

Workshop for Research in Electricity Infrastructure Hardening

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<i>Faculty</i>	<i>Department, affiliation</i>	<i>Specialization</i>
Kurt Gurley	Civil - UF	Vulnerability of structures in hurricane winds Hurricane wind speed / pressure measurement Retrofits to improve wind resistance
Forrest Masters	Civil – FL International University	Simulation of full-scale hurricane winds and rain Hurricane wind speed / pressure measurement
Ron Cook	Civil - UF	Design against high winds, lifeline recovery
Ralph Ellis	Civil – UF	Cost modeling for infrastructure planning
Bob Dean	Coastal – UF	Coastal erosion
Peter Sheng	Coastal – UF	Storm surge modeling
Ed Gilman	Environmental Horticulture - UF	Performance of trees in high winds Vegetation management strategies in wind prone regions

Hurricane Wind Field and Infrastructure Vulnerability (Gurley, Masters, Cook)

Since 1999 Drs. Gurley (UF), Masters (FIU) and Cook (UF) have collaborated on research that addresses the effects of hurricane winds on residential infrastructure and critical lifelines. These projects are collectively referred to as the Florida Coastal Monitoring Program (www.ce.ufl.edu/~fcmp).

Current relevant projects include:

- Measurement and modeling of overland hurricane winds (in-situ, real-time)
- Measurement and modeling of hurricane wind pressures on residential housing (in-situ)
- Wall of Wind: Full-Scale laboratory simulation of hurricane winds and wind-driven rain for the development and direct evaluation of vulnerability reduction methods. This apparatus is also used in concert with Ed Gilman to evaluate means to reduce tree vulnerability in hurricane winds
- Computational modeling of structural vulnerability and the effectiveness of retrofits
- Experimental evaluation of the ultimate capacity of building components in high winds
- Design, testing and implementation of cost-effective retrofits to reduce wind vulnerability
- Investigation of structural failure in high winds to produce statistical performance studies

All of the above activities have a direct application to power distribution infrastructure. Direct measurement of wind speeds and resultant wind loads using mobile instrumentation can be correlated with wind related power failures (pole failure, tree blow down, transformer failure), and the real-time wind data during land falling hurricanes can be adapted for power recovery resource allocation. Extensive experience with structural vulnerability modeling (computational and experimental), and the design and implementation of wind resistant retrofits can be extended to the power infrastructure. The ability to create full-scale hurricane winds and wind-driven rain has been proven (FIU – Masters) through the successful completion of the first phase of the Wall of Wind (to be demonstrated at the workshop). The final phase, a 25 ft tall, 45 ft wide wall of hurricane wind, will provide the only facility capable of accurately reproducing full-scale sustained winds, turbulent gusts, and wind driven rain identical to that characterized in our extensive database of in-field measurements collected through 20 storms since 1999. Line and pole dynamics and transformer performance in high winds and rain can be quantified in a controlled hurricane environment, and engineered hardening improvements can be directly evaluated before incurring the cost of in-field implementation. Cost modeling of competing solutions will be addressed by Dr. Ellis. These researchers have worked extensively with Applied Research Associates on a variety of hurricane and infrastructure performance issues. ARA has submitted a companion abstract.

Cost Modeling (Ellis)

Cost is a key factor in strategic planning for infrastructure hardening. Dr. Ellis is a cost modeling expert in the construction management group within the Department of Civil and Coast Engineering. He has 15 years experience as PE and Industry Manager supervising engineering cost estimating activities, and 16 years at UF conducting engineering cost modeling research (50 + projects). Decision makers must have available reliable cost information comparing alternative technical approaches. A robust, life-cycle cost modeling approach is needed throughout the service life of the infrastructure. Detailed development, maintenance and operational cost must be developed for all new technological approaches being considered. Dr. Ellis has a significant research experience in development of advanced cost modeling systems for infrastructure planning, life cycle costing, long range estimating and value engineering. He has an extensive track record with the US Army Corps of Engineers, US Department of Energy and the Florida DOT on projects in this area.

Tree Management to Reduce Failure in High Winds (Gilman)

Dr. Gilman is a recognized expert in environmental horticulture, specializing in the modeling of tree behavior in high winds and developing methods to reduce vulnerability (planting, land and appropriate species use issues, pruning and bracing to resist wind). At end of May, 2006 he will be working with Dr. Masters, using the Wall of Wind to directly quantify tree performance in high winds (defining wind thresholds for acceptable performance, and the influence of planting depth, species and pruning on improved performance). Such data will complement the tree-blow down computational models being developed by ARA (separate abstract). The prevention of tree damage to the power infrastructure through vegetation management strategies is a natural extension of his work.

Storm Surge and Coastal Erosion (Sheng and Dean)

The Coastal and Oceanographic Engineering Group within the Department of Civil and Coastal Engineering represents the leading edge of storm surge, inundation and erosion modeling. Their models successfully forecasted the water level at Ft. Myers during Wilma for South Florida Water Management District. They also validated surge simulation with data from Tampa Bay, Charlotte Harbor, Louisiana, Mississippi, Alabama, and Florida Panhandle during Hurricanes Charley, Jeanne, Ivan, and Dennis.

- Coastal faculty has developed new technology for creating the flood insurance rate map (FIRM), working with Pinellas County and FEMA. The methodology uses a state-of-the-art storm surge and wave model and high resolution Airborne Laser Mapping topography data to simulate the coastal inundation in Pinellas County to be expected in a 100-year storm.
- Coastal faculty have developed robust a real-time storm surge and inundation modeling system for real-time forecasting of the storm surge, currents, wave, and coastal inundation as the hurricane approaches shore. The high-resolution forecasts can identify which coastal community (including power plants in coastal regions) and which streets will be inundated, thus enabling the power companies to plan on power outage to avoid fire hazard, and to guide the repair crew to avoid streets with high inundation. The forecasting system has been extensively validated with field data collected in 2003 – 2005, and enhanced by FCMP real-time wind data (page one).
- The storm surge and inundation modeling system can be employed along with historical hurricane statistics to identify the characteristics of various return period hurricanes, surges, etc., and to quantify the risks of various communities and streets to surge and inundation damages. These results will enable the power companies to better design the power distribution infrastructure to prevent extensive damage such as during Wilma in 2005.
- Based on the forecasted storm surge, currents, wave, and inundation in coastal areas, coastal erosion during hurricanes can be calculated to provide the necessary information for planning of underground power distribution infrastructure resistant to inundation and erosion.
- Large power distribution structures can interact with storm surge and waves, hence it is important to conduct simulations of such interactions to ensure that such structures will remain intact during hurricanes, or identify likely failure modes and propose effective hardening solutions.