Decision Frameworks for Multi-Hazard Resilient and Sustainable Buildings (RSB)

PROGRAM SOLICITATION
NSF 14-557

REPLACES DOCUMENT(S):
NSF 13-544

National Science Foundation

Directorate for Engineering
Division of Civil, Mechanical and Manufacturing Innovation

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

July 24, 2014

Full Proposal Deadline

IMPORTANT INFORMATION AND REVISION NOTES

Major Revisions

- This solicitation replaces NSF 13-544, George E. Brown, Jr. Network for Earthquake Engineering Simulation Research (NEESR) Planning Grants, to broaden support for natural hazards engineering research through advancing fundamental knowledge for multi-hazard resilient and sustainable buildings.
- This solicitation will support research that may make use of the National Hazards Engineering Research Infrastructure (NHERI), when established in FY 2015 through awards to be made under a separate National Science Foundation (NSF) program solicitation.
- All data and metadata from experimental work supported under this solicitation must be archived and curated in the NHERI cyberinfrastructure data repository to be established on/about May 2015.

Any proposal submitted in response to this solicitation should be submitted in accordance with the revised *NSF Proposal & Award Policies & Procedures Guide* (PAPPG) (NSF 16-1), which is effective for proposals submitted, or due, on or after January 25, 2016.

SUMMARY OF PROGRAM REQUIREMENTS

General Information

Program Title:

Decision Frameworks for Multi-Hazard Resilient and Sustainable Buildings (RSB)

Synopsis of Program:

Buildings are a significant part of our nation's civil infrastructure for our welfare, livelihood, security, and safety. Buildings exist in an economic, social, technological, and natural context. They must be designed for resilience to the multiple natural hazards, such as earthquakes, tsunamis, windstorms (e.g., hurricanes and tornadoes), and floods, which may be experienced over their lifespan. Their design must also accommodate emerging societal goals for sustainability to reduce their impact on the natural environment. This high performance for multi-hazard resiliency and sustainability requires a comprehensive understanding of the risks, costs, and opportunities for a range of decisions, from choosing the building materials to designing the many systems comprising the building. Among these systems, the building's soil-foundation-structural-envelope (SFSE) system is critical to maintain the integrity and functionality of the building to protect occupants and the interior.

The goal of the Decision Frameworks for Multi-Hazard Resilient and Sustainable Buildings (RSB) solicitation is to advance knowledge for new concepts for multi-hazard resilient and sustainable SFSE building systems using decision frameworks for selection among alternative building system designs. Research for multi-hazard resilient and sustainable SFSE building systems supported under the this solicitation must include the consideration of a rational decision framework, preferences, concepts for SFSE systems, and design optimization methods for generating and choosing among alternative SFSE systems.

Multidisciplinary collaborations are essential for this research. Proposals must broadly integrate across the fields of architecture; engineering; material, environmental, social, behavioral, and economic sciences; and other disciplines necessary to address the research scope. Research supported under this solicitation may include computational, analytical, and/or experimental work. Research may also undertake the collection of new data or the use of existing data, but the data must be integral to the decision framework. This solicitation does not support research that generically addresses materials research or decision frameworks outside the context of decision making for multi-

hazard resilient and sustainable SFSE building systems.

Cognizant Program Officer(s):

Please note that the following information is current at the time of publishing. See program website for any updates to the points of contact.

- Joy M. Pauschke, Program Director, George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Operations and Research, telephone: (703) 292-7024, fax: (703) 292-9053, email: jpauschk@nsf.gov
- Kishor Mehta, Program Director, Hazard Mitigation and Structural Engineering (HMSE), telephone: (703) 292-7081, email: kimehta@nsf.gov
- Richard J. Fragaszy, Program Director, Geotechnical Engineering (GTE), telephone: (703) 292-7011, email: rfragasz@nsf.gov
- Chris Paredis, Program Director, Engineering and Systems Design (ESD) and Systems Science, telephone: (703) 292-2241, email: cparedis@nsf.gov

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

- 47.041 --- Engineering

Award Information

Anticipated Type of Award: Standard Grant

Estimated Number of Awards: 8

Award budgets will be commensurate with the research scope and research team's disciplinary composition. NSF anticipates supporting up to 8 awards, subject to the availability of funds and quality of proposals. Awards for single institution proposals and collaborative proposals in total may range from $800,000 to $1,200,000 total, for up to four years.

Anticipated Funding Amount: $9,000,000

for new awards, subject to availability of funds and quality of proposals.

Eligibility Information

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such organizations also are referred to as academic institutions.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may appear as Principal Investigator (PI), co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget in no more than one proposal submitted in response to the full proposal deadline. Applicants are responsible for ensuring that no individual is listed as PI, co-PI, Senior Personnel, Consultant or elsewhere in the proposal budget on more than one proposal. If an individual is included as PI, co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget in two or more proposals submitted by the full proposal deadline, then the first proposal submitted, based on the FastLane system time stamp, will be deemed the one allowable submission. All subsequent proposals that include the individual as PI, co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget will be returned without review. For collaborative proposals comprised of simultaneous proposal submissions, the FastLane time stamp for the first proposal submitted as part of that collaborative, whether or not the lead proposal, will be used to determine compliance with this eligibility requirement.

Proposal Preparation and Submission Instructions

A. Proposal Preparation Instructions

- **Letters of Intent:** Not required
- **Preliminary Proposal Submission:** Not required
- **Full Proposals:**
  - Full Proposals submitted via FastLane: NSF Proposal and Award Policies and Procedures Guide, Part I: Grant Proposal Guide (GPG) Guidelines apply. The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg.
  - Full Proposals submitted via Grants.gov: NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov Guidelines apply (Note: The NSF Grants.gov Application Guide is

available on the Grants.gov website and on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide)

B. Budgetary Information

- **Cost Sharing Requirements:**

  Inclusion of voluntary committed cost sharing is prohibited.

- **Indirect Cost (F&A) Limitations:**

  Not Applicable

- **Other Budgetary Limitations:**

  Other budgetary limitations apply. Please see the full text of this solicitation for further information.

C. Due Dates

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

  July 24, 2014

  Full Proposal Deadline

Proposal Review Information Criteria

Merit Review Criteria:

National Science Board approved criteria apply.

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

Every day, each of us interacts with buildings, spending 90 per cent of our time indoors. Buildings - commercial, residential,

industrial, and public - are a significant part of our nation's civil infrastructure for our welfare, livelihood, productivity, continuity of operations, shelter, safety, and security. Buildings have evolved into complex systems, comprised of many different materials, components, and systems for the exterior and interior, to support the intended function. Among these elements are the load-bearing components (soil-foundation-structural system), building envelope (e.g., roof, exterior wall panels, windows, and doors), and interior components such as ceilings, floors, walls, and partitions and mechanical, electrical and plumbing systems. The building life cycle, i.e., siting, planning, design, construction, maintenance, use, operation, deconstruction, and recycling and reuse to minimize waste, adds to this complexity.

Buildings exist in an economic, social, technological, and natural context. If they are designed, engineered, constructed, and operated in a way that fits this context, they can strengthen our urban fabric and contribute to the achievement of broader societal goals. High performance requires a comprehensive understanding of the risks, costs, and opportunities over a broad range of decisions - from the selection of the building materials to the integration of the various building systems - to enable buildings that are resilient to the various natural hazards experienced over their lifetime and that meet emerging societal goals for sustainability.

The building's soil-foundation-structural-envelope (SFSE) system protects the occupants and interior of the building. The SFSE building system is integral to providing resilience during a natural hazard event and for contributing toward sustainability. During its lifespan, the building may be subject to earthquakes, tsunamis, windstorms (e.g., hurricanes and tornadoes), floods, and other natural hazards. Over the past several decades, damage to SFSE building systems resulting from natural hazard events has led to loss of building function and occupancy, causing a cascading disaster to the community. Historically, research on building materials, design, and performance has focused on structural system resilience for a single natural hazard. Considerably less research has been undertaken toward understanding resilience for an integrated SFSE building system under a variety of different natural hazard loadings. Buildings designed to be multi-hazard resilient will contribute toward broader societal goals for communities to recover rapidly from natural disturbances. Strategies for green buildings are emerging, addressing societal goals for a sustainable nation, in which human needs are met and the built environment is provided for without harm to the natural environment and without sacrificing the ability of future generations to meet their needs. These buildings have included features such as sustainable materials, minimization of non-renewable energy use during the building life cycle, use of on-site renewable energy source(s), and maximization of material reuse and recyclable components. However, current building system designs for single hazard resilience do not always take advantage of new technologies for sustainable buildings and do not provide multi-hazard resilience.

Decision frameworks and greater collaboration among architects, engineers, and material, environmental, social, behavioral, and economic scientists are needed to ensure that buildings are more than the sum of the parts so that they can meet current and future challenges for multi-hazard resilience and sustainability. The Decision Frameworks for Multi-hazard Resilient and Sustainable Buildings (RSB) solicitation supports research to create new concepts for multi-hazard resilient and sustainable SFSE building systems and decision frameworks that will enable comparison of alternative SFSE system designs to achieve both multi-hazard resiliency and sustainability.

II. PROGRAM DESCRIPTION

A. Research Program

The goal of the RSB program is to advance knowledge for new concepts for multi-hazard resilient and sustainable SFSE building systems using decision frameworks for selection among alternative SFSE system designs. Decision frameworks can provide better understanding of the potential gains for design for both multi-hazard resiliency and sustainability. Research areas of interest encompass the following:

- What are rational decision frameworks for multi-hazard resilient and sustainable SFSE building systems?
- What are preference attributes for multi-hazard resilient and sustainable SFSE building systems?
- How are stakeholder preferences considered?
- What are appropriate analysis abstractions to support broad decision space exploration?
- What are design concepts (alternatives) for multi-hazard resilient and sustainable SFSE building systems? For example, alternatives might consider: (a) multi-functional, performance-driven sustainable materials, (b) new configurations developed from existing and/or new sustainable materials, and (c) smart building technologies and decision support systems integrated with (a) or (b) to provide information on building health or damage to assess remaining structural integrity following a natural hazard event.
- How can uncertainty be quantified in the decision framework?
- What are high-fidelity computational models to capture multi-hazard resilient and sustainable SFSE building system performance?
- What are design optimization processes for generating and choosing among alternative multi-hazard resilient and sustainable SFSE building systems?
- What are the organizational, social, psychological, legal, political and economic obstacles for providing multi-hazard resilient and sustainable SFSE building systems and what might be strategies for overcoming these obstacles?
- What is the role of multi-hazard resilient and sustainable SFSE building systems in the context of community multi-hazard resilience and sustainability?

Proposals submitted to this solicitation **must** explicitly address each of the following topics in the research plan:

- A decision framework for multi-hazard resilient and sustainable SFSE building systems that addresses preferences, concept generation (alternative SFSE system designs), analysis, uncertainty quantification, and design optimization.
- Description of and rationale for the multi-hazards considered.
- Description of and rationale for the sustainability metrics considered.
- Description and scope of the SFSE system considered.

Research projects should productively cross the boundaries of architecture; engineering; materials science; environmental science; social, behavioral, and economic sciences; and other disciplines necessary for the research scope. Projects supported under this solicitation may undertake the collection of new data or the use of existing curated data, but the data must be integral to the decision framework. Research may include computational work, analytical work and/or experimental work. This solicitation will not support the following: (a) materials research investigated in absence of explicitly considered SFSE building system(s), such as materials research supported through existing NSF programs, solicitations, and Dear Colleague Letters issued by the Directorate for Mathematics and Physical Sciences, Division of Materials Research, and the Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation, and (b) investigation of fire and/or blast loading as part of the multiple hazards considered.

NSF support for operations of the current George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

experimental facilities and cyberinfrastructure, described at http://www.nees.org, ends on September 30, 2014, when the five-year NSF cooperative agreement for NEES operations with Purdue University expires. Under a separate program solicitation to be issued in fiscal year (FY) 2014, NSF will solicit proposals in a separate competition for operations of a multi-user facility entitled the Natural Hazards Engineering Research Infrastructure (NHERI). Preliminary information about this facility is described in NSF Dear Colleague Letter 14-054, "Support for Natural Hazards Engineering Research Infrastructure and Research during FY 2015-FY 2019." Awards made through this solicitation may use NHERI resources after NHERI is established in early FY 2015.

NSF is one of four Federal agencies participating in the National Earthquake Hazards Reduction Program (NEHRP) (http://www.nehrp.gov) and the National Windstorm Impact Reduction Program (NWIRP). Awards supported under this program solicitation that investigate earthquakes and windstorms as part of the multiple natural hazards considered will contribute to NSF's contributions to NEHRP and NWIRP, respectively.

B. International Collaboration

NSF encourages collaboration with foreign researchers. Proposals including international collaboration should (a) identify the names and affiliations of the international collaborators, (b) describe the nature and goals of collaborative activities, (c) highlight the synergies and benefits to be gained from the collaboration, and (d) describe the international collaborators' current or anticipated resources that will be available to the project. International collaborators cannot be funded under this solicitation and must provide their own support. Two international collaborations have been identified through recent single natural hazard workshops and may be a resource; however, proposers are cautioned that proposals that only focus on a single natural hazard will be returned without review.

- International Collaboration with Researchers using Japan's E-Defense Shake Table Facility: The 3-D Full-Scale Earthquake Testing Shake Table Facility, known as E-Defense, (http://www.bosai.go.jp/hyogo/ehyogo/), built by the Japanese National Research Institute for Earth Science and Disaster Prevention (NIED), opened for research in 2005. Proposals may be submitted to this solicitation that plan to use the E-Defense shake table in the conduct of the research. Proposals must include letter(s) of support verifying the availability of the E-Defense facility for the proposed research. Research topics of mutual interest to researchers in Japan and the United States have been identified through recent workshops (see http://www.nees.org).
- International Collaboration with Academic Researchers Supported by the National Natural Science Foundation of China (NSFC): Recent NSFC/NSF sponsored workshops have identified priority research topics for joint collaboration (see http://www.nees.org). Proposals must provide letters of support from the Chinese counterparts verifying the collaboration.

C. Software Development

Proposals may include software development to support the research activities. This solicitation requires open source software development regardless of the intended use or application. Proposals with a software development component must include the following:

- Rationale for this software based on analysis of capabilities of existing software tools.
- Specific examples and use cases of how use of the software is integral to RSB research.
- Preliminary user requirements.
- Summary of the software development process, including user manual and documentation.
- Plan for maintenance of the software beyond the NSF award period.
- Plan for use of the software by the natural hazards engineering community beyond the proposal team.
- Expected annual user base.
- Identification of the open source license to be used.

D. Data Management Plan

The NSF-required Data Management Plan must include a plan for archiving in the NEHRI operations awardee's data repository all experimental data generated as part of the research supported under this solicitation. The data archiving must follow the data archiving and curation policies to be announced and implemented by the NHERI operations awardee. All experimental data must be archived, regardless of the experimental facility used to generate the data. The NHERI data repository is expected to be made operational on/about May 2015. Data in this context refers to all measurements, calibrations, observations, analyses, images, commentary, reports, logs, notes, and electronic notebook entries that relate directly to the proposed experiments. Any data (as described above) that are recorded in hardcopy of any form must be transcribed or converted, without loss of information, to electronic media using an appropriate searchable format. Hybrid simulation involving experimental and computational components must also include computational data recorded as output of the experiments conducted, and models and software codes used. In addition, this information must be properly characterized with appropriate metadata descriptors and then subsequently stored into one of the NHERI operations awardee's accepted digital formats to facilitate archiving. For purposes of establishing a level of effort required for data archiving and curation, proposers may base their plan on the current NEES operations awardee's Data Sharing and Archiving Policies available at http://nees.org/resources/6218/download/Data_Sharing_and_Archiving_Policy_20130501.pdf

III. AWARD INFORMATION

Award budgets will be commensurate with the research scope and research team's disciplinary composition. NSF anticipates supporting up to 8 awards, subject to the availability of funds and quality of proposals. Awards for single institution proposals and collaborative proposals in total may range from $800,000 to $1,200,000 total, for up to four years.

IV. ELIGIBILITY INFORMATION

Who May Submit Proposals:

Proposals may only be submitted by the following:

- Universities and Colleges - Universities and two- and four-year colleges (including community colleges) accredited in, and having a campus located in, the US acting on behalf of their faculty members. Such

organizations also are referred to as academic institutions.

Who May Serve as PI:

There are no restrictions or limits.

Limit on Number of Proposals per Organization:

There are no restrictions or limits.

Limit on Number of Proposals per PI or Co-PI: 1

An individual may appear as Principal Investigator (PI), co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget in no more than one proposal submitted in response to the full proposal deadline. Applicants are responsible for ensuring that no individual is listed as PI, co-PI, Senior Personnel, Consultant or elsewhere in the proposal budget on more than one proposal. If an individual is included as PI, co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget in two or more proposals submitted by the full proposal deadline, then the first proposal submitted, based on the FastLane system time stamp, will be deemed the one allowable submission. All subsequent proposals that include the individual as PI, co-PI, Senior Personnel, Other Personnel, Consultant, or elsewhere in the proposal budget will be returned without review. For collaborative proposals comprised of simultaneous proposal submissions, the FastLane time stamp for the first proposal submitted as part of that collaborative, whether or not the lead proposal, will be used to determine compliance with this eligibility requirement.

V. PROPOSAL PREPARATION AND SUBMISSION INSTRUCTIONS

A. Proposal Preparation Instructions

Full Proposal Preparation Instructions: Proposers may opt to submit proposals in response to this Program Solicitation via Grants.gov or via the NSF FastLane system.

- Full proposals submitted via FastLane: Proposals submitted in response to this program solicitation should be prepared and submitted in accordance with the general guidelines contained in the NSF Grant Proposal Guide (GPG). The complete text of the GPG is available electronically on the NSF website at: http://www.nsf.gov/publications/pub_summ.jsp?ods_key=gpg. Paper copies of the GPG may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov. Proposers are reminded to identify this program solicitation number in the program solicitation block on the NSF Cover Sheet For Proposal to the National Science Foundation. Compliance with this requirement is critical to determining the relevant proposal processing guidelines. Failure to submit this information may delay processing.

- Full proposals submitted via Grants.gov: Proposals submitted in response to this program solicitation via Grants.gov should be prepared and submitted in accordance with the NSF Grants.gov Application Guide: A Guide for the Preparation and Submission of NSF Applications via Grants.gov. The complete text of the NSF Grants.gov Application Guide is available on the Grants.gov website and on the NSF website at: (http://www.nsf.gov/publications/pub_summ.jsp?ods_key=grantsgovguide). To obtain copies of the Application Guide and Application Forms Package, click on the Apply tab on the Grants.gov site, then click on the Apply Step 1: Download a Grant Application Package and Application Instructions link and enter the funding opportunity number, (the program solicitation number without the NSF prefix) and press the Download Package button. Paper copies of the Grants.gov Application Guide also may be obtained from the NSF Publications Clearinghouse, telephone (703) 292-7827 or by e-mail from nsfpubs@nsf.gov.

In determining which method to utilize in the electronic preparation and submission of the proposal, please note the following:

Collaborative Proposals. All collaborative proposals submitted as separate submissions from multiple organizations must be submitted via the NSF FastLane system. Chapter II, Section D.4 of the Grant Proposal Guide provides additional information on collaborative proposals.

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

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

Please note that per guidance in the GPG, the Project Description must contain, as a separate section within the narrative, a discussion of the broader impacts of the proposed activities. Unless otherwise specified in this solicitation, you can decide where to include this section within the Project Description.

Proposals **must** include the items listed below, as well as those specified as **must** to be included per the GPG or NSF Grants.gov Application Guide. Proposals missing one or more of these items will be **returned without review.**

Cover Sheet. Under "Program Announcement/Solicitation No," identify this Solicitation Number. The "Title of the Proposed Project" entry must begin with the acronym "RSB." For collaborative proposals, the "Title of the Proposed Project" entry must begin with the phrase "Collaborative Research RSB."

Project Description. The Project Description **must** start with the following two sections using the headings: "Project Team Table" for the first section and "Synopsis of Scope" for the second section.

***Project Team Table*.** The first page and first section of the Project Description **must** start with the Project Team Table, which provides information about each project team member in the project description, i.e., **every**

individual named in the proposal who has a role in the proposal, must be included in this table, regardless of the role in the project and whether or not that role is financially supported. Include international collaborators. Include for each project team member the following: name, title, affiliation, expertise, and a brief description of team member's role (one or two sentences) and full-time equivalent person-months effort during each year of the project. This table will be used by NSF to check for conflicts of interest in assembling the reviewer community. Note: Proposals must not include the names of external advisory board/group/committee members. Proposals that include the names of external advisory board/group/committee members will be **returned without review**.

Synopsis of Scope. The second section of the Project Description **must** include a synopsis of the following research scope that will be discussed in more detail later the Project Description (synopsis must not exceed one page):

- Brief outline (or graphic) of the decision framework for multi-hazard resilient and sustainable SFSE building systems.
- Description of the multi-hazards considered.
- Description of the sustainability metrics considered.
- Definition and scope of the SFSE building system investigated.

Facilities, Equipment & Other Resources. Information in this section should include, but is not limited to, the following:

- Description of all experimental facilities to be used.
- Under the category "Other," all contributions and resources that will be used to conduct the research and other activities. Contributions could include items such as donated personnel time; donated use of facilities, equipment, and instrumentation; and donated materials and test specimens. Such information must be provided in this section, in lieu of other parts of the proposal such as the project summary, project description, budget, or budget justification. The description must be narrative in nature and must not include quantifiable financial information or assign any equivalent costs for the contributions and resources within the proposal. Any individual named in this section must be included in the Project Team Table in the Project Description.

Special Information and Supplementary Documentation. Proposals may include in the Special Information and Supplementary Documentation section only the additional information listed below. Proposals that include letters of support, endorsement, or participation from individuals or organizations not listed in the Project Team Table in the Project Description will be **returned without review.**

- Letters of commitment documenting collaborative arrangements of significance to the proposal from individuals or organizations, including foreign collaborators, which are explicitly listed in the Project Team Table in the Project Description but are not requesting support. The description of the arrangement must be narrative in nature and must not include quantifiable financial information or assign any equivalent costs for the contributions and resources within the letter. Letters of collaboration must not be submitted from any organization that requests financial support.
  - For E-Defense collaboration discussed in Section II, "Program Description," include: (a) one letter of endorsement from the counterpart Japanese collaborator verifying interest in collaboration and proposed or funded sources of research support, and (b) one letter of support from the Director of E-Defense verifying the availability, costs, and accommodation of that facility for coordinated research.
  - For U.S./China collaboration as discussed in Section II, "Program Description," one letter of endorsement from the counterpart Chinese collaborator(s) verifying interest in collaboration and the collaborator(s)' current or anticipated support from the NSFC.
- Formal vendor quote(s), as appropriate for the scope of work. Note: A formal vendor quote states a specific price for equipment or specimen to be provided or for services to be rendered.

Single-Copy Document (do not include under the Special Information and Supplementary Documentation section; see NSF Grant Proposal Guide Chapter II.C.1 **for further information)**

Collaborators/Individuals with Conflicts of Interest (text-searchable PDF, in FastLane, under Single Copy Documents). A list, in an alphabetized table, of the full names (last name, first name) and institutional affiliations of all persons with potential conflicts of interest as specified in NSF's Grant Proposal Guide Exhibit II-2 is required. For each PI, Co-PI, collaborator and other Senior Personnel, include all co-authors/editors and collaborators (within the past 48 months), all graduate advisors and advisees, and any other individuals or institutions with which the investigator has financial ties (please specify type). Include all PIs, Co-PIs, and other Senior Personnel from collaborative submissions to this solicitation.

B. Budgetary Information

Cost Sharing:

Inclusion of voluntary committed cost sharing is prohibited.

Other Budgetary Limitations:

A collaborative proposal may be submitted to this solicitation in one of two methods: as a single proposal, in which a single award is being requested (with subawards administered by the lead organization) or by simultaneous submission of proposals from different organizations, with each organization requesting a separate award. For both types of collaborative proposal submissions, this solicitation considers the collaborative proposal to be a single unified project. Proposal budgets for single institution proposals and collaborative proposals may range from $800,000 to $1,200,000 total for the entire project. Single institution proposals and collaborative proposals submitted with total budget requests exceeding $1,200,000 will be returned without review.

Budget Preparation Instructions:

The budget justification must include for each year and for each experimental facility to be used, an itemization of all associated user fee/recharge rate costs for which support is requested.

C. Due Dates

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

July 24, 2014

Full Proposal Deadline

D. FastLane / Grants.gov Requirements

For Proposals Submitted Via FastLane:

To prepare and submit a proposal via FastLane, see detailed technical instructions available at: https://www.fastlane.nsf.gov/a1/newstan.htm. For FastLane user support, call the FastLane Help Desk at 1-800-673-6188 or e-mail fastlane@nsf.gov. 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.

For Proposals Submitted Via Grants.gov:

Before using Grants.gov for the first time, each organization must register to create an institutional profile. Once registered, the applicant's organization can then apply for any federal grant on the Grants.gov website. Comprehensive information about using Grants.gov is available on the Grants.gov Applicant Resources webpage: http://www.grants.gov/web/grants/applicants.html. In addition, the NSF Grants.gov Application Guide (see link in Section V.A) provides instructions regarding the technical preparation of proposals via Grants.gov. For Grants.gov user support, contact the Grants.gov Contact Center at 1-800-518-4726 or by email: support@grants.gov. The Grants.gov Contact Center answers general technical questions related to the use of Grants.gov. Specific questions related to this program solicitation should be referred to the NSF program staff contact(s) listed in Section VIII of this solicitation.

Submitting the Proposal: Once all documents have been completed, the Authorized Organizational Representative (AOR) must submit the application to Grants.gov and verify the desired funding opportunity and agency to which the application is submitted. The AOR must then sign and submit the application to Grants.gov. The completed application will be transferred to the NSF FastLane system for further processing.

Proposers that submitted via FastLane are strongly encouraged to use FastLane to verify the status of their submission to NSF. For proposers that submitted via Grants.gov, until an application has been received and validated by NSF, the Authorized Organizational Representative may check the status of an application on Grants.gov. After proposers have received an e-mail notification from NSF, Research.gov should be used to check the status of an application.

VI. NSF PROPOSAL PROCESSING AND REVIEW PROCEDURES

Proposals received by NSF are assigned to the appropriate NSF program for acknowledgement and, if they meet NSF requirements, for review. All proposals are carefully reviewed by a scientist, engineer, or educator serving as an NSF Program Officer, and usually by three to ten other persons outside NSF either as *ad hoc* reviewers, panelists, or both, who are experts in the particular fields represented by the proposal. These reviewers are selected by Program Officers charged with oversight of the review process. Proposers are invited to suggest names of persons they believe are especially well qualified to review the proposal and/or persons they would prefer not review the proposal. These suggestions may serve as one source in the reviewer selection process at the Program Officer's discretion. Submission of such names, however, is optional. Care is taken to ensure that reviewers have no conflicts of interest with the proposal. In addition, Program Officers may obtain comments from site visits before recommending final action on proposals. Senior NSF staff further review recommendations for awards. A flowchart that depicts the entire NSF proposal and award process (and associated timeline) is included in the GPG as Exhibit III-1.

A comprehensive description of the Foundation's merit review process is available on the NSF website at: http://www.nsf.gov/bfa/dias/policy/merit_review/.

Proposers should also be aware of core strategies that are essential to the fulfillment of NSF's mission, as articulated in *Investing in Science, Engineering, and Education for the Nation's Future: NSF Strategic Plan for 2014-2018*. These strategies are integrated in the program planning and implementation process, of which proposal review is one part. NSF's mission is particularly well-implemented through the integration of research and education and broadening participation in NSF programs, projects, and activities.

One of the strategic objectives in support of NSF's mission is to foster integration of research and education through the programs, projects, and activities it supports at academic and research institutions. These institutions must recruit, train, and prepare a diverse STEM workforce to advance the frontiers of science and participate in the U.S. technology-based economy. NSF's contribution to the national innovation ecosystem is to provide cutting-edge research under the guidance of the Nation's most creative scientists and engineers. NSF also supports development of a strong science, technology, engineering, and mathematics (STEM) workforce by investing in building the knowledge that informs improvements in STEM teaching and learning.

NSF's mission calls for the broadening of opportunities and expanding participation of groups, institutions, and geographic regions that are underrepresented in STEM disciplines, which is essential to the health and vitality of science and engineering. NSF is committed to this principle of diversity and deems it central to the programs, projects, and activities it considers and supports.

A. Merit Review Principles and Criteria

The National Science Foundation strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs in understanding across all areas of science and engineering research and education. To identify which projects to support, NSF relies on a merit review process that incorporates consideration of both the technical aspects of a proposed project and its potential to contribute more broadly to advancing NSF's mission "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." NSF makes every effort to conduct a fair, competitive, transparent merit review process for the selection of projects.

1. Merit Review Principles

These principles are to be given due diligence by PIs and organizations when preparing proposals and managing projects, by reviewers when reading and evaluating proposals, and by NSF program staff when determining whether or not to recommend proposals for funding and while overseeing awards. Given that NSF is the primary federal agency charged with nurturing and supporting excellence in basic research and education, the following three principles apply:

- All NSF projects should be of the highest quality and have the potential to advance, if not transform, the frontiers of knowledge.
- NSF projects, in the aggregate, should contribute more broadly to achieving societal goals. These "Broader Impacts" may be accomplished through the research itself, through activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. The project activities may be based on previously established and/or innovative methods and approaches, but in either case must be well justified.
- Meaningful assessment and evaluation of NSF funded projects should be based on appropriate metrics, keeping in mind the likely correlation between the effect of broader impacts and the resources provided to implement projects. If the size of the activity is limited, evaluation of that activity in isolation is not likely to be meaningful. Thus, assessing the effectiveness of these activities may best be done at a higher, more aggregated, level than the individual project.

With respect to the third principle, even if assessment of Broader Impacts outcomes for particular projects is done at an aggregated level, PIs are expected to be accountable for carrying out the activities described in the funded project. Thus, individual projects should include clearly stated goals, specific descriptions of the activities that the PI intends to do, and a plan in place to document the outputs of those activities.

These three merit review principles provide the basis for the merit review criteria, as well as a context within which the users of the criteria can better understand their intent.

2. Merit Review Criteria

All NSF proposals are evaluated through use of the two National Science Board approved merit review criteria. In some instances, however, NSF will employ additional criteria as required to highlight the specific objectives of certain programs and activities.

The two merit review criteria are listed below. **Both** criteria are to be given **full consideration** during the review and decision-making processes; each criterion is necessary but neither, by itself, is sufficient. Therefore, proposers must fully address both criteria. (GPG Chapter II.C.2.d.i. contains additional information for use by proposers in development of the Project Description section of the proposal.) Reviewers are strongly encouraged to review the criteria, including GPG Chapter II.C.2.d.i., prior to the review of a proposal.

When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:

- **Intellectual Merit:** The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- **Broader Impacts:** The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.

The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to
    a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
    b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?

Broader impacts may be accomplished through the research itself, through the activities that are directly related to specific research projects, or through activities that are supported by, but are complementary to, the project. NSF values the advancement of scientific knowledge and activities that contribute to achievement of societally relevant outcomes. Such outcomes include, but are not limited to: full participation of women, persons with disabilities, and underrepresented minorities in science, technology, engineering, and mathematics (STEM); improved STEM education and educator development at any level; increased public scientific literacy and public engagement with science and technology; improved well-being of individuals in society; development of a diverse, globally competitive STEM workforce; increased partnerships between academia, industry, and others; improved national security; increased economic competitiveness of the United States; and enhanced infrastructure for research and education.

Proposers are reminded that reviewers will also be asked to review the Data Management Plan and the Postdoctoral Researcher Mentoring Plan, as appropriate.

B. Review and Selection Process

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

Ad hoc Review and/or Panel Review.

Reviewers will be asked to evaluate proposals using two National Science Board approved merit review criteria and, if applicable, additional program specific criteria. A summary rating and accompanying narrative will generally be completed and submitted by each reviewer and/or panel. 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 notice, 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 notice; (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 notice. 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:

Project Data

All experimental data and metadata generated during an award must be submitted electronically for data archiving and curation to the NHERI cyberinfrastructure data repository, which is anticipated to be operational on/about May 2015, in accordance with the data archiving and curation policies to be announced and implemented by the NHERI cyberinfrastructure awardee.

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 no later than 90 days prior to the end of the current budget period. (Some programs or awards require submission of more frequent project reports). No later than 120 days following expiration of a grant, the PI also is required to submit a final project report, and a project outcomes report for the general public.

Failure to provide the required annual or final project reports, or the project outcomes report, will delay NSF review and processing of any future funding increments as well as any pending proposals for all identified PIs and co-PIs on a given award. PIs should examine the formats of the required reports in advance to assure availability of required data.

PIs are required to use NSF's electronic project-reporting system, available through Research.gov, for preparation and submission of annual and final project reports. Such reports provide information on accomplishments, project participants (individual and organizational), publications, and other specific products and impacts of the project. Submission of the report via Research.gov constitutes certification by the PI that the contents of the report are accurate and complete. The project outcomes report also must be prepared and submitted using Research.gov. This report serves as a brief summary, prepared specifically for the public, of the nature and outcomes of the project. This report will be posted on the NSF website exactly as it is submitted by the PI.

More comprehensive information on NSF Reporting Requirements and other important information on the administration of NSF awards is contained in the NSF *Award & Administration Guide* (AAG) Chapter II, available electronically on the NSF Website at http://www.nsf.gov/publications/pub_summ.jsp?ods_key=aag.

Final Project Report

The final project report for all awards supported under this solicitation must include the following information:

The website (URL) in the NHERI data repository where all experimental metadata and data generated under the award is archived, curated, and complete.
- If the project included a software development component, the website (URL) where the open source software and supporting documentation may be found, and identification of the open source license used.

VIII. AGENCY CONTACTS

Please note that the program contact information is current at the time of publishing. See program website for any updates to the points of contact.

General inquiries regarding this program should be made to:

- Joy M. Pauschke, Program Director, George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) Operations and Research, telephone: (703) 292-7024, fax: (703) 292-9053, email: jpauschk@nsf.gov
- Kishor Mehta, Program Director, Hazard Mitigation and Structural Engineering (HMSE), telephone: (703) 292-7081, email: kimehta@nsf.gov
- Richard J. Fragaszy, Program Director, Geotechnical Engineering (GTE), telephone: (703) 292-7011, email: rfragasz@nsf.gov
- Chris Paredis, Program Director, Engineering and Systems Design (ESD) and Systems Science, telephone: (703) 292-2241, email: cparedis@nsf.gov

For questions related to the use of FastLane, contact:

- FastLane Help Desk, telephone: 1-800-673-6188; e-mail: fastlane@nsf.gov.

For questions relating to Grants.gov contact:

- Grants.gov Contact Center: If the Authorized Organizational Representatives (AOR) has not received a confirmation message from Grants.gov within 48 hours of submission of application, please contact via telephone: 1-800-518-4726; e-mail: support@grants.gov.

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, "NSF Update" is an information-delivery system designed to keep potential proposers and other interested parties apprised of new NSF funding opportunities and publications, important changes in proposal and award policies and procedures, and upcoming NSF Grants Conferences. Subscribers are informed through e-mail or the user's Web browser each time new publications are issued that match their identified interests. "NSF Update" also is available on NSF's website.

Grants.gov provides an additional electronic capability to search for Federal government-wide grant opportunities. NSF funding opportunities may be accessed via this 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 55,000 proposals each year for research, education and training projects, of which approximately 11,000 are funded. In addition, the Foundation receives several thousand applications for graduate and postdoctoral fellowships. The agency operates no laboratories itself but does support National Research Centers, user facilities, certain oceanographic vessels and Arctic and Antarctic research stations. The Foundation also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level.

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

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

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

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:

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Office of the General Counsel
National Science Foundation
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