U.S. NUCLEAR REGULATORY COMMISSION
NOTICE OF GRANT/ASSISTANCE AWARD

1. GRANT/AGREEMENT NO.	2. MODIFICATION NO.	3. PERIOD OF PERFORMANCE	4. AUTHORITY
NRC-04-08-144		FROM: 10/1/2008 TO: 09/30/2014	Pursuant to Section 31b and 141b of the Atomic Energy Act of 1954, as amended

5. TYPE OF AWARD	6. ORGANIZATION TYPE	7. RECIPIENT NAME AND ADDRESS
☐ GRANT ☒ COOPERATIVE AGREEMENT	State Controlled Hi-Ed. Instit	REGENTS OF THE UNIVERSITY OF CALIFORNIA, THE UNIVERSITY OF CALIFORNIA, BERKELEY 2150 SHATTUCK AVE RM 313 BERKELEY CA 947045940

8. PROJECT TITLE:
Next Generation Attenuation Models for Central and Eastern US (NGA-East) DUNS 124726725 Obligate $50,000.00 RES-C08-400

9. PROJECT WILL BE CONDUCTED	10. TECHNICAL REPORTS ARE REQUIRED	11. PRINCIPAL INVESTIGATOR(S) NAME AND ADDRESS
PER GOVERNMENT'S/RECIPIENT'S PROPOSAL(S) DATED 05/06/2008 AND APPENDIX A-PROJECT GRANT PROVISIONS	☒ PROGRESS AND FINAL ☐ FINAL ONLY ☐ OTHER (Conference Proceedings)	Jack Moehle, Prof./PEER Director University of CA, Berkeley, 325 Davis Hall, Mail Code 1792 Berkeley, CA 94720-1792

12. NRC PROGRAM OFFICE (NAME & ADDRESS)	13. ACCOUNTING & APPROPRIATION DATA	14. METHOD OF PAYMENT
Office of Nuclear Regulatory Research Attn: Ms. Ann Kammerer Mail Stop T-10M05 Washington, DC 20555 Tel. 301-415-7964	APPN. NO: 31X0200.860 B&R NO: 8-60-15-171-277 JOB CODE: K6681 BOC NO: BOC: 252A OFFICE ID NO: 04 (RES)	☐ ADVANCE BY TREASURY CHECK ☐ REIMBURSEMENT BY TREASURY CHECK ☐ LETTER OF CREDIT ☒ OTHER (SPECIFY) ASAP System (See Attach. 30 in Appendix A - "Electronic Payment")

15. NRC OBLIGATION FUNDS		16. TOTAL FUNDING AGREEMENT		
THIS ACTION	$50,000.00	NRC	$1,500,000.00	This action provides funds for Fiscal Year 2008 in the amount of $50,000.00
PREVIOUS OBLIGATION		RECIPIENT	0	
TOTAL	$50,000.00	TOTAL	$1,500,000.00	

17. NRC ISSUING OFFICE (NAME AND ADDRESS)

U.S. Nuclear Regulatory Commission
Div. of Contracts
Attn: Sharon M. Lim
Mail Stop: TWB-01-B10M
Washington, DC 20555

18. RECIPIENT	19. NRC CONTRACTING OFFICER
(Signature) [signature] (Date) 9/22/08	(Signature) [signature] (Date) 9/22/08
NAME (TYPED) for Patricia A. Gates	NAME (TYPED) Stephen Pool
TITLE Asst. Director, Federal Projects	TITLE Contracting Officer
TELEPHONE NO. 510-642-8109	TELEPHONE NO. 301-492-3618

20. PAYMENT INFORMATION

Payment will be made by: Automated Standard Application for Payments (ASAP). See Section 11.7 of the Terms and Conditions.

21. Attached is a copy of the "NRC Standard Terms and Conditions for U.S. Nongovernmental Recipients"
Acceptance of these terms and conditions is acknowledged when Federal funds are used on this project. Proposal dated 5/6/08 and Budget dated 9/16/08 are incorporated.

22. ORDER OF PRECEDENCE
In the event of a conflict between the recipient's proposal and this award, the terms of the Award shall prevail.

23. By this award, the Recipient certifies that payment of any audit-related debt will not reduce the level of performance of any Federal Program

TEMPLATE - ADM001 SUNSI REVIEW COMPLETE OCT 03 2008 ADM002

The Nuclear Regulatory Commission's Standard Terms and Conditions for U.S. Nongovernmental Recipients

Preface

The Recipient and any sub-recipients must, in addition to the assurances made as part of the application, comply and require each of its sub-awardees employed in the completion of the project to comply with all applicable statutes, regulations, Executive Orders (EOs), Office of Management and Budget (OMB) circulars, terms and conditions, and approved applications.

This award is subject to the laws and regulations of the United States. Any inconsistency or conflict in terms and conditions specified in the award will be resolved according to the following order of precedence: public laws, regulations, applicable notices published in the Federal Register, EOs, OMB Circulars, the Nuclear Regulatory Commission's (NRC) Mandatory Standard Provisions, special award conditions, and standard award conditions.

Some of the NRC terms and conditions contain a summary of pertinent statutes, regulations, Code of Federal Regulations (CFR), EOs, OMB Circulars or assurances by reference or in full text. Although it is a summary, it does not diminish the full force and effect of such statute, regulation, EOs, or OMB Circulars.

SPECIAL PROVISIONS APPLICABLE TO COOPERATIVE AGREEMENT

This award is subject to the following provisions:

1. General

a. Because the proposed effort is for the award of a cooperative agreement, substantial involvement on the part of the Nuclear Regulatory Commission is contemplated during performance of the agreement. Government activity that may constitute "substantial involvement," can be found in the Office of Management and Budget (OMB), Implementation of the Federal Grant and Cooperative Agreement Act of 1977 (OMB Final Guidance) 43 Fed. Reg. 36,860, 36,863 (1978) and may include:

i. Agency's involvement and collaboration with the Recipient by becoming a part of the Joint Management Committee (JMC);
ii. Select subawardees as a part of JMC, to include review and approval of reasonableness of costs;
iii. Review one stage of work before another can begin as a part of the JMC;
iv. Monitor to permit specified kinds of direction or redirection of the work as a part of JMC; and,
v. Substantial, direct agency operational involvement or participation during the assisted activity as a part of the JMC.

b. This award is composed of an award face page (which may incorporate the recipient's proposal by reference) and the NRC Standard Terms and Conditions for Nongovernmental Recipients.

c. This award constitutes acceptance by the U.S. Nuclear Regulatory Commission (NRC) of the recipient's proposal and budget unless otherwise indicated on the face page.

d. The recipient is obligated to conduct such project oversight as may be appropriate, to manage the funds with prudence, and to comply with the provisions outlined herein. Within this framework, the Principal

Investigator (PI) named on the award face page is responsible for the scientific or technical direction of the project and for preparation of the project performance reports.

e. This award is funded on a cost reimbursement basis not to exceed the amount awarded as indicated on the face page and is subject to a refund of unexpended funds to NRC.

f. This award is subject to the policies prescribed in OMB Circular A-110, dated November 29, 1993, as amended.

g. The contractor's proposal dated May 6, 2008 and the accompanying attachments are hereby incorporated into this award document. The contractor's Proposed Budget dated September 16, 2008 is hereby incorporated into this award.

h. On a monthly basis the NRC will pay 34.09091% of reasonable, allowable, and allocable costs incurred per the Proposed Budget dated September 16, 2008 at an amount not-to-exceed $1,500,000.

2. Reporting Program Technical Performance

Recipients are responsible for the performance under grants and other agreements and, where appropriate, ensure that time schedules are being met, projected work units by time periods are being accomplished, and other performance goals are being achieved.

a. Frequency of Performance Reports

Performance reports are due semiannually and cover 6-month periods beginning with the project's start date. Performance reports are due electronically directly to the NRC Project Officer and are due no later than 30 days after each 6-month project period. A final report is due no later than 90 days after the expiration date of an award.

b. Copies of Performance Reports

One copy of the letter report shall be submitted to the Division of Contracts, and three copies to the NRC Program Office (at the address indicated on the face page).

c. Content of Performance Report

The report content shall be as follows:

(1) A comparison of actual accomplishments with the goals established for the period, the findings of the investigator, or both. If the output of programs or projects can be readily quantified, such quantitative data should be related to cost data for computation of unit costs.

(2) Reasons why established goals were not met.

(3) Other pertinent information including, when appropriate, analysis and explanation of anticipated cost overruns or high unit costs.

(4) Between the required performance reporting dates, events may occur that have significant impact upon the project or program. In such instances, the recipient shall inform the Nuclear Regulatory Commission as soon as the following types of conditions become known:

(a) Problems, delays, or adverse conditions that will materially affect the ability to attain program objectives, prevent the meeting of time schedules and goals, or preclude the attainment of project work units by established time periods. This disclosure shall be accompanied by a

statement of the action taken, or contemplated, and any Federal assistance needed to resolve the situation.

(b) Favorable developments or events that enable time schedules to be met sooner than anticipated or more work units to be produced than originally projected.

(c) If any performance review conducted by the recipient discloses the need for change in the budget estimates in accordance with the criteria established in Circular A-110, the recipient shall submit a request for budget revision.

I. Mandatory General Requirements

The order of these requirements does not make one requirement more important than any other requirement.

1. APPLICABILITY OF 2 CFR PART 215

a. All provisions of 2 CFR Part 215 and all Standard Provisions attached to this grant/cooperative agreement are applicable to the Recipient and to sub-recipients which meet the definition of "Recipient" in Part 215, unless a section specifically excludes a sub-recipient from coverage. The Recipient shall assure that sub-recipients have copies of all the attached standard provisions.

b. Recipients are required to ensure compliance with monitoring procedures in accordance with OMB Circular A-133.

[END OF PROVISION]

2. AWARD PACKAGE

a. This award is composed of an award face page (which may incorporate the Recipient's proposal by reference) and the NRC Standard Provisions for U.S. Nongovernmental Recipients. The contractor's proposal dated 5/6/08 and contractor's proposed budget dated 9/16/08 are hereby incorporated.
b. This award constitutes acceptance by the NRC of the Recipient's proposal and budget unless otherwise indicated on the face page, Block 9.
c. The Recipient is obligated to conduct such project oversight as may be appropriate, to manage the funds with prudence, and to comply with the provisions outlined herein. Within this framework, the Principal Investigator (PI) named on the award face page, Block 11, is responsible for the scientific or technical direction of the project and for preparation of the project performance reports.
d. This award is funded on a cost reimbursement basis not to exceed the amount awarded as indicated on the face page, Block 16, and is subject to a refund of unexpended funds to NRC.

[END OF PROVISION]

3. NONDISCRIMINATION

(This provision is applicable when work under the grant/cooperative agreement is performed in the U.S. or when employees are recruited in the U.S.)

No U.S. citizen or legal resident shall be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity funded by this award on the basis of race, color, national origin, age, religion, handicap, or sex. The Recipient agrees to comply with the non-discrimination requirements below:

a. Title VI of the Civil Rights Act of 1964 (42 USC §§ 2000d et seq)
b. Title IX of the Education Amendments of 1972 (20 USC §§ 1681 et seq)
c. Section 504 of the Rehabilitation Act of 1973,as amended (29 USC § 794)
d. The Age Discrimination Act of 1975, as amended (42 USC §§ 6101 et seq)
e. The Americans with Disabilities Act of 1990 (42 USC §§ 12101 et seq)
f. Parts II and III of EO 11246 as amended by EO 11375 and 12086.
g. EO 13166, "Improving Access to Services for Persons with Limited English Proficiency."
h. Any other applicable non-discrimination law(s).

Generally, Title VII of the Civil Rights Act of 1964, 42 USC § 2000e et seq, provides that it shall be an unlawful employment practice for an employer to discharge any individual or otherwise to discriminate against an individual with respect to compensation, terms, conditions, or privileges of employment because of such individual's race, color, religion, sex, or national origin. However, Title VII, 42 USC § 2000e-1(a), expressly exempts from the prohibition against discrimination on the basis of religion, a religious corporation, association, educational institution, or society with respect to the employment of individuals of a particular religion to perform work connected with the carrying on by such corporation, association, educational institution, or society of its activities.

[END OF PROVISION]

4. NONLIABILITY

NRC does not assume liability with respect to any personal or property damage or loss for any third party claims for damages arising out of this award.

[END OF PROVISION]

5. MODIFICATIONS

Changes to the grant/cooperative agreement can only be made by issuance of a modification by the NRC Grants Officer.

[END OF PROVISION]

6. NOTICES

Any notice given by NRC or the Recipient shall in writing and delivered in person, mailed, or sent electronically as follows:

To the NRC Grants Officer, at the address specified in the award document.

To the Recipient, at the address shown in the award document.

Notices shall be effective as stated in the notice.

[END OF PROVISION]

7. SUBGRANT

Sub-recipients, sub-awardees, and contractors have no relationship with NRC under the terms of this grant/cooperative agreement. All required NRC approvals must be directed through the Recipient to NRC.

[END OF PROVISION]

8. LOBBYING RESTRICTIONS

a. The Recipient shall comply with provisions of 31 USC § 1352. This provision generally prohibits the use of Federal funds for lobbying in the Executive or Legislative Branches of the Federal Government in connection with the award, and requires disclosure of the use of non-Federal funds for lobbying.
b. The Recipient receiving in excess of $100,000 in Federal funding shall submit a completed Standard Form (SF) LLL, "Disclosure of Lobbying Activities," regarding the use of non-Federal funds for lobbying. The SF-LLL shall be submitted within 30 days following the end of the calendar quarter in which there occurs any event that requires disclosure or that materially affects the accuracy of the information contained in any disclosure form previously filed. The Recipient must submit the SF-LLL, including those received from sub-recipients, contractors, and subcontractors, to the Grants Officer.

[END OF PROVISION]

9. DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

a. The Recipient agrees to notify the Grants Officer immediately upon learning that it or any of its principals:

(1) Are presently excluded or disqualified from covered transactions by any Federal department or agency;

(2) Have been convicted within the preceding three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, receiving stolen property, making false claims, or obstruction of justice; commission of any other offense indicating a lack of business integrity or business honesty that seriously and directly affects your present responsibility;

(3) Are presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State, or local) with commission of any of the offenses enumerated in paragraph (1)(b); and

(4) Have had one or more public transactions (Federal, State, or local) terminated for cause or default within the preceding three years.

b. The Recipient agrees that, unless authorized by the Grants Officer, it will not knowingly enter into any subGrant or contracts under this grant/cooperative agreement with a person or entity that is included on the Excluded Parties List System (http://epls.arnet.gov).

The Recipient further agrees to include the following provision in any subGrant or contracts entered into under this award:

DEBARMENT, SUSPENSION, INELIGIBILITY, AND VOLUNTARY EXCLUSION

The Recipient certifies that neither it nor its principals is presently excluded or disqualified from participation in this transaction by any Federal department or agency.

c. The policies and procedures applicable to debarment, suspension, and ineligibility under NRC-financed transactions are set forth in 2 CFR Part 180.

[END OF PROVISION]

10. DRUG-FREE WORKPLACE

The Recipient must be in compliance with The Federal Drug Free Workplace Act of 1988. The policies and procedures applicable to violations of these requirements are set forth in 41 USC 702.

[END OF PROVISION]

11. EQUAL PROTECTION OF THE LAWS FOR FAITH-BASED AND COMMUNITY ORGANIZATIONS

a. The Recipient may not discriminate against any beneficiary or potential beneficiary under this award on the basis of religion or religious belief. Accordingly, in providing services supported in whole or in part by this grant/cooperative agreement or in its outreach activities related to such services, the Recipient may not discriminate against current or prospective program beneficiaries on the basis of religion, a religious belief, a refusal to hold a religious belief, or a refusal to actively participate in a religious practice;

b. The Federal Government must implement Federal programs in accordance with the Establishment Clause and the Free Exercise Clause of the First Amendment to the Constitution. Therefore, if the Recipient engages in inherently religious activities, such as worship, religious instruction, and proselytization, it must offer those services at a different time or location from any programs or services directly funded by this award, and participation by beneficiaries in any such inherently religious activities must be voluntary.

c. If the Recipient makes sub-awards under this grant/cooperative agreement, faith-based organizations should be eligible to participate on the same basis as other organizations, and should not be discriminated against on the basis of their religious character or affiliation.

[END OF PROVISION]

12. IMPLEMENTATION OF E.O. 13224 -- EXECUTIVE ORDER ON TERRORIST FINANCING

The Recipient is reminded that U.S. Executive Orders and U.S. law prohibits transactions with, and the provision of resources and support to, individuals and organizations associated with terrorism. It is the legal responsibility of the Recipient to ensure compliance with these Executive Orders and laws. This provision must be included in all contracts/sub-awards issued under this grant/cooperative agreement.

[END OF PROVISION]

13. DOMESTIC TRAVEL

Domestic travel is an appropriate charge to this award and prior authorization for specific trips are not required, as long as the trip is identified in the original program description and original budget. All other domestic travel must not increase the total estimated award amount. Trips that have not been identified in the approved budget require the prior approval of the Grants Officer.

All common carrier travel reimbursable hereunder shall be via the least expensive class rates consistent with achieving the objective of the travel and in accordance with the Recipient's policies and practices. Travel by first-class travel is not authorized unless prior approval is obtained from the Grants Officer.

[END OF PROVISION]

14. INTERNATIONAL AIR TRAVEL AND TRANSPORTATION

(This provision is applicable when costs for international travel or transportation will be paid for with NRC funds. This provision is not applicable if the Recipient is providing for travel with private funds as part of a cost-sharing requirement, or with Program Income generated under the award.)

a. PRIOR BUDGET APPROVAL

In accordance with OMB Cost Principles, direct charges for foreign travel costs are allowable only when each foreign trip has received prior budget approval. Such approval will be deemed to have been met when:

(1) the trip is identified. Identification is accomplished by providing the following information: the number of trips, the number of individuals per trip, and the destination country(s).

(2) the information noted at (a)(1) above is incorporated in: the proposal, the program description or schedule of the award, the implementation plan (initial or revisions), or amendments to the award; and

(3) the costs related to the travel are incorporated in the approved budget of the award.

The Grants Officer may approve travel which has not been incorporated in writing as required by paragraph (a)(2). In such case, a copy of the Grants Officer's approval must be included in the grant/cooperative agreement file.

b. NOTIFICATION

(1) As long as prior budget approval has been met in accordance with paragraph (a) above, a separate Notification will not be necessary.

c. SECURITY ISSUES

Recipients are encouraged to obtain the latest Department of State Travel Advisory Notices before travelling. These Notices are available to the general public and may be obtained directly from the State Department, or via Internet.

Where security is a concern in a specific region, Recipients may choose to notify the US Embassy of their presence when they have entered the country. This may be especially important for long-term posting.

d. THE FLY AMERICA ACT

The Fly America Act (49 U.S.C. 40118) requires that all air travel and shipments under this award must be made on U.S. flag air carriers to the extent service by such carriers is available. The Administrator of General Services Administration (GSA) is authorized to issue regulations for purposes of implementation. Those regulations may be found at 41 CFR Part 301, and are hereby incorporated by reference into this award.

e. COST PRINCIPLES

The Recipient will be reimbursed for travel and the reasonable cost of subsistence, post differentials and other allowances paid to employees in international travel status in accordance with the Recipient's applicable cost principles and established policies and practices which are uniformly applied to federally financed and other activities of the grantee.

If the Recipient does not have established written policies regarding travel costs, the standard for determining the reasonableness of reimbursement for overseas allowance will be the Standardized Regulations (Government Civilians, Foreign Areas), published by the U.S. Department of State, as from time to time amended. The most current subsistence, post differentials, and other allowances may be obtained from the Grants Officer.

This provision must be included in all sub-awards and contracts which require international air travel and transportation under this award.

[END OF PROVISION]

15. TERMINATION

Termination of this award by default or by convenience shall follow provisions as established in 2 CFR 215.60, Termination and Enforcement.

[END OF PROVISION]

16. PROPERTY MANAGEMENT STANDARDS

Property standards of this award shall follow provisions as established in 2 CFR 215.30.

[END OF PROVISION]

17. PROCUREMENT STANDARDS

Procurement standards of this award shall follow provisions as established in 2 CFR 215.40.

[END OF PROVISION]

18. INTANGIBLE AND INTELLECTUAL PROPERTY

Intangible property of this award shall generally follow provisions established in 2 CFR 215.36.

Intellectual property rights shall follow provisions listed below:

a. Inventions

The rights to any invention made by a Recipient under an NRC financial assistance award are determined by the Bayh-Dole Act, Pub. Law 96-517, as amended and codified in 35 USC § 200 et seq, except as otherwise required by law. The specific rights and responsibilities are described in more detail in 37 CFR Part 401 and in particular, in the standard patent rights clause in 37 CFR § 401.14.

1. Ownership

(a) Recipient. The Recipient has the right to own any invention it makes (conceived or first actually reduced to practice) or made by its employees. The Recipient may not assign its rights to a third party without the permission of NRC unless it is to a patent management organization (i.e., a university's Research Foundation). The Recipient's ownership rights are subject to the Government's nonexclusive paid-up license and other rights.

(b) NRC. If the Recipient elects not to own or does not elect rights or file a patent application within the time limits set forth in the standard patent rights clause, NRC may request an assignment of all rights, which is normally subject to a limited royalty free nonexclusive revocable license from the Recipient. NRC owns any invention made solely by its employees but may license the Recipient in accordance with the procedures in 37 CFR Part 404.

(c) Inventor/Employee. If neither the Recipient nor the NRC is interested in owning an invention by a Recipient employee, the Recipient, with the written concurrence of NRC, may allow the inventor/employee to own the invention subject to certain restrictions as described in 37 CFR § 401.9.

(d) Joint inventions. Inventions made jointly by a Recipient and an NRC employee will be owned jointly by the Recipient and NRC. However, NRC may transfer its rights to the Recipient as authorized by 35 USC § 202(e) and 37 CFR § 401.10 if the Recipient is willing to patent and license the invention usually in exchange for a share of "net" royalties based on the number of inventors (e.g., 50-50 if there is one Recipient and NRC employee). The grant/cooperative agreement will be prepared by the NRC and may include other provisions, such as royalty free license to the Government and certain other entities. 35 USC § 202(e) also authorizes the Recipient to transfer its rights to the Government which can agree to share royalties similarly as described above.

2. Responsibilities – iEdison

The Recipient has responsibilities and duties set forth in the standard patent rights clause. The Recipient is expected to comply with all the requirements of the standard patent rights clause and 37 CFR Part 401. Recipients of NRC financial assistance awards are required to submit their disclosures and elections electronically using the Interagency Edison extramural invention reporting system (iEdison) at www.iedison.gov. Recipients may obtain a waiver of this electronic submission requirement by providing to NRC compelling reasons for allowing the submission of paper copies of reports related to inventions.

b. Patent Notification Procedures

Pursuant to EO 12889, NRC is required to notify the owner of any valid patent covering technology whenever the NRC or its financial assistance Recipients, without making a patent search, knows (or has demonstrable reasonable grounds to know) that technology covered by a valid United States patent has been or will be used without a license from the owner. To ensure proper notification, if the Recipient uses or has used patented technology under this award without license or permission from the owner, the Recipient must notify the Grants Officer. This notice does not necessarily mean that the Government authorizes and consents to any copyright or patent infringement occurring under the financial assistance.

c. Data, Databases, and Software

The rights to any work produced or purchased under a NRC federal financial assistance award are determined by 2 CFR 215.36. Such works may include data, databases or software. The Recipient owns any work produced or purchased under a NRC federal financial assistance award subject to

NRC's right to obtain, reproduce, publish or otherwise use the work or authorize others to receive, reproduce, publish or otherwise use the data for Government purposes.

d. Copyright

The Recipient may copyright any work produced under a NRC federal financial assistance award subject to NRC's royalty-free nonexclusive and irrevocable right to reproduce, publish or otherwise use the work or authorize others to do so for Government purposes. Works jointly authored by NRC and Recipient employees may be copyrighted but only the part authored by the Recipient is protected because, under 17 USC § 105, works produced by Government employees are not copyrightable in the United States. On occasion, NRC may ask the Recipient to transfer to NRC its copyright in a particular work when NRC is undertaking the primary dissemination of the work. Ownership of copyright by the Government through assignment is permitted under 17 USC § 105.

[END OF PROVISION]

19. EQUIPMENT

Equipment procedures shall follow provision established in 2 CFR 215.34.

[END OF PROVISION]

20. RETENTION AND ACCESS REQUIREMENTS FOR RECORDS

Retention and access requirements for records of the Recipient shall follow established provisions in 2 CFR 215.53.

[END OF PROVISION]

21. ORGANIZATIONAL PRIOR APPROVAL SYSTEM

a. In order to carry out its responsibilities for monitoring project performance and for adhering to award terms and conditions, each performing organization shall have a system to ensure that appropriate authorized officials provide necessary organizational reviews and approvals in advance of any action that would result in either the performance or modification of an NRC supported activity where such approvals are required by the award instrument, including the obligation or expenditure of funds where the governing cost principles either prescribe conditions or require approvals.

b. The organization shall designate an appropriate official or officials to review and approve the types of actions described in Section "a" above. Preferably, the official(s) should be the same official(s) who sign(s) or countersign(s) those types of requests that require submission to and approval by NRC. The designated official(s) shall not be the principal investigator or any official having direct responsibility for the actual conduct of the project, or a subordinate of such individual.

[END OF PROVISION]

22. CONFLICT OF INTEREST

Conflict of interest standards of this award shall follow provisions as established in 2 CFR 215.42 Codes of Conduct.

[END OF PROVISION]

23. DISPUTE REVIEW PROCEDURES

a. Any request for review of a notice of termination or other adverse decision should be addressed to the Grants Officer. It must be postmarked or if sent by electronic means dated no later than 30 days after the postmarked date of such termination or adverse decision from the Grants Officer.

b. The request for review must contain a full statement of the recipient's position and the pertinent facts and reasons in support of such position.

c. The Grants Officer will promptly acknowledge receipt of the request for review and shall forward it to the Director, Office of Administration, who shall appoint a review committee consisting of a minimum of three persons.

d. Pending resolution of the request for review, the NRC may withhold or defer payments under the award during the review proceedings.

e. The review committee will request the Grants Officer who issued the notice of termination or adverse action to provide copies of all relevant background materials and documents. The committee may, at its discretion, invite representatives of the recipient and the NRC program office to discuss pertinent issues and to submit such additional information as it deems appropriate. The chairman of the review committee will insure that all review activities or proceedings are adequately documented.

f. Based on its review, the committee will prepare its recommendation to the Director, Office of Administration, who will advise the parties concerned of his/her decision.

[END OF PROVISION]

[END OF MANDATORY PROVISIONS]

II. Financial Requirements

1. FINANCIAL MANAGEMENT ACTIVITIES

Financial Management procedures shall follow the established provisions in 2 CFR 215.20.

2. SPECIFIC FINANCIAL MANAGEMENT PROVISIONS

The following financial management procedures shall follow the established provisions in 2 CFR 215 as follows:

a. Payment – 2 CFR 215.22
b. Cost Share – 2 CFR 215.23
c. Program Income – 2 CFR 215.24
   i. Earned program income, if any, shall be added to funds committed to the project by the NRC and Recipient and used to further eligible project or program objectives.
d. Budget Revision – 2 CFR 215.25

i. In accordance with 2 CFR 215.25(e), the NRC waives the prior approval requirement for items identified in sub-part (e)(1-4).
ii. In accordance with 2 CFR 215.25(f), the NRC shall restrict the transfer of funds among direct cost items as provided in this sub-part.
iii. The Recipient is not authorized at any time to transfer amounts budgeted for direct costs to the indirect costs line item or vice versa, without written approval of the Grants Officer.

e. Allowable Costs – 2 CFR 215.27

3. FINANCIAL REPORTS

a. The Recipient shall submit a "Financial Status Report" (SF-269) on a semi-annual basis for the periods ending March 31 and September 30, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-269 shall be submitted within 90 days after expiration of the award.
b. The Recipient shall submit a "Federal Cash Transaction Report" (SF-272) on a semi-annual basis for the periods ending March 31 and September 30, or any portion thereof, unless otherwise specified in a special award condition. Reports are due no later than 30 days following the end of each reporting period. A final SF-272 shall be submitted within 90 days after expiration of the award.
c. The reports must be submitted to the Grants Officer in hard copy (no more than the original and two copies), or electronically when specified in the special award conditions.

4. INDIRECT COSTS

a. Indirect costs will not be allowable charges against the award unless specifically included as a line item in the approved budget incorporated into the award. (The term "indirect cost" has been replaced with the term "facilities and administrative costs" under 2 CFR 220, "Cost Principles for Educational Institutions.")
b. Excess indirect costs may not be used to offset unallowable direct costs.
c. If the Recipient has not previously established an indirect cost rate with a Federal agency, the negotiation and approval of a rate is subject to the procedures in the applicable cost principles and the following subparagraphs:

1a. State, Local and Indian Tribal Governments; Educational Institutions; and Non-Profit Organizations (non-commercial organizations).

For the above listed organizations, cognizant federal agency is generally defined as the agency that provides the largest dollar amount of direct federal funding. For those organizations for which the NRC is cognizant or has oversight, NRC or its designee will either negotiate a fixed rate with a forward pricing rate agreement, or in some instances, will limit its review to evaluating the procedures described in the Recipient's cost allocation methodology plan. Indirect cost rates and cost allocation methodology reviews are subject to future audits to determine actual indirect costs.

1b. Commercial Organizations

For commercial organizations, cognizant federal agency is defined as the agency that provides the largest dollar amount of negotiated contracts, including options. If the only federal funds received by a commercial organization are NRC award funds, then NRC becomes the cognizant federal agency for the purpose of indirect cost negotiations. For those organizations for which NRC is cognizant, NRC or its designee will negotiate a fixed rate forward pricing rate agreement with the Recipient. Fixed rate means an indirect cost rate which has the same characteristics as a pre-determined rate, except that the difference between the estimated costs and the actual costs of the period covered by the rate is carried forward as an adjustment to the rate computation of the subsequent period.

NRC or its designee will negotiate cost rates using the cost principles found in 48 CFR Part 31, "Contract Cost Principles and Procedures." For guidance on how to put an indirect cost plan together go to:

http://www.dol.gov/oasam/programs/boc/costdeterminationguide/main.htm

2. Within 90 days of the award start date, the Recipient shall submit documentation (indirect cost proposal, cost allocation plan, etc.) necessary to perform the review to the address listed below. The Recipient shall provide the Grants Officer with a copy of the transmittal letter.

   U.S. Nuclear Regulatory Commission
   Division of Contracts
   Mail Stop: TWB-01-B10M
   Washington, DC 20555

3. The Recipient can use the fixed rate proposed in the indirect cost plan until such time as the NRC provides a response to the submitted plan. Actual indirect costs must be calculated annually and adjustments made through the forward pricing rate agreement used in calculating next year's rate. This calculation of actual indirect costs and the forward pricing rate agreement is subject to audit. Indirect cost rate proposals must be submitted annually. Organizations that have previously established indirect cost rates must submit a new indirect cost proposal to the cognizant agency within six months after the end of the Recipient's fiscal year.

d. When NRC is not the oversight or cognizant Federal agency, the Recipient shall provide the Grants Officer with a copy of a negotiated rate agreement or a copy of the transmittal letter submitted to the cognizant or oversight Federal agency requesting a negotiated rate agreement.

e. If the Recipient fails to submit the required documentation to NRC within 90 days of the award start date, the Grants Officer may modify the award to preclude the recovery of any indirect cost under the award. If the NRC, oversight, or cognizant Federal agency determines there is a finding of good and sufficient cause to excuse the Recipient's delay in submitting the documentation, an extension of the 90 day due date may be approved by the Grants Officer.

f. Regardless of any approved indirect cost rate applicable to the award, the maximum dollar amount of allocable indirect costs for which the NRC will reimburse shall be the lesser of:

   1. The line item amount for the Federal share of indirect costs contained in the approved budget of the award; or
   2. The Federal share of the total allocable indirect costs of the award based on the indirect cost rate approved by a cognizant or oversight Federal agency and current at the time the cost was incurred, provided the rate is approved on or before the award end date.

5. INCURRING COSTS OR OBLIGATING FEDERAL FUNDS BEYOND THE EXPIRATION DATE

a. The Recipient shall not incur costs or obligate funds for any purpose pertaining to the operation of the project, program, or activities beyond the expiration date stipulated in the award. The only costs which are authorized for a period of up to 90 days following the award expiration date are those strictly associated with closeout activities. Closeout activities are normally limited to

the preparation of final progress reports, financial, and required project audit reports unless otherwise approved in writing by the Grants Officer.

b. Unless otherwise authorized in 2 CFR 215.25(e)(2) or a special award condition, any extension of the award period can only be authorized by the Grants Officer in writing. Verbal or written assurances of funding from other than the Grants Officer shall not constitute authority to obligate funds for programmatic activities beyond the expiration date.
c. The NRC has no obligation to provide any additional prospective or incremental funding. Any modification of the award to increase funding and to extend the period of performance is at the sole discretion of the NRC.
d. Requests for extensions to the period of performance shall be sent to the Grants Officer at least 30 days prior to the grant/cooperative agreement expiration date. Any request for extension after the expiration date shall not be honored.

6. TAX REFUNDS

Refunds of FICA/FUTA taxes received by the Recipient during or after the award period must be refunded or credited to NRC where the benefits were financed with Federal funds under the award. The Recipient agrees to contact the Grants Officer immediately upon receipt of these funds. The Recipient further agrees to refund portions of FICA/FUTA taxes determined to belong to the Federal Government, including refunds received after the award end date.

7. AUTOMATED STANDARD APPLICATION FOR PAYMENTS PROCEDURES

Unless otherwise provided for in the award document, payments under this award will be made using the Department of Treasury's Automated Standard Application for Payment (ASAP) system. Under the ASAP system, payments are made through preauthorized electronic funds transfers, in accordance with the requirements of the Debt Collection Improvement Act of 1996. In order to receive payments under ASAP, Recipients are required to enroll with the Department of Treasury, Financial Management Service, Regional Financial Centers, which allows them to use the on-line and Voice Response System (VRS) method of withdrawing funds from their ASAP established accounts. The following information will be required to make withdrawals under ASAP: (1) ASAP account number – the award number found on the cover sheet of the award; (2) Agency Location Code (ALC) – 31000001; and Region Code. Recipients enrolled in the ASAP system do not need to submit a "Request for Advance or Reimbursement" (SF-270), for payments relating to their award. Awards paid under the ASAP system require the following information for enrollment:

Grantees must enroll in the ASAP system by emailing the following information to Vicki.Gladhill@nrc.gov:

1. EIN#
2. DUNS#
3. Name of Organization
4. Type of Organization (i.e. Non-profit, For Profit, State etc.)
5. Address
6. Point of Contact
7. Title
8. Point of Contact's Email Address
9. Phone Number

Please put the award number on the subject line of the email for reference.

8. AUDIT

Under the Inspector General Act of 1978, as amended, 5 USC App. 3§ 1 et seq, an audit of the award may be conducted at any time. The Inspector General of the NRC, or any of his/her duly authorized representatives, shall have access to any pertinent books, documents papers and records of the Recipient, whether written, printed, recorded, produced or reproduced by any electronic, mechanical, magnetic or other process or medium, in order to make audits, inspections, excerpts, transcripts or other examinations as authorized by law. When the Office of the Inspector General (OIG) requires a program audit on an NRC award, the OIG will usually make the arrangements to audit the award, whether the audit is performed by OIG personnel, an independent accountant under contract with the NRC, or any other Federal, state or local audit entity.

Organization-wide or program-specific audits shall be performed in accordance with the Single Audit Act Amendments of 1996, as implemented by OMB Circular A-133, "Audits of States, Local Governments, and Non-Profit Organizations." Recipients that are subject to the provisions of OMB Circular A-133 and that expend $500,000 or more in a year in Federal awards shall have an audit conducted for that year in accordance with the requirements contained in OMB Circular A-133. A copy of the audit shall be submitted to the Bureau of the Census, which has been designated by OMB as a central clearinghouse. The address is:

Federal Audit Clearinghouse
Bureau of the Census
1201 E. 10th Street
Jeffersonville, IN 47132

In accordance with 2 CFR 215.26 (c) and (d), for-profit hospitals, commercial, and other organizations not covered by the audit provisions in OMB Circular A-133 that expend $500,000 or more in a year in Federal awards, are required to have a program-specific audit performed at the conclusion of the project, but no less than once every five years. Some NRC programs have specific audit guidelines that will be incorporated into the award. If NRC does not have a program-specific audit guide available for the program, the auditor should follow Generally Accepted Government Auditing Standards and the requirements for a program-specific audit as described in OMB Circular A-133 § .235. A copy of the program-specific audit shall be submitted to the OIG at the following address with a copy of the transmittal letter to the Grants Officer:

US Nuclear Regulatory Commission
Office of the Inspector General
(Program Specific Audit)
Washington, DC 20555

III. Programmatic Requirements

1. PERFORMANCE (TECHNCIAL) REPORTS

a. The Recipient shall submit performance (technical) reports in triplicate (one original and two copies) or electronically to the NRC Project Officer as specified in the special award conditions in the same frequency as the Financial Status Report (SF-269) unless otherwise authorized by the Grants Officer.

b. Unless otherwise specified in the award provisions, performance (technical) reports shall contain brief information as prescribed in the applicable uniform administrative requirements incorporated in the award.

2. UNSATISFACTORY PERFORMANCE

Failure to perform the work in accordance with the terms of the award and maintain at least a satisfactory performance rating or equivalent evaluation may result in designation of the Recipient as high risk and

assignment of special award conditions or other further action as specified in the standard term and condition entitled "Termination".

Failure to comply with any or all of the provisions of the award may have a negative impact on future funding by NRC and may be considered grounds for any or all of the following actions: establishment of an accounts receivable, withholding of payments under any NRC award, changing the method of payment from advance to reimbursement only, or the imposition of other special award conditions, suspension of any NRC active awards, and termination of any NRC award.

3. PROGRAMMATIC CHANGES

The Recipient shall report programmatic changes to the Grants Officer, and shall request prior approvals in accordance with 2 CFR 215.25(c)(1-3).

4. OTHER FEDERAL AWARDS WITH SIMILAR PROGRAMMATIC ACTIVITIES

The Recipient shall immediately provide written notification to the NRC Project Officer and the Grants Officer in the event that, subsequent to receipt of the NRC award, other financial assistance is received to support or fund any portion of the program description incorporated into the NRC award. NRC will not pay for costs that are funded by other sources.

5. PROHIBITION AGAINST ASSIGNMENT BY THE RECIPIENT

The Recipient shall not transfer, pledge, mortgage, or otherwise assign the award, or any interest therein, or any claim arising thereunder, to any party or parties, banks, trust companies, or other financing or financial institutions without the express written approval of the Grants Officer.

6. SITE VISITS

The NRC, through authorized representatives, has the right, at all reasonable times, to make site visits to review project accomplishments and management control systems and to provide such technical assistance as may be required. If any site visit is made by the NRC on the premises of the Recipient or contractor under an award, the Recipient shall provide and shall require his/her contractors to provide all reasonable facilities and assistance for the safety and convenience of the Government representative in the performance of their duties. All site visits and evaluations shall be performed in such a manner as will not unduly delay the work.

IV. Environmental Requirements

Environmental impacts must be considered by Federal decision makers in their decisions whether or not to (1) approve a proposal for Federal assistance; (2) approve the proposal with mitigation; or (3) approve a different proposal having less adverse environmental impacts. Federal environmental laws require that the funding agency initiate a planning process with an early consideration of potential environmental impacts that projects funded with Federal assistance may have on the environment. The Recipient and sub-recipients must comply with all environmental standards, to include those prescribed under the following statutes and Executive Orders, and shall identify to the awarding agency any impact the award may have on the environment. In some cases, award funds can be withheld by the Grants Officer under a special award condition requiring the Recipient to submit additional environmental compliance information sufficient to enable the NRC to make an assessment on any impacts that a project may have on the environment.

The Recipient must adhere to the following environmental laws:

1. The National Environmental Policy Act of 1969 (42 USC §§ 4321-4327)

2. Floodplain Management, EO 11988 and, Protection of Wetlands, EO 11990, May 24, 1977
3. Clean Air Act, Clean Water Act, and EO 11738
4. The Flood disaster Protection Act of 1973 (42 USC § 4002 et seq)
5. The Endangered Species Act of 1973, as amended, (16 USC § 1531 et seq).
6. The Coastal Zone Management Act, as amended, (16 USC § 1451 et seq)
7. The Coastal Barriers Resources Act, (16 USC §3501 et seq)
8. The Wild and Scenic Rivers Act, as amended, (16 USC §§ 1271 et seq)
9. The Safe Drinking Water Act of 1974, as amended, (42 USC §§ 300f-j)
10. The Resource Conservation and Recovery Act of 1976, as amended, (42 USC §§ 6901 et seq).
11. The Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, and the Superfund Amendments and Reauthorization Act of 1986, and the Community Environmental Response Facilitation Act of 1992, as amended, (42 USC §§ 9601 et seq)
12. Environmental Justice in Minority Populations and Low Income Populations, EO 12898, February 11, 1994.

V. Miscellaneous Requirements

1. CRIMINAL AND PROHIBITED ACTIVITIES

a. The Program Fraud Civil Remedies Act (31 USC §§ 3801-3812), provides for the imposition of civil penalties against persons who make false, fictitious, or fraudulent claims to the Federal government for money (including money representing grant/cooperative agreements, loans, or other benefits.)
b. False statements (18 USC §§ 287 and 1101), provides that whoever makes or presents any false, fictitious, or fraudulent statements, representations, or claims against the United States shall be subject to imprisonment of not more than five years and shall be subject to a fine in the amount provided by 18 USC § 287.
c. False Claims Act (31 USC 3729 et seq), provides that suits under this Act can be brought by the government, or a person on behalf of the government, for false claims under federal assistance programs.
d. Copeland "Anti-Kickback" Act (18 USC § 874 and 40 USC § 276c), prohibits a person or organization engaged in a federally supported project from enticing an employee working on the project from giving up a part of his compensation under an employment contract.

[END OF PROVISION]

2. AMERICAN-MADE EQUIPMENT AND PRODUCTS

Recipients are herby notified that they are encouraged, to the greatest extent practicable, to purchase American-made equipment and products with funding provided under this award.

[END OF PROVISION]

3. INCREASING SEAT BELT USE IN THE UNITED STATES

Pursuant to EO 13043, Recipients should encourage employees and contractors to enforce on-the-job seat belt policies and programs when operating company-owned, rented or personally-owned vehicle.

[END OF PROVISION]

4. FEDERAL EMPLOYEE EXPENSES

Federal agencies are generally barred from accepting funds from a Recipient to pay transportation, travel, or other expenses for any Federal employee unless specifically approved in the terms of the award. Use of award funds (Federal or non-Federal) or the Recipient's provision of in-kind goods or services, for the purposes of transportation, travel, or any other expenses for any Federal employee may raise appropriation augmentation issues. In additions, NRC policy prohibits the acceptance of gifts, including travel payments for Federal employees, from Recipients or applicants regardless of the source.

[END OF PROVISION]

5. MINORITY SERVING INSTITUTIONS (MSIs) INITIATIVE

Pursuant to EOs 13256, 13230, and 13270, NRC is strongly committed to broadening the participation of MSIs in its financial assistance program. NRC's goals include achieving full participation of MSIs in order to advance the development of human potential, strengthen the Nation's capacity to provide high-quality education, and increase opportunities for MSIs to participate in and benefit form Federal financial assistance programs. NRC encourages all applicants and Recipients to include meaningful participations of MSIs. Institutions eligible to be considered MSIs are listed on the Department of Education website.

[END OF PROVISION]

6. RESEARCH MISCONDUCT

Scientific or research misconduct refers to the fabrication, falsification, or plagiarism in proposing, performing, or reviewing research, or in reporting research results. It does not include honest errors or differences of opinions. The Recipient organization has the primary responsibility to investigate allegations and provide reports to the Federal Government. Funds expended on an activity that is determined to be invalid or unreliable because of scientific misconduct may result in a disallowance of costs for which the institution may be liable for repayment to the awarding agency. The Office of Science and Technology Policy at the White House published in the Federal Register on December 6, 2000, a final policy that addressed research misconduct. The policy was developed by the National Science and Technology Council (65 FR 76260). The NRC requires that any allegation be submitted to the Grants Officer, who will also notify the OIG of such allegation. Generally, the Recipient organization shall investigate the allegation and submit its findings to the Grants Officer. The NRC may accept the Recipient's findings or proceed with its own investigation. The Grants Officer shall inform the Recipient of the NRC's final determination.

[END OF PROVISION]

7. PUBLICATIONS, VIDEOS, AND ACKNOWLEDGMENT OF SPONSORSHIP

Publication of the results or findings of a research project in appropriate professional journals and production of video or other media is encouraged as an important method of recording and reporting scientific information. It is also a constructive means to expand access to federally funded research. The Recipient is required to submit a copy to the funding agency and when releasing information related to a funded project include a statement that the project or effort undertaken was or is sponsored by the NRC. The Recipient is also responsible for assuring that every publication of material (including Internet sites and videos) based on or developed under an award, except scientific articles or papers appearing in scientific, technical or professional journals, contains the following disclaimer: "This [report/video] was prepared by

[Recipient name] under award [number] from [name of operating unit], Nuclear Regulatory Commission. The statements, findings, conclusions, and recommendations are those of the author(s) and do not necessarily reflect the view of the [name of operating unit] or the US Nuclear Regulatory Commission." This also applies to videos produced under NRC financial assistance awards.

[END OF PROVISION]

8. HOMELAND SECURITY PRESIDENTIAL DIRECTIVE – 12

If the performance of this grant/cooperative agreement award requires Recipients to have physical access to Federal premises for more than 180 days or access to a Federal information system, personal identity verification procedures must be implemented. Any items or services delivered under this financial assistance award shall comply with the Nuclear Regulatory Commission's personal identity verification procedures that implement Homeland Security Presidential Directive -12, FIPS Pub 201, and OMB Memorandum M-05-24. The Recipient shall insert this clause in all sub-awards or contracts when the sub-award recipient or contractor is required to have physical access to a Federally controlled facility or access to a Federal information system.

[END OF PROVISION]

9. 2052.215-70 KEY PERSONNEL (JAN 1993)

(a) The following individuals are considered to be essential to the successful performance of the work hereunder:

Yousef Bozorgnia
Jack Moehle

The contractor agrees that personnel may not be removed from the contract work or replaced without compliance with paragraphs (b) and (c) of this section.

(b) If one or more of the key personnel, for whatever reason, becomes, or is expected to become, unavailable for work under this contract for a continuous period exceeding 30 work days, or is expected to devote substantially less effort to the work than indicated in the proposal or initially anticipated, the contractor shall immediately notify the contracting officer and shall, subject to the concurrence of the contracting officer, promptly replace the personnel with personnel of at least substantially equal ability and qualifications.

(c) Each request for approval of substitutions must be in writing and contain a detailed explanation of the circumstances necessitating the proposed substitutions. The request must also contain a complete resume for the proposed substitute and other information requested or needed by the contracting officer to evaluate the proposed substitution. The contracting officer and the project officer shall evaluate the contractor's request and the contracting officer shall promptly notify the contractor of his or her decision in writing.

(d) If the contracting officer determines that suitable and timely replacement of key personnel who have been reassigned, terminated, or have otherwise become unavailable for the contract work is not reasonably forthcoming, or that the resultant reduction of productive effort would be so substantial as to impair the successful completion of the contract or the service order, the contract may be terminated by the contracting officer for default or for the convenience of the Government, as appropriate. If the contracting officer finds the contractor at fault for the condition, the contract price or fixed fee may be

equitably adjusted downward to compensate the Government for any resultant delay, loss, or damage.

10. DELIVERY SCHEDULE

Deliverables and their due dates are summarized below.

Deliverable	Schedule
Performance Reports	Semi-annually, no later than 30 days after each 6 month project period
Final Performance Report	No later than 90 days after the expiration of the award
Financial Status Report (SF-269)	Semi-annually, for the periods ending March 31 and September 30, no later than 30 days after each 6 month project period
Final Financial Status Report (SF-269)	No later than 90 days after the expiration of the award
Federal Cash Transaction Report (SF-272)	Semi-annually, for the periods ending March 31 and September 30, no later than 30 days after each 6 month project period
Final Federal Cash Transaction Report (SF-272)	No later than 90 days after the expiration of the award
Draft Ground Motion Prediction Equations	No later than April 30, 2013
Final Ground Motion Prediction Equations (PEER Report)	No later than April 30, 2014

[END OF MISCELLANEOUS PROVISIONS]

APPLICATION FOR FEDERAL ASSISTANCE

Version 7/03

		2. DATE SUBMITTED	Applicant Identifier
1. TYPE OF SUBMISSION: Application ☐ Construction ☑ Non-Construction	Pre-application ☐ Construction ☐ Non-Construction	3. DATE RECEIVED BY STATE	State Application Identifier
		4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier

5. APPLICANT INFORMATION

Legal Name: The Regents of the University of California	Organizational Unit: Department: Civil and Environmental Engineering
Organizational DUNS: 12-472-6725	Division:
Address: Street: 2150 Shattuck Avenue, Suite 313	**Name and telephone number of person to be contacted on matters involving this application (give area code)** Prefix: First Name: Viviane
City: Berkeley	Middle Name
County: Alemeda	Last Name: Her
State: CA / Zip Code: 94704-5940	Suffix:
Country: United States	Email: vher@berkeley.edu
6. EMPLOYER IDENTIFICATION NUMBER *(EIN)*: 9 4 - 6 0 0 2 1 2 3	Phone Number (give area code): (510) 642-8120 / Fax Number (give area code): (510) 642-8236
8. TYPE OF APPLICATION: ☑ New ☐ Continuation ☐ Revision. If Revision, enter appropriate letter(s) in box(es) (See back of form for description of letters.) ☐ ☐ Other (specify)	**7. TYPE OF APPLICANT:** (See back of form for Application Types) I: State Controlled Institution of Higher Learning. Other (specify)
	9. NAME OF FEDERAL AGENCY: Nuclear Regulatory Commission
10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: ☐☐-☐☐☐. TITLE (Name of Program): unsolicited	**11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT:** Next Generation Attenuation Models for Central and Eastern US (NGA-East)
12. AREAS AFFECTED BY PROJECT *(Cities, Counties, States, etc.)*: Central and Eastern US	
13. PROPOSED PROJECT Start Date: 10/01/2008 / Ending Date: 09/30/2014	**14. CONGRESSIONAL DISTRICTS OF:** a. Applicant CA-009 / b. Project

15. ESTIMATED FUNDING:

a. Federal	$ 4,401,013.00
b. Applicant	$ .00
c. State	$ .00
d. Local	$ .00
e. Other	$ .00
f. Program Income	$ .00
g. TOTAL	$ 4,401,013.00

16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?

a. Yes. ☐ THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON DATE:

b. No. ☑ PROGRAM IS NOT COVERED BY E. O. 12372

☐ OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW

17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?

☐ Yes If "Yes" attach an explanation. ☑ No

18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT. THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED.

a. Authorized Representative

Prefix	First Name: Patricia	Middle Name
Last Name: Gates		Suffix
b. Title: Assistant Director		c. Telephone Number (give area code): (510) 642-8109
d. Signature of Authorized Representative: Patricia Gates		e. Date Signed: 5/6/08

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Standard Form 424 (Rev.9-2003)
Prescribed by OMB Circular A-102

OMB Approval No. 0348-0040

ASSURANCES - NON-CONSTRUCTION PROGRAMS

PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.

2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.

3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.

4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.

5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).

6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee-3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.

7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.

8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.

10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is $10,000 or more.

11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).

12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.

13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).

14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.

15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.

16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.

17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."

18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL	TITLE
Patricia Bates	Assistant Director
APPLICANT ORGANIZATION	DATE SUBMITTED
The Regents of the University of California	May 6, 2008

A Project Plan for Next Generation Attenuation Models for Central & Eastern North America (NGA-East)

To:

US Nuclear Regulatory Commission (NRC),
US Department of Energy (DOE),
US National Earthquake Hazard Reduction Program (NEHRP),
Electric Power Research Institute (EPRI)

By:

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May 2008

CONTENTS

INTRODUCTION

This project plan summarizes the planning for a major multidisciplinary research program to develop Next Generation Attenuation Models for Central & Eastern North America (CENA), NGA-East. The NGA-East is a follow up of a successful multi-institution, multi-investigator, multi-sponsor collaborative project called the Next Generation Attenuation Relationship (NGA-West) project (originally referred to as NGA) which was coordinated over five years by the Pacific Earthquake Engineering Research Center (PEER). PEER is a US national earthquake engineering research center with headquarters at the University of California, Berkeley. The NGA-West project was sponsored by a group of California-based agencies, principally the California Department of Transportation, California Energy Commission, and Pacific Gas & Electric Company. The newly developed Ground Motion Prediction Equations (GMPEs) for the Western North America (WNA) have met their objectives and have been adopted by the United States Geological Survey (USGS) for development of the latest version of the US National Seismic Hazard Maps.

For CENA, the GMPEs have constituted a major source of uncertainty for seismic hazard calculations. This is a result of the ad hoc nature of attenuation relationship developments in the past, lack of sufficient recorded ground motions, and lack of coordinated efforts to develop a consistent, yet independent, set of GMPEs for CENA.

Currently PEER has a contract with the US Nuclear Regulatory Commission (NRC) to:

- Bring together a group of experts in GMPEs for CENA,
- Organize two invitational workshops and a public workshop on the NGA-East program to cast a tentative plan for the execution of the NGA-East program, and obtain feedback from experts, stakeholders, and a larger earthquake community, and
- Provide project plan for execution of the NGA-East program.

The project plan report is based on the NGA-East planning workshops, and numerous interactions with various experts in the field of GMPEs. The report provides a background on the NGA-West program for the Western US, a summary of the NGA-East workshops held, a list of

technical issues to be addressed during the course of NGA-East, plan for management of the NGA-East, and its tentative budget and the timeline.

BACKGROUND ON NGA-WEST

The biggest changes in the 2008 US National Seismic Hazard Maps are due to changes in the ground motion attenuation relations selected to estimate ground motions from shallow crustal earthquakes in the Western United States. New attenuation relations were developed in a comprehensive 5-year NGA-West program coordinated by PEER, in partnership with the U.S. Geological Survey (USGS) and the Southern California Earthquake Center (SCEC). The NGA-West project involved development of attenuation relations by five expert teams (the ground motion model "developers"). Each team developed their own separate attenuation models but interacted extensively with each other and with other scientists and engineers during the model development process. To ensure that the best available science was incorporated in the development of the ground motion relations, the NGA-West program included important supporting components, including:

1. development of an updated and expanded PEER strong-ground motion database,
2. conducting of supporting research projects in key technical areas, and
3. conducting of a program of interactions throughout the development process.

The NGA-West database is one of the largest uniformly processed databases of earthquake ground motion recordings, with 3551 recordings from 173 shallow crustal earthquakes. It also includes a comprehensive list of supporting information (metadata) about the recordings, such as various earthquake source parameters, source-to-site distance measures, site classification schemes, among other parameters. The database is available to the public via PEER Internet web site: http://peer.berkeley.edu/. The NGA models were developed for horizontal components of peak ground acceleration, peak ground velocity, and response spectral ordinates at periods ranging from 0.01 to 10 seconds, for distances ranging from 0 to 200 km, and for magnitudes ranging from 5 to 8.5. Most NGA models also directly use site amplifications based on the parameter V_{S30} (average shear wave velocity in the upper 30 meters of soil), which is important for implementation of the models for the US National Seismic Hazard Maps. According to the

NGA-West developers, the new models supersede their previous GMPEs. During the course of NGA-West:

- Six working groups were organized to provide input to the model developers in specific technical areas,
- Eight workshops, each involving 40 to 80 scientists and engineers, were organized to provide periodic review of the project,
- Numerous information-exchange meetings among the model developers were held, and
- Extensive review processes were conducted to review the NGA-West database and the newly developed attenuation relations.

A peer review of the attenuation relations was carried out by the USGS, the California Geological Survey (CGS), and an independent national review panel selected by the USGS. The review panel consisted of prominent US seismologists, geotechnical engineers, and structural engineers. As a result of this process, the USGS adopted the documented NGA-West ground motion relations for development of the new US National Seismic Hazard Maps.

The impacts of the NGA-West relations on the National Seismic Hazard Maps are illustrated in Figures 1 and 2, developed by the USGS National Seismic Hazard Maps team. These figures show the ratio of the estimated ground motion based on the NGA-West values over those based on the existing (2002) National Seismic Hazard Maps. These figures are for a return period of 2500 years (i.e., 2% probability of exceedance in 50 years). Figures 1 and 2 are for oscillator periods of 0.2 and 1.0 sec, respectively. The impact of the NGA-West relations are significant, especially for a period of 1.0 sec, where there is a significant reduction in the estimated ground motions based on the NGA-West relations. There are two main reasons for such a significant reduction, as indicated by Dr. Arthur Frankel (ATC Workshop, December 2006): (a) correction of soil shear-wave velocity assigned for "rock sites" in the 2002 hazard maps; and (b) having additional data from moderate and large earthquakes and improved functional forms to fit the observed data.

NGA-EAST PLAN

As previously indicated, the goal of the NGA-East program is to develop next generation attenuation relations (GMPEs) for central & eastern North America (CENA). In the NGA-East program a set of well-coordinated and yet separate, well-reviewed, GMPEs for CENA will be developed.

During the course of the NGA-East program, the database developers, GMPE developers, researchers, stake holders, and end-users of the GMPEs will all be involved in a multi-disciplinary and fully transparent process. Similar to the NGA-West program, researchers and practitioners will work on various tasks of the NGA-East program. The compiled database along with its documentation will be fully available to the public via a dedicated NGA-East web site. The draft and final reports of the supporting research projects will be also available to the public. There will be various small and large workshops to collect feedback and comments from experts as well as the earthquake community at large. The GMPEs developed in the NGA-East program will be reviewed by independent reviewers, various stakeholders and end-users including the NRC, DOE, NEHRP, USGS staff and their designated review panel(s). The end-users such as engineers and utilities will have an opportunity to see the preliminary results and provide feedback.

The end products of the NGA-East will include:

- A comprehensive database of recorded and simulated ground motions for Stable Continental Regions, such as the CENA,
- Findings and reports of various supporting research projects, and
- A set of well-coordinated yet separate GMPEs that are based on a well-reviewed database and vetted ground motion simulation techniques.

These NGA-East products can be used for a wide range of applications within CENA. A short list of such applications include seismic design and analysis of nuclear power plants, DOE facilities, industrial facilities, buildings, bridges and all civil engineering facilities. Another important aspect of the NGA-East GMPEs is their implementation for development of the US National Seismic Hazard Maps. Building code committees use these maps to generate a set of

design maps for use in seismic design according to building codes. In summary, the NGA-East GMPEs have the potential to impact almost the entire spectrum of seismic design in CENA.

Management Organization of NGA-East Program

The NGA-East program will be managed by a Joint Management Committee (JMC). Figure 3 shows a conceptual management organization chart for the NGA-East. The members of the JMC include representatives of key funding agencies, who fund the program by contributing $500,000 or more, and PEER. For each subaward (project), the JMC reviews and finally approves:

- Scope of work,
- Budget,
- Principal Investigator (PI),
- Duration, and
- Deliverables.

In the decision making process in the JMC, each group member (e.g., PEER) will collectively have one vote. The decision of the JMC must be unanimous among the JMC members. The JMC is advised by a Technical Advisory Committee (TAC). The members of the TAC will be well-known experts in the earthquake community. After the initiation of the NGA-East program, the TAC members will be selected by the JMC.

Timeline and Estimated Budget

The plan is to finish all the supporting research projects and GMPEs in five years after the starting date of the NGA-East program. The sixth year of the NGA-East program will be devoted to the PSHA implementation, and review of the data and models. The review will be carried out by various experts including the USGS and its independent review panel. This will allow the USGS to adopt the attenuation relations for the next revision of the US National Seismic Hazard Maps.

The total budget for the NGA-East program from all funding sources is $4.4M. The tentative distribution of the overall budget for the eight technical topics is shown in Table 1. The overall

time-distribution of the budget (i.e., budget profile) is listed in the last row of Table 1. As indicated above, within each topic, the final budget for each sub-project will be decided upon by the JMC with input from the Technical Advisory Committee.

Summary List of Technical Issues to be Addressed by NGA-East

During the planning phase of the NGA-East program, through several communications, meetings and workshops with numerous experts, a list of technical issues to be addressed during the course of NGA-East was compiled. The technical issues were organized into eight large topics, as briefly summarized below. The complete list of the technical issues is provided in **Attachment A** of this report.

I. **Development of Ground Motion Database:** An important element of NGA-East is the development of a very comprehensive database of ground motions recorded worldwide in Stable Continental Regions (SCRs). The database will include the recorded time series and their spectra, as well as their supporting metadata, such as magnitude, various distance measures, site conditions, among other parameters. The database will be heavily used by the model developers, but will also be available to the public.

II. **Source Rupture Characterization:** Under this topic, seismic source parameters will be compiled, such as rupture area, seismic moment, rise time, average slip, average slip velocity, number and size of asperities, dynamic stress drop/corner frequency, and finite fault rupture models of CENA and other SCR earthquakes. Other projects under this topic include, among others, the determination of appropriate stress parameters required for use with stochastic ground motion simulation models.

III. **Source-Site Path:** Several issues will be addressed under this topic, including physical causes for a geometrical spreading steeper than 1/R. Recent studies have shown that this issue plays an important role for ground motion predictions in CENA. It will also be determined if there are differences in the geometrical spreading coefficient within CENA, or between WNA and CENA. Also, appropriate Q models, as a function of depth and frequency, will be derived, among other issues listed in Attachment A.

IV. **Site Effects:** Technical issues to be addressed include the use of small earthquakes in CENA to empirically derive basin/sediment depth effects; use of 1-D site-response analysis to determine whether shallow site-response effects are transferable from WNA to CENA; among other projects. Site response effects for hard-rock site conditions (V_{S30}>1500 m/s) will also be addressed since this site condition is common in the CENA region.

V. **Other Constraints on Ground Motions:** In this topic, data for Modified Mercalli Intensity (MMI) values and liquefaction data in CENA and other SCRs will be collected to constrain and check the predicted spectral levels for large earthquakes. Other issues to be addressed include resolving the apparent contradiction between the predicted relative ground motions in CENA and WNA and those inferred from intensity studies; among other issues.

VI. **Ground Motion Simulation:** Due to the limited number of recorded ground motions in CENA, ground motion simulations play an important role in the NGA-East program. Related projects include calibration and validation of viable ground motion simulation models using CENA and other SCR ground motions and showing that forward predictions compare favorably with observed recordings, including time series and elastic and inelastic response spectra. Both point-source and finite-source models will be included, although it is anticipated that finite-source models will be preferred by the model developers. Additionally, validated and calibrated simulation models will be used to generate suites of ground motions for various magnitude, distances, source geometry, and faulting mechanisms to be used by the GMPE developers.

VII. **Development of Ground Motion Prediction Equations**: Next generation GMPEs will be developed under this topic. GMPEs will be applicable to magnitude range of 4.0 to 8.0 and distances up to 500-1000 km. GMPEs for both horizontal and vertical components will be developed. The models will be carefully checked against the compiled ground motion data. As part of development of GMPEs, aleatory uncertainty models for CENA will also be developed, including determining whether aleatory uncertainty is a function of magnitude, distance, and site conditions. Quantification of uncertainty is a key issue when conducting a defensible PSHA for the CENA.

VIII. PSHA Implementation: Under this topic, an epistemic uncertainty model will be developed for the NGA-East GMPEs. This can be used in PSHA implementation of the developed ground motion relations. For the PSHA implementation, if it is needed, a conversion between magnitude measures (e.g., moment magnitude and m_N/m_{LG}) will be also developed.

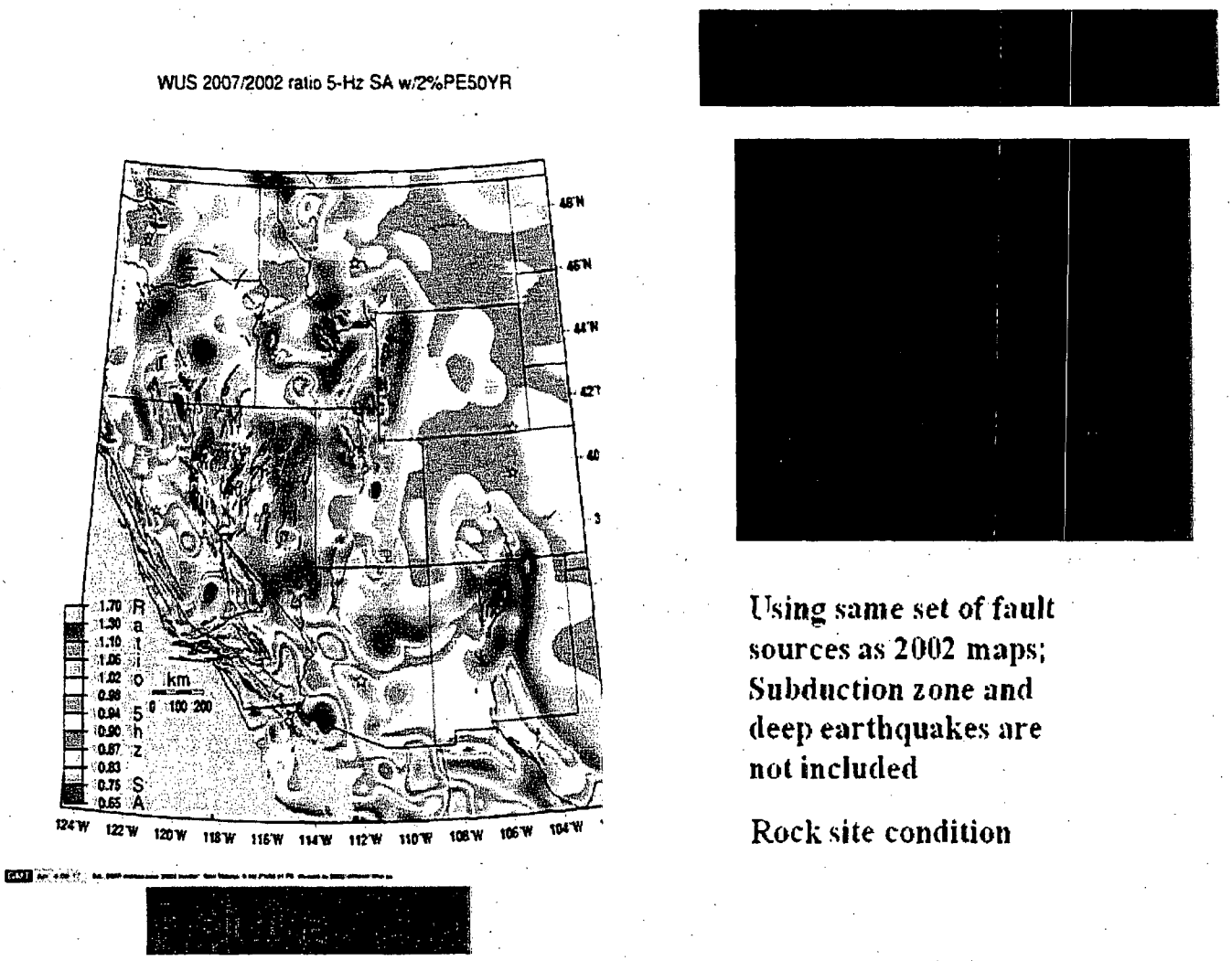

Figure 1: Impact of NGA-West on the US National Seismic Hazard Map (UNSHM). This map shows the ratio of the NGA-based values over the values in the 2002 UNSHM for period 0.2 sec for the same set of faults.

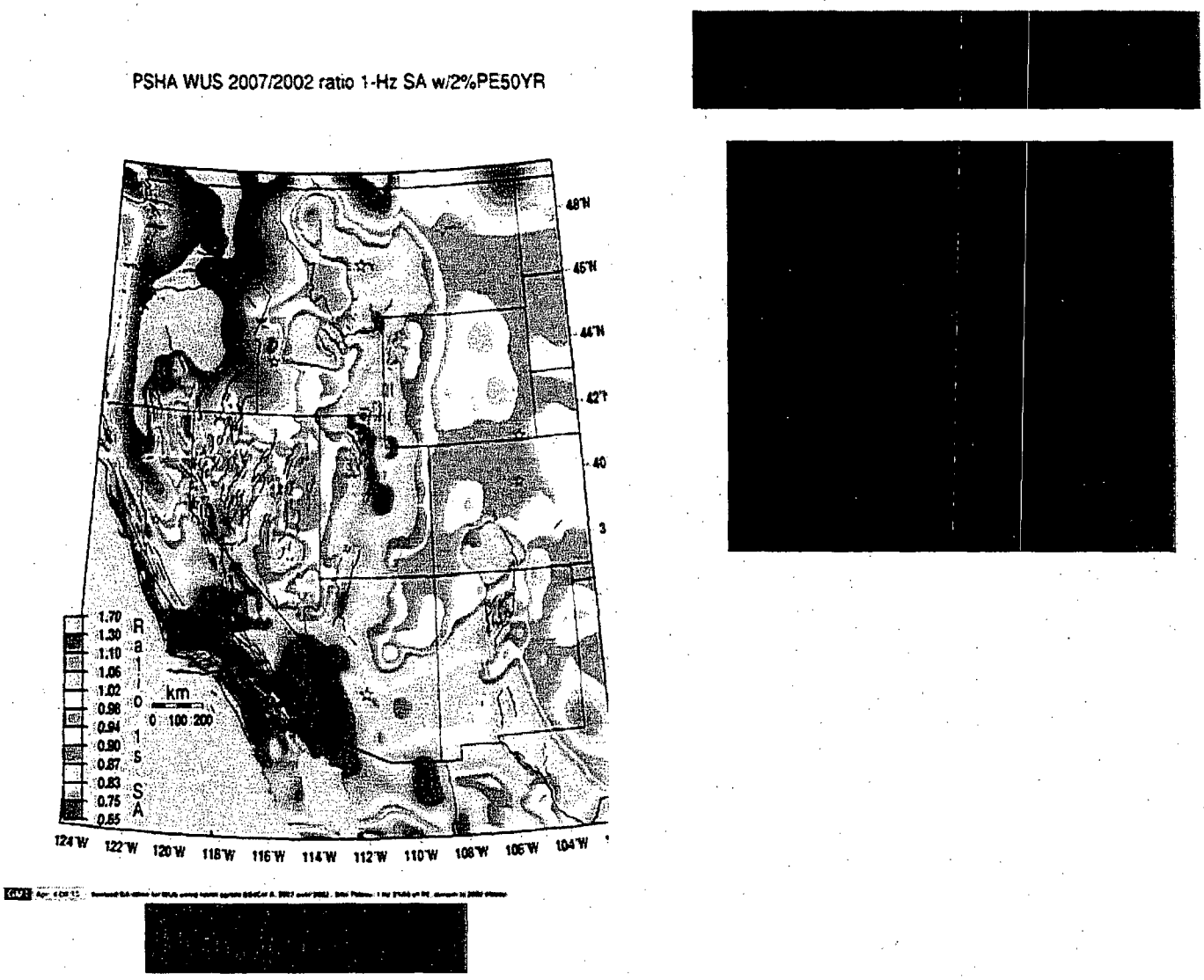

Figure 2: Impact of NGA-West on the US National Seismic Hazard Map (UNSHM). This map shows the ratio of the NGA-based values over the values in the 2002 UNSHM for period 1.0 sec for the same set of faults.

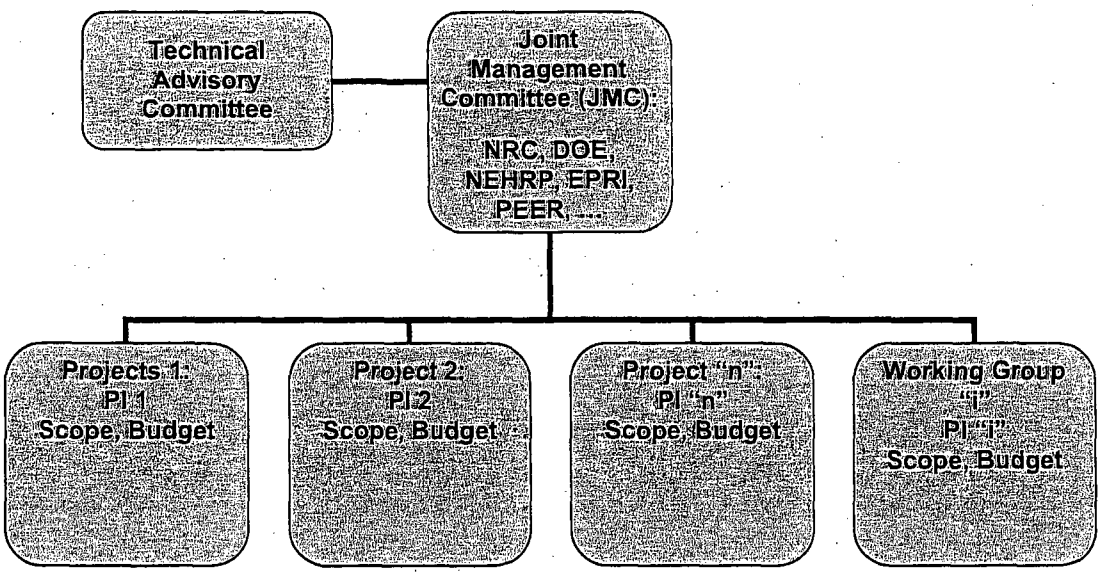

Figure 3: Conceptual organization chart for the NGA-East program. "Projects" include various supporting R&D projects, development of GMPEs, etc. Example "Working Group" is working group on database development, etc.

Table 1: Tentative Budget for NGA-East Program (*)

Year ==>	1	2	3	4	5	6 (Review & Adoption of models)	Total
I. Database (**)	0.3	0.3	0.2	0	0	0	0.8
II. Source Characteristics	0.2	0.1	0.1	0	0	0	0.4
III. Source-Site Path	0	0.2	0.2	0	0	0	0.4
IV. Site Effects	0	0.1	0.1	0.2	0	0	0.4
V. Other Constraints	0.1	0.1	0.1	0	0	0	0.3
VI. GM Simulation	0	0.2	0.3	0.2	0	0	0.7
VII. GMPEs	0.1	0.1	0.1	0.3	0.4	0.1	1.1
VIII. PSHA Implementation					0.1	0.2	0.3
Review Process by USGS, NRC, etc.	0	0	0	0	0	0	0
Total Estimate ($M)	0.7	1.1	1.1	0.7	0.5	0.3	4.4
Total Adjusted Estimate, $M (***)	**0.73**	**0.94**	**0.95**	**0.75**	**0.62**	**0.42**	**4.4**

(*) **Note 1:** Numbers are in $M, and include overhead, travel expenses, workshops and meeting expenses, office expenses, labor to organize projects, etc.

(**) **Note 2:** Each topic will have various sub-projects. The scopes, budgets, Principal Investigators (PIs) of each sub-project will be determined by the NGA-East Joint Management Committee (JMC).

(***) **Note 3**: In the time-profile of the "adjusted budget", estimated expenses that are uniformly distributed over time have been taken into account.

Attachment A

Complete List of Technical Issues to be Resolved In the Course of NGA-East Program

Next Generation Ground Motion Prediction Equations ("Attenuation") for Central and Eastern North America (CENA)
NGA-East

Complete List of Technical Issues to Be Addressed

I. Ground Motion Database

1. Collect and archive ground motion records from Central and Eastern North America (CENA) events along with pertinent metadata. If possible, ground motion data as far as 1000 km from the source should be collected.
2. Collect and include relevant international data (records and metadata) from Stable Continental Regions (SCRs) that are believed to have similar tectonic characteristics as CENA.
3. Form a Database Working Group to advise on various technical issues related to the database and to recommend short-term and intermediate-term supporting projects related to the database development. Because it is critical path, the Working Group should start its activities before the start of the other NGA-East tasks.
4. The database should be well-documented, including documentation of Quality Assurance (QA) of the record collection, record processing, and metadata collection.
5. Record processing should be carried out uniformly. In this regard, the experience gained from the record processing tasks in the NGA-West project will be helpful.
6. Metadata should include an estimate of moment magnitude and various distance measures, including closest distance to rupture (rupture distance), closest distance to the surface projection of rupture (i.e., Joyner-Boore distance), epicentral distance, and hypocentral distance.
7. Obtain measurements of V_{S30} for all recording sites included in the database. If this is not possible for some sites, V_{S30} should be estimated using correlations between surface geology and V_{S30} specifically developed for CENA.
8. Measure or estimate the depth to hard rock and to the 1.0, 1.5 and 2.5 km/sec shear-wave velocity horizons for all recording sites included in the database.
9. Compile information about the recording instruments, including component orientations, instrument type, etc.
10. Compile or calculate all ground motion components of interest, including the vertical component and various definitions of the horizontal components, such as the as-recorded components, the geometric mean of the as-recorded components, the GMRotI50 geometric mean component, the maximum rotated component, the strike-normal component, and the strike-parallel component.
11. Calculate all ground motion parameters of engineering and seismological interest, including the Fourier amplitude spectra, PGA, PGV, PGD, and Pseudo Spectral Acceleration (PSA) for multiple damping values at the same periods used in the NGA-West project.

12. If available, collect more detailed information about the earthquake that might be available, such as the finite-fault rupture model inversion (both for CENA and other SCR events).
13. The highest priority in data collection and processing should be given to the larger events (M>4), but it is also important to collect good quality data for smaller events down to magnitudes of 3.0.
14. Ground motion database should only include information regarding the recordings, the recording site, and the earthquake and, except the items listed above, should not contain data that is inferred from modeling.

II. Source Rupture Characterization

1. Source Parameter Database: Compile source parameters such as rupture area, moment, rise time, average slip, average slip velocity, number and size of asperities, dynamic stress drop/corner frequency, and finite fault rupture models of CENA and analogous earthquakes.
2. Refine or develop scaling relations for CENA, such as area vs. moment, area vs. rise time, average slip vs. moment, average slip velocity, number and size of asperities, dynamic stress drop/corner frequency, etc., and determine whether these scaling relations are model dependent.
3. Directly compare source characteristics of earthquakes in the magnitude range of 4-5 in the WNA and CENA and determine whether the shapes of the source spectra are the same in CENA and WNA and, if not, what parameters cause the observed differences.
4. Determine appropriate stress parameters (required for stochastic models) in CENA. Issues to be addressed are the average stress drop and its variability, whether there are regional differences, and whether it depends on magnitude, focal mechanism, depth, etc.

III. Source-Site Path

1. Determine near-source geometrical spreading effects (especially within 70 km of the source). Issues to be addressed are: whether there are regional differences within CENA, what is the physical cause for a geometrical spreading steeper than 1/R, whether there are differences between WNA and CENA, whether there are regional differences within CENA, whether they are dependent on fault mechanism, etc.
2. Determine the effect of mid-crustal and Moho reflections on the amplitude decay with distance, including its dependence on magnitude and wave frequency.
3. Derive appropriate Q models as a function of depth and frequency and determine whether there are regional differences in these models. Note that Q and geometrical spreading are closely linked and need to be developed together.
4. Scattering model: Treat scattering as a Source-Site Path parameter, separate from Q. This is motivated by the concept that the parameter that is currently measured as Q may partly reflect a scattering process, not just an absorption process.
5. Derive regional velocity structures.

6. Examine regional differences in ground motions for CENA, and possibility of dividing the CENA into ground motion regions.

IV. Site Effects

1. Define a reference site condition to use in the development of the GMPEs (e.g., NEHRP B-C, hard rock, V_{S30} = 2000 m/sec, V_{S30} = 2800 m/sec, etc.)
2. Develop one or more reference NEHRP B-C site profiles for CENA, including layer thickness, total profile depth, Vp, Vs, density, lithology, Q, and kappa. Issues to be addressed are whether these profiles should be dependent on depth to hard rock and, if only one profile is to be selected, what depth it should represent.
3. Determine whether WNA and CENA reference NEHRP B-C and other NEHRP Site Class site profiles should be regionalized.
4. Derive reference soil profiles for NEHRP Site Classes A, B, C, D and E (see parameters defined in item 5) and use these profiles to determine whether the NEHRP site factors should be revised for CENA (e.g., whether they are different from the current set of factors developed for WNA) and whether the relationship between ground motion and Vs30 should be a function of profile depth and other measures that characterize the deeper structure of the profile.
5. Using the reference soil profiles, use 1-D site-response analysis to determine whether shallow site-response effects are transferable from WNA to CENA.
6. Extend the site response range to high VS30 values (up to 3000 m/s) for application to hard-rock conditions in the CENA.
7. Use small earthquakes in CENA to empirically derive basin/sediment depth effects in CENA.

V. Other Constraints on Ground Motions

1. Develop and use MMI distributions for CENA and other SCR earthquakes to help constrain and check spectral levels for large magnitudes.
2. Collect and analyze liquefaction data in CENA and other SCR earthquakes to help constrain and check spectral levels for large magnitudes.
3. Explain the apparent contradiction between the predicted relative amplitudes of CENA and WNA ground motions and those inferred from intensity studies.
4. For average soil sites, determine whether observed spectral accelerations are greater for CENA earthquakes than for WNA earthquakes of the same magnitude for all distances as implied by intensity data, and if they are determine why this is the case.
5. Use intensity, liquefaction and ground motion data to help determine whether there is a spectral sag in the CENA source spectra at intermediate frequencies and, if so, how deep the sag is.

VI. Ground Motion Simulation

1. Calibrate and validate viable ground motion simulation models using CENA and other SCR ground motion data and show that forward predictions compare favorably with observed recordings, including time series and elastic and inelastic response spectra. Both finite-source and point-source models will be included.
2. Use validated and calibrated simulation models to generate suites of ground motions for various magnitude, distances, source geometry, and faulting mechanisms to be used by GMPE modelers.
3. Determine whether ground motion saturation effects are transferable from WNA to CENA.
4. Derive source spectral shapes. Issues to be addressed are whether there exists a spectral sag at intermediate frequencies and whether the shapes are different between WNA and CENA.
5. Determine whether faulting mechanism, hanging-wall, and source depth effects are transferable from WNA to CENA and, if not, what these effects are in CENA.
6. Determine whether basin/sediment-depth effects are transferable from WNA to CENA.

VII. Ground Motion Prediction Equations (GMPEs): Modeling Issues and Supporting Research Topics

1. Develop true Next Generation GMPEs as opposed to using or updating existing models (i.e., in a process consistent with NGA-West).
2. GMPEs should be applicable to M 4.0 to 8.0 and distances of 500 to1000 km.
3. Develop GMPEs for horizontal (GMRotI50) and vertical components of ground motion.
4. Demonstrate that the NGA-East GMPE models agree with the observed ground motion data in the ground motion database (including relevant data from worldwide SCRs such as the Bhuj earthquake) over the magnitude and distance ranges defined in item 2.
5. Demonstrate that the attenuation characteristics predicted by the GMPE models take into account the range in crustal structures and the transition between crustal provinces in CENA as identified in other tasks of the NGA-East project.
6. Consider the following issues when developing GMPE models:
    a. Most recorded data come from magnitudes-distance combinations that are not of engineering interest.
    b. The models will have already used these data to define functional forms and constrain parameter values; thus, the models are not independent from the data.
    c. The models are not independent of each other and might, as a group, underestimate epistemic uncertainty.
7. Develop aleatory uncertainty models for CENA and determine whether aleatory uncertainty is a function of magnitude, distance, and site conditions. Issues to be addressed are whether there should be a single aleatory uncertainty model independent of the median models, whether it should be different than in WNA, and whether there are negative correlations amongst parameters that will reduce it.

VIII. PSHA Implementation

1. Derive an epistemic uncertainty model. Issues to be addressed are whether uncertainty in addition to that corresponding to the suite of GMPE models should be included, whether it is a function of magnitude, distance and other parameters, and what weights should be assigned to the GMPE models.
2. Develop conversions between magnitude measures (e.g., **M** and m_N/m_{LG}) and distance measures (e.g., R_{RUP} and hypocentral distance) to use when source and site parameters are defined in terms parameters not used to develop the GMPE models.

IX. Other Issues Related to, But Outside Scope of, NGA-East

1. Develop V_{S30} and depth to bedrock maps for CENA.

erso Engineering Research Support Organization

University of California, Berkeley
Proposed Budget
NRC, US-DOE, NEHRP, EPRI

NRC-04-08-144 9/16/08
Final Revision
Incorporated into Contract

Principal Investigators: Jack Moehle, Yousef Bozorgnia
Title: Next Generation Attenuation for Central & Eastern US (NGA-East)
Begin Date: 10/1/2008
End Date: 9/30/2014
Research Type: On Campus-Sponsored Research
Sponsor Type: Modified Total Direct Costs

						Budget Years:	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
							2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2008-2014
SALARIES			No. of Mos.	Monthly Rate	Percent of Time		Subtotal	Subtotal	Subtotal	Subtotal	Subtotal	Subtotal	Subtotal
Faculty	Jack Moehle		1	18,986	50%		9,493	9,873	10,268	11,212	11,661	12,127	64,633
					Total		9,493	9,873	10,268	11,212	11,661	12,127	64,633
Graduate Student Researchers		No. GSR											
Academic	Resident	0	9	3,358	50%		0	0	0	0	0	0	0
Summer	Resident	0	3	3,358	100%		0	0	0	0	0	0	0
Academic	Non-Resident	0	9	3,358	50%		0	0	0	0			0
Summer	Non-Resident	0	3	3,358	100%		0	0	0	0			0
					GSR Total		0	0	0	0	0	0	0
Other Personnel													
1	Yousef Bozorgnia	1	12	10,899	35%		45,777	47,608	49,512	51,492	53,552	55,694	303,635
1	Postdoc (TBD)	1	12	3,625	100%		43,500	45,240	47,050	48,932	50,889	0	235,610
1	Mariko Yasuda	1	12	5,984	10%		7,181	7,468	7,767	8,078	8,401	8,737	47,631
1	AA III	1	12	3,640	10%		4,368	4,543	4,724	4,913	5,110	5,314	28,973
					Total		100,826	104,859	109,053	113,415	117,952	69,745	615,850
SALARY SUBTOTAL							110,319	114,731	119,321	124,627	129,612	81,872	680,482
BENEFITS					Rate								
	Professors				12.7%		1,206	1,254	1,304	1,424	1,481	1,540	8,208
	GSR Workers' Compensation - Academic Year				1.3%		0	0	0	0	0	0	0
	GSR Summer Appointment Benfefits				3.0%		0	0	0	0	0	0	0
	Resident Tuition Fees	2008-2009	0 semesters		$5,269		0	0	0	0	0	0	0
	Nonresident Tuition Fees	2008-2009	0 semesters		$13,512		0	0	0	0	0	0	0
	Yousef Bozorgnia				29.0%		13,275	13,806	14,358	14,933	15,530	16,151	88,054
	Postdoc (TBD)				22.0%		9,570	9,953	10,351	10,765	11,196	0	51,834
	Mariko Yasuda				22.0%		1,580	1,643	1,709	1,777	1,848	1,922	10,479
	AA III				22.0%		961	999	1,039	1,081	1,124	1,169	6,374
BENEFITS SUBTOTAL							26,592	27,655	28,761	29,980	31,179	20,783	164,950
PERSONNEL SUBTOTAL							136,910	142,387	148,082	154,607	160,791	102,655	845,432
TRAVEL	Domestic Travel for technical meetings:						4000	5000	5000	5000	5000	7000	31000
	Foreign Travel:						0	0	0	0	0	0	0
TRAVEL SUBTOTAL							4,000	5,000	5,000	5,000	5,000	7,000	31,000
EQUIPMENT	(only individual items ≥5K)												
	1						0	0	0	0	0	0	0
	2						0	0	0	0	0	0	0
	3						0	0	0	0	0	0	0
EQUIPMENT SUBTOTAL						Total	0	0	0	0	0	0	0
SUPPLIES & EXPENSES													
	Meeting expenses and workshops						4,000	6,000	7,000	7,000	8,000	12,000	44,000
	Honorarium/Consultant Services						24,000	24,000	24,000	24,000	24,000	24,000	144,000
	Publications (reports, papers, etc.)						0	3,000	6,000	6,000	6,000	6,000	27,000
	Miscellaneous office expenses						1,500	2,000	2,000	2,000	2,000	2,000	11,500
SUPPLIES & EXPENSES SUBTOTAL							29,500	35,000	39,000	39,000	40,000	44,000	226,500
SUBAWARDS	Subaward's overhead is on first 25K only.Edit MTDC to subtract 25K from each institution's $.												
	I. Database						182,071	156,061	130,051	0	0	0	468,182
	II. Source Characteristics						130,051	52,020	52,020	0	0	0	234,091
	III. Source-site Path						0	130,051	130,051	0	0	0	260,101
	IV. Site Effects						0	52,020	52,020	130,051	0	0	234,091
	V. Other Constraints						52,020	52,020	52,020	0	0	0	156,061
	VI. GM Simulation						0	130,051	182,071	130,051	0	0	442,172
	VII. GMPEs						52,020	52,020	52,020	182,071	234,091	52,020	624,243
	VIII. PSHA Implementation						0	0	0	0	52,020	130,051	182,071
SUBAWARD SUBTOTAL							416,162	624,243	650,253	442,172	286,111	182,071	2,601,013
TOTAL DIRECT COSTS							$586,572	$806,630	$842,335	$640,779	$491,903	$335,726	$3,703,945
MODIFIED TOTAL DIRECT COSTS* **							270,410	257,387	192,062	198,607	230,791	153,655	1,302,932
INDIRECT COST TOTAL 10/1/08-6/30/09					@	53.00%	$107,488						$107,488
INDIRECT COST TOTAL 7/1/09-6/30/11					@	53.50%	$36,167	$137,702	$102,764	$106,255	$123,473	$82,206	$588,567
					TOTAL COST		$730,228	$944,332	$945,099	$747,034	$615,376	$417,932	$4,400,000

Subaward OH calculation		1	2	3	4	5	6	
OH	I. Database	25,000	0	0	0	0	0	25,000
no OH	#1	157,071	156,061	130,051	0	0	0	443,182
	II. Source Characteristics	25000	0	0	0	0	0	25,000
	#2	105,051	52,020	52,020	0	0	0	209,091
	III. Source-site Path	0	25,000	0	0	0	0	25,000
	#3	0	105,051	130,051	0	0	0	235,101
	IV. Site Effects	0	25000	0	0	0	0	25,000
	#4	0	27,020	52,020	130,051	0	0	209,091
	V. Other Constraints	25000	0	0	0	0	0	25,000
	#5	27,020	52,020	52,020	0	0	0	131,061
	VI. GM Simulation	0	25,000	0	0	0	0	25,000
	#6	0	105,051	182,071	130,051	0	0	417,172
	VII. GMPEs	25,000	0	0	0	0	0	25,000
	#7	27,020	52,020	52,020	182,071	234,091	52,020	599,243
	VIII. PSHA Implementation	0	0	0	0	25,000	0	25,000
	#8	0	0	0	0	27,020	130,051	157,071
	First $25,000 charged OH	100,000	75,000	0	0	25,000	0	200,000
	No OH	316,162	549,243	650,253	442,172	261,111	182,071	2,401,013

Next Generation Attenuation Models for Central & Eastern US (NGA-East)

Abstract of a Proposal to:
US Nuclear Regulatory Commission (NRC)
US Department of Energy (DOE)
US National Earthquake Hazard Reduction Program (NEHRP)
Private Organizations

The Pacific Earthquake Engineering Research Center (PEER) has successfully coordinated a comprehensive multi-year multi-disciplinary research program "Next Generation Attenuation Models (NGA-West)"; originally referred to as NGA. The goal of the NGA-West program has been to develop the next generation attenuation models for shallow crustal earthquakes, such as earthquake events in California.

NGA-West has been very successful program. The relationships were developed by bringing all major attenuation relationship developers together in a single comprehensive and collaborative research project. The NGA-West database and models went through a comprehensive review process by the USGS and were adopted for the upcoming US National Hazard Maps.

Even more so than the western United States (WUS), attenuation relationships for the Central and Eastern US (CEUS) have constituted a major source of uncertainty for seismic hazard calculations throughout the CEUS. As with the WUS, this is a result of the ad hoc nature of attenuation relationship development in the past. Uncertainty in these relationships leads to discrepancies in hazard levels. The NGA-East project would use the methods, tools, and many of the researchers of the NGA-West program to develop a new set of consistent and broadly accepted attenuation relationships for the CEUS.

A natural step beyond the NGA-West is to develop a research program for "Next Generation Attenuation Relationship East (NGA-East)" for the Central and Eastern US (CEUS). The objective of the NGA-East project is to develop a set of next generation attenuation relationships for the Central and Eastern US (CEUS).

PEER received fund from the US NRC to organize a research plan for the NGA-East program. During this planning phase, PEER organized workshops in the east and west coasts of the US, collected input from several national experts, and communicated with US NRC, UC DOE and other funding agencies for the actual research phase of NGA-East.

The objective of NGA-East program is to compile a very comprehensive database of earthquake ground motions in Stable Continental Regions, and to develop next generation attenuation models for CEUS. The impact of NGA-East will be enormous on seismic design of new facilities such as nuclear power plants, and on the seismic evaluation of existing facilities located in CEUS.

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EDUCATION

UNIVERSITY OF CALIFORNIA, Berkeley: Ph.D. Civil Engineering, Structural Engineering & Structural Mechanics, June 1981.
Ph.D. Dissertation Committee: Prof. James M. Kelly; Prof. Ray W. Clough; and Prof. Dan Mote
UNIVERSITY OF CALIFORNIA, Berkeley: M.S., June 1975.
SHARIF UNIVERSITY OF TECHNOLOGY, Iran: B.S., June 1973. Graduated with Honors.
MCMASTER UNIVERSITY, Department of Civil Engineering, Canada, Post-Doctoral Research Fellow, 1982-1984

APPOINTMENTS

Pacific Earthquake Engineering Research Center (PEER), University of California at Berkeley, Berkeley, California, *Associate Director*, 2004-present
Applied Technology & Science, San Francisco, California, *Principal*, 2000-2004
Exponent Failure Analysis Associates, Menlo Park, California, *Managing Engineer*, 1996-2000
EERI/FEMA NEHRP Professional Fellow, in collaboration with UC Berkeley and USGS, 1995
EQE International, San Francisco, California, *Principal Engineer*, 1990-1994
URS/John A. Blume & Associates, San Francisco, California, *Consultant*, 1988-1990
TENERA LP, Berkeley, California, *Associate*, 1985-1988

HONORS

- Selected as the *U.S. National Earthquake Hazard Reduction Program (NEHRP) Professional Fellow,* by Earthquake Engineering Research Institute (EERI), supported by the Federal Emergency Management Agency (FEMA), 1995.
- Elected as *Fellow* of the American Society of Civil Engineers (ASCE), 1998.
- Recipient of the University of California at Berkeley graduate scholarship, 1975, and 1978.
- Exempted from taking doctoral preliminary examination due to high academic standing, Department of Civil Engineering, University of California, Berkeley, 1978.

PROFESSIONAL LICENSES AND REGISTRATION

- Registered Professional Civil Engineer (PE) in the State of California.
- Registered with California Office of Emergency Services (OES) as Damage Assessment Volunteer for post-earthquake investigation.

MEMBERSHIP

- *Fellow*, American Society of Civil Engineers (ASCE)
- Associate Editor, *Bulletin of Seismological Society of America (BSSA)*, 2007-present
- Member, Board of Directors, Northern CA Chapter of Earthquake Engineering Research Institute (EERI), 2007-present
- Member, State of *California Strong-Motion Instrumentation Program*, Earthquake Ground Response Sub-committee, 2004-present
- Member, *Advisory Committee, California Integrated Seismic Network (CISN)*, 2007-present

- Member, *Commission on Earthquake Hazard, Risk and Strong Ground Motion*, International Association of Seismology and Physics of the Earth's Interior (IASPEI), 2007-present.
- Member, *Earthquake Engineering Research Institute (EERI)*, 1986-present
- Member, *Structural Engineers Association of Northern California (SEAONC)*
- Member, *Seismological Society of America (SSA)*
- Member, *Steering Committee*, 2009 Conference of the ASCE *Technical Council on Lifeline Earthquake Engineering (TCLEE)*, Berkeley, CA
- Member, *Technical Committee*, 5th National Seismic Conference on Bridges & Highways, September 18-20, 2006, San Francisco, CA

SELECTED PUBLICATIONS

- ***Book***: "***Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering***", Yousef Bozorgnia and Vitelmo V. Bertero (Coordinating Editors). CRC Press, June 2004, p.1150. The book has been a text for graduate courses at various universities, including: ***University of California, Berkeley, State University of New York, Buffalo,*** and ***Lehigh University.***

- ***"Engineering characterization of ground motion"***, Y.Bozorgnia and K.W. Campbell, Chapter 5, *Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering*, Bozorgnia and Bertero (Eds.), CRC Press, June 2004.

- ***"Early years of earthquake engineering and its modern goal"***, V.V.Bertero and Y.Bozorgnia, Chapter 1, *Earthquake Engineering: From Engineering Seismology to Performance-Based Engineering*, Bozorgnia and Bertero (Eds.), CRC Press, June 2004.

- "***Campbell-Bozorgnia NGA Ground Motion Relations for the Geometric Mean Horizontal Component of Peak and Spectral Ground Motion Parameters***," Kenneth W. Campbell and Yousef Bozorgnia, *Report PEER 2007/02*, Pacific Earthquake Engineering Research Center (PEER), University of California, Berkeley, May 2007.

- "NGA Ground Motion Model for the Geometric Mean Horizontal Component of PGA, PGV, PGD and 5% Damped Linear Elastic Response Spectra for Periods Ranging from 0.01 to 10 s", K.W. Campbell and Y. Bozorgnia, *Journal of Earthquake Spectra*, Vol. **24**, March 2008.

- "An Overview of NGA Project", M.Power, B.Chiou, N.Abrahamson, Y. Bozorgnia, T.Shantz, and C.Roblee, *Journal of Earthquake Spectra*, Vol. **24**, March 2008.

- "Comparisons of the NGA ground-motion relations", N. Abrahamson, G. Atkinson, D. Boore, Y. Bozorgnia, K. Campbell, B. Chiou, I.M. Idriss,W. Silva, and R. Youngs, *Journal of Earthquake Spectra*, Vol. **24**, March 2008.

- "Ground Motion Issues for Seismic Analysis of Tall Buildings: A Status Report", Y.Bozorgnia, K.W.Campbell, N.Luco, J.P.Moehle, P.Somverville, T.Yang, *Journal of The Structural Design of Tall and Special Buildings*, Vol. **16**, December 2007, pp. 665-674.

- "The tall buildings initiative," Jack Moehle, Yousef Bozorgnia, and Tony Yang, *Proceedings of the 2007 Convention of the Structural Engineers Association of California*, September 26-29, 2007, Tahoe, California.

- "Ground Motion Selection, Modification, and Simulation for Seismic Analysis of Tall Buildings," Y. Bozorgnia, N. Luco, F. Naeim, P. Somerville, *ASCE Structures Congress*, Long Beach, CA, May 16-19, 2007.

- "How should ground motions for average horizontal component and strike-normal and strike-parallel components be interpreted for use in design?" K. W. Campbell and Y. Bozorgnia, *Third ATC-35/USGS National Earthquake Ground-Motion Mapping Workshop*, San Mateo, California, December 7, 2006.

- "Collapse of lightly confined reinforced concrete frames during earthquakes," J.P. Moehle, W. Ghannoum, and Y. Bozorgnia, in ***Advances in Earthquake Engineering for Urban Risk Reduction***, S.T. Wasti and G. Ozcebe (Eds.), 317-332, August 2006.

- "Next generation attenuation (NGA) ground motion models: Can they be used in Europe?", K.W. Campbell and Y. Bozorgnia, *Proceedings of the 1st European Conference on Earthquake Engineering ad Seismology*, Geneva, Switzerland, September 3-8,2006, Paper 458.

- "Campbell-Bozorgnia next generation attenuation (NGA) relations for PGA, PGV and spectral acceleration", K.W. Campbell and Y. Bozorgnia, *Proceedings of the 8th National Conference on Earthquake Engineering*, San Francisco, CA, April 2006, Paper 906.

- "Attenuation of Inelastic and Damage Spectra", Y. Bozorgnia, M. Hachem, and K.W. Campbell, *Proceedings of the 8th National Conference on Earthquake Engineering*, San Francisco, CA, April 2006, Paper 1127.

- "Computation of Inelastic Response Spectra for NGA", M. Hachem and Y. Bozorgnia, *Proceedings of the 8th National Conference on Earthquake Engineering*, San Francisco, CA, April 2006, Paper 1612.

- "Collapse of lightly confined reinforced concrete frames during earthquakes", W. Ghannoum, J.P. Moehle, and Y. Bozorgnia, *Proceedings of the 8th National Conference on Earthquake Engineering*, San Francisco, CA, April 2006, Paper 1854.

- "Structural classifications of traditional houses in Iran based on their seismic behavior", S.E. Mousavi, A. Khosravifar, M.A. Ghannad, A. Bakhshi, A.A. Taheri, and Y. Bozorgnia, *Proceedings of the 8th National Conference on Earthquake Engineering*, San Francisco, CA, April 2006, Paper 1143.

- "Demonstration of the COSMOS/PEER-LL virtual geotechnical data center", J. Swift, J. Benoit, L. Turner, D. Ponti, J. Bobbitt, C. Real, J. Futrelle, C. Stepp and Y. Bozorgnia, *ASCE Atlanta GEOCONGRESS*, February 26-March 1, 2006.

- ***"The December 26, 2003, Bam, Iran, Earthquake"***, Special Issue of *Journal of Earthquake Spectra*, **Technical Editors**: F. Naeim, M. Mehrain, and Y. Bozorgnia, December 2005, Volume 21, Issue S1, 534p.

- "Development of international data standards for the COSMOS/PEER-LL Virtual Data Center", with J. Swift, et al., presented at the *Annual Meeting of American Geophysical Union (AGU)*, December 2005, San Francisco.

- "Study of the effects of near-source vertical ground motion on seismic design of precast concrete cladding panels," *ASCE Journal of Architectural Engineering*, Vol. 10, No. 4, pp. 167-184, 2004. Co-authored with Prof. A.Memari and H.Maneetes.

- "Damage spectrum and its applications to performance-based earthquake engineering", *Proceedings of the 13th World Conference on Earthquake Engineering*, paper number 1497, Vancouver, Canada, August 2004. Co-authored with Prof. V.V. Bertero.

- "Preliminary observations on the Bam, Iran, earthquake of December 26, 2003", *Earthquake Engineering Research Institute*, Preliminary Reconnaissance Report, April 2004. Co-authored with EERI Reconnaissance Team.

- "Vertical-to-horizontal response spectra ratio and tentative procedures for developing simplified V/H and vertical design spectra," *Journal of Earthquake Engineering*, Vol. 8, No. 2, 2004, pp. 175-207, Co-authored with Dr. Kenneth W. Campbell.

- "Damage spectra: Characteristics and applications to seismic risk reduction", *ASCE Journal of Structural Engineering*, October 2003, Vol. 129, No. 10, pp. 1330-1340, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Updated near-source (attenuation) relations for estimating horizontal and vertical components of PGA and acceleration response spectra," *Bulletin of Seismological Society of America*, Vo. 93, February 2003, by Kenneth W. Campbell and Yousef Bozorgnia.

- "An introduction to the classic paper: A mechanical analyzer for the prediction of earthquake stresses, by Maurice Biot", Journal of *Seismological Research Letters*, Vol. 74, Number 3, 312, May/June 2003, by Yousef Bozorgnia.

- "Damage spectra and their applications to rapid post-earthquake damage assessments," *7th US-Japan Workshop on Urban Earthquake Hazards Reduction*, Hawaii, March 23-26, 2003, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Estimation of damage potential of recorded earthquake ground motion using structural damage indices." *Proceedings of the 12th European Conference on Earthquake Engineering*, September 9-13, 2002, London, UK, paper number 475, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Near real-time post-earthquake damage assessment based on reliable damage indices and damage spectra." *Proceedings of the 7th U.S. National Conference on Earthquake Engineering*, July 21-25, 2002, Boston, Massachusetts, Paper no. 363, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Improved damage parameters for post-earthquake applications," *Proceedings of SMIP02 Seminar on Utilization of Strong-Motion Data*, May 2, 2002, Los Angeles, CA, pp. 61-82, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Effect of near-field vertical ground motion on seismic design of precast concrete cladding panels." *Proceedings of the Second International Conference on Advances in Structural Engineering and Mechanics (ASEM'02)*, Busan (Pusan), Korea, August 21-23 2002, By Prof. A.M. Memari, and H. Maneetes, and Y.Bozorgnia.

- "Evaluation of damage potential of recorded earthquake ground motion." *96th Annual Meeting of the Seismological Society of America, San Francisco*, April 18-20, 2001, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "Engineering implications of ground motions from the *Mw* 6.8 Nisqually (Seattle) earthquake of February 28, 2001." *96th Annual Meeting of the Seismological Society of America, San Francisco*, April 18-20, 2001. Co-authored with Dr. Ken Campbell.

- "Improved damage parameters for post-earthquake applications," *Report, State of California, Strong Motion Instrumentation Program*, Sacramento, December 2001, by Yousef Bozorgnia, and Prof. Vitelmo V. Bertero.

- "New empirical models for predicting near-source horizontal, vertical, and V/H response spectra: Implications for design," *Proceeding of the 6th International Conference on Seismic Zonation*, November 12-15, 2000, Palm Springs, by Ken W. Campbell and Yousef Bozorgnia.

- "Vertical response of twelve structures recorded during the Northridge earthquake," Journal of *Earthquake Spectra*, Vol. 14, pp. 411-432, August 1998, by Yousef Bozorgnia, Prof. S. A. Mahin, and Dr. A. G. Brady.

- "Structural damage claims attributed to aftershocks," *Proceedings of the Second Congress on Forensic Engineering, American Society of Civil Engineers (ASCE)*, May 21-23, 2000, San Juan, Puerto Rico, pp. 123-131, By B.M. McDonald, J.D.Osteraas, and Y.Bozorgnia.

- "Vertical ground motion and estimation of V/H spectral ratios," *Proceedings, U.S.-Japan Conference on Structural Design and Construction Practices in the United States and Japan*, August 2000, Victoria, Canada, by Yousef Bozorgnia, and Dr. Ken W.Campbell.

- "Seismic collapse of reinforced concrete towers," Proceedings, *World in Concrete & Structures*, August 22-24, 2000, Singapore. Co-authored with Drs. B.Ross, J.D.Osteraas, G.Luth, and P.D.Moncarz.

- "Observed spectral characteristics of vertical ground motion recorded during worldwide earthquakes from 1957 to 1995," Proceedings of the *12th World Conference on Earthquake Engineering*, Auckland, New Zealand, Jan-Feb 2000. Co-authored with Dr. Ken W.Campbell and Dr. M.Niazi.

- "Attenuation of vertical and horizontal response spectra of the Loma Prieta earthquake," *USGS Professional Paper 1552-D, United States Geological Survey, "The Loma Prieta, California, Earthquake of October 17, 1989 – Earth Structures and Engineering Characterization of Ground Motion,"* Tom Holzer (Editor), December 1998. Co-authored with Dr. M.Niazi.

- "Ductility and strength demands of near-Fault ground motions of the Northridge earthquake," *Proceedings of the 6th U.S. National Conference on Earthquake Engineering*, Seattle, May-June 1998. Co-authored with Prof. S. A. Mahin.

- "Recorded vertical response of twelve instrumented structures," *Proceedings of the Northridge Earthquake Research Conference*, California Universities for Research in Earthquake Engineering (CUREe), August 1997. Co-authored with Prof. S. A. Mahin and Dr. A. G. Brady.

- "Ductility demands of near-Fault ground motions of the Northridge earthquake," *Proceedings of the Northridge Earthquake Research Conference*, California Universities for Research in Earthquake Engineering (CUREe), August 1997, by Yousef Bozorgnia, Prof. S. A. Mahin and Dr. A. G. Brady.

- "Relationship between vertical and horizontal response spectra of the Northridge earthquake," *Proceedings of the 11th World Conference on Earthquake Engineering*, June 1996, Mexico, by Yousef Bozorgnia, Dr. M.Niazi, and Dr. Ken W. Campbell.

- "Spectral characteristics of vertical ground motion in the Northridge and other earthquakes," *Technical Council on Lifeline Earthquake Engineering Monograph No. 6, Lifeline Earthquake Engineering*, Proceedings of the Fourth U.S. Conference, American Society of Civil Engineers, New York, Aug. 1995, pages 660-667, by Yousef Bozorgnia, Dr. M.Niazi and Dr. K.W. Campbell.

- "Vertical responses of twelve instrumented structures recorded during the Northridge earthquake," *Earthquake Engineering Research Institute (EERI)*, Report published by EERI, December 1995, by Yousef Bozorgnia, Prof. S.A. Mahin and Dr. A.G. Brady. 275 p.

- "Characteristics of Free-Field Vertical Ground Motion during the Northridge Earthquake," Journal of *Earthquake Spectra*, Vol. 11, No. 4, November 1995, pp.515-525, by Yousef Bozorgnia, Dr. M.Niazi, and Dr. Ken W.Campbell.

- "Empirical analysis of ground motion recorded during the 1992 Landers, California, earthquake," *Bulletin of the Seismological Society of America*. Volume 84, No. 3, June 1994, pp.573-588, by Ken W. Campbell and Yousef Bozorgnia.

- "Near-source attenuation of peak horizontal acceleration from worldwide accelerograms recorded from 1957 to 1993," *Proceedings of the Fifth U.S. National Conference on Earthquake Engineering*, Chicago, July 1994, by Ken W. Campbell and Yousef Bozorgnia.

- "Vertical ground motion during the 1994 Northridge earthquake," *ATC-15-5, 6th U.S.-Japan Conference on Structural Design and Construction Practices in the United States and Japan*, September 19-21, 1994, Victoria, Canada. Co-authored with Dr. M.Niazi, and Dr. Ken W.Campbell.

- "Distance scaling of vertical and horizontal response spectra of the Loma Prieta earthquake." Journal of *Earthquake Engineering and Structural Dynamics*, Vol. 22, pp.695-707, August 1993. Co-authored with Dr. M.Niazi.

- "1990 Manjil, Iran, earthquake: Geology and seismology overview, PGA attenuation, and observed damage." *Bulletin of Seismological Society of America*, Vol. 82, No. 2, April 1992, pp. 774-799. Co-authored with Dr. M.Niazi.

- "Behavior of near-source peak vertical and horizontal response spectra over SMART-1 Array, Taiwan." Journal of *Earthquake Engineering and Structural Dynamics,* Vol. 21, February 1992, pp. 37-50. Co-authored with Dr. M.Niazi.

- "Behavior of near-source peak vertical and horizontal ground motions over SMART-1 Array, Taiwan." *Bulletin of the Seismological Society of America*, Vol. 81, No. 3, pp. 715-732, June 1991. Co-authored with Dr. M.Niazi.

- "Ductility demand due to asymmetry." Proceedings of the *9th World Conference on Earthquake Engineering,* Tokyo, Japan, August 1988. Co-authored with Prof. W.K.Tso.

- "Additional ductility demand due to inelastic torsional responses." Proceedings of the *8th European Conference on Earthquake Engineering*, Vol. 3: 6.7/49-55. Portugal, September 1986. Co-authored with Prof. W.K.Tso.

- "Inelastic earthquake response of asymmetric structures." *Journal of Structural Engineering, ASCE,* Vol. 112, No. 2, February 1986, pp. 383-400. Co-authored with Prof. W.K.Tso.

- "Distance-dependent behavior of response spectra of the 1989 Loma Prieta earthquake for different site geology." *44th Annual Meeting of the Earthquake Engineering Research Institute*, February 6, 1992, San Francisco, CA. Co-authored with Dr. M.Niazi.

- "A statistical study of phasing between vertical and horizontal components of PGA." *87th Annual Meeting of the Seismological Society of America*, April 14-16, 1992, Santa Fe, New Mexico. Co-authored with Dr. M.Niazi.

- "Comparison of the ground-motion attenuation during the 1990 Manjil, Iran, and the 1989 Loma Prieta, California, USA, earthquakes." Proceedings of the *International Conference on Seismology and Earthquake Engineering, Tehran*, Iran, May 1991. Co-authored with Dr. M.Niazi.

- "Observed ratios of PGV/PGA and PGD/PGA for deep soil sites across SMART1 2D Array, Taiwan." Proceedings of the *Fourth U.S. National Conference on Earthquake Engineering,* Palm Springs, CA, May 1990. Co-authored with Dr. M.Niazi.

- "Vertical to horizontal PGA ratios of October 17, 1989 Loma Prieta earthquake as compared to distance dependent predictions of SMART1 data." *1990 Annual Meeting of the Seismological Society of America,* Santa Cruz, CA, May 1990. Co-authored with Dr. M.Niazi.

- "Empirical modeling of site-specific response spectra for Lotung, Taiwan." Proceedings of the *General Assembly of International Association of Seismology and Physics of the Earth's Interior,* Istanbul, August 1989. Co-authored with Dr. M.Niazi.

- "Effective eccentricity for seismic response of buildings." Journal of *Earthquake Engineering and Structural Dynamics,* Vol. 14, No. 3, June 1986, pp. 413-427. Co-authored with Prof. W.K.Tso.

- "Ground acceleration distribution in Iran: A probabilistic approach." *Proceedings of the 8th World Conference on Earthquake Engineering,* San Francisco, CA, July 1984, Vol. 1, pp.45-51. Co-authored with Dr. A.A.Mohajer.

- "Seismic risk investigation of major cities of Iran." *Journal of Earth and Space Physics,* Vol. 11, No. 2, pp. 15-38, December 1982.

- "An alternative equivalent linear model for hysteretic structures." Proceedings of the *9th U.S. National Congress of Applied Mechanics:* 485. Cornell University, June 1982. Co-authored with Prof. J.M. Kelly.

- "Linearization Methods in Earthquake Analysis and Design of Hysteretic Structural Systems." *Ph.D. Thesis*, 1981, Department of Civil Engineering , Structural Engineering and Structural Mechanics, University of California, Berkeley.

SELECTED RESEARCH AND PROFESSIONAL EXPERIENCE

- Co-Principal Investigator, **$2,955,289** research funding from the ***California Department of Transportation (Caltrans) for Seismic Performance of Lifelines,*** (2005-present), Pacific Earthquake Engineering Research Center (PEER), University of California, Berkeley.

- Program Manager, ***Lifelines Program***, Pacific Earthquake Engineering Research Center (PEER), University of California, Berkeley (2004-present).

- Principal Investigator, research project funded by the California Geological Survey on "Identification of improved **damage parameters** for post-earthquake applications." Improved structural damage indices were defined for seismic performance-based assessment of existing structures and performance-based design of new structures. Inelastic dynamic analyses were performed using hundreds of the ground motions recorded during the 1992 Landers, 1994 Northridge, and 1999 Kocaeli (Turkey) earthquakes.

- Co-developer, **Campbell-Bozorgnia Attenuation Equation**, "Next generation attenuation of strong ground motion" (2003-present), Pacific Earthquake Engineering Research Center, University of California, Berkeley. The model has been adopted by the USGS for the 2007 edition of the US National Seismic Hazard Maps.

- Co-developer, **Campbell-Bozorgnia Attenuation Equation** (1994 to 2003 versions) for near-source earthquake ground motion, including peak ground acceleration and response spectra. In the U.S., the model has been selected as one of the models to generate the Maximum Considered Earthquake (MCE) maps for seismic design. The MCE maps are used in seismic structural design according to the International Building Code (IBC-2000), ASCE seismic design loads (SEI/ ASCE 7), NEHRP 2000 provisions (FEMA-368), and FEMA prestandard for seismic rehabilitation of buildings (FEMA-356).

- Technical Manager, **seismic vulnerability study of three large refineries** in Turkey, including Izmit refinery that was severely damaged during the 1999 Kocaeli earthquake. The team comprised more than 15 professors and engineers from the U.S. and Turkey.

- Analyzed more than four hundred ground motions recorded during the **1999 Chi-Chi, Taiwan, earthquake** to estimate response spectra at several hydroelectric industrial sites in Taiwan. The project was funded by Electric Power Research Institute (EPRI) through ABS Consulting.

- Analyzed recorded ground motions during the **1999 Kocaeli, Turkey**, earthquake to estimate response spectra at several industrial facilities in Turkey. The project was funded by Electric Power Research Institute (EPRI) through ABS Consulting.

- Principal Investigator, research project on "Evaluation of measured vertical response of **12 instrumented structures** during the 1994 Northridge earthquake." The structures included 4 steel buildings, 5 concrete structures, and 3 base-isolated buildings. Dynamic structural characteristics were identified by frequency domain identification techniques. Research was funded by the **Federal Emergency Management Agency (FEMA)**, through the **EERI** Professional Fellowship.

- Major earthquake investigation study on root causes of partial **collapse of a reinforced concrete structure** during the 1993 Guam earthquake (magnitude 8.1). Comprehensive nonlinear time history analyses were carried out to identify the failure initiation and the subsequent failure propagation. The models included detailed nonlinear finite element models of beam-column subassemblies and global nonlinear building models.

- Field investigation of earthquake-caused damage to various structures including buildings, bridges and industrial facilities after the 1989 Loma Prieta, 1990 Manjil, 1994 Northridge, 1999 Kocaeli (Turkey), earthquakes, and **EERI Reconnaissance Team Member** for damage investigation of the 2003 Bam, Iran, earthquake.

- Principal Investigator, research project on engineering analyses, engineering implications, and **damage potential of thousands of ground motions** recorded during worldwide earthquakes for various engineering applications. The project was funded by Strong Motion Instrumentation Program, California Geological Survey. The project included development of attenuation of

horizontal and vertical response spectra and investigation of characteristics of vertical ground motion and its building code implications. The recorded ground motions during numerous worldwide earthquakes were used in this study, including: 1989 Loma Prieta; 1990 Manjil; 1992 Landers; 1994 Northridge; 1995 Kobe earthquakes.

- Evaluation of seismic risk for a major **reinforced concrete water storage tank** for the City of Beverly Hills, California. Fragility curves were generated based on the proposed design. Probability of the tank failure during an earthquake on the Hollywood fault, located less than two kilometers from the site, was investigated.

- Investigation of a **17-story steel moment frame building**, damaged during the 1994 Northridge earthquake. Brittle fracture of beam-column welds resulted in a 6-inch permanent lateral deflection of the roof. The recorded motions of the building during the earthquake were analyzed to detect time-variation of structural characteristics.

- Nonlinear structural analysis of **St John Medical Plaza located in Santa Monica, California**. This steel moment frame building was damaged during the 1994 Northridge earthquake. The analyses included modeling of beam-column test specimen, and dynamic nonlinear analysis of the steel frame.

- Dynamic analysis and earthquake-resistant **upgrade design of Hoxie Bridge in Los Angeles County** for California Department of Transportation (Caltrans). Elastic and inelastic static analyses were performed for seismic evaluation of the bridge.

- In-house technical consultant on dynamic analyses and **seismic retrofit designs of various highway bridges** in California, EQE International.

- Dynamic structural analysis and **seismic strengthening design of 11-story reinforced concrete Hayward City Center**, located less than 1/3 of mile from the Hayward fault. The seismic retrofit design included *base-isolation* system. The analyses included detailed three-dimensional linear analysis and inelastic two- and three-dimensional time-history analyses.

- Research project on **inelastic analysis of asymmetrical buildings** to examine the effects of ground motion characteristics on ductility demand of buildings with plan irregularities.

- A major earthquake analysis and strengthening design of a **15-story reinforced concrete building** for Pacific Bell in Oakland, California. The project included a detailed 15,000 degrees of freedom finite element analysis of the foundation, soil-structure interaction analysis, and numerous computer analyses to investigate various seismic retrofit alternatives.

- Research project on the analysis of more than **seven hundred earthquake ground accelerations** recorded at SMART array in Taiwan, to investigate the relationship of vertical and horizontal ground motions in the near-field.

- Seismic evaluation, analysis and earthquake-resistant retrofit design of a **Chemistry Lab Building** located in northern California. A complete finite element model of the entire building, including diaphragms, was developed and analyzed. Seismic retrofit design included new reinforced concrete buttresses and upgrading of the diaphragm-wall connections.

- **Nonlinear finite element analysis** of a reinforced concrete liquid container. Concrete crashing and crushing as well as inelastic behavior of steel reinforcements were included. The analyses included thermal as well as dynamic loadings.

- Independent **third party reviewer for seismic analysis and design** of various structures and systems for an electric utility in Texas.

- Seismic vulnerability assessment of a major **underground reinforced concrete liquid-storage tank** including three dimensional dynamic soil-structure interaction effects.

- **Probabilistic seismic hazard analyses** of many sites, including modeling of hundreds of faults, area sources, and background seismic sources. Generated seismic hazard maps and ground acceleration contours for various probabilities of exceedance.

- **Shake table experimental studies** for seismic qualification for Bell Northern Research.

- Research project on seismic analysis of **base-isolated structures** to develop equivalent linearization techniques for analysis of elastic structures supported on inelastic base-isolators.

- **Research proposal reviewer** for the National Science Foundation, US Geological Survey.

- **Reviewer of research papers** submitted for publication in:
  - Bulletin of Seismological Society of America (BSSA)
  - American Society of Civil Engineers (ASCE) Journal of Structural Engineering
  - Journal of Earthquake Spectra
  - Journal of Earthquake Engineering and Structural Dynamics (EESD)
  - Journal of Earthquake Engineering (JEE)
  - Journal of Engineering Structures
  - Canadian Geotechnical Journal
  - World Conferences on Earthquake Engineering
  - US National Conferences on Earthquake Engineering