American Association for Wind Engineering

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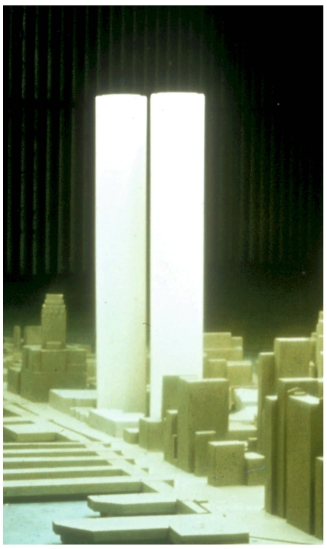
THE WIND ENGINEER

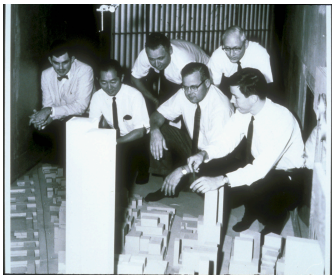
NEWSLETTER OF AMERICAN ASSOCIATION FOR WIND ENGINEERING

Bogusz (Bo) Bienkiewicz, Editor

November 2001



Model of the World Trade Center Towers tested in a boundary-layer wind tunnel at the Wind Engineering and Fluids (formerly Fluid Dynamics and Diffusion) Laboratory at Colorado State University.



Can you recognize people involved in the above testing? A list of names of researchers shown above will be provided in the next issue of the Newsletter.

In this issue:

Towards Accelerated Reduction in Wind Losses in the U. S. through Engineering Research Component of the National Wind Hazard Reduction Program - A Discussion Paper

by B. Bienkiewicz

Introduction

This discussion paper is focused on engineering aspects of wind hazards and civil engineering research to reduce losses due to such hazards. It addresses the following questions related to an ongoing discussion on establishment of the National Wind Hazard Reduction Program:

- What are wind hazards and their impact on life and material losses in the U.S.
- How to justify cost of wind hazards research.
- What are accomplishments to-date of engineering research to reduce wind losses.
- What is the status of U.S. infrastructure for wind hazards research.
- What are engineering research needs to reduce impact of wind hazards.
- What is potential for the national research program to accelerate wind hazards loss reduction.

Material presented herein is in part based on references listed in Appendix A.

Wind Hazards and Their Impact

Wind-related events inflict major losses on the built environment, far exceeding the impact associated with other disasters, with the exception of floods. For example, hurricane Andrew, resulted in $26.5 billion in losses and 61 fatalities - the highest level of direct and indirect economic loss ever sustained in the U.S. as the result of a natural hazard event.

Wind damage statistics demonstrate that material and human losses due to strong winds continue to be unacceptably high. For example, in May 1999 tornadoes killed 57 and caused $1 billion damage in Oklahoma and Kansas. Landfall of Hurricane Floyd in October 1999 devastated eastern North Carolina and caused 56 deaths and $1.3 billion damage. In June 2001, tropical storm Allison resulted in significant damage in Louisiana and Texas.

All 50 states are vulnerable to the hazards of windstorms. Annual loss of life and material damage due to these

events is significant. For example, tornadoes cause 80 deaths and $1 billion damage, while hurricanes lead to 50 to 100 deaths and $ 5.4 billion damage per year, on the average. These and other statistics summarized on a fact sheet compiled by the Wind Hazard Reduction Caucus, see Appendix B, well illustrate the magnitude of the problem.

The highest level of material damage and loss of life has been attributed in the U.S. to hurricanes, tornadoes and thunderstorms. While devastating effects of landfall of hurricanes have been primarily limited to Atlantic and Mexican Gulf coasts and south - eastern islands, hazards due to tornadoes and thunderstorms are of concern to inhabitants of most of the U.S.

The highest numbers of fatalities and injuries are attributed to tornadoes. Although most of the largest tornadoes occur in central U.S. – the tornado alley – tornadoes have been reported both west and east of the alley. Tornado touchdown (this Fall) in College Park, Maryland, is a good illustration of a wide territorial reach of tornadoes.

Thousands of thunderstorms occur every year all over the U.S. Strong winds associated with passage of thunderstorms, at times accompanied by (thunderstorm-spun) tornadoes, gust fronts and downbursts result in a significant physical damage and loss of human life. 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 down slope Chinook wind in Rocky Mountains, Santa Anna wind in California and strong winds in north - western U.S, and in Alaska. Strong gusts associated with these events are responsible for wind-related damage in such areas.

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

Justifying the Cost of Wind Hazards 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. 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 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, at an accelerated rate.

Because our 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, a reoccurrence of hurricane of magnitude of hurricane Andrew, with landfall passage 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. Recent tragic events in New York City underscore the severity of economic impact of a major disruption in urban infrastructure and interruptions in business activities.

If research can reduce the economic loss from a single future strong-wind event by as little as 10%, the payoff on the research investment will be as much as hundred times the annual research budget for wind engineering research in this country. The impact of the research will also reduce losses in subsequent wind events. Moreover, the competitiveness of U.S. engineering and construction firms will be enhanced as they adopt improved technologies de-

veloped through such effort.

It is worth mentioning that current overall Federal funding to develop and promote knowledge, practice and policies that seek to reduce losses from wind related disasters is approximately equal to $5 – 10 million per year. A significantly higher Federal research investment is needed to accelerate reduction in the wind losses.

Accomplishments to-Date to Reduce Losses Due to Wind Hazards

Despite the lack of a national program focused on reduction of wind-induced losses, research and development efforts to-date have helped to advance our understanding of wind loads and their effects on the built environment. One of outcomes of this effort are improved design specifications. Examples include the American Society of Civil Engineers Standard ASCE 7-98 "Minimum Design Loads for Buildings and Other Structures," which serves as a resource document for model building codes.

Other research and development accomplishments include:

- Improved characterization of winds;
- Statistical analysis and modeling of historical wind records to develop a design wind speed map;
- Improved descriptions of wind pressures and associated loads on structures;
- Improved evaluations of the performance of building envelopes and load-carrying members;
- Devices for low-rise structures to improve the wind resistance;
- Improved knowledge regarding wind-generated missile impacts and mitigation techniques;
- Innovations to improve wind design of many structures.

However, despite the above developments, our understanding and ability to quantify wind load effects for use for design and construction practices is far from complete.

Status of U.S. Infrastructure for Wind Hazards Research

Laboratory Facilities - Majority of wind engineering research continues to be carried out in laboratory setting. Boundary-layer wind tunnels remain the main tool employed in this effort. The number of boundary layer wind tunnels routinely used in wind engineering research and service in the U.S. is smaller than ten. The size of these facilities is modest, when compared with wind tunnels available for wind engineering research in other industrialized countries.

Valuable insight into the performance of specific components of the structure may be obtained using other facilities. Such an approach has been employed (so far on a limited basis) in the testing of roofing components, impact resistance, and cladding/glazing components.

Field Facilities - There are a few full-scale sites in the U.S. for monitoring extreme wind characteristics and wind-structure interaction studies. Sophistication of instrumentation and level of personnel support varies.

Utilization of Research Results - In spite of a relatively low level of financial support, there has been significant research carried out in the U.S. to improve understanding of characteristics of wind and its interaction with structures. This research has provided a basis for a number of effective wind-resistant engineered designs. However, many related questions remain unresolved.

Human Resources – Support for wind engineering research continues to be at a significantly lower level than that of 10 to 15 years ago. As a result, the number of researchers who are willing to focus on wind research as a primary research area has diminished significantly. This also has repercussions on the production of future educators and researchers who are sufficiently experienced to continue research activities and are capable of incorporating improved wind design information in academic programs. In addition, it creates a shortage of prac-

ticing professionals capable of utilizing and disseminating such knowledge.

Education - Improving the level of awareness and capabilities for wind-resistant design requires that relevant information be conveyed to all levels of the profession, from scientists down through construction personnel, via instructional courses and educational materials which could be made readily available through conventional media. There is a relative paucity of material and tools necessary to accomplish this task.

Partnering - Developing an effective program to reduce the undesirable impacts of wind requires a team effort involving academics, design, industry, and government interaction. One such partnership is that between wind engineers and meteorologists. Another example is partnership between insurance industry and wind engineering community. Additional partnerships must be formed between academe, professional societies, design firms, contractors, manufacturers of components and devices, and various levels of government.

Engineering Research Needs to Reduce Impact of Wind Hazards

Areas identified for engineering research focused on reduction of wind hazards include:

- 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;
- Study of internal load paths, performance of structural systems, and effectiveness of connections between structural components;
- Field monitoring of structures in natural environment and full-scale tests in simulated loading environment;
- Health monitoring and structural control studies for mitigation of wind effects;
- Application of effective numerical schemes of computational fluid dynamics for studies of wind effects on structures;
- 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.

Activities related to the above research include:

- Implementation of new technologies;
- Effective information dissemination;
- Education and training in the area of wind hazards mitigation;
- Partnering with industry and government; and
- International collaboration.

Potential for National Research Program to Accelerate Reduction in Wind Hazards Losses in the U.S.

Recent debate and initiatives focused on the wind hazards problem are very encouraging. The Wind Hazard Reduction Caucus has been formed in U.S. House, under chairmanship of Reps. Walter Jones (R-NC) and Dennis Moore (D-KS). Its activity is supported by the Wind Hazard Reduction Coalition, spear-headed by the American Society of Civil Engineers. Legislative action in the House included introduction (in October 2000) of a bill, calling for creation of the National Wind Hazard Reduction Program. Reintroduction of the bill is expected

shortly. In U.S. Senate, the Natural Hazards Caucus was formed under leadership of Senators T. Stevens (R-AK) and J. Edwards (D-NC). In addition, the Natural Hazards Work Group was formed to aid activities of the Senate Caucus. Synergic interaction among the Coalition, the Workgroup and members of Congress and Congressional staffers has developed.

The goals of the proposed National Wind Hazard Reduction Program (WHRP) are:

- Increase public safety; and
- Decrease economic losses due to strong winds and associated natural phenomena.

Tasks identified as needed to accomplish these goals include:

- Better design and construction methods and practices;
- Better emergency response;
- Improved early-warning systems;
- Building codes enforcement; and
- Public education and involvement programs.

In context of an overview presented earlier in this paper, a substantial engineering research effort will be required to effectively and timely address the above tasks. Initial stage of these activities will require the following effort:

- Assess and synthesize the existing knowledge;
- Identify specific research needs;
- Assess the existing research infrastructure and needed improvements; and
- Develop strategy for implementing the identified research & infrastructure needs.

Drawing on experience of the National Earthquake Hazard Mitigation Program (NEHRP), it is suggested that the engineering wind hazards research component of the NWHRP be carried out through a few regional wind hazards engineering research centers, to be established as part of the program. Each center would comprise of a number of academic institutions and other research affiliates. The lead institution(s) of a center would coordinate research activities within the center and would be engaged in collaboration with the remaining centers and with other partners. A coordinated interaction with such partners could be enhanced through establishment of regional wind research consortia involving academic, industrial and state entities. The mission of such consortia could be broader than the main focus of the NWHRP.

Over the years, the engineering research component of the NEHRP has been carried out by a number of earthquake engineering research centers. Three regional centers are currently funded by the NSF under an umbrella of the NEHRP: Pacific Earthquake Engineering Research Center, Mid-America Earthquake Engineering Research Center and Multidisciplinary Earthquake Engineering Research Center. Each center has a different focus of the research and related activities. As a result, duplication of research effort is eliminated.

Based on this model, establishment of a limited number of regional wind hazard engineering research centers appears to be a reasonable approach to create research infrastructure necessary to carry out the research component of the NWHRP. They could include, but are not limited to, the following wind hazard engineering research centers:

- Center focused on Atlantic coast region;
- Center focused on Southern (Mexican Gulf coast) region;
- Center focused on South-Eastern region;
- Center focused on West-Central region.

In addition to the research mission, each center would be substantially engaged in education, service and outreach. Partnering, technology transfer and other activities of a particular center could be aided by a regional wind research consortium. Such a consortium could serve as a vehicle to identify regional issues of wind hazards and related natural phenomena. In addition, it could foster regional

collaboration of interested parties and facilitate economic utilization and modernization of the existing regional infrastructure and pooled sharing of financial resources. One of possibilities for a model consortium is a concept currently being developed for the West-Central Wind Research Consortium (W2RC), see Appendix C.

As delineated in the discussed Congressional bill, the national program is anticipated to:

- Focus on mitigation, response, and recovery;
- Involve physical science and engineering; and
- Take into account social, economic, political, and legal implications.

Ultimately it is expected to result in:

- Improved building codes and implementations;
- Cost-effective retrofit of buildings; and
- Public education/outreach.

It is believed that the wind hazards engineering research and the research infrastructure discussed herein have a potential to lead to significant contributions to all of the listed above expectations. A broad debate on these topics is needed to establish the most optimal strategy for planning and implementation of the wind hazards research necessary to ensure success of the proposed program. Ultimately, this effort will lead to formulation and implementation of the action plan of potential to significantly accelerate reduction in wind hazards losses in the U.S.

Concluding Remarks

We are not hampered by a lack of research expertise, innovative ideas, adaptive technologies or justifiable mitigation needs. Rather, as late Congressman George Brown stated in context of one of Congressional authorizations of the National Earthquake Hazard Reduction Program, "Much of the national earthquake mitigation effort has been hampered by one simple thing: lack of money." This comment can be equally applied to wind hazards mitigation effort. With an increase in the funding associated with the establishment of the proposed National Wind Hazard Reduction Program, the country can prepare for wind hazards at an accelerated rate and preclude an economic loss of a much greater magnitude than the research expenditure.

Since it is not prudent or cost effective to continue at our present slow pace, the rate at which we do wind hazards research must be increased. This will not only improve our safety and substantially reduce future wind-generated losses, but also help to regain the U.S. lead in the area of wind hazard mitigation.

Appendix A - References

"Minimum Design Loads for Buildings and Other Structures," ASCE 7-98, Published by the American Society of Civil Engineers.

“Wind Engineering: New Opportunities to Reduce Wind Hazard Losses and Improve the Quality of Life in the USA, ” Report Prepared by the American Association for Wind Engineering, August 1997.

“Proceeding of the Workshop on Research Needs in Wind Engineering," February 1995, Maryland.

"Wind and the Built Environment; U. S. Needs in Wind Engineering and Hazard Mitigation," Panel on the Assessment of Wind Engineering Issues in the United States, Committee on Natural Disasters, Commission on Engineering and Technical Systems, National Research Council, National Academy Press, Washington, D.C., 1993.

"Reducing Disasters’ Toll: the United States Decade for Natural Disaster Reduction," Advisory Committee on the International Decade for Natural Hazard Reduction, National Research Council, 1989, National Academy Press, Washington, D.C.

Note from the Editor

This paper was presented during the 2001 ASCE Convention and Exhibition, Houston, Texas, October, 2001. Opinions expressed in the paper are those of the author. They do not represent a formal position of the AAWE on the discussed topics. Readers’ feedback on the paper should be forwarded to: bogusz@engr.colostate.edu.

Appendix B – Fact Sheet

Wind Hazard Reduction Caucus

The Facts

1998 Atlantic Hurricanes

- ★ 14 tropical storms
- ★ 10 hurricanes
- ★ $3.6 billion in damages
- ★ 32 fatalities

1998 Tornadoes

- ★ 488 tornadoes, category F1 or greater
- ★ 130 deaths, 1,868 injuries
- ★ $1.56 billion in property damage
- ★ $22 million in crop damage
- ★ During 1959-1989 tornadoes claimed 3,550 lives – an average of 96 fatalities per year.

1998 Thunderstorms

- ★ 11,592 thunderstorms
- ★ 41 deaths, 860 injuries
- ★ $1.06 billion in property damage
- ★ $161 million in crop damage

All 50 states are vulnerable to the hazards of wind storms.

Losses in life and property can be substantial. In 1992, hurricane Andrew resulted in $26.5 billion in losses and 61 fatalities. In 1989, hurricane Hugo resulted in $7 billion in losses and 86 fatalities. In 1998, a calm year according to experts, wind related storms resulted in more than $5.5 billion in damages, and at least 186 fatalities.

The Problem

At approximately $5 million, the Federal investment to develop and promote knowledge, practices, and policies that seek to reduce and where possible eliminate losses from wind related disasters is woefully inadequate. In contrast the Federal government invests nearly $100 million per year in reducing earthquake losses through the National Earthquake Hazards Reduction Program.

A Federal investment in Wind Hazard Reduction will pay significant dividends in lives saved and decreased property damage.

Goals

The goal of the Wind Hazard Reduction program will be to reduce loss of life and property by 50% by 2010. This damage can be substantially reduced through the development and implementation of an effective National Wind Hazard Reduction Program (NWHRP). The NWHRP would address:

- ➢ Better design and construction methods and practices;
- ➢ Better emergency response;
- ➢ Use of modern technology for early-warning systems;
- ➢ Building codes enforcement; and
- ➢ Public education and involvement programs.

The Caucus

The **Wind Hazard Reduction Caucus**, chaired by **Reps. Walter Jones (R-NC) and Dennis Moore (D-KS)**, is focused on increasing the awareness of Members of Congress about the public safety and economic loss issues associated with wind. The goal of the caucus is to seek government funding to support a National Wind Hazard Reduction Program that would focus on increasing public safety and decreasing the economic losses associated with tropical storms, thunderstorms, and tornadoes.

For further information on the **Wind Hazard Reduction Caucus** contact Jana Denning in Rep. Dennis Moore's office at x52865, e-mail jana.denning@mail.house.gov, Geoff in Walter Jones' office at x53415, e-mail geoff.bowman@mail.house.gov or Brian Pallasch, Director, Government Relations, American Society of Civil Engineers at 202-789-2200, email bpallasch@asce.org.

Appendix C - West-Central Wind Research Consortium (W2RC)

Mission and Background

The mission of the West-Central Wind Research Consortium (W2RC) shall be to develop, fund and conduct collaborative research programs leading to useful and economically viable results on subjects related to wind, its associated hazards and its beneficial effects. The W2RC shall also create educational infrastructure and foster technology transfer programs to provide the citizens of the west-central states with practical information on the application of the research results that will benefit their safety and economic health**.** The W2RC is being created recognizing the special needs of the citizens of the west-central states - Colorado, Wyoming, Montana, South Dakota, North Dakota, Utah, Iowa, Kansas, Missouri, and Nebraska. The primary objectives of the consortium are to improve understanding of the role of wind as a natural hazard, in energy production, and in the safety and economic health of the residents in these states.

Current Activities

Current activities involve initial development and membership selection. Agreements of interest have been made by key faculty and administrators at the University of Wyoming, Colorado State University, the South Dakota School of Mines and Technology, and Kansas University. Commitments have been made by each university to provide startup funds in the amount of $5000 to enable the initial organization of the Consortium. Dr. James R. Goodman, formerly a faculty member at Colorado State University and Academic Vice President at the South Dakota School of Mines and Technology, has agreed to serve as an Interim Director during the initial development of the W2RC. Ongoing discussions are being held among the organizing institutions regarding startup issues, prospects for funding and the involvement of additional universities, federal and state agencies, and private interests. A meeting of the W2RC organizers, key faculty and others interested is planned. Additional members are being sought for the W2RC.

Issues and Opportunities

A partial list of the issues and potential opportunities for the W2RC activities include:

- Mitigation of Damage and Improved Safety During High Wind Events;
- Energy Issues;
- Transportation Issues;
- Environmental Issues;
- Agricultural Issues;
- Fire Safety;
- Multi-Hazard Aspects of Wind and Weather Effects;
- Economic Effects and Policy Issues; and
- Educational Opportunities.

Benefits for Members of W2RC

The universities, research organizations, governmental agencies and industries of the central states have a long history of concern for the impact of the forces of nature on the citizens of the area. Centers of excellence that relate to the effects of the environment on the safety and economic health of its citizens exist in each state in the region. Governmental agencies active in this area include NOAA, the Bureau of Reclamation, NASA, USDA, the Forest Service, the Soil Conservation Service, USGS, NIST, and others. Each state also has parallel agencies charged with applications on state lands. Thus, a high level of capability exists that relates to special research problems on the effects of wind. The W2RC will provide an organizational structure to bring together, regardless of affiliation, those desiring to research and disseminate the results to be implemented in these states. The collaborative research programs developed and funded under the auspices of the W2RC will seek to bring together the collective capabilities of each member. This in turn will lead to enhancement of national efforts to reduce the adverse impacts of wind and related hazards and to more effective utilization of the benefits of wind, thus improving quality of life.

AMERICAN ASSOCIATION FOR WIND ENGINEERING

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American Association for Wind Engineering

OBJECTIVES

The American Association for Wind Engineering (AAWE) was established in 1966. The objectives of AAWE are: (1) the advancement of the science and practice of wind engineering and (2) the solution of national wind engineering problems through transfer of new knowledge into practice.

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WHY YOU SHOULD JOIN:

AAWE provides networking opportunity with U.S. wind engineering community through regular and special publications, e-mail communication, internet re-sources, and technical meetings.

HOW TO JOIN

Fill–in the Membership Application/Renewal Form and forward it to AAWE Secretary/Treasurer. For more information visit AAWE web site or contact Mike Gaus (mgaus@gausassoc.com, 716-689-4914, voice) or Bo Bienkiewicz (bogusz@engr.colostate.edu, 970-491-8232, voice).

Get involved in formulating
National Wind Hazard Reduction Program

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American Association for Wind Engineering

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FIRST ANNOUNCEMENT & CALL FOR PAPERS

ENGINEERING SYMPOSIUM to Honor ALAN G. DAVENPORT for his 40 Years of Contributions June 20-22, 2002

Alan G. Davenport Wind Engineering Group
Boundary Layer Wind Tunnel Laboratory
University of Western Ontario, London, Canada

SYMPOSIUM PURPOSE AND SCOPE

The Alan G. Davenport Wind Engineering Group is inviting the engineering community to gather at UWO from June 20-22, 2002, to honor Professor Alan Davenport's tremendous contributions over the past 40 years. This Symposium is to provide a collegial venue for state-of-the-art and historical discussions in all areas in which Professor Davenport has advanced our current understanding.

SYMPOSIUM ACTIVITIES

Thursday and Friday will be dedicated to technical papers; Saturday's presentations will be of a historical nature. The program will be arranged as a single forum with ample discussion time. There will be a special banquet on Thursday to honor Dr. Davenport. Two other recent retirees of the Laboratory, Dr. Barry Vickery and Dr. Nicholas Isyumov will be honored at special lunches. Following the conference, on Saturday afternoon, a trip to nearby Stratford is planned for dinner and to attend a play at the well-known Shakespearean festival.

ATTENDANCE REGISTRATION

For planning purposes, preliminary registration is strongly encouraged via email, fax or through our web page before September 30, 2001. After that date, commitment to facilities will limit future attendee numbers. Formal registration details will be issued by November 30, 2001, with a response deadline by April 30, 2002.

CALL FOR AND SELECTION OF PAPERS

Technical research papers and/or review articles are solicited that reference Dr. Davenport's contributions to the field. In addition, briefer, informal papers providing a historical perspective on Dr. Davenport's career and accomplishments are requested. Former students and others associated with 'AGD' and/or the Laboratory are encouraged to submit manuscripts. Prospective authors are requested to submit an extended abstract of four pages for technical papers, or one page for the historical perspectives, by **December 1, 2001**.

Selection of papers will be by the UWO host committee and presentation of papers will be by invitation only. Only 25-30 papers will be accepted for presentation. Others may be accepted for inclusion in the meeting Preprint package. Presented technical papers will also be published in a special issue of the Journal of Wind Engineering and Industrial Aerodynamics following the normal peer-review process. Authors will be notified of abstract acceptance by **January 31, 2002** and will be invited to submit their completed manuscript by **April 30, 2002**.

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Conference details will be regularly posted on the BLWTL web page and transmitted electronically wherever possible. Please direct abstract submissions and other inquiries to:

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American Association for Wind Engineering

Objectives:

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

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