Testimony of
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Chairman Wu and Members of the Committee:

Good morning. My name is James Harris, and I am pleased to be here as you consider reauthorization of the National Earthquake Hazards Reduction Program (NEHRP). I am a consulting structural engineer employed at J. R. Harris & Company in Denver, Colorado. My business is designing structures, mainly buildings, to be useful and economical for their owners and to be safe for their users and the general public. NEHRP impacts what I do, and how well I achieve the objectives of my service.

I am also a member of and affiliated with several other organizations that are deeply interested in the success of NEHRP:

- I am currently the president of the board of governors of the Structural Engineering Institute of the American Society of Civil Engineers. SEI endeavors to serve the structural engineering profession and the public by continuously improving technical and professional practices. I am also a member and past chair of the committee that produces the standard ASCE/SEI 7 *Minimum Design Loads for Buildings and Other Structures*, which is directly impacted by NEHRP.
- I am the immediate past president of the board of directors of the Applied Technology Council. ATC is a nonprofit organization specializing in technology transfer to improve engineering practice to resist natural and other hazards. A majority of ATC's work is relevant to NEHRP and is performed under contract with FEMA and NIST.
- I am a member of the board of directors of The Masonry Society. TMS is a professional, technical, and educational association dedicated to the advancement of the knowledge of masonry. It produces standards for design and construction that are directly impacted by NEHRP.
- I am a member of standards development committees of the American Concrete Institute and the American Institute of Steel Construction, both of which produce standards for design and construction that are directly impacted by NEHRP.
- I am a member of various committees of the Building Seismic Safety Council, an arm of the congressionally-chartered nonprofit National Institute of Building Sciences. BSSC brings together nearly all the national, state, and regional organizations concerned with improving resistance to the effects of future damaging earthquakes.
- I am a member of the Advisory Committee on Earthquake Hazard Reduction, convened over the past two years by the National Institute of Standards and Technology, in response to the most recent reauthorization of NEHRP.

I cite all these activities and relations for two reasons: my testimony is certainly informed by each and every one of these affiliations, as well as others in the past, but my opinions are my own and must not be interpreted as the official position of any one of these organizations.

In your invitation, you asked me to answer four questions, and I will organize my testimony in that fashion.

Please comment on the level and effectiveness of interagency coordination and program performance since the previous reauthorization of NEHRP. Where are there opportunities for improvement?

I believe the level of interagency coordination has improved and the effectiveness of the program is beginning to show the result of that improvement. In large measure this is due to the work of Dr. John Hayes, the man that NIST selected to become the director of the program in their agency, but of course he could not succeed without the backing of senior management at NIST. I have observed the agencies working together on the new *Strategic Plan for NEHRP*, and I have been impressed that they did collaborate strongly in putting that plan together. Thirty years ago I was an employee at the (then) National Bureau of Standards (now NIST) as NEHRP was being created. I know that cooperation of agencies across major departments of the Federal Government to jointly achieve programmatic objectives is not nearly as simple as might be desired. It appears to me that the Interagency Coordinating Committee is a key element of making the cooperation effective, and I encourage the Congress to maintain the emphasis that the highest levels of management at each of the NEHRP agencies be committed to the program.

I will cite two examples of recent interagency coordination with which I am personally involved:

- USGS and FEMA have worked together to prepare a significant update to the maps of seismic ground shaking hazard used for design of most structures. The activity began at least three years ago in a committee of the BSSC, and it incorporates results of the newest research on attenuation of ground motion waves with distance and a more sophisticated method of considering both the nature of the hazard and the nature of structural response to produce what we call "risk-targeted" ground motions. The new maps have been approved at BSSC and are well on their way to approval within ASCE 7. If all goes well the new maps will be the basis of building codes in cities and states within two to three years. This would simply not be possible without true cooperation between USGS and FEMA.
- FEMA and NIST are targeting their funds for the support of applied research in a coordinated fashion to move forward as rapidly as feasible a potentially promising method for systematic quantification of parameters used by structural engineers in design to resist earthquakes. In the past these parameters have been established mostly on the basis of professional judgment, which is a political process and subject to powers of persuasion. This new work offers the opportunity to exchange some of the subjective judgment with objective analysis. It appears to be eagerly sought by professionals in the field, and the accelerated testing of the methodology would not be possible without the cooperation of FEMA and NIST.

I do want to note my appreciation for the leadership that FEMA offered to the program in the past. Their focus on implementation of mitigation measures is very close to my central focus, and I think NEHRP has been singularly successful over the years. It appeared to me that FEMA's ability to lead the program was being impaired by the change from being an independent agency to being a part of the new Department of Homeland Security, and thus I supported the change directed by Congress to make NIST the lead agency.

In addition to the enhanced cooperation that I mentioned earlier, I believe that the change to NIST has truly made the program a four agency program. Even though NIST was listed as one of the four agencies in the past, their budget, and therefore their commitment to and effectiveness within the program became so small as to be inconsequential.

There are opportunities for improvement. One obvious issue is that the appropriated funding of the program should reach the authorized levels. I appreciate that arriving at a Federal budget is an awesome task, but I do want to note that the appropriated funds are less than either the authorized amounts or the proposed funding in the President's budget in FY 2009. The Strategic Plan dated October 2008 lays out a very ambitious program, but it does not contain budgets. The authorized funding levels provide a base level to work towards the goals of that plan, and any smaller amounts will simply delay progress. Another opportunity for improvement is to either deepen the commitment of DHS to NEHRP or to enhance the ability of the earthquake program at FEMA to carry out its mission within the large and developing organization that is DHS.

What are the priorities for earthquake R&D to increase community resiliency? How well does NEHRP address these priorities? What would you recommend to ensure these priorities are addressed by NEHRP?

Please assess the technology transfer efforts supported by NEHRP. What would you recommend to improve the adoption of earthquake mitigation measures?

I will answer these two sets of questions together. I certainly support the priorities set forth in the recent Strategic Plan, and improving earthquake resilience of communities is one of the overarching goals of that plan. It is not possible to achieve that goal without effective technology transfer. Given my interest in design and construction, I will take this opportunity to highlight the activities necessary to support the objectives pertinent to those fields.

The productivity and effectiveness of the nation's seismic design and construction community is affected by a variety of factors (see the ATC 57 report, *The Missing Piece: Improving Seismic Design and Construction Practices*, prepared in a project supported by NIST). These include

- the makeup of the industry, which consists of a large number of small design offices, clients, vendors, and contractors, who do not have the resources or business models for supporting research and development in seismic risk reduction;
- the complexity and wide variety of construction types, including buildings of varying height, size, and construction materials, and a wide range of transportation and utility infrastructure facilities;
- the ever expanding number of buildings and structures in the nation's inventory, which naturally and routinely increases our exposure to seismic risk; (4) the availability of modern tools to improve efficiency; and
- the availability of new technology and information for reducing the effects of earthquakes on the built environment.

Future NEHRP plans must recognize and acknowledge these factors, and identify, promote, and fund actions that not only promote the development of new knowledge and methods for

earthquake risk reduction, but also halt the ever widening gap between knowledge development and its application. The gap is one of the major factors affecting the decline in productivity of the U.S. design and construction industry over the last two decades (ATC-57). To this end, a wide variety of recommended actions are necessary, some of which are already underway. These include:

- The continued implementation of an expanded, coordinated program of problem-focused research and development in earthquake engineering, which was started by NIST in 2008 in response to strong recommendations from industry. The recommended program includes:
    - Systematic support of the *Seismic Code Development* process:
        - Provide technical support for the seismic practice and code development process, including research to support development of more rational methods for determining critical design variables;
        - Support the development of performance-based seismic engineering through the conduct of research to develop fragility information on the broad range of structural and nonstructural components for which such information is not available;
    - Improve seismic *Design Productivity*:
        - Support the development of technical resources (e.g., guidelines and manuals) to improve seismic engineering practice, focusing on structure types (e.g., infrastructure) for which guidelines are not currently available or no longer reflect the state of practice, or the state of research;
        - Make evaluated technology available to practicing professionals in the design and construction community through the development of technical briefs and other means;
        - Develop tools to enhance the productivity, economy and effectiveness of the earthquake resistant design and construction process, including improved processes for computer aided design.
- Continued support of the FEMA-funded program to develop next-generation performance based seismic design guidelines for new and existing buildings, following the program plan that has been established for this purpose;
- Continued support of FEMA-funded programs for supporting mitigation activities necessary to improve technical quality in the field of earthquake engineering, including the investigation of seismic and related multi-hazard technical issues as they are identified by FEMA, the development and publication of technical design and construction guidance products, the dissemination of these products, and support of training and related outreach efforts based on these products;
- Expanded support of research being carried out under NSF-funded NEES Program, which was established to conduct research to improve the seismic design and performance of our Nation's civil and mechanical systems, with improved coordination and planning of research to support the major development programs being carried out by FEMA and NIST;
- Expanded support of efforts to identify research needs from the perspective of design professionals and of efforts to coordinate research to enhance its effectiveness.
- New programs to encourage local communities to adopt and enforce programs to identify and reduce the numbers of seismically hazardous structures in their community;

- Involvement in international cooperative efforts, such as the Global Earthquake Model (GEM), to better understand and evaluate how seismic hazard, structural vulnerability, and seismic risk are characterized and determined by other countries, thereby enhancing the potential for improving our competitiveness world wide.

I am particularly hopeful about the performance based seismic design program. NIST has published *Research Required to Support Full Implementation of Performance-Based Seismic Design* (NIST GCR 09-917-2) making use of the assistance of BSSC that defines the needs. To me the work appears to be groundbreaking, and I believe there will be many ancillary, or spinoff, benefits to this research.

How should the Federal Government address R&D for other natural hazards? What opportunities exist to coordinate hazards R&D across the Federal Government?

As a structural engineer I am required to consider many natural hazards in the conduct of my practice; earthquake, wind, snow, flood, ice and expansive soils can all have significant effects on the designs that I prepare. The role of the Federal Government in R&D is quite varied across these areas. Earthquakes are a prime example of a situation that requires a strong Federal effort to make progress towards disaster resilience, and NEHRP is a shining example of a successful Federal program. In my view the needs are not the same across this spectrum of hazards, but there are unfilled needs.

On the engineering design side, earthquake is unlike wind, snow, flood or ice. The nature of the action upon the structure couple with the extreme rarity and severity of strong earthquakes makes realistic a design strategy to accept significant damage to ordinary structures while still protecting against large loss of life. This brings a complexity to the engineering design and analysis that is simply unmatched in design for wind, snow, flood or ice. And this is the strongest underlying reason why so much R&D is necessary in earthquake engineering.

On the natural hazard definition side the differences do not appear to me to be quite as significant. Predicting the future from observation of the past is in the best tradition of strong science. The rarity of earthquake events does make seismology a challenging field, in my opinion, but I am sure there are comparable difficulties in meteorology.

I have long had a research interest in snow loads on roofs, and I think a contrast with the information available for definition of the hazard between earthquake and snow is instructive here. The USGS has done a very commendable job as the central focus for the applied science of defining the ground shaking hazard across the US. Their program does strongly benefit from the earth sciences research at NSF, and the USGS is very cooperative with the engineering community, especially in their interactions with BSSC. In ASCE/SEI 7, and therefore in the building codes used across the nation, we directly incorporate the maps that are produced by USGS. ASCE/SEI 7 also has hazard maps for snow, wind, and ice. These hazard definition maps are all produced by committee members in what amount to volunteer efforts.

The map for snow has a Federal relation; the committee member most responsible was Wayne Tobiasson, an engineer now retired, who worked for the U. S. Army Corps of Engineers at their

Cold Regions Research and Engineering Laboratory. It was not central to the role of the Corps; it was this man's professional convictions that led him to wade through available data from the Weather Service and the (former) Soil Conservation Service to prepare these maps. Even though the maps are extremely useful and the basis of our legal building codes, they have huge voids in mountainous regions where the snow loads are the largest, and the most difficult to discern. There is very little private sector incentive to collect, archive, and analyze the data necessary for the improved definition of the snow load hazard. In my opinion it is most appropriate for the Federal Government to fulfill at least the data collection and archiving of the information, if not the analysis. Yet the Weather Service has in recent years reduced their collection of information vital to predicting the weight of accumulated snow. The amount of money necessary is minor compared to the NEHRP budget, but there should be some way to accomplish the mission. The ASCE/SEI 7 map for ice has a similar story and a similar champion, Kathy Jones a scientist who also works for the Army Corps at CRREL.

The ASCE/SEI 7 map for windspeed is also produced by a volunteer committee. I know that this committee has heard testimony in the past concerning national needs for reducing the risk associated with high winds, and I will not attempt to repeat that here. But I will state that I certainly support increased Federal support for R&D to reduce the consequence of high winds, including support for technology transfer. I previously stated that the engineering side of the earthquake problem is complex. I want to note that a recent survey of practicing engineers pointed to the wind load provisions of ASCE/SEI 7 as being very difficult to understand or apply (more so than the seismic design provisions of the same standard). I attribute at least a part of this discrepancy to NEHRP. There is no wind equivalent of BSSC, which FEMA has supported for nearly three decades. The critical mass assembled and the continuity at BSSC have in no small measure made our seismic design provisions better. We need similar help in the wind area.

I am confident that Katrina has focused the attention of the Federal Government on coastal flood issues. It appears to me that there are large public policy issues that need to be resolved, included the proper level of safety and the appropriate means for funding protection. I will say that the level of safety from flooding is considerably lower that the level of safety provided against other natural hazards. There are very likely benefits to be gained from coordinated social science, engineering, and physical science research on these public policy issues.

Overall, I believe that NEHRP stands as an example of how to assemble a critical mass of expertise to move the nation forward. This has involved developing consensus on R&D priorities among all stakeholders, funding a wide group of interests to develop the expertise and to carry out the work, and focusing on implementation. These lessons can and should be applied to other natural hazards, but not at the expense of diluting the critical mass necessary for the synergy that has been realized.