




American Association
for Wind Engineering

THE WIND ENGINEER

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NEWSLETTER OF AMERICAN ASSOCIATION FOR WIND ENGINEERING

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2008

THE NEED FOR WIND ENGINEERING RESEARCH

**MIKE GAUS, AAWE PAST PRESIDENT,
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1. The built infrastructure in the United States has been very vulnerable as evidenced by the level of physical, economic and social damages sustained each year and the losses are increasing each year rather than decreasing. However these losses are not uniform as the losses to highly engineered structures such as tall buildings and other properly engineered structures have actually decreased. Thus, the problem is the huge amount of non-engineered and code-built construction which has not shown significant improvement in many years in most parts of the country. One consequence of this situation is the accumulation of a huge inventory of existing construction that is vulnerable to wind damage and losses and this inventory of vulnerable

construction has increased each year and is continuing to increase.

As can be seen above there is not a lot of progress that has been made in most parts of the country in more than a century.

2. A large part of the fundamental improvement in code-based construction is the result of wind engineering research that was done 30 or 40 years ago and some component-based construction that was contributed by industry. This research provided a more rational basis for estimating possible loadings, the return periods that need to be considered to provide safe construction, and the design requirements to resist these loads. As code writing groups do not generally have research capabilities, a robust research and education capability is needed to provide input on new sciences and technology opportunities for loss reduction. On the other hand industry has contributed



Americas Conference on Wind Engineering
to be held in beautiful Puerto Rico.



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significant improvements on wind vulnerability reduction but due to economic factors these tend to be incremental improvements on existing technologies and have been mainly focused on new construction or market areas that are viewed as a viable market. Both types of developments are needed with close integration. As support for university-based, wind-engineering programs is currently very low this sector needs improved support to reestablish the flow of new underlying information and the training of students practicing engineers and outreach for the application industry. Thus, a national initiative is needed to jump start university programs to provide a sound basis for wind impact reduction. The areas of research that are needed have been identified in a large number of reports prepared over the last 30 years but few of the recommendations have been implemented. Thus, much of what needs to be researched is known but the resources to do this have not been available. The university programs could be closely integrated with industry needs and efforts. Unfortunately the major focus of wind-research resources has been focused on prediction, response and recovery rather than on ways to provide wind resistant construction. Unless the construction aspects are addressed we will continue our pattern of increases in losses each year. It is time to mount a proactive program that is aimed at reducing losses rather than on just prediction, response and recovery. The engineering community in a multidisciplinary effort would be able to achieve a significant reduction in losses if given the chance.

3. The problem with NWIRP and similar programs such as NHRI (HR 2407) is that they propose to supply funds to or through agencies that have not shown a very great interest in wind hazard reduction programs. This problem is further exaggerated because these agencies fear that the new responsibilities for wind impact research may be thrust upon them without any funds provided and this would cause them to "pirate" funds from current pet programs and this is not a popular subject area. What is needed is more bottom-up involvement from the program level rather than the top down activity such as the NSB report that does not seem to have much connection to loss reduction. A proactive approach is needed to provide specific program plans for agencies such as NSF, FEMA and NIST rather than just incremental addition to their overall budgets. As has been seen in the past simply adding funds to an overall budget tends to result in the funds being blended into existing programs rather than being used to more closely focus on loss reduction research needs. In addition a proactive public and builder education program needs to be mounted to implement

transfer of present knowledge and practice as well as to more rapidly infuse new developments into practice.

4. There are a number of challenges to transferring research and knowledge into practice. A big part of the problem is that for the most part the general public does not perceive windstorms as a big threat until a damaging event occurs. Unfortunately for wind, much of the public shrugs off the impacts as acts of some supernatural being and the attitude seems to be that we are powerless to change this. Builders on the other hand fear the introduction of new requirements for construction will increase the cost of their product and make them less competitive and that they would have to develop new skill levels for their employee. As a result of this lack of public interest or understanding and the lethargy in the construction industry and code-writing groups to accept new knowledge it takes a long time to effect needed changes that will result in significant wind hazard loss reduction. One example of this is that it took more than 15 years before the ASCE-7 loading standard was accepted by code-writing groups.

So what more specifically could be proposed? First it is necessary to somehow get the message across to Congress and the public to educate them to the fact that we do not have to suffer the current major impacts from wind storms and associated water penetration problems to anywhere the degree we now see. This could be accomplished through a dedicated research, training and information providing program if the wind community is given a chance. Some random ideas on how this awareness could be developed could involve:

1. Develop public awareness activities to inform the public that it is not necessary to sustain the losses we currently have by commissioning the production of PBS programs such as NOVA, sponsor the writing of articles for widely read magazines and publications such as Popular Science, Mechanics Illustrated, Sunday supplements, Science magazine, New York Times, etc. We would also have to caution them that this is a slow procedure and that it is unlikely that we could have a big-bang program that would eliminate the problem immediately.
2. Develop a National Wind Hazard Reduction Corps, sort of like the Peace Corps, that would provide an opportunity for students and others to be available to provide information, guidance and builder education programs.
3. Hold one or more workshops to update the ideas and opportunities for advancement through research.

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4. Develop a web-based activity that would help to coordinate research programs around the country and world.
5. Develop demonstration programs to illustrate effective approaches for improving wind resistant construction by having a few state-of-the-art buildings and facilities constructed and use these to generate video segments that could be shown around the country or made available on web sites such as the one operated by AAWE.
6. Develop a research initiation program similar to the one developed by NSF in the 1960s that make it possible for new faculty members to work in the wind field.
7. Develop plans demonstrating the importance of large-scale and component testing beyond that already available and possible locations and operation of such facilities.
8. Provide more funds through already established programs such as the engineering programs at NSF and NIST to revitalize an effective wind engineering program in the US.
9. Give significant attention to developing practical and economically acceptable retrofit methods as well as shelters for existing vulnerable construction.

I am sure that others could think up better examples than I, but the point I am trying to make is that we need to impress the public and Congress that significant progress could be made in wind hazard reduction if more emphasis is placed on the construction aspect rather than just response, prediction and recovery. We need some very punchy programs to propose that would grab attention rather than the dreary lists of research topics given to them in the past. We need to emphasize that it is not necessary for structures now constructed by carpenter eclecticism and often inadequate codes to fail. Improved research on use and improvements in more adequately connecting parts of the structure and making it perform as a system rather than individual pieces have already been shown to yield great improvement. Wind engineering research could not only refine and improve the specification of loadings but could point the way toward structural improvements going beyond the “band-aid” approach of adding connectors to existing construction but could also explore new approaches to structures, possibly taking advantage of new materials now available such as high strength composites and develop structures that have significant ductility that may suffer damage in the most severe events but would not come apart like a house of cards.



HURRICANE NETTING – A NEW PRODUCT DISCUSSION

JOHN TERBOSS, JTERBOSS@CREATIVECONNECTION.COM

Why should someone who lives thousands of miles from the Gulf or Atlantic Coasts care about hurricane protection? While it might seem that a hurricane protection system would be of little interest to property owners in the West, Midwest or Northeast. The innovative Cat-5 Hurricane Netting system actually has many applications throughout North America.

“Cat-5 Hurricane Netting was developed to meet the needs of property owners in hurricane-prone areas, but its benefits apply equally well in virtually all parts of the country,” said Charlie Johnson, National Sales Manager of Cat-5 Protection Inc., which manufactures the innovative new product.

“The Cat-5 system is just as effective in protecting against wind damage from a Northern blizzard as it is in protecting against hurricane-force winds in the Southeast,” he said.

Called “the next generation of hurricane protection,” the Cat-5 system uses reinforced, tear-resistant netting, which diffuses the force of hurricane-strength winds, greatly reducing the amount of direct wind pressure on doors, windows and walls. The tautly stretched mesh also deflects wind-borne debris.

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While Cat-5 Hurricane Netting was originally designed to replace cumbersome, sharp-edged metal panels or expensive, jam-prone roll-down awnings on homes and businesses, it is ideal for use in conjunction with such shutter systems as well. In addition, since its introduction several years ago, it has also proven itself in a variety of other applications, such as protecting vulnerable signage, landscaping and other outdoor structures.

“The Cat-5 system offers extended protection for virtually all types of exposed structures and materials including lanais, garage doors, front porches, manufactured homes, sheds, signs, cars, boats, barns/stables, open walkways, airplanes, landscaping, and even loose construction materials and debris”, said Johnson.

The CAT-5 net has passed ASTM 1886/1996 along with ASTM cyclical loading, Miami Dade TAS 201-202-203 tests, is a Miami Dade, Florida Product, and is also Texas approved. The fabric has passed ASTM smoke and weatherability testing, and the clamps have been ASTM pull tested to match the grommet strength for when the fabric is cut and clamped for a custom on-site fit. The fabric is a 2000 denier warp and fill weave surrounded by a polytextaline coating. Further test information can be found online at the product website www.hurricane-net.com.

“While shutters cover only windows and doors, Cat-5 Hurricane Netting can cover an entire building, including the roof,” Johnson noted. “It’s like a safety belt for your entire home.” “Not only does the Cat-5 system deflect wind-borne debris, the mesh design effectively reduces destructive wind pressures by a claimed 63 percent, and it is the least expensive hurricane protection on the market today,” Johnson explained.

Cat-5 Hurricane Netting is lightweight and easy to install, requiring no special tools. Specially designed with grommets every 6” on center, the system is easy to secure to walls, foundations and soil with standard hardware and approved ground anchors. When installed, it allows light and fresh air to come through after the storm has passed, which is important since power is often out for several days after a major storm.

The Cat-5 system is sold in kits of 12.5, 25 and 50-foot lengths and 8-foot tall, which can be cut on site to fit smaller areas. The system comes with patented clamps used in place of any grommets that are necessary to cut off to make a custom fit. The nets can be joined together to cover an entire structure

or other large surfaces. When not in use, it can be folded in the storage bag that is provided and stored in a small space.

In addition to a number of high-profile commercial installations, Cat 5 provided systems to numerous homeowners in the Southeast, and to a growing number of customers in other parts of the nation, who use the tear-resistant system to protect their properties against high winds during winter blizzards and other storms year-round.

“Because it’s so easy to store and install, Cat-5 Hurricane Netting is ideal for use as protection against virtually all types of windstorms on all types of properties in all climate zones,” Johnson added.

Cat-5 Hurricane Netting has passed all applicable product tests including ASTM Uniform Static Air Pressure Difference, Large Missile Impact and Cyclic Static Air Pressure Loading tests and the ASTM weatherability, fire and smoke density tests. It is approved as a HVHZ (High Velocity Hurricane Zone) Large Missile Impact Protection System under the Florida Building Code (Approval FL9356), and has passed the rigorous Miami-Dade County Large Missile Impact and Cyclical Loading test requirements.

For more information, contact Charlie Johnson, National Sales Manager at 877-228-5462, or visit the company’s Web site at www.hurricane-net.com.



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HURRICANE GUSTAV: POWER DELIVERY SYSTEM DAMAGE

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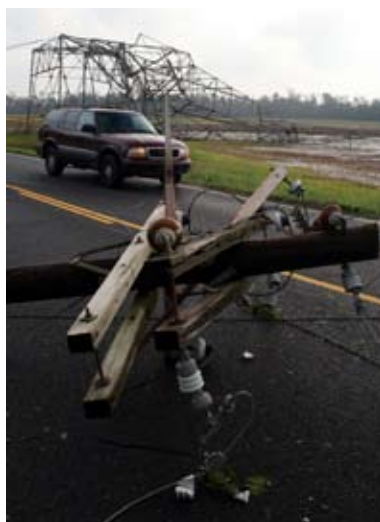
This photographic essay shows some of the damage to the electrical power distribution system in Louisiana during Hurricane Gustav in September 2008. Contact Dorothy Reed and Elizabeth English for more images or further information.



Multiple transmission tower failure.



Snapped wooden poles add to local outages.



All levels of the distribution system were impacted.



Flooded substations and distribution hubs impacted by heavy rains.



Multiple failures of high tension lines devastate the power grid.



One of the many downed towers.

**Director of the CLP Wind/Wave Tunnel Facility and Professor/Associate Professor**

A Tenure-Track Faculty Position

Department of Civil and Environmental Engineering
Hong Kong University of Science and Technology

Applications are sought for the position of director of the CLP Wind/Wave Tunnel Facility at the Hong Kong University of Science and Technology. Candidates should have a PhD in wind engineering or a related field and be eligible for a tenure-track appointment with the Department of Civil and Environmental Engineering at the professor or associate professor level based on a record of teaching, research, and service. Responsibilities of this joint appointment include establishing leading research programs in wind engineering fields, pursuing funding to support the wind tunnel activities and managing its operation, and teaching wind engineering related courses. Qualified applicants from non-academic backgrounds in consulting, industry or government will also be considered. Candidates should have a clear understanding of current needs and future directions in wind engineering and possess a commitment to advancing diversity and interdisciplinary collaboration.

The CLP Wind/wave Tunnel Facility (www.wwtf.ust.hk) was inaugurated in June 2000 and is a central research facility of the university. It is a state-of-the-art wind/wave tunnel facility with a high-speed and a low-speed test sections and a wave tank. The facility is used extensively for teaching, research and consulting in wind effects on buildings and structures, bridge aerodynamics, bluff body aerodynamics, environmental fluid mechanics, urban air ventilation, air pollution dispersion, wind flow over complex terrain and wind power generation. The facility also has a separate building motion simulator for research on human perception of motion and occupant comfort assessment.

The initial contract period is three years and can be extended based on a satisfactory performance review. Salary is highly competitive and will be commensurate with qualifications and experience. A gratuity will be payable upon successful completion of contract. Fringe benefits including medical/dental benefits, annual leave and housing will be provided where applicable.

Applications must include a curriculum vitae, statement of research and teaching interests, and the names, addresses, phone numbers, and email addresses of at least three referees. Review of applications will begin as soon as they are received and will continue until the position is filled. Please send application materials to Head of the Department of Civil and Environmental Engineering, the Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong (or by Fax: (852) 2335 5493; Email: cejob@ust.hk). Enquiries can also be sent to cejob@ust.hk. For more information on the Department and the University, please visit website at <http://www.ce.ust.hk>.

(Information provided by applicants will be used for recruitment and other employment-related purposes.)



JOB OPPORTUNITY: Wind Engineering Research

Building and Fire Research Laboratory (BFRL) National Institute of Standards and Technology (NIST)

The NIST Building and Fire Research Laboratory is seeking a staff research structural engineer to participate in a comprehensive in-house research program in the area of wind engineering. Information on NIST research in this area can be found at <http://www.nist.gov/wind>. Only applications from U.S. Citizens will be considered.

Candidates should have a strong background and experience in several of the following disciplines: wind engineering, structural reliability and probabilistic analysis, structural dynamics and random vibrations, aerodynamics and aeroelasticity, computational modeling of nonlinear structural behavior, performance-based engineering, and software development. The successful candidate will preferably have an advanced degree in civil/structural engineering or a closely related field, or equivalent experience in research and practice. The position will be filled at the ZP III, ZP-IV, or ZP-V level, commensurate with the individual's education and experience (\$60,989 - \$153,200).

NIST seeks to fill this position immediately. Address inquiries to Fahim Sadek, Leader, Structures Group, NIST, 100 Bureau Drive, Stop 8611, Gaithersburg, MD 20899-8611; fahim.sadek@nist.gov; 301-975-4420.

Federal employees are offered a generous benefits package (<http://www.nist.gov/hrmd/benefits/summarychart.htm>). Where appropriate, NIST will cover relocation expenses in accordance with federal regulations.

NIST, Department of Commerce, is an Equal Employment Opportunity employer that values, celebrates, and thrives on the rich diversity, abilities, and perspectives of its staff. NIST pledges equal access to employment, facilities, and programs regardless of race, color, religion, gender, disability status, age, national origin, or veteran status.

NIST collects formal applications for current and future job openings in an automated Applicant Supply File (ASF) system. Applicants are considered when NIST fills a Direct Hire vacancy. Applications may be submitted at this web site: <https://rproxy.nist.gov/asf/>. **Please note that only applications from U.S. Citizens will be considered.**

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REPORT ON PLANS FOR CWE2010

ALAN HUBER, ALAN.HUBER@UNC.EDU



The Fifth International Symposium on Computational Wind Engineering (CWE2010) will be held May 23-27, 2010 at the William and Ida Friday Center for Continuing Education, Chapel Hill, North Carolina, USA. The International Association for Wind Engineering co-convenes this Computational Wind Engineering (CWE) symposium every four years in rotation with one of its three global regional organizations. The American Association for Wind Engineering is co-convening the 2010 event. Announcements, submission instructions, program, registration, hotel accommodations, and general related information are posted on the symposium website (www.cwe2010.org).

THE PLACE

The Friday Center has excellent facilities to host a symposium. There is easy wheelchair access to the whole facility. It will be a comfortable environment with no outside traffic though the building. There is free high speed wireless internet connection throughout the facility and public access telephones are conveniently located. There is a message center. The Friday Center maintains the latest audiovisual technology and support for each room. The Friday Center is part of the University of North Carolina at Chapel Hill (UNC) and is adjacent to the main campus area. UNC is the oldest public University in the USA. The normal University class sessions will have finished 2 weeks before CWE2010. This is a quiet period in Chapel Hill with limited summer students and campus activities. May is a colorful period in North Carolina with many blooming flowers and trees. The average high and low temperatures for this period are 27 deg C and 15 deg C.

There are non-stop flights to RDU from many major USA Cities and a few from cities outside the USA. The travel time from Raleigh-Durham International Airport (RDU) to Chapel Hill is only 15-20 minutes using public transportation. There is only one hotel adjacent to The Friday Center. A group of hotels near the Friday Center will be selected for preferred symposium housing and will be connected to The Friday Center by a shuttle bus so everyone may attend without needing a rental car. Arrangements are being planned to provide dormitory type housing on the UNC campus, especially for attending students.

Travel by automobile or airplane to all eastern USA cities is convenient for pre or post CWE2010 vacation or business plans. There are also several special interest areas for vacations in North Carolina. North Carolina is a golfer's paradise, especially in the Pinehurst Area which is less than 60 minute travel time south of Chapel Hill. In the western part of North Carolina is the Appalachian Mountains with the highest elevation east of the Rocky Mountains and America's biggest house, the Biltmore House. In the eastern part of North Carolina are the Outer Banks with kilometers of undeveloped beaches with sand dunes. This area includes a National Monument at the site of the Wright Brother's first powered flight. The National Monument includes replicas of their airplane and wind tunnels used to help design the airplane. The Outer Banks is also home of England's first settlement in America. If there is enough interest arrangements could be made for planned group travel to several areas following CWE2010.

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SPONSORSHIP OPPORTUNITIES

Sponsorship Packages have been posted on the symposium website. Tell your favorite companies about the unique marketing opportunity while supporting computational wind engineering. A technical exposition is planned for areas near the symposium sessions. Funds from sponsors will help offset symposium costs and provide sponsored events such as the symposium banquet.

SYMPOSIUM AGENDA

The symposium includes a Sunday Evening Reception with buffet dinner and a Wednesday Evening Banquet. Optional evening events will be planned for Monday, Tuesday, and Thursday. Each day will begin with a plenary session. Each day will include a lunch buffet in the dining room. Each day will include a light breakfast, a morning refreshment break and afternoon refreshment break in the atrium.

Both pre- and post-symposium workshops are possible. Professors Meroney has already planned a 3-day workshop "Introduction to Computational Fluid Dynamics/Computational Wind Engineering for the 21st Century" for May 21-23.

Posters as well as oral presentations on all computational wind engineering topics are invited. CWE2010 will provide a platform for discussing and exchanging the latest information associated with the application of Computational Fluid Dynamics (CFD) simulations to wind engineering problems and the tremendous advances in CFD technology in the past several years. Poster presentations will be a significant element of the program, including convenient display in the atrium for easy viewing throughout the day and several periods will be set for direct interaction with all attendees. Poster presenters will be provided a 2-3 minute period for a brief oral overview of the poster as part of the technical sessions.

Each international symposium on CWE reflects the significant scientific advances in the rapidly developing computational wind engineering sciences linked to advances in high performance computing hardware and software. CWE does not necessarily mean CFD, but can include various techniques using computers. Presentations with critical full-scale data and wind tunnel data needed to support advancing CWE are also invited. The theme and a plenary session for CWE2010 are entitled "CWE applications for homeland/ societal security including natural and human-caused hazards and disasters." There are many emerging issues for computational wind engineering, not only in wind hazard mitigation, but also in air contamination problems near and

in the far field of buildings, and in natural/cross ventilation or wind energy phenomena to preserve natural resources and to realize a sustainable society. Additional plenary sessions entitled "CWE model development, validation, and applications linked to future computing software and hardware", "Development, validation, and application of atmospheric boundary layer models and turbulence models for CWE", and "Coupling Computational Wind Engineering and Mesoscale Meteorological Models" are being planned. For more details see the AAWE Newsletters in 2009.

CALL FOR PRESENTATIONS

Please submit your abstract electronically via the symposium website (www.cwe2010.org) by 1 October 2009.

Full papers (including supporting electronic applications) must be submitted electronically by 1 March, 2010 in order to be included on the symposium USB flash drive.

For further information please contact the symposium chairperson :

Alan Huber
Institute for the Environment
Campus Box 6116
University of North Carolina
Chapel Hill, North Carolina, 27599
(email: chairman@cwe2010.org or alan.huber@unc.edu).

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PRESIDENT'S CORNER



It is with great pleasure that I assume the Presidency of the AAWE and thank you for your support of my candidacy. Let me begin, first and foremost, by acknowledging the tremendous work done by Past President Leighton Cochran. Not only do I wish to thank him for handing over such a smoothly running machine, but wish to recognize that his leadership, dedication, and efforts on behalf of the wind engineering community have advanced the organization's mission and positioned AAWE to accomplish much in the future.

There is little question that this is an important time for wind engineering and for AAWE and that we must take advantage of the opportunities that exist at this juncture. Today, there is renewed national interest in many areas of direct relevance to our organization (e.g., sustainability, infrastructure renewal, environmental concerns) as well as in related areas (e.g., renewable energy, notably wind). While we will all be busy responding as individuals and teams to these opportunities, I believe that it behooves us to think carefully and strategically about the role that our professional organization should play in both the short and long term.

To that end, I am proposing, during my term as president, to lead a strategic planning effort for AAWE in order to chart a course for the years ahead. The process will fully engage the directors and membership, as well as external constituencies (including professional organizations such as ASCE and AWEA), in order to position AAWE as a leader in thought and action and as an effective national and global resource for the technical community and the public. In developing this plan we will need to think carefully about our role—what we should do and should not do—and define metrics to ensure that we are adhering to our goals and objectives. The next board meeting for AAWE will be held at the upcoming ACWE in Puerto Rico and I plan to use this meeting to get this planning process started. Look for opportunities to participate in this effort in the coming months.

Again, I congratulate Leighton and his predecessors for navigating AAWE to a place where we can, in fact, take on such an important process in earnest and position AAWE for a great future. I look forward to working with all of you during my tenure and hope that I can contribute to advance the organization as effectively as Leighton has done.

Lastly, I would like to ask the members to encourage others interested in wind engineering to join AAWE, either as individuals or as a corporation. Please pass this newsletter on to them so they can see what we do and encourage them to visit the website to become a member (note that the membership calendar year of 2009 now applies).

NICK JONES

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11th Americas Conference on Wind Engineering (11ACWE)

San Juan, Puerto Rico

June 22-26, 2009

Convened by the American Association for Wind Engineering
Hosted by Polytechnic University of Puerto Rico

SECOND ANNOUNCEMENT AND CALL FOR PAPERS

The conference is accepting abstract submission in all topics related to Wind Engineering, such as (but not limited to):

- Wind climate
- Extreme value analysis and design wind prediction
- Wind measurement and monitoring
- Hurricanes, tornadoes and downburst characteristics
- Wind-related hazards
- Wind-borne debris - trajectories and impacts
- Structural aerodynamics
- Wind loading and response of offshore platforms
- Dynamic response and control
- Wind-induced vibrations
- Computational wind engineering
- Wind tunnel testing
- Full scale and field studies
- Wind damage
- Loss estimation and insurance
- Wind and emergency management
- Wind energy
- Wind erosion
- Dispersion of pollutants
- Urban wind issues
- Vehicle aerodynamics
- Wind engineering applications
- Wind codes and standards
- Wind engineering education

KEYNOTE SPEAKERS:

DR. PETER IRWIN
DR. MARK POWELL
DR. EMIL SIMIU

CONFERENCE VENUE:



THE CONDADO PLAZA HOTEL & CASINO

December 10, 2008

KEY DATES:

November 24, 2008	Last date for abstract submission
February 28, 2009	Notification of acceptance
April 30, 2009	Submission of full length paper

For more information and details, please visit:

www.pupr.edu/11acwe

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**American Association
for Wind Engineering**

Established in 1966

Objectives:

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

Corporate Members of AAWE

ABS Consulting Group
www.absconsulting.com

Boundary Layer Wind Tunnel Laboratory, University of Western Ontario
www.blwtl.uwo.ca

CBuck Engineering
www.cbuckinc.net

Cermak Peterka Petersen, Inc.
www.cppwind.com

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High Velocity
www.category5.com

Risk Management Solutions, Inc.
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Rowan Williams Davies & Irwin, Inc.
www.rwdi.com

Weidlinger Associates Inc.
www.wai.com

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

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