Dear Wind Turbine Modeling Enthusiast,

Based on the level of interest and indicated participant availability from our recent polling, we are planning to sponsor a three-day workshop on September 22-24, 2008 covering the topic of stochastic turbulent inflow and its simulation, with particular reference to the theory, use, and applications of the NREL TurbSim inflow turbulence simulation code. On September 25, we will hold a workshop to introduce the latest improvements in other DOE-sponsored design codes: FAST, BModes, AeroDyn, PreComp, NuMAD, and MCrunch (the new Matlab®-based version of the post-processor Crunch).

At the present time we are planning to hold these workshops at the facilities of NREL's National Wind Technology Center south of Boulder, Colorado. DOE security regulations require that we obtain site access approval for our international colleagues several days in advance of the opening session on September 22nd. We will be furnishing information for the requirement to obtain this access as well as general logistical information about the workshops later this year when we have a more complete list of attendees. We have set up an online poll using the Doodle® Polling/Scheduling facility for those who wish to indicate their current intention to attend the workshops and to whom we can communicate regarding the details of the workshops.

Background

It is becoming recognized that there is a need for a greater degree of site specificity in the turbulence operating environment when designing modern, multi-megawatt capacity wind turbines. Because of class certification requirements, most current turbine design processes depend almost exclusively on the turbulence characteristics defined by the IEC 61400 Normal Turbulence Models (NTM) and a suite of discrete load cases. The standard itself considers these as minimum requirements and suggests that they should not be used as a complete set of design specifications.

NREL has been active in research to understand the effects of both natural and wind-farm generated atmospheric turbulence on the aeroelastic response of wind turbines since 1989. Our approach has been to establish correlations between these responses and their consequences (component damage and fatigue, system integrity and reliability, power production, etc.) with key measureable fluid dynamics descriptors of the turbulent inflow. We have also applied the available knowledge of atmospheric boundary layer turbulence dynamics and scaling to place our simulation capabilities on as firm a scientific footing as possible.

Because wind turbines often must operate in turbulent flow conditions that are not always theoretically understood and cannot be fully described by closed-form mathematics, we must resort to stochastic simulations using Monte Carlo techniques that are based on observed, site-specific statistical scaling relationships. Built on the foundation of Paul Veers' original SNLWIND simulator[1], the TurbSim code has been expanded to include four diverse but often encountered turbine inflow operating environments. TurbSim scales the inflow turbulence

[1] Veers, P.S. (March 1988). *Three-Dimensional Wind Simulation,* SAND88-0152. Albuquerque, NM: Sandia National Laboratories.

characteristics and structures based on detailed, site-specific meteorological measurements. TurbSim simulations then represent individual stochastic realizations of flow fields derived from the observed turbulence statistics of a particular site or class of sites. An overview of the TurbSim code and a user's guide are available in PDF format at:

http://wind.nrel.gov/designcodes/preprocessors/turbsim/TurbSimOverview.pdf
http://wind.nrel.gov/designcodes/preprocessors/turbsim/TurbSim.pdf

Turbulence Workshop Purpose

We are proposing to hold a workshop at NREL's National Wind Technology Center (NWTC) in which the following topics will be covered using a lecture-discussion format:

- An overview of the atmospheric boundary layer, its dynamics, and the turbulence characteristics associated with it
- Atmospheric boundary layer structures that generate turbulence characteristics that can be detrimental to wind turbine component lifetimes and operations
- Specific turbulence characteristics that have been shown to influence the dynamic response of wind turbine structures and components
- The site-specific turbulence models available in the TurbSim code in addition to the IEC Kaimal NTM, including
    - Smooth, homogeneous terrain
    - Upwind and within a multi-row wind farm with 7 and 14D row-to-row spacing
    - The NWTC Test Site (downwind of very complex, mountainous terrain)
    - A North American High Plains site with and without the presence of a nocturnal low-level jet stream
- Setting up and using the TurbSim code
- Interpreting the statistical summaries provided with TurbSim simulations
- Suggested methodologies for using TurbSim inflow simulations as part of the turbine design process, including IEC and site-specific turbulence models
- A concluding roundtable discussion of the general topic of the turbulent inflow, its simulation, and its impact on wind turbine design and operations.

We expect to provide the opportunity for workshop attendees to actually use the TurbSim code to generate various inflow regimes using the IEC NTM and the site-specific turbulence models listed above. These inflows can be used to simulate the turbulence-induced response of a virtual multi-megawatt turbine design using the FAST/AeroDyn design codes. The turbine simulations then can be analyzed using a post-processing program. This will allow the

attendees to compare the load dynamics and statistics resulting from the turbulence characteristics associated with the available turbulence models in TurbSim.

Design Code Update Workshop

The fourth day would include a workshop devoted to discussing the latest updates and new capabilities available in the DOE-sponsored turbine design codes developed by the Wind Program activities at NREL and Sandia National Laboratory. The codes to be discussed will include:

- PreComp (computes structural properties for composite turbine blades)
- NuMAD (ANSYS® pre/post-processor for three dimensional finite element blade design)
- BModes (software for computing tower and rotating blade coupled modes)
- AeroDyn (aerodynamics software library for use with structural codes)
- FAST (wind turbine structural dynamics simulator)
- MCrunch (Matlab®-based version of the Crunch post-processor)

Tentative Schedule

We plan hold these workshops on four consecutive days (Monday through Thursday) beginning September 22-25, 2008 from 08:30 to 17:00 at NREL's National Wind Technology Center south of Boulder, Colorado. An online Doodle® Polling/Scheduling facility has been established for to indicate an intended interest in attending by participating in the poll. This poll may be accessed at

http://www.doodle.ch/wawqux7rg5auhs97

Comments Solicited

We welcome any comments or suggestions on the organization of the workshops or their subject matter. Comments may be sent to

TurbSim Workshop

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