Testimony to the Subcommittee on Technology and Innovation of the House Committee on Science and Technology

Hearing on

National Windstorm Impact Reduction Program: Strengthening Windstorm Hazard Mitigation

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Statement of

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1. Introduction

Mr. Chairman and members of the subcommittee, my name is Marc Levitan and I appreciate the opportunity to address you this morning. I am Director of the Louisiana State University Hurricane Center and the Charles P. Siess, Jr. Associate Professor of Civil and Environmental Engineering at Louisiana State University. I am also the immediate past-President of the American Association for Wind Engineering (AAWE), and a member of the American Society of Civil Engineers (ASCE). I am appearing today on behalf of the Louisiana State University Hurricane Center, AAWE, and ASCE.

Louisiana State University is the flagship institution of the state, classified by the Carnegie Foundation as a Doctoral/Research-Extensive University. The university has a long history of research in hurricanes, coastal sciences and engineering. The LSU Hurricane Center was founded and approved by the Louisiana Board of Regents in the year 2000 to provide a focal point for this work, with a mission to advance the state-of-knowledge of hurricanes and their impacts on the natural, built and human environments, to stimulate interdisciplinary and collaborative research activities, to transfer new knowledge and technology to students and professionals in concerned disciplines, and to assist the state, the nation, and world in solving hurricane-related problems. The study of wind effects on the built infrastructure and wind damage mitigation is one of the main focus areas of the LSU Hurricane Center, including: wind tunnel studies for wind effects on buildings, industrial structures and bridges; techniques for hurricane and tornado shelter assessment; evacuation and sheltering decision support tools; wind damage investigations; and participation in development of national wind loading codes and standards

The American Association for Wind Engineering (AAWE) was originally established as the Wind Engineering Research Council in 1966 to promote and disseminate technical information in the research community. In 1983 the name was changed to American Association for Wind Engineering and incorporated as a nonprofit professional organization. The multi-disciplinary field of wind engineering considers problems related to wind and associated water loads and penetrations for buildings and structures, societal impact of winds, hurricane and tornado risk assessment, cost-benefit analysis, codes and standards, dispersion of urban and industrial pollution, wind energy and urban aerodynamics.

The American Society of Civil Engineers ASCE, founded in 1852, is the country's oldest national civil engineering organization representing more than 140,000 civil engineers in private practice, government, industry and academia dedicated to the advancement of the science and profession of civil engineering. ASCE is a 501(c) (3) non-profit educational and professional society. ASCE is an American National Standards Institute (ANSI) -approved standards developer and publisher of the Minimum Design Loads for Buildings and other Structures (ASCE-7), which is referenced in the nation's major model building codes. As part of the ASCE-7 document, engineers are provided guidance in estimating the loads resulting from wind effects on structures. Thus, ASCE is at the forefront in the development of new information for engineers regarding wind and is in a unique position to comment on the status quo and our needs for the future.

2. Vulnerability of US Built Environment – and its Occupants – to Windstorm Hazards

As well documented in recent years, the damage and destruction caused by windstorms in the US has continued to rise dramatically. According to the National Oceanographic and Atmospheric Administration, 2008 could be a record setting year for tornado deaths.

> *This year may set records for tornadoes and tornado-related deaths. …"It is only the third time since the 1974 super tornado outbreak that there have been more than 100 tornado-related deaths during a single tornado season in the U.S.," added Harold Brooks, a research meteorologist at NOAA's National Severe Storms Laboratory also in Norman. "In 1998 and 1984 there were 132 and 122 tornado-related deaths, respectively — 2008 will likely equal or exceed that record." (NOAA, 2008).*

In just the past few years, the country has experienced an unprecedented level of damage due to landfalling hurricanes.

> *It is of note that the 2004 and 2005 hurricane seasons produced seven out of the nine costliest systems ever to affect the United States. (Blake et al., 2007).*

The combined cost of those seven storms was approximately $160 Billion dollars. Even after adjusting for inflation, the 2004-2005 hurricane seasons account for four of the top five costliest hurricanes in history.

The trends for rising damage are due in part to increasing population, urbanization, movement of population to areas more prone to severe windstorms, and cyclical trends in storm activity levels. While recent investigations have shown that buildings designed and constructed in accordance with the latest building codes and standards perform much better than earlier buildings in extreme winds (e.g., Gurley et al., 2006; Building Code Compliance Office, 2006), they still experienced significant damage from wind and wind-driven rain. Furthermore, since adoption of new building codes only impacts future new construction and major renovations - it will take decades before the majority of buildings in the US would even get this benefit, and that assumes much more widespread education of design professionals in windstorm hazard mitigation and more widespread adoption and enforcement of the lastest codes and standards. Without significant improvements in technologies and products for retrofitting existing buildings, the windstorm vulnerability of the majority of the current building inventory will remain static.

3. Research Needed to Facilitate Wind Damage Mitigation

Basic and Applied Research Needed to Facilitate Mitigation for New and Existing Buildings

A number of recent publications have discussed big picture research needs related to windstorm hazard mitigation. Rather than revisiting those topics, this section will focus on discussion of several of the most important specific research questions and opportunities, those that have the potential to ultimately provide a significantly advance in windstorm hazard mitigation.

> <u>Wind Environment of Landfalling Hurricanes:</u> Comparatively little is known about wind transitions from water to land and the mechanisms which cause localized higher intensity winds. Developing a greater understanding of these phenomena will lead to better estimates of maximum hurricane wind speeds, velocity profiles, and turbulence characteristics needed for building design.
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> <u>Computational Wind Engineering:</u> This technology offers the promise of a ‘wind tunnel on a computer,’ where details of a building and surrounding structures and terrain could all be modeled in a computational environment to provide information on wind loads and, when coupled with structural analysis programs, the response of the structure to different wind conditions.
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> <u>Windstorm Damage Assessment Using Remote Sensing:</u> This technology could potentially provide rapid and consistent damage estimates over entire windstorm impacted areas, with applications to rapid response and recovery operations, building performance observations, and validation data for damage models.
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> <u>Performance-Based Design for Windstorm Hazards:</u> Current wind load design procedures are somewhat prescriptive in that the building performance objectives are not clearly defined. The next generation of procedures is for a facility owner to identify what performance level (e.g., no damage and building is fully operational, significant damage requiring evacuation of the building but repairable) is desired for different probability windstorm events and designing the facility accordingly.

Retrofit Technologies for Wind Resistance: Although it is much easier to build wind resistance into new construction, the country has an enormous investment in existing building stock. Technologies for cost-effective retrofits to improve windstorm resistance of these buildings should be an important focus of any new research program.

Balance Between Long Term and Short Term Priorities

The National Windstorm Impact Reduction Program Act of 2004 (P.L. 108-360) identifies three primary program components:

1. Understanding of Windstorms
2. Windstorm Impact Assessment
3. Windstorm Impact Reduction

In principle, the short term priorities should be those activities that have the quickest payoff and are the most cost effective. There is a large body of research findings available right now that has not yet been translated into practical applications. The very applied research and technology transfer activities that primarily support the third program component of Windstorm Impact Reduction should therefore be given the highest initial priority. Section 5 of this Statement summarizes the main tasks required for technology transfer. Tasks 2 and 3 in that section (translation of research into improved codes and standards and design tools) will provide the most immediate returns and should have the highest initial priority. The more basic research activities, such as those discussed in the previous section, will really advance the state of knowledge and should be the focus of longer term priorities. They should not be ignored from the start, but rather begun at a comparatively lower level and then ramped up over time.

Private Industry Research

The fragmented nature of the entire built infrastructure design and construction industry effectively precludes any industry-funded basic research, as opposed to industries like electronics, aircraft or automobile manufacturing that are dominated by a small number of global-scale corporations that must make significant basic and applied research investments to remain competitive. The modest amount of industry funding applied to wind hazard mitigation has been very applied in nature. It has created important new products and services and helped transform a few industries, but these changes generally occurred only when driven by advances in building codes and standards.

Private industry research in wind hazard mitigation has primarily taken place in the arena of product-oriented research and development, particularly in the area of products to protect building openings from windborne debris. Building code changes in Florida after Hurricane Andrew created a new market, initiating development of products to meet the impact testing requirements of that code. The most notable effect was the introduction of many new types of impact resistant windows, shutters, and screens. Significant product-oriented research and development has also taken place for wind and debris impact resistant doors, garage doors, wall systems, roof systems, and wall and roof anchoring and bracing systems. The market for all of these products has continued to expand in recent years, as more coastal areas in other states have begun to adopt and (to a lesser extent) enforce building codes that require higher wind loads and in some cases, debris impact protection.

Following several devastating tornados in the Midwest US in the late 1990's and the well-publicized devastation caused by the Oklahoma City Tornado in May 1999, the Federal Emergency Management Agency published two milestone reports that provided guidance for design and construction of residential and community storm shelters (FEMA, 1999; FEMA, 2000). These documents, along with the National Storm Shelter Association's publication of an industry standard (NSSA, 2001), helped spur a significant product-oriented research and development for tornado shelters and helped create a market for products designed and tested to meet these technical criteria, which provided a major step forward for the fledgling storm shelter industry.

Private industry has also made significant advances in a few other areas as well, including: wind hazard, vulnerability, and risk assessment; wind loss estimation techniques, and wind tunnel testing.

4. National Windstorm Impact Reduction Program Implementation

Implementation and Funding of NWIRP

The National Windstorm Impact Reduction Program (NWIRP) was created through the National Windstorm Impact Reduction Program Act of 2004 (P.L. 108-360). The objective of the NWIRP is to achieve measurable reductions in losses of life and property due to windstorms. The objective is to be reached through a coordinated, Federally-led effort to first, assess and prioritize research, technology transfer, and education needs, and second, to conduct wind hazard mitigation activities in context of the overall objectives of the Program.

Unfortunately, funding for the NWIRP was never appropriated, so little has been achieved towards meeting the program objectives. The federal agencies involved in the program (NSF, FEMA, NIST, and NOAA) report that they have undertaken a modest level of activities in areas related to or consistent with the aims of the NWIRP. However, given funding constraints, the overarching planning and coordination activities are still missing and the agencies have not been able to significantly increase their level of wind hazard mitigation activities as authorized by the NWIRP.

Recommended Changes to NWIRP Legislation

As coordination of NWIRP activities is critical to maximizing the effectiveness of the existing and proposed wind hazard mitigation efforts, **the National Institute of Standards and Technology (NIST) should be designated as the lead agency.** The NWIRP has strong parallels to the successful National Earthquake Hazards Reduction Program (NEHRP), for which NIST is the lead agency. Additionally, the topic area and the required mix of basic and applied research and technology transfer activities makes NIST the logical choice. They have significant expertise and experience in wind engineering research and technology transfer and research program management.

The continued escalation of loss of life and property due to windstorms, with several records being set in just the 2004-2008 time period, highlights that NWIRP is needed now more than ever. **Authorized funding levels for the first year of the Program should therefore be at least consistent with the currently authorized amounts. Funding should ramp up significantly in the following years,** as initial planning and prioritization activities are completed and funding of wind hazard mitigation project activities can most effectively expand.

5. Challenges of Transferring Research Results from the Laboratory into Practice

The challenges of transferring windstorm damage mitigation findings are numerous, but many can be addressed comparatively easily if adequate funding is provided. Others include tough hurdles unrelated to financial resources. The main technology transfer tasks are summarized in the following list.

1. Using basic research findings to create new assessment, analysis, and design procedures for building components, systems, and entire structures
2. Incorporating wind engineering research findings into building codes and standards
3. Developing wind design guides, software tools, and other products for practicing professionals
4. Developing textbooks and other materials for use in undergraduate and graduate education in the fields of engineering, architecture, construction, and building science
5. Incorporating windstorm hazard mitigation into engineering, architecture, construction, and building science curricula
6. Education and training of building construction tradespeople and laborers
7. Adoption of strong and current building codes by municipalities and states
8. Enforcement of building codes
9. Education and training of persons working in the fields of insurance, real estate, mortgage lending, emergency management, and elected and appointed officials
10. Consumer education

Tasks 1-4 are reasonably straightforward and progress is primarily dependent on availability of funding. Incorporation of windstorm hazard mitigation into the formal educational programs of design professionals (Task 5) will be made easier by the results of tasks 2-4, but still faces two hurdles. Most of the professors are not knowledgeable in this field, and the current trend at universities is for cutting the number of credit hours required for degrees, making it more difficult to add new material. These challenges must however be met if we are to begin graduating design professionals who understand the theory and practice of windstorm hazard mitigation. Education and training of tradespeople and laborers (Task 6) on how to install critical components such as wind bracing or roofing shingles or hurricane shutters is obviously important but difficult in an industry where there is a transient workforce that often has language barriers.

Adoption of building codes is often a political hot potato. In recent years some states and municipalities have adopted strong model building codes but stripped out the windborne debris protection requirements in coastal areas, gutting one of the most critical components of the code. There are still many areas of the country that have not adopted building codes or their codes are very outdated. Enforcement is even more problematical, particularly for rural and poorer municipalities where funding and training of building department staff is often inadequate.

Tasks 9 and 10 are critical in order to develop public understanding of the need for and benefits of windstorm hazard mitigation through building codes and code plus alternatives. The areas that have experienced repeated devastating windstorms, such as South Florida and Oklahoma City, seem to have built a higher level of public awareness of these issues and understand that building code adoption and enforcement have direct implications for life safety, property damage, cost of construction, cost and availability of insurance, and resale value. Windstorm related research, building code changes, and insurance are front page news in those communities. It's much more difficult to raise significant awareness of these issues in communities that have not had a wind-related disaster in recent years.

6. Closing Remarks

The unparalleled devastation in the US caused by windstorms in just the last four years, with damage costs approaching $200 Billion, makes it clear that something must be done. The funding levels authorized in the existing NWIRP ($25 million per year) are trivial with respect to the average damage costs per year. If the program were to produce even the smallest of improvements in wind hazard mitigation, the NWIRP would pay for itself many times over. A fully-funded NWIRP would in actuality provide a step change improvement in wind damage reduction, which would over time significantly reduce the US vulnerability to severe windstorms.

Reauthorization of the National Windstorm Impact Reduction Program is a critical step in the process, but ultimately of little value unless funds are appropriated to make the Program a reality. As annualized windstorm costs continue to skyrocket, this country can no longer afford to ignore the problem. An investment must be made in windstorm hazard mitigation and the National Windstorm Impact Reduction Program is the way to get it done.

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Biographical Sketch

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Dr. Marc Levitan has been actively engaged in wind and hurricane engineering research, practice, and education for 20 years. His areas of research include assessment, analysis and design of structures for hurricane resistance, including wind and hurricane effects on critical and essential facilities, storm shelters, and industrial and petrochemical structures. He is the founding Director of the LSU Hurricane Center and co-founder of the LSU Wind Tunnel Laboratory. He chairs the ICC committee developing a national standard for the design and construction of storm shelters, and also chairs the ASCE committee developing wind loading guidelines for the petrochemical industry. Other national service includes the ASCE 7 Main Committee and Wind Load Subcommittee, the ASCE Aerodynamics Committee, and the ASCE Wind Effects Committee. Dr. Levitan also chairs the ASCE National Infrastructure and Research Policy Committee. He is Past-President of the American Association for Wind Engineering and chaired the 10th Americas Conference on Wind Engineering in Baton Rouge in 2005. The academic pursuits of Dr. Levitan are structural engineering, wind engineering, and hurricane engineering. Prior to joining LSU, he spent five years as the first Managing Director of the Wind Engineering Research Field Laboratory at Texas Tech University.