will be expected to function with an Industrial/Practitioner Advisory Board (IAB) involving all of its industry/practitioner partners. The IAB will carry out an analysis of the ERC's strengths, weaknesses, opportunities, and threats to survival (a SWOT analysis). It will meet twice a year, and one of these meetings will include participation in the annual NSF review of the ERC's performance and plans.

The membership agreement will include a fee structure for member firms/agencies/hospitals that recognizes the differing capacity of small, medium, and large firms and practitioner organizations to contribute university research and education. These will be cash fees for industry but may be in-kind for local government agencies/public hospitals that join as members. Members may contribute augmented support through sponsored projects. There may be affiliated firms who will pay a fee to spend time in collaboration with the ERC before becoming a full-scale member. Finally, members, affiliates and other firms may contribute in-kind support through equipment donations and other efforts. Thus the ERC's support from NSF and academe will be augmented by membership fees, sponsored project fees, fees charged to affiliated firms considering membership, and equipment donations from industry.

- b. **Innovation Partners:** The ERC also will include innovative ways to speed the translation of knowledge into innovation. These will include small firms engaged in translational research within the ERC's research program as discussed in the research section. The small firms engaged as research partners in translational research within the ERC's research program would not be expected to be members of the industrial/practitioner membership program but may be considered members if that facilitates IP. If the topic area focuses on service delivery, health care, or the infrastructure, where those that play the role of translating research to practice are not technology oriented firms, then the appropriate type of organization that carries out that role in that sector should be supported for the translational research needed to move knowledge into practice. These firms are not expected to be included in the research program at start-up, rather at the appropriate time in the progress of the research.

The ERC will exploit opportunities offered by the Federal Small Business Innovation Research (SBIIR)/Small Business Technology Transfer (STTR) programs.

In addition to members drawn from industry and other organizations, the ERC will include a partnership(s) with academic, state or local government, or other organizations designed to stimulate entrepreneurship, and otherwise speed innovation. These will be partners engaged in fulfilling the innovation mission of the ERC in ways that complement the industrial/practitioner partnership program and the role of small firms in translational research. The preliminary and invited full proposals will include a letter of commitment from each of the proposed innovation partners.

The ERC will include analyses to determine the most effective ways to achieve these innovation goals through these types of partnerships.

8. Infrastructure

- a. **Leadership and Team:** Each ERC must have the following leaders and team members:
1. Center Director: in compliance with the PI eligibility criteria, a tenured faculty member and the NSF Principal Investigator (PI) who is responsible for leading the ERC and administering the award in accordance with the terms and conditions of the Cooperative Agreement issued by the NSF in the event of an award.
 2. Deputy or Associate Director(s): faculty who shares the leadership and management responsibilities.
 3. Thrust Leaders: faculty members responsible for leading and managing major research thrusts.
 4. Other Investigators: other faculty, postdocs, staff, and undergraduate and graduate students carrying out the research and education programs.
 5. Education Program Director: faculty responsible for the development and execution of the ERC's strategic education plan who is supported by faculty, students, staff.
 6. Pre-College Education Program Director: faculty or staff member, experienced in pre-college education, who is responsible for the pre-college education programs, supported by faculty, students, and staff.
 7. Industrial Collaboration and Innovation Director: staff member at the lead university who is responsible for marketing the ERC to industry/practitioners, gaining their financial support, developing and coordinating industrial/practitioner involvement, managing the role of small firms in research and innovation, managing the partnerships for innovation, etc.

8. **Administrative Director:** staff member at the lead university who is supported by staff and responsible for management, financial management, data collection, publicity, and reporting, etc.
9. **Student Leadership Council (SLC),** comprised of undergraduate and graduate students responsible for coordinating student activities to strengthen the ERC and providing input to other leaders of the ERC and the NSF site visit team.
10. **Scientific Advisory Board:** outside experts who are selected by the ERC and meet collectively as a board to advise the leadership team.
11. **Industrial/Practitioner Advisory Board:** representatives of member companies/agencies/hospitals who meet collectively as a board twice a year to advise the leadership team and meet with the NSF site visit team.
12. **Internal Academic Policy Board:** administrators from the lead university who meet collectively as a board to coordinate ERC plans and policies with departmental and university leaders and committees.
13. **Council of Deans:** led by the Dean of Engineering from the lead university, this Council of Deans from the lead and partner academic institutions meets collectively as a board to coordinate the ERC's research and education efforts across the lead and partner campuses.

The designation of individuals serving as the Administrative Director, the Industrial Collaboration and Innovation Director, and the leaders of the SLC may occur after notification of award.

- b. **Diversity:** NSF expects the leadership, faculty, and students involved in an ERC to be diverse in gender, race, and ethnicity and to include persons with disabilities at levels that are benchmarked against the academic engineering-wide national averages. This diversity is expected of the participants from all the lead and partner academic institutions, including at least one partner institution serving groups predominantly underrepresented in engineering and science (women, African Americans, Native Americans, Pacific Islanders, Alaskan Natives, Hispanic Americans, and persons with disabilities). Foreign partner universities are expected to respect the diversity of the ERC's faculty and students. The ERC also will be multicultural through the involvement of faculty and students from other countries by virtue of their role as faculty or students in the ERC's domestic institutions and through the involvement of faculty and students from the foreign partner university. The ERC will include pre-college institutions with diverse student bodies as discussed above. The ERC will prepare and execute diversity strategic plans in collaboration with the home departments and Deans of the ERC-affiliated faculty. These plans articulate the ERC's diversity goals and intended actions but not quantitative targets. Post-award annual reports include the ERC diversity strategic plan, information on the activities carried out, and the resulting quantitative impact on diversity.
- c. **Organization and Management Systems:** The ERC must report to the Dean of Engineering of the lead university. The ERC will function with management systems to assure effective integration of its components to meet its goals, sound financial management and reporting systems, and project selection and assessment systems that include input from its Scientific and Industrial/Practitioner Advisory Boards.
- d. **Facilities, Equipment, and Headquarters:** At the full proposal stage the lead university must commit to provide headquarters of sufficient space and resources to support the leadership, management, and collaboration functions of the ERC. The ERC will have appropriate facilities and equipment to achieve its goals. The ERC also will be supported by the cyberinfrastructure with appropriate software and staff to enable effective cross-campus collaboration.
- e. **Institutional Commitment:** The ERC will be a partnership with the lead and partner universities that support the ERCs research, education, and innovation culture and augment NSF's support and sustain the ERC once NSF's support ceases. To gauge the commitment to this culture, the ERC Program expects cost sharing and that there will be policies in place to reward faculty in the tenure and promotion process for cross-disciplinary research, research on education, research and other activity focused on advancing technology and innovation, and mentoring of university postdoctoral researchers (if supported), tenure-track faculty, graduate and undergraduate students, and pre-college students and teachers. In addition, the ERC Program expects that university students engaged in mentoring of other university students and in pre-college outreach will receive credit or official recognition for this activity.

The pre-college partners of the ERC are expected to be committed to a long-term partnership that will involve teachers and students in the ERC, a Young Scholars program, and will be expected to include engineering information and activities in their curricula.

C. FINANCIAL SCOPE AND SCALE OF THE ERC

1. **NSF Award Size:** Start-up base support will not exceed \$3,250,000 for year one. Pending satisfactory annual performance, need, and availability of funds, the base support may increase to \$3,500,000 (year 2), \$3,750,000 (year 3), \$4,000,000 (year 4), and \$4,000,000 (year 5).

If a foreign university is proposed as a partner, non-U.S. government support for that partner for the first five years will be expected to be committed during year one.

2. **Total Support:** ERCs establish a Center account into which is deposited the ERC program base support and any other support provided by other sources directly to the ERC to carry out the ERCs goals. In addition, the ERC may include support provided to a PI's department for projects that are to be carried out under the ERC's Strategic Plan. This support and the support provided by the foreign partner's universities or governments are considered associated project support.

III. AWARD INFORMATION

Anticipated Type of Award: Cooperative Agreement

Estimated Number of Awards: 4

Depending upon availability of funds, at least two and possibly four new ERC awards will be made.

Anticipated Funding Amount: \$13,000,000 (approximately) is expected to be available to support at least two and up to four new Gen-3 ERCs, with approximately two in the Fall of 2010 and two in FY 2011 with year one start-up budgets each of up to \$3,250,000, year two budgets of up to \$3,500,000, year three budgets of up to \$3,750,000, and years four and five budgets of up to \$4,000,000 each, pending satisfactory annual performance and availability of funding. NSF support will be augmented by academic cost sharing and financial and in-kind support provided by member firms, and for certain topic areas, these members would include state and local government agencies. Additional support from states and other sources is desired, but not required.

IV. ELIGIBILITY INFORMATION

Organization Limit:

Proposals may only be submitted by the following:

- Only U.S. universities with undergraduate, masters, and doctoral engineering programs with the breadth and depth appropriate to support the vision may submit proposals as the lead university. Proposals must be submitted by the lead university. Separately submitted collaborative proposals are not acceptable and will be returned without review.

Other Organizational Requirements:

ERC Proposals must meet all of the following organizational requirements or they will be returned without review:

- Commitments for lead and partner university cost sharing and industrial/government agency financial support must be included in the invited full proposal but not in the preliminary proposal.
- The number of domestic partner universities is limited to the lead university plus up to four domestic partner universities. The lead or one of the domestic partner universities must be a university that serves students predominantly underrepresented in engineering and science in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities).
- At least one but no more than three foreign universities are required to be partners in research and education and post-award their support must be provided by foreign governments or other non-NSF sources.
- The ERC must partner with middle and high schools in pre-college education.
- The ERC must partner with local level organizations devoted to stimulating entrepreneurship and innovation and must include a plan for the support of start-up firms to carry out translational research through the ERC's research program. These firms should not be identified in the proposal stages

PI Limit:

The Center Director must be a tenured faculty member in an engineering department at the lead university or may hold a joint appointment in an engineering department at the lead university. The Director's doctoral degree must be in engineering or an associated field of science; if the latter, she/he must have substantial career experience in engineering and a joint appointment in an engineering department at the lead university.

Limit on Number of Proposals per Organization:

There is no limit on the number of proposals to be submitted by a lead university and there is no limit on the number of ERC partnerships a partner university may join. A lead university can only receive one ERC award through this solicitation.

Limit on Number of Proposals per PI:

A PI may be identified as Center Director on only one proposal.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Letters of Intent (required):

A Letter of Intent (LOI) is required to facilitate the NSF review process. The letter should be submitted via FastLane no later than the LOI

deadline date specified in this solicitation. The LOI allows NSF to screen the proposals with respect to eligibility requirements, to categorize the proposals, and identify conflicts-of-interest so as to prepare for the proposal review processes. Follow these steps for the LOI preparation and submission:

Submit information for your LOI through FastLane under these categories and only under these categories (note the character limits, which include spaces, as stated below):

- **Project Title:** The Project Title should begin with "NSF Engineering Research Center for" and follow with a short title that reflects the system focus of the proposed Center.
- **Synopsis (maximum of 2,500 characters in this section):** Provide brief statements of the vision and goals of the ERC, its research program including research thrust titles and goals, and its university and pre-college education, diversity, and industrial/practitioner collaboration and innovation programs, all at a sufficient level of detail to understand the proposed ERC.
- **Other Comments (maximum of 2,500 characters in this section):** Continue the Synopsis as needed in this section.
- **Topic Area Proposed (maximum of 255 characters in this section):** Indicate the topic area under which the preliminary proposal will be submitted: Complex, Coupled Physical Civil Infrastructure Systems under Stress; Energy Systems for a Sustainable Future; or Transformational Engineered Systems - Open Category Chosen by the Proposing ERC Team.
- **Participants (maximum of 255 characters in this section):** Identify the key ERC participants including their ERC titles/roles, and their departmental and institutional affiliations for the center director, the deputy director, the thrust leaders, the education program director, and other key faculty.
- **Participants (continued, maximum of 255 characters in this section):** Continuation of Participants section, if needed.
- **Point of Contact for NSF Inquiries**
- **Project PI Information**
- **Submitter Information**
- **Senior Project Personnel:** Include the names, university(ies), departments and locations (city, state, country) for senior project personnel [maximum of four official Co-PIs].
- **Participating Organizations:** Include university names and addresses (city, state, country) and the appropriate ERC headings (i.e. lead university) for the following partner organizations: 1) the lead university, 2) the domestic partner university(ies) (limited to the lead university plus up to three domestic partner universities), 3) the university(ies) contributing affiliated faculty, and 4) the foreign partner university(ies) (at least one but no more than three). If desired use these abbreviations for the types of partners: LU (lead university), DPU (domestic partner university), UCAF (university contributing affiliated faculty) and FPU (foreign partner university).

Letter of Intent Preparation Instructions:

When submitting a Letter of Intent through FastLane in response to this Program Solicitation please note the conditions outlined below:

- Sponsored Projects Office (SPO) Submission is not required when submitting Letters of Intent
- A Minimum of 1 and Maximum of 4 Other Senior Project Personnel are allowed
- A Minimum of 1 and Maximum of 15 Other Participating Organizations are allowed
- Topic Area Proposed is required when submitting Letters of Intent
- Participants is required when submitting Letters of Intent
- Participants (continued) is required when submitting Letters of Intent
- Submission of multiple Letters of Intent is allowed

Preliminary Proposals (required): Preliminary proposals are required and must be submitted via the NSF FastLane system.

Follow the full proposal instructions where the differences between the preliminary and full proposals are articulated and submit through FastLane.

Full Proposal Instructions: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the guidelines specified in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at:

http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-PUBS (7827) or by e-mail from nsfpubs@nsf.gov.

The text of the project description of the preliminary and the invited full proposals must follow the spacing, font and formatting requirements of the NSF Grant Proposal Guide (GPG). Tables and lists in the project description may be in smaller but readable type. Supplementary materials may also be in smaller but readable type. Both will include the items listed below in the order indicated. As a multi-university ERC, the preliminary proposal and any invited full proposal must be submitted as an integrated proposal by the lead university, with proposed sub awards to the other partner institutions. Separate preliminary and full proposals from each partner will not be accepted.

The required format for preliminary and invited full proposals is indicated below. Sections required in the full proposal but not in the preliminary proposal are noted. The preliminary proposal must include the information requested in brief but to be successful, there must be clear statements of goals and clear statements of how these goals will be addressed. The invited full proposal would have a fuller explication of goals and methods.

1. **Cover Sheet.** Select the ERC Program solicitation number from the pull down list. Where asked to identify the NSF Unit of Consideration select the Division of Engineering Education and then Engineering Research Centers Program. The proposal title should begin with "NSF Engineering Research Center for" and follow with a short title that reflects the system focus of the proposed Center. For planning purposes, October 1, 2010 should be shown as the start date. The proposed Center Director must be shown as the Principal Investigator.
2. **Project Summary (limited to one page).** The summary should be written in the third person (i.e. the use of the pronoun "it" not "we" to represent the ERC) and should make a compelling case for the ERC. The summary should be informative to persons working in the same or related fields and, insofar as possible, understandable to a scientifically or technically literate lay reader. Include the ERC's name, the Director's name, and the lead university's name, and the names of the domestic and foreign universities at the top of the page. Write a clear description of the ERC, stating its vision and goals, the transforming nature of the systems technology, the fundamental barriers in the way, and its impact on innovation. Under the headings Intellectual Merit and Broader Impact as relevant, provide highlights of the proposed research, capacity to address the Gen-3 university and pre-college education goals, diversity strategy, industrial collaboration, technology transfer and innovation goals and strategies. Briefly indicate the unique opportunities that the Center will provide and its cross-disciplinary composition. **A preliminary proposal or invited full proposal that does not include titled sections (Intellectual Merit and Broader Impacts) referencing the NSF review criteria and specific reference to how the proposal will address these criteria will be returned without review.**
3. **Table of Contents** will be generated automatically by FastLane.
4. **Project Description** The project description must contain sections 4.a-4.f and is limited to 15 pages for preliminary proposals and 40 pages for full proposals, including all figures, tables, and charts. These page limits (for both preliminary and invited full proposals) are extended by the length of the Table of Academic and Other Participants, Scientific Advisory Board, and Industrial

and Practitioner Members (see section V.A.(4.a)). The project description should be prepared with reference to the review criteria and the guidance provided in this and the preceding sections of this solicitation. The intellectual merit and broader impacts of the ERC must be addressed and described as an integral part of the narrative.

Each proposal that requests funding to support postdoctoral researchers must include, as a separate section within the project description's University Education Section, a description of the mentoring activities that will be provided for such individuals. Examples of such activities are provided and the mentoring plan will be evaluated during the merit review process, under the Broader Impacts and Education review criteria. Proposals that do not include a separate section on mentoring activities within the Project Description will be returned without review.

The project description will not include the normally required separate section on prior NSF support, as this information will be integrated into the discussion of the state of the art in research and education.

If invited to submit a full proposal you have up to thirty days from the date of notification of the invitation to change the configuration of your partner and affiliated universities. By that deadline please send Lynn Preston (lpreston@nsf.gov) an email with an updated (complete) ERC Participant Table.

Start the project description with the Table of Academic and other Participants, Scientific Advisory Board, and Industrial and Practitioner Members (see Section V.A.(4.a)). NSF will extend the page limits above by the number of pages taken up by this table. For example, a three-page table extends the page limit for the narrative for a preliminary proposal to 18 pages and for a full proposal to 43 pages. These page limits include other charts, figures, and tables required as a part of the narrative and others the proposers wish to include. **If the Project Description section exceeds these extended page limits, the preliminary or full proposal will be returned without review.**

(4.a) Table of Academic and other Participants, Scientific Advisory Board, and Industrial and Practitioner Members. The table should be inserted into an Excel spreadsheet using the format available on the ERC Program's Website (<http://www.erc-assoc.org>).

The table will list 1) the academic and other partners carrying out the research, education, innovation/technology transfer functions of the ERC, 2) nominated and committed members of its Scientific Advisory Board (SAB) for the preliminary proposal and invited full proposal, and 3) the firms and agencies and individuals contacted to be partners in the preliminary proposal and committed to be partners in the full proposal. NSF will use this table to determine whether potential reviewers have conflicts-of-interest and as a reference for the staffing and industrial participation in the proposed ERC. Insert the table at the beginning of the Project Description.

In addition to inclusion in the proposal submission, the proposer must send the following two documents via email. After receipt of the proposal number from FastLane, send an email to ercintnt@nsf.gov . Do not submit these two documents separately through FastLane. The subject heading of the email should note the proposal number, the PI's name, and the lead university. Attach the following documents to the email:

1. Table of Academic and other Participants (see above).
2. Power Point Slides: one slide summarizing the vision of the ERC and another showing the ERC's three-plane strategic planning chart. On each slide indicate the proposal number, the PI's name, the name of the ERC, and the lead university's name. A sample can be found on the ERC Program's Website (<http://www.erc-assoc.org>). These documents will be used during the review process. Remember to email these documents to ercintnt@nsf.gov ; do not submit the slides through FastLane.

The following sections should be prepared with reference to the guidance in Section II above and the review criteria.

(4.b) Vision and Rationale for the ERC. State the vision of the ERC, justify why it is transformational, position the proposed ERC in the state of the art, and provide a rationale for value added by the creation of the ERC in research, innovation, and education.

(4.c) Strategic Research Plan and Research Program. Given the ERC's engineered system vision and strategy for innovation, present the ERC's strategic research plan, including its deliverables, the major fundamental and technological barriers in the way of achieving them, and the major research goals. Provide a graphical depiction of the strategic plan using the ERC Program's 3-Plane Strategic Planning Chart. Describe how the ERC's research program will be structured into thrusts or groups of projects and the role of small firms, testbeds, and partnerships with entities designed to speed innovation in achieving the vision. Provide a milestone chart or "road map" depicting the timing of the key research topics and their interdependencies, the test beds, and deliverables of the ERC over a ten-year period, with greater detail for years one through five.

For each thrust area, provide the following information as a minimum. At the start of each thrust's narrative, provide a small table listing the thrust leader and other faculty participants by name, their departments, and institutions. Discuss the goals and objectives of the thrust vis-a-vis the goals of the ERC. Position the research proposed for the thrust in the state of the art and discuss its role in the ERC's three-plane strategic plan. Provide information on projected fundamental knowledge and technology deliverables, and the specific fundamental knowledge and other barriers the thrust will address in the context of the ERC's strategic plan. Provide specific examples of key research projects in sufficient detail for the reviewers to judge how the work will be done and methodologies to be used. Discuss the integration of projects within the thrust and the interdependencies among the thrusts. Discuss the cross-disciplinary mix needed to achieve the thrust's goals. Discuss when and how small firms will be involved in translational research to speed innovation.

(4.d) University and Pre-college Education Programs. Given the guidance in Section II, University Education, provide the ERC's hypothesis of the desired characteristics of a creative and innovative engineer, capable of success in a global economy; the strategy to achieve these characteristics; and the implementation and assessment plans to determine progress and impact. The educational program should encompass all the partner academic institutions and should take advantage of available cyberinfrastructure for cross-institution educational impact.

Given the guidance in Section II, Pre-college Education, describe the ERC's pre-college education program goals, its strategy, its metrics for success and its assessment plan. Discuss the following: the role of the ERC's faculty and students and the pre-college institutions administrators, teachers, and students in the program; how the students and postdoctoral researchers will be mentored (discuss in separate statements); and how the university faculty and students will be rewarded for their educational/mentoring efforts by the university administrations involved.

(4.e) Industrial/Practitioner Collaboration and Innovation. Given the guidance in Section II, provide the ERC's goals and strategies to address these challenges. For the preliminary and invited full proposals, discuss the general terms of the ERC's membership agreement and intellectual property (IP) policy. The completed membership agreement and IP policy

are not required.

Preliminary and invited full proposals must include letter(s) from partner organizations or programs, etc. devoted to entrepreneurship, nurturing start-up firms to speed innovation, etc. If a state or local government agency is committed to providing support to the ERC to enhance its impact on local economic development, a letter of commitment must also be included. These letters are to be uploaded into the supplementary documents section of the proposal.

Preliminary proposals also may include up to ten letters from firms and/or other organizations that involve practitioners (such as state and local infrastructure agencies) that are committed to membership in the ERC's Industrial/Practitioner Partnership if an award is made. Full proposals will include letters from all firms/organizations committed to partnership. These letters should be uploaded into the supplementary documents section of the proposal. Do not include letters from those only interested in partnership in either the preliminary proposal or the invited full proposal.

(4.f) Infrastructure.

Institutional Configuration, Team, Diversity, and Administration Partnership

Justify the institutional configuration given the vision. Discuss the value added by each domestic and foreign university partner in research, education, and innovation. Discuss the role of the ERC in the strategic plans of the lead and partner institutions and how the ERC will be supported and sustained by the lead and partner universities. Discuss how the partnership with a foreign university(ies) will be administered.

Discuss the composition and roles of the leadership team, including the Director, Deputy Director, Research Thrust Leaders, University Education and Pre-college Education Program Directors, Industrial Collaboration and Innovation Director, Administrative Director, and Student Leadership Council. Provide summary information in the form of a pie chart indicating the disciplinary composition of the faculty team, based on their departmental affiliations or degrees, as appropriate for each person.

Provide the ERC's 10-year diversity strategic plan, including goals, non-quantitative milestones, and intended actions for success in building diverse leadership, faculty, graduate and undergraduate student teams and diverse cadres of ERC graduates. Plans may not include quantitative targets; however, upon award, annual reports will include quantitative information on impacts benchmarked against engineering-wide averages.

NSF is committed to providing equal opportunities for participation in its programs and promoting the full use of the Nation's research and engineering resources. To aid in meeting these objectives, NSF requests information on the gender, race, ethnicity and disability status of individuals named as PIs/co-PIs on proposals and awards. For proposals submitted to this solicitation we are also requesting information on the current diversity of the ERC's leadership team and faculty. Provide a table of the current diversity of the leadership team and faculty (U.S. citizens and permanent residents only) for the proposed ERC using the following sample format. Submission of the information on this table by individuals or university(ies) is voluntary and is not a condition of receiving an award.

ERC Name	Male	Female	African American	Native American, Pacific Islander	Hispanic American	Persons with Disabilities
Leadership Team
Faculty Total
Total

The data provided in this table may reflect the reportable diversity of the leadership team and faculty who have been identified to participate in the ERC during years one through five from the lead and the university-level domestic partner institutions. These data may include the number of men and the number of women (U.S. citizens and permanent residents) and the number of U.S. citizens or permanent residents who are members of racial groups underrepresented in engineering and science (African American, Pacific Islander, Native American, Alaskan Native), ethnic groups underrepresented in engineering and science (Hispanic American), and persons with disabilities who are involved in the ERC's research and curriculum development efforts. Since it is not clear at the proposal stage which students will be involved, please do not include students. Do not include non-tenure-track faculty, research staff, post-doctoral students, technicians, or office staff. Do not include pre-college teachers or students. A person who is both a faculty member and a member of the leadership team should be counted only on the leadership team.

Discuss the commitment of the partner institutions to the goals of the proposed ERC and how they will assure their policies and practices support the center in achieving its goals. Include a discussion of tenure and mentoring policies per guidance in II.B.8.e.

Organizational Structure and Management System

Describe the proposed organizational structure including information on how the members from participating universities and pre-college institutions will be developed into an integrated team. Include an organization chart for the ERC. Discuss the roles of the Council of Deans in coordinating the partner institutions, the lead university policy boards, the Student Leadership Council, the Scientific Advisory Board and the Industrial/Practitioner Advisory Board. Describe how projects will be selected and evaluated and who will be responsible for integration of projects to achieve the ERC's deliverables.

Financial Support and Functional Allocation of Resources

- 1. Functional Budget Table (for invited full proposals only):

Insert into this section of the full proposal a functional budget table, showing only the proportional distribution of effort across the functions of the ERC without showing the support levels from any sources. The reviewers are not allowed to access information regarding university cost sharing. A template of the table can be found at (<http://www.erc-assoc.org>).

- 2. Committed Industrial and Other Non-NSF, Non-Academic Support (for invited full proposals only):

In addition, the proposal should include information regarding the expected levels of support for the first year from committed member firms and any commitment from state and/or local governments for cash and/or in-kind support. A template of the table can be found at (<http://www.erc-assoc.org>).

Headquarters and Equipment Infrastructure

Briefly discuss the laboratories, shared facilities and equipment for the ERC, referring the reader to the required section on Facilities and Equipment in the FastLane proposal template for more detail. Discuss those that will be shared by

members of the ERC team. Distinguish between equipment and facilities that are already available and any that will be acquired by the Center. Invited full proposals only will include a description of headquarters space, its size, and functionality. Note, the headquarters space must be located on the campus of the lead academic institution. Discuss how the facilities and equipment of the ERC and the Cyberinfrastructure will be used to form a collaborative team with shared resources and information.

5. **References Cited.** Section not to exceed five pages.
6. **Biographical Sketches** (two-page limit per person). The basic GPG guidelines for preparation of biographical material apply. Biographical sketches are required of all the key participants (e.g., the Center Director, Deputy Director, the University Education Director the Pre-College Education Director (if known), Industrial Collaboration and Innovation Director (if known), the Research Thrust Leaders, the Administrative Director (if known), if known, and other faculty expected to receive more than \$80,000 in year one from the ERC. For faculty, publications listed should be highly relevant to the proposal.
7. **Budgetary Information.** The preliminary and invited full proposals will include a budget for each of the five years proposed. FastLane will automatically provide a cumulative budget. Preliminary proposals should not include any subcontracts, however enter the anticipated total level of subcontract support on line G5, Subawards and provide a budget justification or the planned levels for subcontracts to the partners. Full proposals require the inclusion of separate budgets for subcontracts for the partner institutions at any level.

In the budget justification section of the preliminary and invited full proposals, provide a pie chart or a table showing the planned distribution among the lead and domestic partner universities of the requested NSF funds as proposed for year one. Also show the total expected to be distributed to any or all universities contributing affiliated faculty.

Cost sharing is specialized. Please see Section V.B. for additional information.
8. **Current and Pending Support.** Include only for the Director, Deputy Director, and Research Thrust Leaders, and other faculty expected to receive more than \$80,000 in year 1 from the ERC.
9. **Facilities, Equipment, Resources, and Headquarters.** Refer to the GPG for allowable content.
10. **Reviewer Information.** Use FastLane to enter a "List of Suggested Reviewers," if desired.
11. **Supplementary Documents. The following items must be provided as supplemental documents.**

Letters of Commitment:

At the preliminary proposal stage submit the following letters of commitment: 1) letters from senior university administrators (Dean of Engineering and higher-level university officials) for the lead university attesting to the institutional commitment to the goals of the ERC and that the lead and/or one of the domestic partner universities is a university that serves students predominantly underrepresented in engineering and science in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities). The letters should not mention cost sharing, as that information cannot be revealed to reviewers, or a commitment to headquarters space at the preliminary proposal stage as that is not required; 2) letters from senior university administrators (Deans of Engineering and higher-level university officials) for the partner universities attesting to the institutional commitment to the goals of the ERC; 3) letters from the administrators of proposed innovation partners and proposed pre-college partners committing to their roles in the ERC; 4) up to ten letters from firms or agencies committed to membership; 5) letters from any participating federal laboratories indicating their financial support for their staff participating in the ERC; 6) letters from state or local government agencies committed to providing support to the ERC to enhance its impact on local economic development and/or as members; 7) letters of commitment from the foreign university administrator(s) regarding their participation and eventual financial support. Funds from the foreign university partners, and/or other non-NSF sources, do not have to be in place at the proposal stage, rather they will be provided during year one, if an award is made. No letters are required from the universities providing affiliated faculty.

The same letters submitted with the preliminary proposal for items 2) through 7) may be used for the invited full proposal as long as the letters use the generic term "proposal" (not "preliminary proposal").

At the invited full proposal stage submit the following letters of commitment: 1) letters from senior university administrators (Dean of Engineering and higher-level university officials) for the lead university attesting to the institutional commitment to the goals of the ERC; that the lead and/or one of the domestic partner universities is a university that serves students predominantly underrepresented in engineering and science in the U.S. (i.e. women, African Americans, Pacific Islanders, Native Americans, Hispanic Americans, and persons with disabilities); and the commitment to headquarters of sufficient space and resources to support the leadership, management, and collaboration functions of the ERC. The headquarters space must be located on the campus of the lead university. The letters should not mention cost sharing as that information cannot be revealed to reviewers; 2) letters from senior university administrators (Deans of Engineering and higher-level university officials) for the partner universities attesting to the institutional commitment to the goals of the ERC 3) letters from the administrators of proposed innovation partners and proposed pre-college partners committed to their roles in the ERC; 4) letters from all firms or agencies committed to membership; 5) letters from participating federal laboratories indicating their financial support for their staff participating in the ERC; 6) letters from state or local government agencies committed to providing support to the ERC to enhance its impact on local economic development and/or members; 7) letters of commitment from the foreign university administrators regarding their participation and eventual financial support. Funds from the foreign university partner(s), and/or other non-NSF sources, do not have to be in place at the proposal stage, rather they will be provided during year one, if an award is made. No letters are required from the universities providing affiliated faculty.

The letters as they appear in the proposal should be addressed to Ms. Lynn Preston, Leader of the ERC Program, Division of Engineering Education and Centers, Suite 585, National Science Foundation, 4201 Wilson Boulevard, Arlington, VA 22230. **All letters must be placed in the Supplementary Documents section of the FastLane proposal and submitted electronically, as part of the proposal. Please instruct the authors of these letters not to mail, email, or fax copies to the NSF.**

SUMMARY OF REQUIREMENTS

Topic	Preliminary proposal	Invited Full proposal
Proposal Requirements:		
Commitment of academic and industrial funds	No	Yes
Commitment from foreign partner university(ies)	Yes	Yes
Identification of participating faculty members from the lead and university-level partner institutions	Years 1-5	Years 1-5
Names of participating pre-college institutions	Yes	Yes
Names of pre-college teachers	No	No
Name of participating innovation partner(s), i.e. program devoted to entrepreneurship, stimulating innovation, etc.	Yes	Yes

Names and affiliations of industry/agency or practitioner organization personnel committed to partnership in the ERC	Yes	Yes
Submission Requirements:		
Table of Participants in NSF's Excel spreadsheet and 2 PowerPoint slides on vision and strategic plan emailed to ercintent@nsf.gov	Yes	Yes
Letter of Intent (LOI) submitted through FastLane	Yes	No
Mode of submission of proposal	Submission in FastLane	Submission in FastLane, only by Invitation
Format:		
Information about PI	Yes	Yes
NSF Cover Sheet	Yes	Yes
FastLane Submission of Cover Sheet	FastLane only	FastLane only
Table of Contents	Automatic	Automatic
Project Summary with reference to Intellectual Merit and Broader Impacts	Yes	Yes
Table of Participants/Partners, at the start of the project description	Yes	Yes
Project Description	15 pages, including charts, etc., but extended by the size of the Table of Participants/Partners	40 pages, including charts, etc., but extended by the size of the Table of Participants/Partners
Letters of Commitment:		
Letters from lead and domestic and foreign partner universities committing to ERC	Yes	Yes
Letter from lead university committing to HQ space	No	Yes
Letters of commitment to membership from industry/practitioners	Up to 10	All
Letters of Commitment to partnership from pre-college partners	Yes	Yes
Letters of Commitment from any state or local government providing non-member financial support to the ERC	No	Yes
Letters of Commitment to partnership from innovation partners	Yes	Yes
Budgetary Information:		
Separate budgets for years 1-5	Yes, but no subaward budgets	Yes with subaward budgets
Cumulative budget for years 1-5	Generated by FastLane	Generated by FastLane
Allocation of Funds by Institution (Year 1 only) and functional budget	No	Yes, but place in the single copy documents section
Justification for Secretarial & Admin. Support	No	Yes

Proposers are reminded to identify the program solicitation number (NSF 09-545) in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

B. Budgetary Information

Cost Sharing: 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.

Cost Sharing Requirements: Academic cost sharing is required to support and sustain the ERC. The lead university is responsible for securing, retaining, managing, and certifying and delivering to NSF the ERC's cost sharing (cash and in-kind), at the level stated in the cooperative agreement if an award is made. The total level of cost sharing will be the responsibility of the lead university but can also include contributions by any or all of the partner universities. The actual amount will be calculated based on the formula described below. The formula reflects institution type and the level of funding proposed. Cost sharing is not required or expected of the institutions **solely** contributing affiliated faculty.

Cost sharing is not a review criterion but is an eligibility criterion for the invited full proposal. The provision and quality (space, size, and functionality) of headquarters space is an eligibility criterion and a review criterion for the invited full proposals. The proposed cost sharing must be shown on Line M on the proposal budget (for the invited full proposal budget). (Line M is masked from reviewers during the review process.) Documentation of the availability of cost sharing must be included in the invited full proposal (see below for information on submitting the proposed cost sharing information). Only items which would be allowable under the applicable cost principles and administrative requirements if charged to the project may be included as the awardee's contribution to cost sharing.

It is understood that the availability of financial resources may present significant challenges to commit to cost sharing in an ERC for some smaller universities and colleges and universities that do not have high research activity. Therefore, the ERC cost sharing requirements are graduated and vary by the basic classification categories of universities and colleges as defined in the "Carnegie Foundation's Classification of Institutions of Higher Education." The classification categories and ERC cost sharing requirements are as follows:

- RU/VH: Research Universities (very high research activity) – required cost sharing level is 20% of the allocation of the NSF budget to the lead or partner university;
- RU/H: Research Universities (high research activity) – required cost sharing level is 15% of the allocation of the NSF budget to the lead or partner university;
- DRU: Doctoral/Research Universities – cost sharing level is 10% of the allocation of the NSF budget to that partner university;
- Master's L: Master's Colleges and Universities (larger programs) – cost sharing level is 10% of the allocation of the NSF budget to that partner university/college;
- Bac/Diverse: Baccalaureate Colleges--Diverse Fields – cost sharing level is 5% of the allocation of the NSF budget to that partner college.

If the university is classified in more than one Carnegie category, it must cost share at the highest cost sharing category as

described above. In addition, the Carnegie classification that is to be used is the classification in place at the LOI submission deadline and will remain throughout the duration of the competition and a subsequent award.

Source: <http://www.carnegiefoundation.org/classifications/index.asp>

In order for NSF to determine that the proposed ERC meets the cost sharing requirements, the cost sharing commitment of the ERC must be documented and the details presented in a table of committed support.

For invited full proposals only: Provide a table of committed cash and in-kind support by the lead university and any partner university providing cash and in-kind support for years 1-5. In the text, indicate the nature of the in-kind support. The table should be inserted into an Excel spreadsheet using the template available on the ERC Program's Website at <http://www.erc-assoc.org>. This table and any text explanations should be uploaded into the single-copy documents section of the full proposal submission in FastLane.

Other Budgetary Limitations:

See Section V.A. for additional information.

Budget Preparation Instructions: See Section V.A. for additional information.

C. Due Dates

- **Letter of Intent Due Date(s) (required)** (due by 5 p.m. proposer's local time):
May 15, 2009
- **Preliminary Proposal Due Date(s) (required)** (due by 5 p.m. proposer's local time):
July 15, 2009
- **Full Proposal Deadline(s)** (due by 5 p.m. proposer's local time):
February 09, 2010
For Invited Non-energy Topic Full Proposals
May 05, 2010
For Invited Sustainable Energy Topic Full Proposals

D. FastLane Requirements

Proposers are required to prepare and submit all proposals for this program solicitation through use of the NSF FastLane system. Detailed instructions regarding the technical aspects of 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 solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this funding opportunity.

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

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program where they will be reviewed if they meet NSF proposal preparation requirements. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with the oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal.

A. NSF Merit Review Criteria

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

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

What is the intellectual merit of the proposed activity?

How important is the proposed activity to advancing knowledge and understanding within its own field or across different

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

What are the broader impacts of the proposed activity?

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

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

Mentoring activities provided to postdoctoral researchers supported on the project, as described in a one-page supplementary document, will be evaluated under the Broader Impacts criterion.

NSF staff also 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:

Additional review criteria for preliminary proposals and invited full proposals are as follows:

Vision and Research-

- Proposal effectively defines a transformational engineered system at the cusp of emerging discoveries in science and engineering and emerging opportunities for technological innovation;
- Proposal defines a culture of discovery and innovation with a symbiotic relationship between research, education, innovation, and life-long skill development in a global economy to stimulate innovation and provide students and faculty with a globally-oriented research and education experience;
- Research strategic plan targets critical systems goals that motivate breakthrough fundamental knowledge and technology barriers and defines:
 - High quality cross-disciplinary research program that addresses these barriers through fundamental research and enabling and systems level research and proof-of-concept testbeds;
 - Significant involvement of undergraduate ERC students in research through the academic year and for other students through a Research Experiences for Undergraduates (REU) experience;
 - Creative and appropriately timed role for small firms/other organizations to carry out translational research within the ERC to speed technology transfer and provide students with an innovation experience;
- Research thrusts propose significant goals, target significant fundamental and technical barriers, use high quality research methodologies that will advance the state of the art, integrate knowledge from other projects and thrusts, and involve a diverse team with the skills and disciplines needed to achieve the goals.

Education-

- University education strategy defines an education program that is based on a convincing hypothesis of how to develop graduates who are adaptive, creative innovators with the capacity to advance fundamental knowledge and exploit it to create innovations in a globally connected, innovation-driven world;
- Strategic Plan specifies desired characteristics, proposes how the education program will impart these to students, and how it will measure and assess progress and impacts through longitudinal data;
- Effective plans proposed to integrate ERC's cross-disciplinary and systems research into courseware and curricula;
- Pre-college education program will develop an effective long-term partnership with a few pre-college institutions (middle and high schools) nearby each domestic partner university to:
 - bring knowledge of engineering to the pre-college classroom through a Research Experiences for Teachers (RET) Program;
 - engage a broadly diverse group of students in the ERC's programs to motivate them to study engineering; and
 - provide a Young Scholars research program for promising high schools students;
- Effective programs and assessment tools for college and pre-college programs based on best practices;
- Effective plans for mentoring students, postdoctoral researchers and pre-college teachers.

Industrial/Practitioner Membership Innovation Program-

- Convincing rationale for the selection of industrial or user members and means to engage these partners in planning, research, education, and innovation;
- Clear strategy for how small firms will be key players and help speed innovation;
- Strong partnership with state, local or other organizations and programs dedicated to speeding innovation;
- Representative group of firms/organizations involving practitioners as appropriate to the vision (state infrastructure agencies, for example) committed to membership;
- Active engagement of industry/practitioner organizations through an Industrial/Practitioner Advisory Board;
- Proposed terms of the industrial membership agreement and intellectual property policy will structure a Center-wide program of industrial/practitioner collaboration to support overall ERC goals;
- A Center-wide intellectual property policy will facilitate collaboration with industry through shared rights for joint work and speed technology transfer.

Infrastructure-

- Institutional configuration is appropriate to the goals of the ERC and a convincing strategy for cross-institution collaboration in

- research, education, and innovation;
- Foreign university(ies) partner is committed to the goals of the ERC and will add value in research and education;
- Diversity strategic plan evidences strong commitment to diversity at all levels and will result in a very diverse team with a strong impact on the diversity of the engineering workforce through:
 - Including partner institutions serving students underrepresented in engineering and science to enhance diversity;
 - Leadership, faculty and student teams that are diverse in gender, race, and ethnicity, and includes persons with disabilities;
- University administrators from the lead and partner institutions will join in partnership with the ERC to facilitate its cross-disciplinary configuration and industrial membership and IP policies that recognize shared rights for joint work, reward cross-disciplinary research and mentoring, and support its educational strategy, and deliver on its diversity goals;
- ERC has high quality expertise in all disciplines required to attain its goals, a capable leader and leadership team;
- Organizational structure and management plan effectively organize and integrate the resources of the ERC across the partner institutions to achieve its goals and include strong advisory and project selection/evaluation systems;
- Experimental, computational, and other required equipment, facilities, and laboratory space are in place or proposed to support the research of the center;
- The cyberinfrastructure is effectively used to achieve collaboration and sharing of information.

For invited full proposals only-

- Headquarters space, which must be located on the campus of the lead university, is sufficiently large to house the leaders and staff, and support the management, communication, and cross-disciplinary collaboration functions of the ERC and cross-institution communications equipment will effectively encourage and facilitate collaboration;
- Level of committed industrial/practitioner support represents a commitment commensurate with typical levels of support for academic research in the fields involved in the ERC.

B. Review and Selection Process

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

Please see "Additional Review Criteria" for further information

Reviewers will be asked to formulate a recommendation to either support or decline each proposal. The Program Officer assigned to manage the proposal's review will consider the advice of reviewers and will formulate a recommendation.

After scientific, technical and programmatic review and consideration of appropriate factors, the NSF Program Officer recommends to the cognizant Division Director whether the proposal should be declined or recommended for award. NSF is striving to be able to tell applicants whether their proposals have been declined or recommended for funding within six months. The time interval begins on the deadline or target date, or receipt date, whichever is later. The interval ends when the Division Director accepts the Program Officer's recommendation.

A summary rating and accompanying narrative will be completed and submitted by each reviewer. In all cases, reviews are treated as confidential documents. Verbatim copies of reviews, excluding the names of the reviewers, are sent to the Principal Investigator/Project Director by the Program Officer. In addition, the proposer will receive an explanation of the decision to award or decline funding.

In all cases, after programmatic approval has been obtained, the proposals recommended for funding 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 administering the program. Verbatim copies of reviews, not including the identity of the reviewer, will be provided automatically to the Principal Investigator. (See Section VI.B. for additional information on the review process.)

B. Award Conditions

An NSF award consists of: (1) the award letter, which includes any special provisions applicable to the award and any numbered amendments thereto; (2) the budget, which indicates the amounts, by categories of expense, on which NSF has based its support (or otherwise communicates any specific approvals or disapprovals of proposed expenditures); (3) the proposal referenced in the award letter; (4) the applicable award conditions, such as Grant General Conditions (GC-1); * or Research Terms and Conditions * and (5) any announcement or other NSF issuance that may be incorporated by reference in the award letter. Cooperative agreements also are administered in accordance with NSF Cooperative Agreement Financial and Administrative Terms and Conditions (CA-FATC) and the applicable Programmatic Terms and Conditions. NSF awards are electronically signed by an NSF Grants and Agreements Officer and transmitted electronically to the organization via e-mail.

*These documents may be accessed electronically on NSF's Website at http://www.nsf.gov/awards/managing/award_conditions.jsp?org=NSF . Paper copies may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov .

More comprehensive information on NSF Award Conditions and other important information on the administration of NSF awards is

contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

Special Award Conditions:

Key Personnel:

Any contemplated changes in Key Personnel should be discussed with the NSF Program Officer. Written approval from the NSF Program Officer must be secured before any change is implemented. Any anticipated change in the person serving as the Center Director or the Deputy Director to be effective within the next performance year must be disclosed in the ERC's annual report, and a succession plan must be provided in the report.

Subawards:

NSF recognizes that, during the performance of this project, it may be necessary for the Awardee to establish subcontracts and subaward agreements with other organizations. Excluding contractual arrangements for commercially available supplies, materials, equipment, or support services, all subcontracts or other agreements under this award involving substantive effort are subject to the approval of the NSF Grants and Agreements Officer. For purposes of this agreement, a subcontract or subaward valued in excess of \$100,000 shall be considered substantive effort.

If an approved subaward is over \$100,000 and the amount allocated to the subawardee increases or decreases significantly (20 percent or more), a revised subaward budget and budget explanation must be submitted to the cognizant NSF program officer. This budget should be submitted via email to the program officer. If approved, the subaward change will be acknowledged by an amendment to the Cooperative Agreement. If approval is not granted, the Program Officer will notify the awardee via email.

Termination:

In the case of inadequate performance of the lead university or at the core partner universities, the National Science Foundation reserves the right to recommend termination of, respectively, the ERC or the core partner.

C. Reporting Requirements

For all multi-year grants (including both standard and continuing grants), the Principal Investigator must submit an annual project report to the cognizant Program Officer at least 90 days before the end of the current budget period. (Some programs or awards require more frequent project reports). Within 90 days after expiration of a grant, the PI also is required to submit a final project report.

Failure to provide the required annual or final project reports will delay NSF review and processing of any future funding increments as well as any pending proposals for that PI. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through FastLane, for preparation and submission of annual and final project reports. Such reports provide information on activities and findings, project participants (individual and organizational) publications; and, other specific products and contributions. PIs will not be required to re-enter information previously provided, either with a proposal or in earlier updates using the electronic system. Submission of the report via FastLane constitutes certification by the PI that the contents of the report are accurate and complete.

NSF requires ERCs to submit annual reports that are more extensive in scope than those required of single investigator awards. NSF provides guidelines for these reports. NSF also requires ERCs to collect and submit to NSF data on indicators of progress, outcome, impact, and financial management. NSF provides data definition guidelines and templates for the recording and submission of these data through a security web site.

VIII. AGENCY CONTACTS

General inquiries regarding this program should be made to:

- Lynn Preston, Leader of the Engineering Research Centers (ERC) Program and Deputy Division Director (Centers), Division of Engineering Education and Centers (EEC), 585N, telephone: (703) 292-5358, fax: (703) 292-9051, email: lpreston@nsf.gov
- Deborah Jackson, Program Director, Engineering Research Centers, Division of Engineering Education and Centers (EEC), 585N, telephone: 703-292-7499, fax: 703-292-9051, email: djackson@nsf.gov
- Barbara Kenny, Program Director, Engineering Research Centers, Division of Engineering Education and Centers (EEC), 585, telephone: (703) 292-4667, fax: (703) 292-9051, email: bkenny@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.
- Shalika N. Walton, FastLane Contact and ERC Program Specialist, telephone: (703) 292-7335, email: swalton@nsf.gov

For information on all aspects of the ERC construct, strategic planning and the solicitation in general, contact Lynn Preston (lpreston@nsf.gov or 703-292-5358), Deborah Jackson (djackson@nsf.gov or 703-292-7499) or Barbara Kenny (bkenny@nsf.gov or 703-292-4667). For pre-college education, Research Experiences for Teachers (RETs) contact Mary Poats (mipoats@nsf.gov or 703-292-5357). For Research Experiences for Undergraduates (REUs) contact Esther Bolding (ebolding@nsf.gov or 703-292-5342).

Revision to ERC Solicitation, NSF 09-545 to address potential NSF/DOE ERC Partnership: The Engineering Research Centers solicitation (NSF 09-545) calls for proposals that address (a) Complex, Coupled Physical Civil Infrastructure Systems under Stress; (b) Energy Systems for a Sustainable Future; and (c) Transformational engineered Systems – Open Category with Topic Chosen by the Proposing Team. NSF is currently in negotiations with the U.S. Department of Energy (DOE) to form a partnership in support of ERC awards that are focused on sustainable energy systems. Because of this developing partnership, the reviews for the preliminary proposals submitted under the sustainable energy systems topic area have been delayed until December 2009/January 2010. The review process has been completed for the non-energy proposals and invitations to submit full

proposals have been sent out for these proposals. As a result of the two-phase preliminary proposal review process, there now will be two full proposal deadlines to address the different review schedules and different invitation notification dates for the two sets of proposals (energy and non-energy). Therefore, the proposals in the non-energy topic areas (see topic (a) and (c) above) will now have a full proposal deadline of 5:00 p.m. proposer's local time on February 9, 2010 and those in the sustainable energy systems topic area (topic area (b) above) will now have a full proposal deadline of 5:00 p.m. proposer's local time on May 5, 2010.

The base funds in the ERC Program budget can support up to four awards and the NSF FY 2010 budget request included one more ERC to bring the potential award total to five using NSF funds, if they are available. In addition, a NSF/DOE partnership, currently under negotiation, has the potential to expand the total number of awards to up to seven, four of which might be jointly funded by NSF and DOE. This is contingent upon realization of the NSF and DOE partnership and budgets provided to these organizations by Congress for FY 2010 and 2011. NSF expects to make the awards for proposals submitted under NSF 09-545 in February or March 2011.

IX. OTHER INFORMATION

The NSF Website provides the most comprehensive source of information on NSF Directorates (including contact information), programs and funding opportunities. Use of this Website by potential proposers is strongly encouraged. In addition, National Science Foundation Update is a free e-mail subscription service designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Regional Grants Conferences. Subscribers are informed through e-mail when new publications are issued that match their identified interests. Users can subscribe to this service by clicking the "Get NSF Updates by Email" link on the [NSF web site](#).

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

ABOUT THE NATIONAL SCIENCE FOUNDATION

The National Science Foundation (NSF) is an independent Federal agency created by the National Science Foundation Act of 1950, as amended (42 USC 1861-75). The Act states the purpose of the NSF is "to promote the progress of science; [and] to advance the national health, prosperity, and welfare by supporting research and education in all fields of science and engineering."

NSF funds research and education in most fields of science and engineering. It does this through grants and cooperative agreements to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations and other research organizations throughout the US. The Foundation accounts for about one-fourth of Federal support to academic institutions for basic research.

NSF receives approximately 40,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

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

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

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

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

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

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

PRIVACY ACT AND PUBLIC BURDEN STATEMENTS

The information requested on proposal forms and project reports is solicited under the authority of the National Science Foundation Act of 1950, as amended. The information on proposal forms will be used in connection with the selection of qualified proposals; and project reports submitted by awardees will be used for program evaluation and reporting within the Executive Branch and to Congress. The information requested may be disclosed to qualified reviewers and staff assistants as part of the proposal review process; to proposer institutions/grantees to provide or obtain data regarding the proposal review process, award decisions, or the administration of awards; to government contractors, experts, volunteers and researchers and educators as necessary to complete assigned work; to other government agencies or other entities needing information regarding applicants or nominees as part of a joint application review process, or in order to coordinate programs or policy; and to another Federal agency, court, or party in a court or Federal administrative proceeding if the government is a party. Information about Principal Investigators may be added to the Reviewer file and used to select potential candidates to serve as peer reviewers or advisory committee members. See Systems of Records, NSF-50, "Principal Investigator/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004), and NSF-51, "Reviewer/Proposal File and Associated Records," 69 Federal Register 26410 (May 12, 2004). Submission of the information is voluntary. Failure to provide full and complete information, however, may reduce the possibility of receiving an award.

An agency may not conduct or sponsor, and a person is not required to respond to, an information collection unless it displays a valid Office of Management and Budget (OMB) control number. The OMB control number for this collection is 3145-0058. Public reporting burden for this collection of information is estimated to average 120 hours per response, including the time for reviewing instructions. Send comments regarding the burden estimate and any other aspect of this collection of information, including suggestions for reducing this burden, to:

Suzanne H. Plimpton
Reports Clearance Officer
Division of Administrative Services
National Science Foundation
Arlington, VA 22230

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The National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230, USA
Tel: (703) 292-5111, FIRS: (800) 877-8339 | TDD: (800) 281-8749

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