



American Association
for Wind Engineering

THE WIND ENGINEER

NEWSLETTER OF AMERICAN ASSOCIATION FOR WIND ENGINEERING

March 2004



Dr. K. C. Mehta Elected to
National Academy of Engineer-
ing (see p. 2)

CHALLENGE OF GROWING VULNERABILITY TO WIND HAZARDS IN THE U.S. AND OPPORTUNITIES TO REVERSE THIS TREND

Abbreviated report "Wind Engineering Research and Outreach Plan to Reduce Losses due to Wind Hazards", prepared by AAWE in collaboration with ASCE. The complete report is available on the AAWE website.

Impact of Wind Hazards in the United States

Wind-related events inflict major loss of life and material losses in the U.S. Table 1 compares annualized losses attributed to wind hazards and other natural disasters. These data was compiled and presented in more detail in a report published by RAND¹. It can be seen that the annualized losses due to wind hazards (continued on p. 2)

Table 1. Estimated Annualized Losses, by Hazard, RAND Report¹

Hazard	Estimated Annualized Loss (\$B)
Hurricanes	5.0
Winter Storms	0.3
Tornadoes	1.0
Total Wind	6.3
Floods	3.0
Hail	0.7
Extreme Heat	0.1
Extreme Cold	0.5
Total All Weather	10.6
Wildfires	2.0
Earthquakes	4.4

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Congressional Update

On March 17, 2004 a bill (H.R. 3980) calling for establishment of the National Windstorm Impact Reduction Program was introduced in U.S. House of Representatives, by Reps. Randy Neugebauer (R-TX) and Dennis Moore (D-KS).

This Congressional action followed a hearing of the House Science Committee, held on February 9, 2004, in Lubbock, TX. Witnesses testifying during the hearing included: B. Bienkiewicz (CSU & AAWE), E. W. Kiesling (TTU), C. Meade (Rand Corp.), and B. Shofner (Shofner & Assoc. Insurance Agency). Testimony of B. Bi-

enkiewicz included a proposal for establishment of the National Wind Hazards Reduction Program and submittal to Congress of the AAWE report presented in this newsletter.

On March 24, 2004, the House Science's Committee's Environment, Technology and Standards and Research Subcommittees held a joint meeting that included testimonies from a number of witnesses. Subsequently, the House Science Committee passed H.R. 3980 during a markup hearing on March 31. More info on the above an related developments will be provided in the forthcoming issue of the AAWE Newsletter.

are estimated to be \$6.3 billion. They exceed by over 40% and 60%, respectively, losses attributed to earthquakes and floods.

As the authors of the RAND report point out, attempts to provide the hazard loss data (and this applies to any natural hazard) face a number of challenges. They include the variability in occurrence times and magnitude of events resulting in measurable losses, the length of the averaging period used in calculating the annualized losses, and other factors. Calculation of the annualized losses is further complicated by lack of national database of the losses and changing society's vulnerability to wind and other hazards.

The above wind damage statistics are strongly influenced by hurricane events of large magnitude. For example, in 1992 Hurricane Andrew resulted in

\$26.5 billion - the highest level of direct and indirect economic losses ever sustained in the United States as the result of a natural hazard event. Analysis of material damage due to landfall of hurricanes in the south-eastern United States over the period 1925 – 1995 showed that the overall damage due to the reported 244 hurricanes and significant tropical storms exceeded \$340 billion, with most of the damage attributed to a relatively small number of strong hurricanes - of category 3 and higher on the Saffir-Simpson Scale, Willoughby². A breakdown of the number of hurricanes (and tropical storms) and damage as a function of the hurricane category is presented (after Willoughby) in Figure 1.

(continued on p. 3)

MEHTA ELECTED TO NATIONAL ACADEMY OF ENGINEERING

Kishor C. Mehta, Ph.D., a P.W. Horn professor of civil engineering at Texas Tech University and former director of the Wind Science and Engineering Research Center, was among 76 new members and 11 foreign associates recently elected to the National Academy of Engineering.

Election to the National Academy of Engineering is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made important contributions to engineering theory and practice, including significant contributions to the literature of engineering and those who have demonstrated accomplishment in the pioneering of new fields of engineering, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education.

Mehta was elected to the National Academy for his work on systematic studies of structural damage caused by windstorms, leadership in the development of design standards for wind loads (ANSI A58.1-1982 through ASCE 7-95) and a multidisciplinary approach to research and education.

“Being elected to the National Academy is a great honor, and I’m both happy and humbled to be

receiving it,” Mehta said. “It is very exciting and gratifying to see recognition of our Wind Science and Engineering program. A lot of people have worked on the program over the years, I am a beneficiary of it.”

“This is tremendously exciting news for the university,” said Texas Tech president Jon Whitmore, Ph.D. “This is another indication that our faculty are respected as academic leaders throughout the nation. Our very enthusiastic congratulations go out to Dr. Mehta for this honor.”

Mehta has retired from the tenure-track position, but continues to work on the development of a new Ph.D. program, “Multidisciplinary Program in Wind Science and Engineering” under the sponsorship of the NSF Integrative Graduate Education and Research Traineeship (IGERT) program. The funding provides NSF fellowships to five (5) new doctoral students each year who choose to pursue this multidisciplinary program. In addition, Mehta continues to work with the NIST/TTU Windstorm Mitigation Initiative program and leads the efforts in windstorm damage documentation.

The National Academy of Engineering has a total U.S. membership of 2,174, with 172 foreign associates.

(from press release by Texas Tech University)

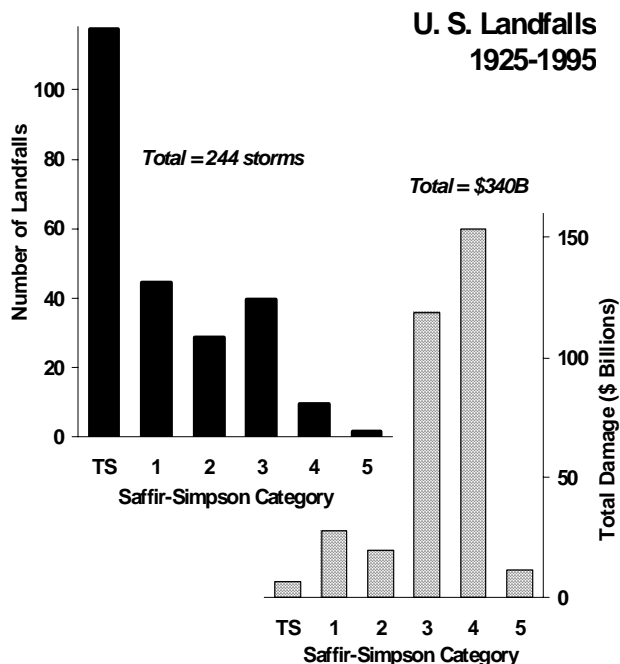


Figure 1. Histogram of U.S. Tropical Cyclone/ Hurricane Landfall, Willoughby²

The highest level of property damage and loss of life has been attributed in the United States to hurricanes, tropical storms, tornadoes and thunderstorms. Devastating effects of landfall of hurricanes have been primarily limited to the Atlantic and Gulf Coast regions and the United States territories. Figure 2 provides a representative composite of hurricane tracks.

Hazards due to tornadoes and thunderstorms are of concern to inhabitants of most of the United States. Territorial reach of tornadoes is illustrated in Figure 3, where a distribution of tornadoes (by states) over the 50-year period is depicted.

The highest numbers of fatalities and injuries are attributed to tornadoes. Although most of the largest tornadoes occur in the central United States - the tornado alley - tornadoes have been reported both west and east of the alley, Figure 3. Tornado touch-downs leading to fatalities and damage in Maryland, Utah and other states are good indications of a wide territorial reach of destructive tornadoes.

Thousands of thunderstorms occur every year all over the United States. Strong winds associated with passage of thunderstorms, at times accompanied by tornadoes, gust fronts and downbursts result

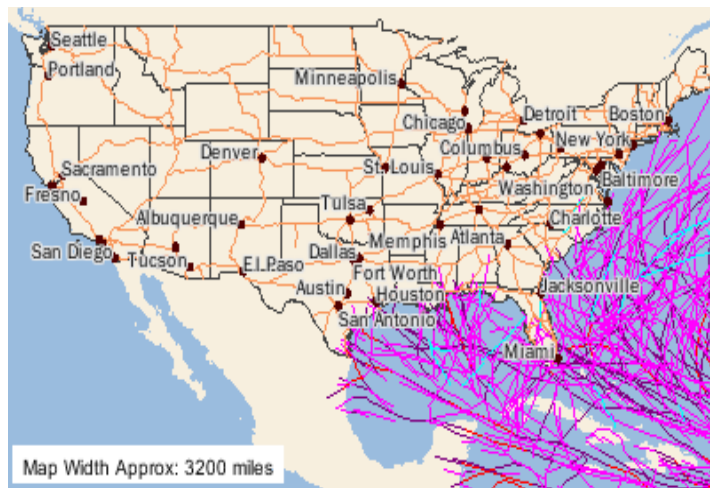


Figure 2. Representative Composite of Hurricane Tracks, HazardMaps.gov

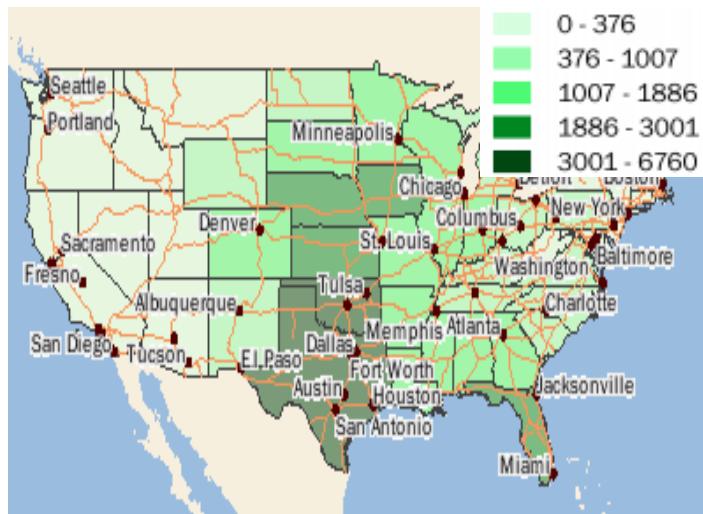


Figure 3. Number of Tornadoes by State (1950-2001), HazardMaps.gov

in a significant physical damage and human suffering. Local topographic features may lead to amplification of such winds, thus compounding adverse wind effects. Mountain ranges may lead to generation of local strong winds, such as downslope Chinook wind in Rocky Mountains, Santa Anna wind in California and strong winds in northwestern U.S. and in Alaska.

Overall (approximate) measure of the potential wind hazard is represented by wind speed maps. Figure 4 depicts an example of such a map. Wind provisions of design codes and standards, such as the American Society of Civil Engineers Standard ASCE 7 entitled "Minimum Design Loads for

Buildings and Structures”³ (ASCE 7) provide the recommended design wind speed maps, with disclaimers/restrictions introduced to account for uncertainties/lack of reliable wind speed data.

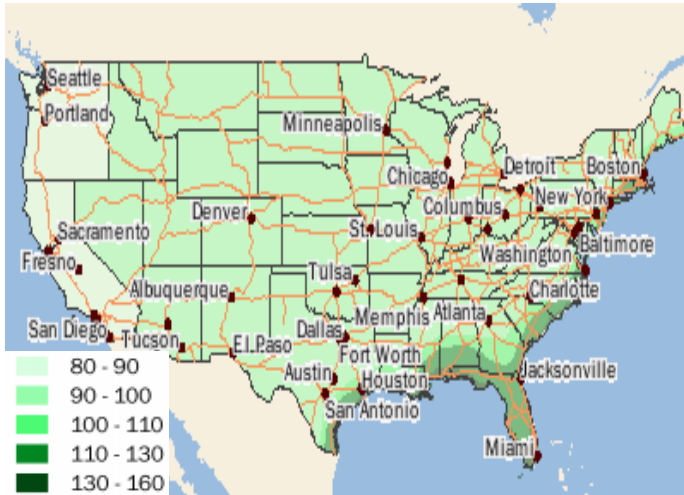


Figure 4. Windstorms – Wind Speed for 100-Year Exposure (mph), HazardMaps.gov

Storm surge and heavy precipitation accompanying hurricanes both contribute to overall damage and have a potential for causing loss of life and a multitude of long-term undesired consequences. Precipitation associated with thunderstorms and tornadoes may lead to severe flash flooding and its contaminant dangers. Other undesired effects associated with high-wind events include disruptions in transportation during winter storms (due to white-outs and/or snowdrifts), summer dust storms and hail storms, as well as adverse wind effects on fires.

As a result of ongoing public and private efforts a number of wind hazards mitigation measures have been developed and put in practice in coastal and other regions of the United States. These measures have led to significant reduction in fatalities attributed to wind hazards, mainly due to improved warning times and life protection systems (shelters) in tornado prone regions, and improved forecasting of hurricane landfall and more effective evacuation measures in the Atlantic and Gulf coast areas of the United States, as is illustrated in Figure 5. The shaded rectangle in the figure corresponds to the average mortality at mid century 1920-1969, which is scaled by the 314% increase in coastal population during the last half of the century to yield an esti-

mate of 210 deaths annually if society’s response to hurricanes had not improved since 1950, Willoughby².

Although a marked progress has been achieved in the area of protection of life against wind hazards and the overall trend - continued reduction in fatalities - is very encouraging, an intensified effort is desired to achieve reduction in wind induced property losses.

The data on these losses exhibit the alarming trend - increasing annualized losses - with increasing rate of change in the losses, especially over the past decade.

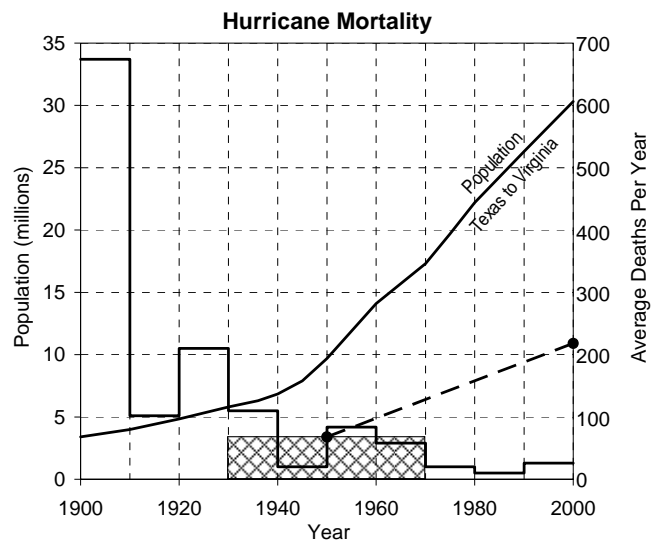


Figure 5. Histogram of U.S. Hurricane Mortality and Texas-Virginia Population, Willoughby³

Barriers to Reducing Vulnerability to Wind Hazards

In discussion of the property losses due to natural disasters, the authors of the RAND Report noted a significant increase (reported by GAO, in 2002) in the disaster relief funds allocated by FEMA: from \$7 billion over the period of 1978 – 89 to \$39 billion over the next twelve-year period. The authors identified growing population in areas vulnerable to natural hazards (a relevant case of coastal population is depicted in Figure 5) as one of primary reasons for such a dramatic increase in damage and the associated relief funds. A significant portion of these funds has been used to offset property losses

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due to wind hazards. It has been postulated that the above demographic trend will continue and that significant measures need to be urgently undertaken in order to address the issue of the increasing property losses (and associated relief funds) due to wind hazards.

A number of factors impeding mitigation of damage due to wind and other natural hazards have been identified by natural hazards mitigation community comprising of researchers and practitioners of broad background (ranging from natural and social sciences, engineering, and economics), decision and policy makers, and others. The domain of their evaluation included research and development, technology transfer and implementation, as well as outreach and education. Some of the impediments to effective mitigation of losses due to natural hazards (including wind) were postulated to be coupled with federal funding policies. The authors of the RAND Report concluded that in a number of programs explicit hazard loss reduction activities received the least R&D funding, while much of the spending supported short-term prediction capabilities of limited potential to long-term loss reduction that could improve the resilience of communities and infrastructure, and ultimately result in substantial reduction of losses. A large disparity between federal R&D funding allocated for different natural hazards also was noted.

As was reported before the Science Committee of the U.S. House of Representatives (testimony by Dr. McCabe, during hearing on October 11, 2001⁴), the average annual overall federal investment in research to mitigate impacts of wind hazards is estimated to be \$5-10 million. It is instructive to compare this amount with FY2001 funding allocations for fundamental research by National Science Foundation: Civil & Mechanical Systems: Wind - \$2.6 million, Earthquakes - \$20.8 million; Atmospheric Sciences: Wind + Flood +Drought - \$183.8 million, RAND Report, p. 23. It should be noted that the federal funding in excess of \$100 million per annum has been invested over the past two decades to support activities geared towards reduction in earthquake losses, through the National Earthquake Hazards Reduction Program. A comparison of these funding levels with the quoted earlier estimate for the annualized wind hazards losses suggests that a

significant increase in federal investment in activities geared towards reduction of losses due to wind hazards is urgently needed, justified, and has considerable potential for short- and long-term payoff.

Wind Engineering/Wind Hazards Research Needs

A list of wind engineering research areas identified as critical for reduction of wind-induced losses, provided in the report published by American Association for Wind Engineering⁵ (AAWE Report), included:

- Collection of wind speed data using robust instrumentation and state-of-the art technology to map detailed structure of the wind, topographic effects, and long-term climate effects;
- Simulation of hurricanes and their wind fields and other extreme wind effects for statistical analysis of wind, wind loads, and wind-induced response of structures and their components;
- Modeling of wind-structure interaction, including effects of integral wind loads on structural systems, components and cladding, effectiveness of retrofitting schemes, effects of structural fatigue and impact by wind-generated missiles, design of cost effective tornado shelters and shelters for hurricane zones to minimize evacuation;
- Study of internal load paths, performance of structural systems, and effectiveness of connections between structural components;
- Field monitoring of structures in natural environment and large-scale tests in simulated loading environment;
- Research in debris impact potential in wind-storm and development of impact resistant building components;
- Mapping of wind climate in urban areas;

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- Health monitoring and structural control studies for mitigation of wind effects;
- Application of effective numerical schemes using computational fluid dynamics to determine the wind environment and wind loading on and response of buildings, structures, transportation systems and other critical components of civil engineering infrastructure, and to mitigate these effects;
- Development of effective techniques for collection and rapid archiving and dissemination of data acquired during post-disaster investigations;
- Development of cost-effective retrofit techniques to enhance wind resistance of existing structures; and
- Development and application of reliable techniques for cost-benefit analysis of wind hazards mitigation measures and other socio-economic evaluations.

Opportunities to Reduce Vulnerability to Wind Hazards

The existing R&D infrastructure and expertise in wind engineering and other disciplines pertinent to mitigation of wind hazards, recent advances in information technology as well as lessons learned from programs focused on mitigation of other natural hazards, especially earthquakes, form the basis that provides unique opportunities to enhance our efforts to reduce vulnerabilities to wind hazards.

The existing research infrastructure includes laboratory and field facilities used to investigate wind characteristics and wind effects on buildings and structures and their components. The main components of the laboratory infrastructure are long-test-section wind tunnels that allow for realistic modeling of boundary-layer winds and other flow modeling facilities that have been employed in exploratory modeling of other wind phenomena, including tornadoes, hurricanes and downburst outflows. Academic institutions in the United States involved in laboratory modeling of wind effects in-

clude: Colorado State University, Texas Tech University, Clemson University, Iowa State University, Louisiana State University and University of Notre Dame.

Over the years, extensive wind engineering field studies focused on wind effects on low-rise buildings and wind hazards mitigation have been carried out by researchers at Texas Tech University, at two sites in Lubbock, TX. A field site to carry out wind engineering investigations primarily focused on manufactured homes was established (and jointly operated by the DOE's Idaho Environmental Engineering Laboratory and University of Wyoming) 30 miles west of Laramie, WY.

Several universities have established programs to collect high fidelity hurricane wind field information near ground, and wind loading on building envelope and building performance during strong wind events. A number of houses at various locations along Atlantic and Gulf coasts have been instrumented or outfitted with wiring and brackets for easy installation of instrumentation. These efforts have been carried out by researchers from Clemson University, University of Florida at Gainesville and University of Illinois at Urbana-Champaign. Several wind engineering research groups (Texas Tech University, Clemson University and University of Florida at Gainesville) use mobile towers (typically 30 feet in height) strategically positioned on an expected path of hurricanes and other high-wind events. These instrumented towers are equipped with back-up power supply and they are capable of withstanding wind speeds up to 200 mph. Recent upgrades of the towers included use of wireless phone communication (successfully deployed for the first time during landfall of Hurricane Isabel in 2003) to transmit the acquired data to a central database in near-real time.

Another example of an innovative application of the emerging sensors, data acquisition and transmission technology is a recent study coordinated by researchers from University of Notre Dame who have been supplementing traditional monitoring devices in measurement of wind-induced response of tall buildings using the Global Positioning System (GPS).

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The above cases are only a representative sample of applications of new technologies incorporated in current R&D focused on mitigation of wind hazards. The revolutionary role of information technology (IT) and unmatched opportunities resulting from its application in efforts geared to reduce vulnerability to natural disasters were discussed in RAND Report. Specific applications of IT in monitoring and simulating seismic hazards and structural response due to earthquakes, as well as in remote data acquisition and interpretation coupled with rapid communication and visualization to aid broad range of stakeholders (ranging from R&D through decision-making and emergency personnel) were discussed in EERI Report⁶. The described applications (of IT) appear to have a tremendous potential to aid tasks to reduce vulnerability to wind hazards and to coordinate local and regional planning to prevent/minimize wind-induced losses.

Benefits of Coordinated Wind Hazards Mitigation Research

Reducing wind hazards risk is a long-term commitment that builds on past experience and advances in our understanding of wind, wind-induced loading and response of structures, impact of wind-generated debris, and effects of other natural phenomena associated with strong winds (for example surge, hail). Advances in quantifying the physical nature of strong winds, coupled with continuing improvements in engineering methods, will result in significantly increased wind hazard safety, as structures existing in critical wind zones are retrofitted, and new and replacement structures and infrastructure systems are constructed. Research on wind hazards can significantly reduce economic losses resulting from future strong-wind events. Whereas several success stories can be cited, there is a pressing need to continue such research in the future, and at an increased rate.

Because our Nation's livelihood is highly dependent on business activity, a future wind event, even one with only a moderate damage potential, can result in significant economic loss. In an extreme case, the recurrence of a hurricane with the magnitude of hurricane Andrew, with landfall pas-

sage over a metropolitan area (such as Miami, Florida) would be devastating. Total loss associated with such event is estimated to exceed \$30 billion, with a significant portion of this loss attributable to interruptions in business operations. The tragic events of 9/11 in New York City underscore the severity of economic impact of a major disruption in urban infrastructure and interruptions in business activities.

If relevant and timely research coupled with effective technology transfer can reduce the economic loss from a single future strong-wind event by even a very-conservative 10%, the payoff on the investment will be in the billions of dollars.

Proposal for Establishment of National Wind Hazards Reduction Program (NWHRP)

In context of arguments put forth in this presentation and findings advanced elsewhere (RAND Report¹, AAWE Report⁵, NRC Report⁷, NIST Report⁸), and in view of the current and anticipated future unacceptably high level of wind damage it should be apparent that effective countermeasures are urgently needed and can be developed to stem and reverse these undesirable trends. Evidence has been also presented to support a proposition that an integrated and coordinated long-term effort with well defined, achievable and measurable goals in R&D, education and outreach will be necessary to significantly reduce societal vulnerability to wind hazards with 10–20 year time horizon. Such a goal could be accomplished through establishment of the National Wind Hazards Reduction Program (NWHRP). The establishment of such a program was proposed in the past by Jones et al.⁹ and others (NRC Report⁷, NIST Report⁸).

The concept and implementation of the NWHRP should be built on lessons learned from the 25-year experience with the National Earthquake Hazards Reduction Program (NEHRP). The starting point in this process could be the revised concept of the NEHRP described in the EERI Report⁶. Adaptation of this model for the NWHRP is summarized in Table 2, where main components and major areas of each component of the program are proposed.

Table 2. Main Components and Major Areas of Activities of the NWHRP

<u>Component A</u>	<u>Component B</u>	<u>Component C</u>		<u>Component D</u>
Understanding of Wind Hazards	Assessment of Impact of Wind Hazards	Reduction of Impact of Wind Hazards		Enhancement of Community Resilience, Education, & Outreach
Enhanced Knowledge and Data on Severe Winds	Performance of Buildings, Structures and Critical Infrastructure Using Data Collection, Experimentation & Synthesis	Retrofit Measures for Existing Buildings, Structures & Infrastructure	Cost Effectiveness of Loss Mitigation	Community Resilience to Wind Hazards
Improved Understanding & Quantification of Wind Loading on Buildings and Structures	Tools for Component and Structure-Level Simulation & Computational Modeling	Innovative Technologies for New Buildings, Structures & Infrastructure	Financial Instruments for Risk Transfer	Cross-Area Outreach & Education
Mapping of Wind Hazards	Tools for System-Level/Loss Assessment	Land Use & Cost Effective Construction	Emergency Response & Recovery	Education & Public Outreach

As shown in Table 2, the program comprises of the following four components:

- A. Understanding of Wind Hazards: Development of knowledge on severe winds; quantification of the attendant wind loading on buildings, structures and infrastructure; and mapping of wind hazards.
- B. Assessment of Impact of Wind Hazards: Assessment of performance of buildings, structures and infrastructure; development of frameworks and tools for simulation and computational modeling; and development of tools for system level modeling and loss assessment.
- C. Reduction of Impact of Wind Hazards: Development of retrofit measures for existing

buildings, structures and infrastructure; development of innovative wind-resistant technologies for buildings, structures and infrastructure; and development of land measures and cost effective construction practices consistent with site-specific wind hazards.

- D. Enhancement of Community Resilience, Education and Outreach: Enhancement of community resilience to wind hazards; effective transfer to professionals of research findings and technology via outreach efforts developed for each component of NWHRP; and development of effective educational programs and public outreach activities.

Efforts specified for each component consist of research and outreach tasks. A tentative list of the proposed tasks is presented in Table 3.

Table 3. Breakdown of NWHRP by Research (R) and Outreach (O) Tasks

UNDERSTANDING OF WIND HAZARDS

- Enhanced Knowledge on Severe Winds.
- Understanding and Quantification of Wind Loading.
- Mapping of Wind Hazards.
- Enhanced Knowledge on Severe Winds.
- Mapping of Wind Hazards.

ASSESSMENT OF IMPACT OF WIND HAZARDS

- Structural Resistance Using Data Collection.
- Tools for Simulation and Modeling.
- Tools for System-Level/Wind Loss Assessment.
- Structural Resistance Using Data Collection.
- Tools for Simulation and Modeling.
- Tools for System-Level/Wind Loss Assessment.

REDUCTION OF IMPACT OF WIND HAZARDS

- Retrofit of Existing Buildings and Structures.
- Innovative Strategies for New Buildings and Structures.
- Land Use Measures and Construction Practices.
- Cost Effectiveness of Wind Loss Mitigation.
- Financial Instruments to Transfer Risks.
- Technologies for Emergency Response and Recovery.
- Codes, Guidelines and Demonstration Projects.
- Financial Instruments to Transfer Risks.
- Technologies for Emergency Response and Recovery.

ENHANCE COMMUNITY RESILIENCE, EDUCATION AND PUBLIC OUTREACH

COMMUNITY RESILIENCE TO WIND HAZARDS

- Research Addressing Community Resilience.
- Outreach Addressing Community Resilience.

EDUCATION AND PUBLIC OUTREACH

- Pre-College (K-12).
- College – Undergraduate Program.
- College - Graduate Program.
- Continuing Education.
- Public Awareness & Outreach.

In formulation of the NWHRP plan attempts were made to develop a dynamic program that would allow for timely use of outcomes of ongoing (in the United States and elsewhere) related research and outreach efforts addressing mitigation of losses due to wind and other natural hazards. A particular attention was given to activities in the area of earthquake engineering, carried out within and beyond the framework of NEHRP. These activities were

carefully examined to avoid duplication of effort delineated in the scope of work proposed for NWHRP.

Potential Impact of Information Technology

Recent developments in information technology (sensors; data collection, transfer, processing and

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visualization; experimental and computational simulation; high-end computing; and adaptive networking) have a potential to lead to unprecedented breakthroughs in our efforts to reduce property losses and human suffering due to wind hazards. These advances in information technology (IT) have already significantly influenced activities addressing impacts of natural hazards. Two representative examples of relevance to NWHRP are discussed below.

The first example is the Network for Earthquake Engineering Simulation (NEES). Significant federal investment has been authorized by Congress for the development of NEES - \$82 million over the 2002-2004 period. This funding was allocated for construction/enhancement of engineering laboratories at fifteen universities and development of an advanced networked and grid-enabled experimental, data, and computational infrastructure. This resource makes possible implementation of a concept of "colaboratory" which enables researchers to remotely interact with each other and with their simulation and computational work via "telepresence" tools. Application of these concepts and infrastructure appears to have a great potential for breakthroughs in wind hazards research and outreach. Modest investment to upgrade wind engineering experimental (laboratory/field) and computational infrastructure, coupled with shared use of the NEES networking capabilities would allow for an efficient exploratory application of these technologies in activities of NWHRP.

The second example is utilization of low-cost, small-size (3 ft x 3 ft) networked radars that can be placed on existing cellular towers. These short-range sensors can provide information on low-level winds and other properties of the atmospheric surface layer. They are currently being developed by one of the Engineering Research Centers (supported by NSF) and they are scheduled to be tested in mid 2005, in a networked configuration covering approximately 20 percent of the State of Oklahoma. This technology appears to have potential for application in mapping of wind hazards and in other activities of the NWHRP.

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⁸ Marshall, R. D., Editor, "Proceedings of Workshop on Research Needs in Wind Engineering", Technical Report NISTIR 5597, Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg, MD, 1995, 69 pp.

⁹ Jones, N. P., Reed, D. A., and Cermak, J. E., "Wind Hazard Reduction Program", Journal of Professional Issues in Engineering, ASCE, 121 (1), 1995, pp. 41-46.

NATO ADVANCED STUDY INSTITUTE TO BE HELD IN KIEV, UKRAINE MAY 4-15, 2004

A NATO Advanced Study Institute "Flow and Transport Processes in Complex Obstructed Geometries: From Cities and Vegetable Canopies to Industrial Problems" will be held in Kiev, Ukraine, 4-15 May, 2004. This meeting is organized by the Institute of Hydromechanics, Ukrainian National Academy of Science. Professors J. C. R. Hunt and V. T. Grinchenko serve as Chairs of this event. A number of distinguished lecturers have been invited to participate in this Institute. Further info is available at: www.hydromech.kiev.ua/eng/news.htm, E-mail: FB_FLOWS@kiev ldc.net and ASI_Kyiv.ua.fm.

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- The solution of national wind engineering problems through transfer of new knowledge into practice.

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Rowan Davies Williams & Irwin Inc.
www.rwdi.com

Wind Engineering and Fluids Laboratory, Colorado State University
www.windlab.colostate.edu

Wind Science and Engineering Research Center, Texas Tech University
www.wind.ttu.edu

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