SAND2012-4115P

Sandia National Laboratories

2012 Wind Turbine Blade Workshop

NREL

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

Welcome

Welcome to Sandia National Laboratories 5th Wind Turbine Blade Workshop. From our first event in 2004, the focus has always been to bring together wind energy leaders from industry, academia, and government to exchange information on the latest trends, barriers, and innovations on wind turbine rotors. From the beginning, this workshop has provided a unique, blade-focused collaborative forum which is not present at any other event. The industry must continue to identify and exploit technology opportunities to further improve blade and turbine designs, to enable the continued success of this industry. That is our focus and why we continue to host the event.

With over 250 attendees from several countries expected this year, we hope that this year's event reflects your comments from previous workshops and continues to provide a comprehensive, informative, and a valuable networking opportunity. Key topics this year include new rotor developments, blade and rotor testing, materials, advanced manufacturing, innovative blade design, aerodynamics, reliability, and more. It is our continued goal to cover the necessary topics that provide insight into the challenges, opportunities, and requirements for the next generation of innovative, reliable, and efficient wind turbine rotors.

We would like to thank our sponsor, the Department of Energy's Wind and Water Power program, for their continued support. We hope you enjoy this year's event, and feel free to let us know how we can continue to improve it.

Best Regards,

Todd and Daniel

D. Todd Griffith, 2012 Workshop Chair

Daniel L. Laird, 2012 Workshop Co-chair

Sandia National Laboratories

Energy, Climate & Infrastructure Security

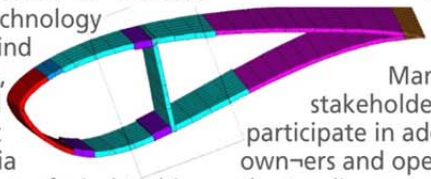
Wind Energy Programs

The Energy Security program area accelerates the development of transformative energy solutions that will enhance the nation's security and economic prosperity.

Vision

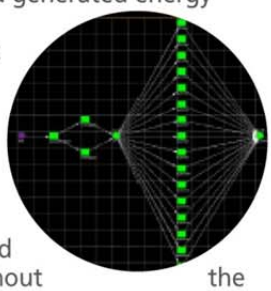
To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems.

Sandia National Laboratories (Sandia) conducts applied research to increase the viability of wind technology by im-proving wind turbine performance, reliability, and reducing the cost of energy. Sandia specializes in all aspects of wind-turbine blade design, manufacturing, and system reliability. By partnering with universities and industry, Sandia works to advance the state of knowledge in the areas of materials, structurally efficient airfoil designs, active-flow aerodynamic control, and sensors. Researchers at the laboratory are inves¬tigating integrated blade designs where airfoil choice, blade platform, materials, manufacturing process, and embedded controls are all considered in a system perspective. By collabo¬rating with operators, developers, and manufacturers, Sandia evaluates known reliability problems and develops tools and methods to anticipate and investigate future reliability issues.



Reliability Database & Systems Analysis

In order for wind generated energy to reach high electrical market penetration, customers must have continued confi¬dence in the quality, durability, and reliability of wind turbines throughout the fleet. Sandia's reliability effort aims to ensure high fleet operating performance levels, judged both by ener-gy delivery and low operating costs. This task measures, ana¬lyzes, documents, and publishes current and future turbine and wind farm availability, as well as targets potential reliabil¬ity issues as early as possible. To accomplish this, the program initiated a national reliability database, which is used to gather and store wind farm operations data. These data are analyzed and baseline statistics on the reliability of the fleet are report¬ed. The program will use these analyses to initiate technol¬ogy improvement projects where critical reliability issues are discovered. Manufacturers and key stakeholders will be invited to participate in addition to wind plant own¬ers and operators. Building from the Sandia-sponsored public Wind Turbine Reli¬ability Workshops of the past two years, Sandia will continue to build partnerships across the industry and facilitate information exchange to bridge the gaps between operators, developers, turbine suppliers, and component vendors.



Large Turbine Technology: Wind Turbine Blades

Blades are the only wind turbine component designed and manufactured uniquely for wind energy applications. The challenge is to create the scientific knowledge base and engineering tools to enable designers to maximize performance at the lowest possible cost. Activities at Sandia seek to produce research results, tools, and prototype evaluations necessary for the successful implementation of advanced design concepts into large innovative utility-grade blade designs. By focusing on improvements in blade technology through improved materials and manufacturing, optimized sensors, improved aerodynamic and structural codes, and enlarged rotors made possible by adaptive techniques, Sandia is providing innovative solutions to the industry.

Materials & Manufacturing

Wind turbine blades constitute a significant portion of the cost of a modern, utility-scale, wind turbine. These blades are comprised of relatively low-cost composite materials with manufacturing processes that are labor-intensive. To facilitate the incorporation of larger blade designs into new turbines, Sandia studies composite materials and manufacturing processes to develop innovations that will help reduce the nonlinear growth in blade weight. The objective of this

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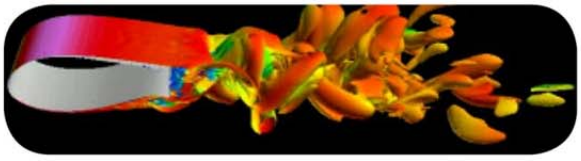
effort is to provide innovations in materials, manufacturing processes, and embedded sensor technologies that will deliver high quality, reliable, and cost-effective blade designs.

Innovative Concepts

As wind turbines become larger and heavier, blades that incorpo¬rate small load-control devices (similar to but smaller than flaps on an airplane wing) and embedded sensors to alleviate fatigue loads offer a potential for improving efficiency and energy capture. Sandia's efforts focus on three areas: (1) analyzing aerody¬namic performance (2) developing advanced controls and (3) calculating the maximum potential cost of energy reduc¬tions that can be reasonably achieved by reducing fatigue loading. Finally, as technology allows blades to grow larger (to capture wind energy more efficiently), they are becoming difficult to transport over the nation's roads (currently, truck transporters are exceeding 180´). Sandia is investigating the possibility of economically manufacturing segmented turbine blades.

Aerodynamic Tools & Aeroacoustics

Sandia continues to develop and use computational fluid dynamics codes to improve our understanding of the highly 3-D flow fields under which wind turbine rotors operate. By leveraging Sandia's high performance computing capability, these tools provide the necessary information to develop the next generation of wind turbine blades that maximize both structural and aerodynamic efficiency. Additionally, SNL will continue to develop aeroacoustics emission and propagation codes that will allow us to predict the noise characteristics of wind turbine rotors. As part of that effort, the aerodynamic per¬formance and acoustic emissions of a rotor with blunt trailing edge airfoils will be compared to those of a similar rotor with conventional airfoils and the effects of varying blunt trail¬ing edge treatments on these characteristics will be studied. This comparison effort is supported by wind tunnel tests to compare the measured noise generation and propagation of a traditional sharp trailing edge airfoil and a structurally efficient flatback airfoil.



Design Tools & System Modeling

Sandia will continue its efforts to develop computational tools to significantly improve the structural and aeroelastic analy¬sis capability available to the wind industry. These analytical capabilities may be used to guide the design of new blades as well as to verify/improve the design of existing blades. The validity of the tools will be dem¬onstrated by continuing a comprehensive design, analysis, build, test, and validation program. A major focus is being placed on better integration of the structural analysis and aeroelastic codes. This effort will reduce design time and lead to better and more efficient designs for future turbine hardware.

System Performance & Blade Testing

Full-scale testing of prototype wind turbine blades is vital to asses the structural and aerodynamic performance of advanced concepts. Recently, Sandia has developed three advanced blade designs which are in the process of being evaluated by a series of structural and aerodynamic tests. Sandia will continue to conduct both laboratory and field testing of advanced blades in the future, and pro¬vide the necessary results to industry to ensure the viability of the unique features of the designs. Additionally, results from the blade testing provide the critical information needed to validate and improve our design codes.

Integration Technology Assessment & Support

Though wind turbine systems continue to improve, the suc¬cess of wind energy in the marketplace increasingly depends on the ability to integrate wind effectively into the existing power grid and address the barriers associated with large-scale deployment. In order to address these challenges, Sandia supports several research activities to determine and mitigate the effect of wind turbines on civilian and military radar systems, and provide the analysis necessary for successful wind integration. Sandia will continue to provide support to the wind integration analysis effort by collaborating with the appropri-ate utility/grid operators and relevant stakeholders. Additionally, Sandia is actively participating in DOE's Transformational Energy Action Manage¬ment initiative through the analysis of an on-sight 30 MW wind farm that would tie into the Sandia distribution network and be used by both Sandia and Kirtland Air Force Base.

For more information please contact:
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Website: windpower.sandia.gov

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Water Power Technologies

Marine HydroKinetics (MHK), Conventional Hydro, & Offshore Wind

Sandia's Water Power Technologies Program

Sandia National Laboratories (SNL) conducts applied research to increase the viability of water power technologies and reduce the cost of energy. Sandia's water power program includes marine hydrokinetic, conventional hydro, and offshore wind energy research efforts and heavily leverages Sandia's 35-years in land-based wind energy, 10 years in water resource research, and Sandia's overall research complex including high-performance computing, advanced materials and coatings, non-destructive inspection, complex systems simulation, and large-scale testing.

RM#1 Tidal Turbine

RM#2 River Turbine

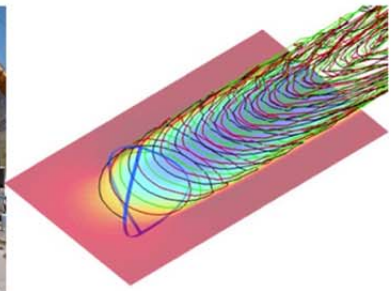
RM#3 WEC Point Absorber

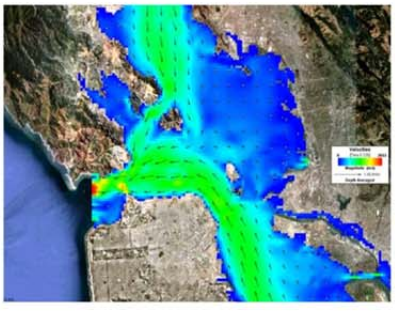
MHK – Reference Models

Sandia leads a highly collaborative effort to develop a representative set of baseline cost models for the comprehensive MHK industry. A key objective of this work is to quantify key component cost and the system cost reduction pathways to enable an efficient, reliable, viable and vibrant industry.

MHK – Technology Development

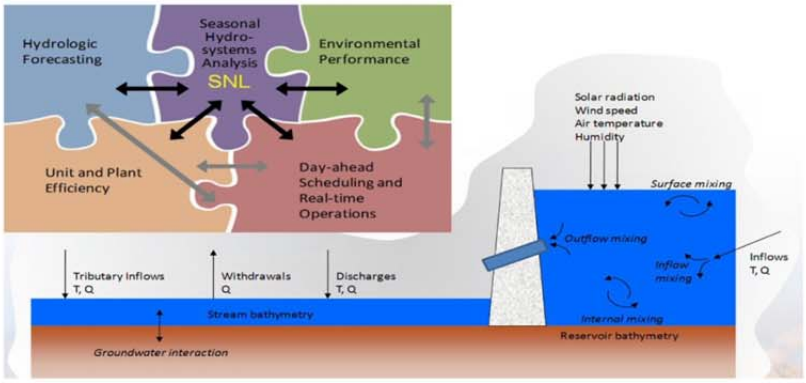
Sandia leads efforts in evaluating and developing codes for MHK device designs and performance. This work is supported by laboratory and field testing for model validation and verification. Additional work develops instrumentation systems and sensors to support Laboratory and industry testing needs.





MHK – Environmental Analysis

SNL develops tools and strategies to monitor and mitigate effects of MHK devices and arrays in order to facilitate project permitting and reduce regulatory costs/time for deploying MHK systems. 'MHK friendly' tools are developed and used to optimize MHK array layouts to maximize energy capture while minimizing environmental concerns.



Conventional Hydro (CH)

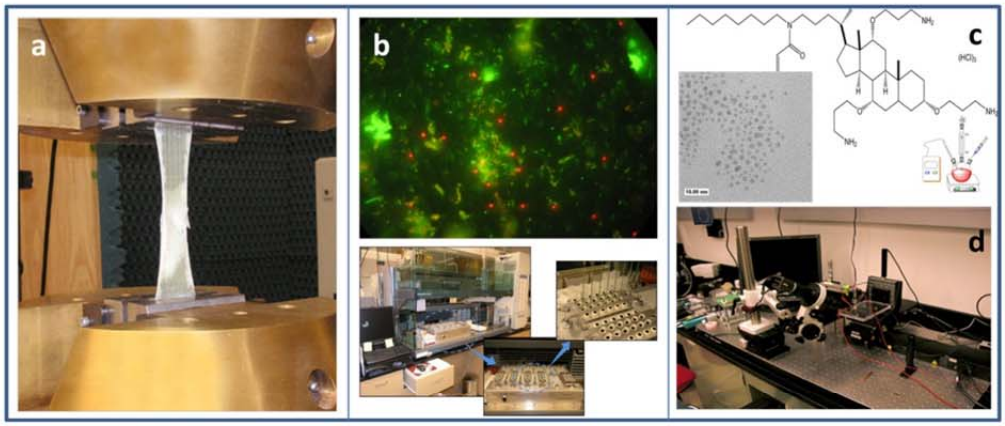
Sandia is collaborating with ANL and PNNL to develop and demonstrate Advanced Hydropower Planning and Operational Decision Tools. This effort focuses on seasonal issues and will improve energy and environmental performance characteristics of CH plants to maximize the CH contribution to the nation's energy mix.

Offshore Wind Energy (OW)

Leveraging Sandia's extensive land-based wind energy research program, the OW effort focuses on topics critical to the offshore environment. Current research activities include ultra-reliable condition-based monitoring; innovative concepts and turbine architectures; sediment transport, scour, and foundation impact analysis; radar mitigation; and very large rotor/blade designs.

Materials Research

Spanning the MHK, Offshore Wind, and Land-based Wind research areas, Sandia's Advanced Materials Program is a core competency dedicated to performing research in materials, coatings, adhesives, and manufacturing process to produce reliable, cost-effective renewable energy devices.



Material Testing: (a) composite fatigue, (b) biofouling & marine coatings assessment, (c) antimicrobial & anticorrosion materials development, (d) corrosion & reliability evaluation.

Verdant Power Gen4 Tidal Turbine

Tidal Turbine

Leveraging Sandia's strong background in the design and analysis of wind turbine rotors, Sandia has partnered with Verdant Power Inc. and the National Renewable Energy Laboratory to redesign the rotor for the Gen4 turbine to be stronger, more efficient, and versatile enough to be placed in multiple environments. The final design will be manufactured with composite materials and will draw on the over 30 years of experience the Sandia and NREL have with wind systems.

Contact Information: Daniel Laird, 505-844-6188, Daniel.Laird@sandia.gov

Sandia National Laboratories

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National Nuclear Security Administration

Speaker Biographies

Matthew Allen (Thursday, May 31: Track 2)

Matt Allen joined the faculty of the Engineering Mechanics program in the department of Engineering Physics at the University of Wisconsin-Madison in 2007. He was previously employed as a post-doctoral researcher at Sandia National Laboratories and received Doctoral and M. S. degrees from the Georgia Institute of Technology in 2005 and 2004 and a B.S. in Mechanical Engineering from Brigham Young University in 2001. His current interests include: experimental modal parameter identification / system identification, nonlinear dynamic systems, experimental/analytical sub-structuring techniques, and just about anything related to structural dynamics. He also enjoys downhill skiing, tennis, and Spanish when he has an evening free with his family.

Matthew "Matt" Barone (Thursday, May 31: Track 2)

Matt Barone is a Principal Member of Technical Staff in the Wind Energy Technologies Department at Sandia National Laboratories. Matt earned his PhD in Aeronautics and Astronautics from Stanford University in 2003. He joined Sandia in 2003 and has made research contributions in computational fluid dynamics, reduced order modeling, wind turbine aerodynamics and noise, and wind turbine loads. In 2011, Matt and co-PI Josh Paquette began a new research project investigating the feasibility of large, vertical-axis wind turbines for offshore application.

Jonathan "Jon" Berg (Thursday, May 31: Track 2)

Jonathan Berg performs structural modeling, dynamic systems & controls simulation, and design tool development in the Wind Energy Technologies Department at Sandia National Laboratories. He started as a student intern in 2006 and joined Sandia's technical staff in 2010 following graduation from the New Mexico Institute of Mining and Technology. Jonathan has a Bachelor's degree in Mechanical Engineering with a minor in Electrical Engineering and a Master's degree in Mechanical Engineering with an emphasis on mechatronic systems and controls.

Derek Berry (Wednesday, May 30)

Derek Berry is the Engineering Supervisor at the Wind Technology Testing Center (WTTC) in Boston, Massachusetts. Prior to joining NREL in 2009, Derek spent 14 years at TPI Composites designing, manufacturing and testing wind turbine blades.

Jay Bhatia (Thursday, May 31: Track 1)

Jay Bhatia is a Business Manager for BASF's Epoxy Systems portfolio for composites markets in the Americas.

Jay has worked in global specialty chemicals and resins industry for past 19 years. Prior to joining BASF in 2005, he has worked with leading global organizations like, Shell Chemicals, Hexion Specialty Chemicals and Reliance Industries of India.

Jay is a Chemical Engineer and MBA (Marketing) from Gujarat University, India.

Jeff Bingaman

No information available.

Maaik Borst (Wednesday, May 30)

Maaik Borst received his M.Sc. in Aerospace Engineering at Delft University of Technology in 2004. After teaching Materials science and Mechanics at INHOLLAND University of Applied sciences, he joined WMC as a Research Scientist in 2008. As project leader for full scale tests, he has a lot of experience with different types of structural blade testing (both static and fatigue).

Carlo Bottasso (Thursday, May 31: Track 2)

Carlo L. Bottasso (Ph.D. in Aerospace Eng., Politecnico di Milano, 1993) is a Professor at the Department of Aerospace Engineering of the Politecnico di Milano in Italy. He leads the POLI-Wind research laboratory, that conducts research in wind turbine design, aero-servo-elasticity, active control and aerodynamics. Dr. Bottasso has published over 250 papers, including over 90 publications in peer-reviewed international journals and book chapters.

Mark Capellaro (Thursday, May 31: Track 2)

Mark Capellaro was born in Wisconsin and studied Economics and South Asian Studies at the University of Wisconsin- Madison. During this period he studied abroad in Florence, Italy and Kathmandu, Nepal. Upon graduation he ended up travelling a lot between commercial fishing stints in Alaska.

He eventually ended up in Seattle to study mechanical engineering at the University of Washington. He started his foray into wind energy at the Wind Energy Company in Seattle. The Wind Turbine Company researched and built prototype two bladed downwind flapping commercial wind turbines.

Mark later attended the Danish Technical University near Copenhagen to attain a Master's of Science in Wind Energy. His master's thesis with Risoe concerned adding an extra half degree (or two-thirds) of freedom to a wind turbine dynamic simulation code. He also worked as a test engineer at the Vestas blade testing facility in the Isle of Wight in England for a summer.

Currently, Mark is a researcher at the Chair of Wind Energy at the University of Stuttgart and lectures at Stuttgart and the university in Freiburg, Germany. He is finishing his doctoral thesis, making all the plots look pretty, and waiting for a date for his defense. The thesis work is about the use of composite bend twist coupling in wind turbine blades. At Stuttgart, he also led the student Inventus team in 2008, who built the world champion Aeolus wind vehicle. Inventus is a vehicle powered by wind that can run against the wind.

Luciano Castillo (Wednesday, May 30)

Luciano Castillo is the Don-Kay-Clay Cash Distinguished Engineering Chair in Wind Energy and the executive Director/President of the National Wind Resource Center (NWRC) at Texas Tech University. After spending 12 years at Rensselaer Polytechnic Institute he joined this summer the ME department at TTU. His research in turbulence using experimental techniques, direct numerical simulations and multi-scale asymptotic analysis has injected new ideas in turbulent boundary layers and our understanding of initial conditions on large scale turbulence, particularly on wind energy. Some of his awards include: the NASA Faculty Fellowship, the Martin Luther King Faculty Award, and the Robert T. Knapp Award on complex flows from the ASME among others. He published over 100 articles including a seminal paper on turbulent boundary layers and scaling laws. He is currently, leading various initiatives on wind energy in the USA and Europe.

Rick Damiani (Friday, June 1)

Dr. Damiani is a Sr. Engineer at NREL working on aeroelasticity and structural dynamics.

His experience is primarily in design and analysis of turbine blades and mechanical components, system performance optimization, and loads analysis.

He has been recently involved in offshore design projects for the support structures and foundations of multi-megawatt turbines.

Rick also serves as technical agreement lead for the DOE Distributed Wind Technology Program at NREL.

Rick holds a PhD in aeronautical engineering, he is a licensed Professional Engineer, and has spent more than a decade as a consultant in wind and other engineering branches such as civil-structural and mechanical engineering.

Mike Desmond (Wednesday, May 30)

Michael Desmond joined NREL in 2009 after receiving both a bachelor's and master's degree in Mechanical Engineering from Embry-Riddle Aeronautical University. For the past three years, Michael has worked as an integral part of the structural test team at the National Wind Technology Center (NWTC), focusing on wind turbine blade testing. He supports all blade testing activities and has led several tests to include certification testing. Most recently, Michael has focused on small blade testing and the development of innovative blade test methods. His diverse resume includes a variety of structural testing which include both full-scale static and fatigue testing, as well as modal and other non-destructive property testing.

Albert Fisas (Wednesday, May 30)

Mr. Albert Fisas, Innovation Director for Alstom's North America Wind Business. Albert has 9 years of experience in Wind energy, has managed several research program in the field of advanced structures and materials and co-authored technical papers in the areas analysis and design of drive train architectures and offshore foudnations. He has been involved in the development of Alstom 1.67MW, 3MW and 6MW platforms. Albert is the Principal Investigator of the Alstom DOE advanced controls grant. Albert was part of Alstom Transport from1996 to 2003 and holds a Masters in Mechanical Engineering from the Polytechnical University of Catalonia, Spain.

Francesco Grasso (Thursday, May 31: Track 2)

MS in Aerospace Engineering at University of Napoli in 2005. PhD in Aerospace Engineering at University of Napoli in 2008. Since 2009, aerodynamicist scientist at Energy Centre of the Netherlands (ECN). Specialized in airfoil design and blade design.

Daniel "Todd" Griffith (Thursday, May 31: Track 2)

D. Todd Griffith is the Chairman of the 2012 Sandia Wind Turbine Blade Workshop. He is a Principal Member of the Technical Staff in the Wind and Water Power Technologies Department at Sandia National Laboratories. Todd is the Technical Lead for Sandia's Offshore Wind Energy Program. His research contributions include work in the areas of structural dynamics, field testing, large offshore rotor technology (Sandia 100-meter blade work), and structural health monitoring methods for wind energy systems. Prior to coming to Sandia 7 years ago, he completed PhD work at Texas A&M University in Aerospace Engineering.

Joel Gruhn (Thursday, May 31: Track 1)

For over 30 years Joel Gruhn has been associated with NEPTCO, Pawtucket, RI, in operational and technical capacities, and today is their VP of Product Engineering and a member of the Executive Committee. Joel was responsible for their introduction of LIGHTLINE unidirectional strength elements for fiber optic cables, and is the project manager for RodPack.

Mark Higgins (Wednesday, May 30)

Mark Higgins is the Chief Operating Officer for the Wind and Water Power Program in the Office of Energy Efficiency and Renewable Energy (EERE) at the U.S. Department of Energy (DOE).

In his role, Mark oversees the Wind and Water Power Program and its efforts to improve the performance, lower the costs, and accelerate the deployment of wind and water power technologies. The program, working with DOE's national laboratories, conducts research and development activities through competitively selected, cost-shared research and development projects with industry and in partnership with federal, state, and other stakeholder groups.

Prior to his current role, Mark served as the Wind and Water Power Program's Technology Lead where he was responsible for program activities at DOE's national laboratories and for projects funded through competitive solicitations including the American Recovery and Reinvestment Act. Mark also served as the Acting Program Manager for Wind and Water in 2011 prior to the arrival of the current PM, Jose Zayas.

Prior to joining the U.S. Department of Energy, Mark was a senior engineer at Bechtel Power and worked on nuclear and conventional coal upgrade projects.

Before entering the energy field, Mark worked in the aerospace industry for 14 years, first at PerkinElmer Aerospace and later at Eaton Aerospace where his focus was on the business development, manufacturing, and design of high temperature, high pressure bleed air systems and components for aero engines and their derivatives.

Mark has both a Bachelor's and Masters of Science in Mechanical Engineering with a specialization in Advanced Design and Manufacturing Technologies from the University of Maryland at College Park.

Find Mølholt Jensen (Thursday, May 31: Track 2)

Master and PhD degree from Technical University in Denmark (DTU). Employed 10 years at Risoe National Laboratory, Denmark. Is now employed in a company called Bladena which is a spin-out of Risø DTU. Find is the inventor of our 7 founding patents, and today holds the position as the Chief Technology Officer. Find lead the groundbreaking research in failure modes and methods to prevent failures in a decade at Risø DTU.

Richard "Rich" Jepsen (Friday, June 1)

Rich Jepsen received his BA (1992), MS (1993), and PhD (1995) in Mechanical Engineering from the University of California, Santa Barbara with an emphasis in fluid mechanics and thermodynamics. Rich's research focused on transport of chemicals and particulates in hydrologic and biological systems. Jepsen continued at UC Santa Barbara as a lecturer and research associate through 1999 before joining Sandia National Laboratories as a senior member of the technical staff. He was later promoted to principal member of the technical staff in 2002. His research at Sandia has primarily focused on water resources in riverine and ocean environments. Other research includes a wide array of subject areas including experimental and model analysis work with large scale explosive and shock testing, liquid atomization and spray, fire and thermal effects, re-entry flight simulation testing, and ground water hydrology. Rich has published over 40 journal articles representing each of the aforementioned areas of research.

Sandie Klute (Thursday, May 31: Track 1)

No information available.

Carl LaFrance (Wednesday, May 30)

Carl LaFrance is Vice President for Renewable Energy and Chief Information Officer at Molded Fiber Glass Companies (MFG) in Ashtabula, Ohio. He has been with MFG for 13 years, filling management positions in manufacturing, engineering, quality assurance, sales and marketing.

Daniel Laird (Wednesday, May 30)

Daniel Laird is the manager of the Water Power Technologies department at Sandia National Laboratories in Albuquerque, New Mexico. Daniel was the Technical Program Chair for the ASME/AIAA Wind Energy Symposium (2006 and 2007) and is the current chair of the ASME Wind Energy Technical Committee. He leads Sandia National Laboratories' internal energy systems education program. He has a Bachelor's degree in General Engineering from the University of Illinois at Urbana-Champaign, and Masters and Doctorate degrees in Mechanical Engineering from the University of Wisconsin-Madison.

Ken Lee (Thursday, May 31: Track 2)

Ken T. Lee is Group Lead for Configuration Design at Wetzel Engineering, Inc. He has been responsible for engineering development of multiple wind turbine rotor blades presently in development and production, spanning in length from 4m to 56m, and has developed customized rotor aero-structural optimization codes used by WEI in its blade development projects. Mr. Lee holds B.S. and M.S. degrees in Aerospace Engineering from the University of Kansas.

Wendy Lin (Wednesday, May 30)

Wendy is a Principal Engineer specializing in Composite Materials & Processing at GE Global Research. Wendy has worked at GE Global Research for 17 years on projects to develop new polymer composite applications for GE Energy (including Wind Energy, Gas & Steam Turbine, PEM Fuel Cells), GE Aviation/Boeing, GE Oil & Gas, and GE Healthcare. She has been involved with wind blade material and manufacturing development since GE acquired Wind Energy in 2003.

She received her BS/MS in Chemical Engineering in 1985 from MIT. She worked at the Naval Air Development Center developing EMI composites and sealants for avionics before entering Stanford University where she received her PhD in Materials Science & Engineering in 1993 on induction heating and joining of carbon fiber composites. She has 27 granted patents and 9 patent applications.

Helge Aagaard Madsen (Thursday, May 31: Track 2)

Prof. Madsen is working at DTU Wind Energy, Campus Risø, which is a new Wind Institute formed January 1st 2012 with around 250 employees. During whole his professional carrier he has worked with wind energy research. The main research areas are wind turbine aerodynamics, aeroelasticity and aeroacoustics with particular focus on engineering model development for design codes. Prof. Madsen has been project leader of a number of national and EU funded research projects and participated in several International Energy Agency (IEA) Annexes on different topics within wind turbine aerodynamics. Presently Prof. Madsen is project leader on the national funded INDUFLAP project focusing on transfer of trailing edge flap technology to industry.

Prof. Madsen is Msc. in Mechanical Engineering and has a PhD from 1982 with a thesis on development of a flow model for vertical axis turbines.

John Mandell (Thursday, May 31: Track 1)

John Mandell (PhD in Materials, MIT, 1971) was a Professor of Chemical Engineering at Montana State University from 1988-2008, following seventeen years at MIT; he is now continuing research and consulting activities as Professor Emeritus. With Dan Samborsky, the composites group at MSU has studied the fatigue behavior of wind blade materials, structural details and environmental effects since 1989, and continues to support the public SNL/MSU/DOE Fatigue of Composite Materials Database.

David "Dave" Minster (Friday, June 1)

Dave Minster is the Manager of the Wind Energy Technologies Department at Sandia National Laboratories and is responsible for overseeing the wind power research activities for the lab. Dave has 30 years of leadership/management experience. He joined Sandia in 2005 after retiring as a Colonel in the U. S. Air Force. Prior to his current job, Dave spent four years as the manager of Sandia's Energetic Threats and Training Department and 1.5 years at Sandia leading intelligence projects for multiple national intelligence agencies. Dave holds a Bachelor's degree in Earth Science from Montana State University, a Master's degree in Geodetic Science from The Ohio State University, and a Master's degree in National Security and Strategic Studies from the U. S. Naval War College.

Mala Nagarajan (Thursday, May 31: Track 1)

Mala Nagarajan is a Senior Applications Development Engineer with Owens Corning's Composites Solution Business reporting into the Innovations organization. She started in her current position in June 2007, developing new high performance fiber glass composite applications for the global wind energy market. Prior to this role, Mala developed new products & processes to meet the customer needs in the building materials sector at Owens Corning (OC).

Mala has 16 years of broad industrial experience holding various positions. She holds a Masters degree in mechanical engineering from the University of Maryland in College Park, MD. In her current role at OC, Mala is leading several joint programs between OC and external organizations.

John Newman (Thursday, May 31: Track 1)

John Newman is the president of Laser Technology Inc. and a new startup company, Digital Wind Systems Inc. and a Director of Polaris Biotechnology Inc. He is the Vice-Chairman of ASTM Committee E7.10, Emerging NDT Methods, Chairman of E7.10.02, Shearography NDT as well as the Chairman of the ASNT Laser Methods Committee. Mr. Newman has a Bs. Physics from Lake Forest College, and is the co-inventor of electronic shearography. He holds 45 US patents in the field of shearography and holography nondestructive testing, optical leak testing of hermetic electronic devices as well as medical devices for spine and neurosurgery.

Khanh Nguyen (Thursday, May 31: Track 2)

Dr. Nguyen received his PhD in aerospace engineering from the Rotorcraft Center of Excellence of the University of Maryland. He then joined NASA Ames Research Center working on wind tunnel tests, control, and modeling of rotorcraft aeromechanics. After spending five years in the wind industry, he joined the National Wind Technology Center developing aeroelastic simulation tools for wind turbines.

Rogier Nijssen (Thursday, May 31: Track 1)

Rogier Nijssen received a PhD degree from Delft University of Technology (department of Aerospace Engineering) in 2006. He is Research Scientist at WMC since 2001 and has been involved in several (inter)national public and industrial research projects. Since 2011 he is also employed at the INHOLLAND University of Applied Sciences where his main task is to develop integrated education and research on composite materials.

Steve Nolet (Wednesday, May 30)

Steve Nolet is Principal Engineer and Senior Director of Innovation and Technology at TPI Composites in Warren, Rhode Island. He manages technical activities in the development of low-cost composite structures for the company's three primary business units: Wind Energy, Military Ground Vehicles, and Transportation Systems. Mr. Nolet also manages the activities of TPI Composite's Physical Sciences Laboratory and is responsible for the characterization and qualification of resins, reinforcements and their composites used in the development and production of composite products across the organization.

Prior to joining TPI, Mr. Nolet was Vice President of Engineering for Fiberspar Corporation where he directed the development of spoolable composite tubulars for the oil and gas industry. Previous positions include Director of Engineering at American Composite Technology and Senior Engineer in the US Air Force Advanced Composite Program Office in Sacramento, California.

Steve received his B.S. degree in aeronautical engineering from the Massachusetts Institute of Technology in June of 1982 and completed his Masters of Science from MIT in the same field in January of 1984. His discipline and course of study focused on application of advanced materials in structural design at both the undergraduate and graduate level.

Mr. Nolet's activities have lead to the issue of more than 23 US Patents on which he is named as inventor.

Alistair Ogilvie (Friday, June 1)

Alistair Ogilvie is the Wind Reliability Data Lead in the Wind and Water Power Technologies department at Sandia National Laboratories. He is responsible for managing the national Continuous Reliability Enhancement for Wind (CREW) database. Alistair brings more than 10 years Information Technology (IT) experience in supporting sensitive data, successful integration of new projects, and network development and administration. He has a Bachelor's degree from the University of New Mexico in Business Administration (MIS).

Joshua "Josh" Paquette (Friday, June 1)

Joshua Paquette is the Task Leader for Laboratory and Field Testing of Wind Turbine Blades. He has worked in the Wind Energy Technologies and Water Power Technologies Departments for five years on wind blade structural modeling and testing, as well as marine hydrokinetic blade design and modeling. Joshua holds a Bachelor's degree in Mechanical Engineering from Kansas State University, and a Master's degree in Engineering Mechanics from the University of Texas at Austin.

Frank Peters (Thursday, May 31: Track 1)

Frank Peters is an Associate Professor in the Industrial and Manufacturing Systems Engineering Department at Iowa State University. He teaches courses in manufacturing processes and manufacturing systems. Manufacturing system improvements has been the central theme of his research. Current research includes improving manufacturing processes for composite wind blades including automation solutions and geometry variability reduction. Work within metal-casting includes visual inspection, heat treatment optimization, rapid patternmaking, and cleaning room efficiency. Metrology, fixturing and geometric variability of manufacturing processes are other strong interest areas. Dr. Peters received his B.S., M.S. and Ph.D. in Industrial Engineering with a Ph.D. minor in Metals Science and Engineering from Penn State.

Brian Resor (Thursday, May 31: Track 2)

Brian Resor is the Design Tools, Structural Dynamics and Aeroelastic System Dynamics Simulation Lead in the Wind Energy Technologies Department at Sandia National Laboratories. He is responsible for ensuring that the team's research activities are supported by state of the art, accurate and effective structural and aeroelastic simulation capabilities. Brian brings eight years of in-depth experience in experimental and analytical structural dynamics with a variety of components and integrated systems. Brian has a Mechanical Engineering Bachelor's degree from the University of Illinois and a Master's degree from Penn State University.

Trey Riddle (Thursday, May 31: Track 1)

Mr. Riddle began his involvement in wind energy as an intern at the National Renewable Energy Laboratory's (NREL) Wind Technology Center while procuring his BS in Mechanical Engineering from Montana State University. After graduation he returned as an employee to NREL where he worked in wind turbine blade testing and gearbox reliability initiatives. He then went on to receive his Masters of Engineering from Cornell University where he led a program developing a novel series electric hybrid vehicle. Currently, Mr. Riddle is a PhD candidate at Montana State University developing probabilistic models which address the disposition of manufacturing defects and their impact on the reliability of wind turbine blades.

Dennis Roach (Thursday, May 31: Track 1)

Dennis Roach is a Senior Scientist in the Transportation Safeguards and Surety Organization at Sandia National Labs. Most of his work has been in the area of experimental and analytical assessment and nondestructive inspection of composite and metallic structures. He is a founding member of the Aerospace Industry Steering Committee on Structural Health Monitoring and chairs the International Commercial Aircraft Composite Repair Committee.

Juan Serrano (Thursday, May 31: Track 1)

Mr. Juan Camilo Serrano is an Engineering Associate for PPG Fiber Glass Science and Technology. His work is focused towards the development of new applications for composite materials in the areas of renewable energies, infrastructure and defense. Mr. Serrano has 10 years of experience in composite materials and structures and has held various roles in materials development, structural design, and finite element analysis of a wide variety of composite structures. Mr. Serrano holds a BSc in Mechanical Engineering from UDLA in Bogota-Colombia, an MSc in Materials Engineering from the University of Alabama – Birmingham and an MBA from the University of Massachusetts.

Chris Shennan (Thursday, May 31: Track 1)

Dr. C D Shennan received Bachelor, Master and Doctorate degrees from University of Oxford. Joined Hexcel (Duxford, UK) in 1997 where he has worked in various R&T management roles. He is currently responsible for global industrial product development with a particular focus on wind energy. In this, he is supported by R&T teams in Duxford, UK and Linz, Austria.

Dave Snowberg (Wednesday, May 30)

Since 2009, David Snowberg has been a senior mechanical test engineer at the National Renewable Energy Laboratory's (NREL's) National Wind Technology Center (NWTC). David's expertise stems from being a professional in the wind turbine industry for more than 15 years and has been instrumental in conducting blade tests and developing new blade test methods within the structural blade group at NREL. He has a bachelor's degree in mechanical engineering from the University of Colorado at Boulder and is currently pursuing a master's degree in engineering management. David is a licensed professional engineer in Arizona.

Frederick "Fred" Stoll (Thursday, May 31: Track 1)

Ph.D., Senior Development Engineer, Milliken & Company

Since 2000, Dr. Fred Stoll has been involved in the development of fiber-reinforced-core products for composite sandwich construction. Fred has been working in composite materials and structures for over 25 years, including seven years in the Structures Group at University of Dayton Research Institute, and 11 years at WebCore Technologies where he was the lead engineer for the development of TYCOR W core products for wind turbine blade applications. Since February 2012, Dr. Stoll has continued work on fiber-reinforced-core products at Milliken. He serves on ASTM Subcommittee D30.09 on Sandwich Construction.

Rick Stulen (Wednesday, May 30)

No information available.

C.P. "Case" van Dam (Thursday, May 31: Track 2)

C.P. "Case" van Dam is the Warren and Leta Giedt Endowed Professor and Chair of Mechanical and Aerospace engineering at the University of California at Davis and heads the California Wind Energy Collaborative; a partnership between the University of California and the California Energy Commission. He previously was employed as a National Research Council (NRC) post-doctoral researcher at the NASA Langley Research Center, was a research engineer at Vigyan Research Associates in Hampton, Virginia, and joined UC Davis in 1985. Van Dam's current research includes wind energy engineering, aerodynamic drag prediction and reduction, high-lift aerodynamics, and active control of aerodynamic loads. He has extensive experience in computational aerodynamics, wind-tunnel experimentation and flight testing; teaches industry short courses on aircraft aerodynamic performance and wind energy; has consulted for aircraft, wind energy, and sailing yacht manufacturers; and has served on review committees for various government agencies and research organizations. He received a B.S. and M.S. from the Delft University of Technology, The Netherlands, and M.S. and Doctor of Engineering degrees from the University of Kansas, all in aerospace engineering.

Kyle Wetzel (Thursday, May 31: Track 2)

Dr. Kyle K. Wetzel is CEO & CTO of Wetzel Engineering, Inc. He has engineered wind turbine and aviation systems for nearly 20 years. He was formerly director of new product development at Enron Wind, and he has consulted to more than 60 companies in wind energy and aviation around the world. Thousands of blades operate worldwide to which he contributed significant engineering. He serves as a technical expert to the IEC and is a member of the PT5 committee drafting the IEC 61400-5 Blade Standard. Dr. Wetzel also serves as an Adjunct Professor in the Department of Aerospace Engineering at the University of Kansas, where he teaches courses on aerodynamics, aeroelasticity, and wind turbine engineering. Wetzel holds an MS in Aeronautical and Astronautical Engineering from the University of Illinois and a PhD in Aerospace Engineering from K.U.

Jonathan White (Wednesday, May 30)

Jonathan White performs research in the areas of Sensing Technology, Offshore Structural Health Monitoring, and Operational Monitoring for the Wind Energy Technologies Department at Sandia National Laboratory. He is currently leading an effort to move the Sandia wind energy test facilities to the Texas Tech University. Jonathan was also recently awarded an early-career Laboratory Directed Research and Development grant. He received a Bachelor's degree in Mechanical Engineering from The Ohio State University and a Masters and Doctorate degree in Mechanical Engineering from Purdue University.

Usama Younes (Thursday, May 31: Track 1)

Dr. Usama Younes is a Principal Scientist in Polyurethanes at Bayer Material Science LLC. He holds a Bachelor of Science degree in Chemistry from Warren Wilson College, a master's degree in Inorganic Chemistry from Western Carolina University and a Ph.D. in Organic Chemistry from the University of New Orleans. After a two-year fellowship at Carnegie Mellon University, Dr. Younes worked at ARCO, Lyondell and Bayer. He's been responsible for new developments in polyurethane Long Fiber Injection as well as polyurethane vacuum infusion technologies. In the last two years he headed the DOE project on Carbon Nanotube Reinforced Polyurethane Composites for Wind Turbine Blades has extensive experience in polymer syntheses, structure property relations, and polyurethane based composite developments. He holds 35 US patents and over 100 foreign patents. He is the author of 18 scientific publications.

Wenbin Yu (Thursday, May 31: Track 2)

Dr. Wenbin Yu, Associate Professor in Mechanical and Aerospace Engineering at Utah State University, received his PhD in Aerospace Engineering from Georgia Tech in 2002. His expertise is in micromechanics and structural mechanics with applications to composite/smart materials. Dr. Yu has received research funding from federal agencies and private industry, and he has authored 130+ refereed technical articles. He and his students have transformed ground breaking fundamental theoretical work into useful software tools which are used extensively in many government labs, universities, research institutes, and companies. He is also the Chief Technology Officer of AnalySwift, a company centered on marketing and licensing the technologies developed in his group. His recent honors include AIAA Associate Fellow, ASEE Outstanding New Mechanics Educator, Georgia Tech Outstanding Young Engineering Alumni, Utah Aerospace Engineering Educator of the Year, and USU Technology Entrepreneur of the Year.

2012 Sandia Wind Turbine Blade Workshop Program

Tuesday, May 29

6:00-8:00pm: Early check-in with a **Reception Hosted by Momentive**

Wednesday, May 30 (Check-in and Continental Breakfast 7:00-8:30am)

Welcome/Industry Status 8:30am

Welcome, D. Todd Griffith, *Sandia National Laboratories*
DOE Wind and Water Program, Mark Higgins, *U.S. Department of Energy*
Washington Perspective on Wind Energy, Jeff Bingaman, *U.S. Senator, N.M.*
Sandia Energy Program, Rick Stulen, *Sandia National Laboratories*
Wind Industry Status, Daniel Laird, *Sandia National Laboratories*
Trends in Turbine and Blade Technology – 2012, D. Todd Griffith, *Sandia National Laboratories*

Break (10:05am-10:35am)

Turbine Manufacturers 10:35am

Wind Blade Technologies to Enable New Paradigms, Wendy Lin, *General Electric*
Alstom Perspective, Albert Fisas, *Alstom*

Break (11:25-11:40am)

Blade Manufacturers 11:40am

DOE Advanced Manufacturing Initiative – Blades, TPI Update, Steve Nolet, *TPI Composites*
Wind Turbine Blade Effects on Turbine Design and Lifecycle Cost, Carl LaFrance, *Molded Fiber Glass Companies (MFG)*

Lunch/Speaker Panel (12:30pm-2:00pm)

Blade Testing 2:00pm

Blade Testing at the National Wind Technology Center, Dave Snowberg and Mike Desmond, *National Renewable Energy Laboratory*
Rotor Blade Testing and International Standards, Derek Berry, *National Renewable Energy Laboratory*
Blade Testing at WMC, Maaik Borst, *Knowledge Centre Wind Turbine Materials and Constructions (WMC)*

Break (3:15-3:35pm)

Rotor Testing 3:35pm

DOE/Sandia Scaled Wind Farm Technology (SWiFT) Facility Update, Jon White, *Sandia National Laboratories*
The Role of Turbulence on Wind Energy: From Single Blade to Wind Arrays, Luciano Castillo, *Texas Tech University*

Adjourn (4:30pm)

6:00-8:00pm: Reception Hosted by BASF

Thursday, May 31

Track I

(Check-in and Continental Breakfast 7:00-8:30am)

Material Suppliers and Testing — 8:30am

The SNL/MSU/DOE Fatigue Program: Recent Results, John Mandell, *Montana State University*

Blade Materials Fatigue Testing and Modelling, Rogier Nijjsen, *Knowledge Centre Wind Turbine Materials and Constructions (WMC)*

Recent Developments in Materials and Processes for Blades at Hexcel, Chris Shennan, *Hexcel*

Break (9:45-10:10am)

Material Suppliers and Testing (continued) — 10:10am

Advanced Material Solutions for Blade Construction, Jay Bhatia, *BASF*

RodPack: A New Form of Aligned Fiber Reinforcement for Wind Blade Spar Caps Joel Gruhn, *NEPTCO*

Recent Core Materials Developments/Applications for Blades at Milliken, Fred Stoll, *Milliken & Company*

Polyurethane Structural Composites for Wind Turbine Blades, Usama Younes, *Bayer Material Science*

Lunch (11:50-1:20pm)

Material Suppliers and Testing (continued) — 1:30pm

Owens Corning Materials for Blades, Mala Nagarajan, *Owens Corning*

Technical and Economic Feasibility Study of Automated Blade Manufacturing, Juan Serrano, *PPG*

Manufacturing and Inspection — 2:10pm

Advanced Blade Manufacturing, Frank Peters, *Iowa State University*

Rapid Flaw Detection in Wind Turbine Blade Assemblies Using Phased Array Ultrasonics, Dennis Roach, *Sandia National Laboratories*

Break (3:00-3:35pm)

Manufacturing and Inspection (continued) — 3:35pm

Blade Reliability Collaborative (BRC) Overview, Josh Paquette, *Sandia National Laboratories*

Fiberoptic Sensing for Blades, Sandie Klute, *LUNA*

Recent Developments/Applications in Blade Inspection, John Newman, ***Laser Technology Inc.***

Adjourn (5:00pm)

Thursday, May 31

Track II

(Check-in and Continental Breakfast 7:00-8:30am)

Blade Research and Innovative Design 8:30am

Change in Failure Type When Wind Turbine Blades Scale-up, Find Jensen, *Bladena*

Potential and Limits for Sweep- and Laminate-Induced Torsion Coupling in Blades Kyle Wetzel, *Wetzel Engineering*

Design Optimization of Bend-Twist Coupled Wind Turbine Blades, Carlo Bottasso, *Politecnico di Milano*

Break (9:45-10:10am)

Blade Research and Innovative Design (continued) 10:20am

Advanced Wind Turbine Blade Structural Modeling, Mark Capellaro , *University of Stuttgart*

Enhanced Test-Based Design Approach to Improving Reliability of Wind Turbine Blades, Ken Lee, *Wetzel Engineering*

Development of Trailing Edge Flap Technology at DTU Wind (Risoe), Helge Madsen, *Risoe*

Update on Sandia Active-Aero Rotor Field Test, Jon Berg, *Sandia National Laboratories*

Lunch (11:50-1:20pm)

Blade Research and Innovative Design (continued) 1:20pm

Sandia 100-m Blade Research Update, D. Todd Griffith, *Sandia National Laboratories*

Design of Thick Airfoils for Wind Turbines, Francesco Grasso, *Energy Centre of the Netherlands (ECN)*

Insights Gained into Rotor Performance and Loads Through Three-dimensional CFD, Case van Dam, *UC-Davis*

System Identification for Linear Time Varying Systems with Application to Rotating Turbines and Continuous Scan Laser Vibrometry, Matt Allen, *University of Wisconsin*

Break (3:00-3:35pm)

Wind Turbine Design and Analysis Codes 3:35pm

Overview of Sandia Wind Turbine Blade Analysis, Brian Resor, *Sandia National Laboratories*

VABS: Going Beyond Linear Elastic Cross-Sectional Analysis, Wenbin Yu, *Utah State*

Overview of NREL Design Codes, Khanh Nguyen, *National Renewable Energy Laboratory*

Adjourn (4:50pm)

Friday, June 1 (Check-in and Continental Breakfast 7:00-8:30am)

Radar 8:30am

Sandia Wind Turbine RADAR Research, Dave Minster, *Sandia National Laboratories*

Water Power 9:00am

Rotor Design for Water Power, Rich Jepsen, *Sandia National Laboratories*

Distributed Wind 9:30am

Distributed Wind Update, Rick Damiani, *National Renewable Energy Laboratory*

Break (10:00-10:30am)

Rotor Design: Offshore 10:30am

Vertical-Axis Wind Turbines Revisited: A Sandia Perspective, Matt Barone, *Sandia National Laboratories*

Reliability and Standards 11:00am

CREW Project Update, Alistair Ogilvie, *Sandia National Laboratories*

BRC: Effects of Defects, Trey Riddle, *Montana State University*

Closing Remarks 12:00pm

D. Todd Griffith, *Sandia National Laboratories*

Adjourn (12:05pm)

2012 Sandia Wind Turbine Blade Workshop Attendee List

Workshop Attendee List

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A Guide

To

Some of the

Neighborhood

Restaurants

Old Town Restaurants

A - Antiquity Restaurant (French International)
112 Romero St NW

B - La Placita Dining Rooms (New Mexican)
206 San Felipe St NW

C - La Hacienda Restaurant - Cantina (New Mexican)
302 San Felipe St NW

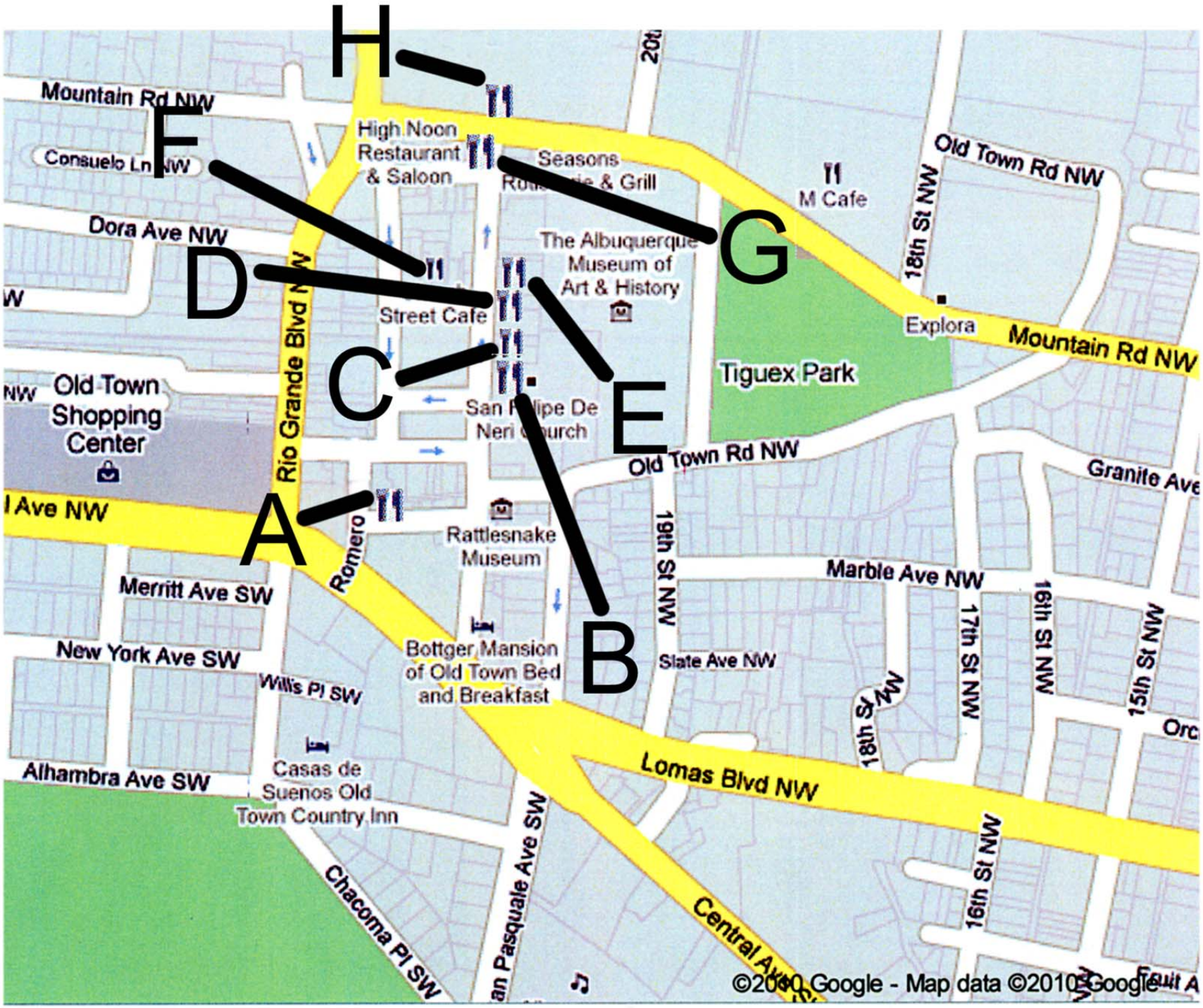
D - Quesadilla Grill (New Mexican)
328 San Felipe St NW

E - La Crepe Michel (French)
400 San Felipe St NW

F - Church Street Cafe (New Mexican)
2111 Church St NW

G - High Noon Restaurant & Saloon (Steak)
425 San Felipe St NW

H - Seasons Rotisserie & Grill (American)
2031 Mountain Rd NW



Disclaimer: This is only a partial list of restaurants in the area. The list is in no particular order, and inclusion or omission does not constitute an endorsement or rejection of the establishment.

Nob Hill Restaurants

A - Yanni's Mediterranean Restaurant (Greek)
3109 Central Ave SE

B - Nob Hill Bar and Grill (American)
3128 Central Ave SE

C - Monte Vista Fire Station (Fine Dining)
3201 Central Ave NE

D - Two Fools Tavern (Irish Pub)
3211 Central Ave NE

E - Kelly's Brewpub (Brew Pub)
3222 Central Ave SE

F - Shogun (Sushi and Japanese)
3310 Central Ave SE

G - Il Vincino Wood Oven Pizza (Italian)
3403 Central Ave NE

H - Flying Star Cafe (American)
3416 Central Ave SE

J - Scalo Northern Italian Grill (Italian)
3500 Central Ave SE

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http://windpower.sandia.gov

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