MARCH 2011

WIND SYSTEMS

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Torque vs. Tension

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Monitoring

Precision Turbine
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COLD WEATHER CONSTRUCTION CONCERNS

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Q&A: Adarsh Mehta
ACCIONA Wind Energy Canada

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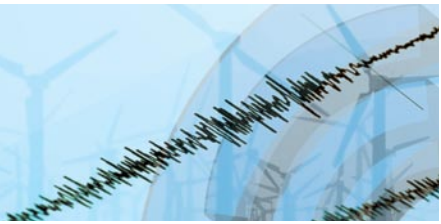

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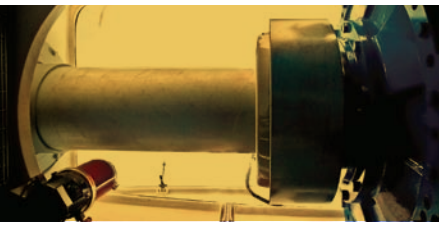

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EDLETTER

During his recent State of the Union address you may have noticed how early in the speech President Barack Obama addressed renewable energy development in this country. Rather than a peripheral "feel good" issue, it took top billing, which I found to be quite remarkable. The next morning he visited Broadwind Energy's wind turbine tower manufacturing facility in Manitowoc, Wisconsin, as you'll see in this issue's news section. In addition, you'll read of the president's recent visit to the Penn State campus to launch the "Better Building Initiative," seeking to improve the energy efficiency of commercial building space by 20 percent over the next nine years. Again, to find these issues front and center on the president's agenda is heartening indeed, and I don't think we would be mistaken in anticipating tremendous growth in the North-American wind market in the coming years.

Companies and organizations of all types are preparing for this prosperity, as you'll find in this issue's editorial lineup. In "A Site for Energy Education," for example, Michael Seifert writes about the launch of the Ecotech Institute's "first of its kind" campus devoted to renewable energy education in Colorado. Bret Dianich of FreeWave Technologies describes how wireless has become an attractive option in "Wireless Vibration Monitoring," and Trent Schon of Mortenson Construction shares pointers on working in challenging conditions in "Cold Weather Construction Concerns." We have two articles addressing shaft alignment in this issue: "Precision Turbine Shaft Alignment" by Paul Berberian of Alignment Supplies, and "Alignment: Torque vs. Tension" by Dan Pogatschnik of TorcUP.

In addition to Sven Schmitz's technology column, mentioned above, we have a piece by Sammy Germany of Henkels & McCoy. My thanks go out to him for taking the time to share his expertise with us—gratitude I'd like to extend to all of our editorial contributors. This certainly includes our longtime maintenance columnist Merritt Brown of Rev1 Renewables, who discusses troubleshooting skills in this installment, and Anne Puhalovich of Professional Logistics Group, who encourages innovation in this month's logistics column. BS Rotor Technic U.S.A. is our company profile, and it was a pleasure speaking with Sharad Mehta, Patrick Parmelee, and Steve Elrod for this story. We wrap up this issue with a conversation with Adarsh Mehta, the development director for ACCIONA Wind Energy Canada who has been named board chair of the Canadian Wind Energy Association (CanWEA). You're sure to enjoy learning about her plans to help support wind energy development throughout that country and around the world.

Anticipation is building for AWEA WINDPOWER 2011, and we hope you'll make a point of stopping by our booth #877. We're all looking forward to seeing you there!

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PRESIDENT OBAMA VISITS BROADWIND ENERGY

President Barack Obama underscored key themes from his State of the Union speech of job creation, innovation, and global competitiveness when he visited Broadwind Energy, Inc.'s wind turbine tower manufacturing facility in Manitowoc, Wisconsin. Broadwind Energy and its more than 800 employees are playing a critical role in powering up the clean energy industry, stimulating local economies like Manitowoc and driving innovation in the U.S.—innovation the President is calling for to maintain our global leadership position.

Once a manufacturing plant for World War II-era submarines, the 250,000 square foot facility the President toured was revitalized by Broadwind Towers (Tower Tech), stimulating the local economy through the hiring of 300 people. The company has become one of the largest employers in Manitowoc, is a leading producer of multi-megawatt (MW) wind turbine towers, and is the first company in the U.S. to manufacture 100-meter towers. Currently the Manitowoc facility is running at near capacity, and when combined with its tower manufacturing facilities in Abilene, Texas, and Brandon, South Dakota, Broadwind Towers has the potential to produce up to 1,500 MWs of wind turbine towers annually. Manitowoc is a great example of a U.S. community rebounding from economic hardship by applying existing talent to new problems, in this case tapping deep roots in steel fabrication to create the tall steel towers that enable wind turbines to capture maximum wind energy.

During the visit, President Obama was able to see how a wind turbine tower is manufactured—from raw plate steel through the process of forming, welding, painting, and moving a completed tower section, which could weigh up to 200 tons. Broadwind Energy President and CEO Peter C. Duprey, Broadwind Towers President Paul Smith, and plant manager Chris Wallander led the President through the facility, where he stopped several times to talk with employees.

"We were honored to host President Obama

Companies wishing to submit materials for inclusion in this section should contact Russ Willcutt at russ@windsystemsmag.com. Releases accompanied by color images will be given first consideration.

and demonstrate clean energy jobs and innovation in action. Broadwind Energy looks at the energy industry with a unique perspective, bringing a variety of solutions to our customers to help them make the most of their energy investments," says Duprey. "President Obama is essentially asking the same of our country—bring together all of our best talents and solutions and help our country and other countries maximize their energy potential—sustainably, cleanly, and profitably."

Broadwind Energy approaches the energy industry in a way unlike any other company. It applies decades of deep industrial expertise to innovate integrated solutions for customers. From gears to towers, to comprehensive remanufacturing of gearboxes and blades, to operations and maintenance services, it has the solutions that domestic energy demands. With facilities throughout the U.S., Broadwind Energy's talented team is committed to helping customers maximize performance of energy and infrastructure investments—quicker, easier, and smarter. To learn more please visit www.bwen.com.

GE ENERGY FINANCIAL SERVICES, PARTNER PURCHASE ALTA WIND I FARM

GE Energy Financial Services, a unit of GE, and Bankers Commercial Corporation, a unit of UnionBanCal Corporation, have purchased the first wind farm to start operations in one of the largest wind energy projects in the United States. GE Energy Financial Services and Bankers Commercial Corporation acquired the 150-megawatt Alta Wind I wind farm in Tehachapi in Kern County, California, and are leasing it back to its developer, operator, and manager, Terra-Gen Power, LLC. The wind farm, using 100 GE 1.5-megawatt SLE turbines, was completed in the fourth quarter of last year. GE Energy Financial Services—a major global investor in multiple energy generation and distribution projects and companies—and Bankers Commercial Corporation each own 50 percent of the wind farm. Funds from the sale will be used to pay off construction loans Terra-Gen entered into for the project last March. Financial details were not disclosed.

The Alta Wind I farm is the first phase of the Alta Wind Energy Center, a planned 3,000-megawatt project. The first 1,550 megawatts of the center, including this phase, is contracted to Southern California Edison. When complete, the center will be able to provide electricity for 1.3 million California homes. Terra-Gen estimates the center will create more than 3,000 domestic manufacturing, construction, operations and maintenance jobs, and will contribute more than $1.2 billion to Kern County's economy. According to Terra-Gen, the center is expected to cut carbon dioxide emissions by more than 52 million metric tons over the next decade, equivalent to taking 890,000 cars off the road. The wind farms will help California meet its goal of ensuring that by 2020, 33 percent of the power it consumes comes from renewable sources. Alta Wind I is the first project to connect with Southern California Edison's Tehachapi Renewable Transmission Project, the first major transmission project in California to be constructed specifically for accessing a renewable-rich resource area. When completed, the Tehachapi Renewable Transmission Project will consist of more

than 250 miles of new and upgraded high-voltage transmission infrastructure. The project is eligible for a U.S. Treasury grant created under the American Recovery and Reinvestment Act. It allows renewable energy project owners to access a cash grant in lieu of tax credits.

GE Energy Financial Services' experts invest globally with a long-term view, backed by the best of GE's technical know-how, financial strength and rigorous risk management, across the capital spectrum, in one of the world's most capital-intensive industries, energy. GE Energy Financial Services helps its customers and GE grow through new investments, strong partnerships, and optimization of its $21 billion in assets. GE Energy Financial Services is based in Stamford, Connecticut. For more information visit www.geenergyfinancialservices.com.

Headquartered in San Francisco, UnionBanCal Corporation is a financial holding company with assets of $79.8 billion at September 30, 2010. Its primary subsidiary, Union Bank, N.A., is a full service commercial bank providing an array of financial services to individuals, small businesses, middle-market companies, and major corporations. The bank operated 397 banking offices in California, Washington, Oregon and Texas, as well as two international offices, on September 30, 2010. UnionBanCal Corporation is a wholly-owned subsidiary of The Bank of Tokyo-Mitsubishi UFJ, Ltd., which is a subsidiary of Mitsubishi UFJ Financial Group, Inc. Union Bank is a proud member of the Mitsubishi UFJ Financial Group, one of the world's largest financial organizations. Visit www.unionbank.com for more information.

LM WIND POWER SERVICE & LOGISTICS MAKES ACQUISITION

At the AWEA O&M Project Performance and Reliability conference held in January global service partner for advanced blade services, LM Wind Power Service & Logistics announced that they have acquired Encore Power Services (EPS), a leading provider of field services and component repair for wind turbine generators in North America. John Mullins, president of EPS, remains in his role following the acquisition. "Service of wind turbine generators is an exciting, timely addition to our portfolio," says Robert Burger, vice president service, Americas. "It's a natural complement to our blade service business and is a convenient, cost-saving option for our customers."

In 2010, LM Wind Power reconfigured its service and logistics business, increasing support to customers. Since then the independent LM Wind Power Service & Logistics business has significantly increased in size and now offers inspection, repair, overhaul, preventive maintenance, and blade logistics, covering a spectrum of service to wind turbine owners anywhere in the world.

Roman Thomassin, president of LM Wind Power Service & Logistics, says that "Our overall strategy is to build upon our well-established, respected blade service business, ultimately providing a complete range of wind related services. This acquisition is a significant part of our worldwide expansion, marking a milestone for our company and creating a value-added service for our customers in North America."

For more information contact Robert Burger, vice president service-Americas, at (503) 575-6494 or rbu@lmwindpower.com. The company's Web site is www.lmwindpower.com.

VERTICAL VISIONGAUGE DIGITAL OPTICAL COMPARATOR FROM METHODS

Methods Machine Tools now offers the VisionGauge® digital optical comparator (patent pending) in a vertical configuration. In the vertical configuration, parts are mounted flat on the system's XY stage and the optical axis is vertical (the lens is looking down on the parts). The most appropriate VisionGauge configuration for a given application—either horizontal or vertical—is typically dictated by fixturing and mounting considerations. Standard XY travel for the vertical configuration is 12" x 12" and extended 24" x 24" travel is available as an option.

All of the standard options available for the horizontal configuration of the VisionGauge digital optical comparator are also available

for the vertical configuration. The list of available options includes: reflected illumination, LASER module for Z-axis measurements, motorized rotary fixtures and a fifth monitor for automatic recall of related documents such as work instructions, part prints, reports, spreadsheets, etc. The vertical VisionGauge is available with the same full range of magnifications as the horizontal model: 5X, 10X, 20X, 50X and 100X, in either single or multi-mag configurations.

Methods Machine Tools, Inc., has been a leading supplier of precision machine tools, automation, and machine tool accessories for over 50 years. For more information call (978) 443-5388, e-mail sales@methodsmachine.com, or visit www.methodsmachine.com.

ACCIONA'S MEHTA ELECTED CANWEA BOARD CHAIR

ACCIONA Energy announces that Adarsh Mehta, development director of ACCIONA Wind Energy Canada, has been elected as the new chair of the Canadian Wind Energy Association (CanWEA) Board of Directors. At the helm of CanWEA Mehta's top priority will be strengthening broad public support for wind energy development.

"Wind energy development has the potential to be one of Canada's fastest growing industries and we must nurture it," she says. "To achieve this we should focus on raising awareness of the economic and environmental benefits of wind energy development and on enhancing our current electricity infrastructure. I look forward to working with CanWEA to achieve these goals."

Other tasks Mehta will tackle include raising visibility of CanWEA and highlighting the benefits the organization provides its members and the communities they serve. She will also push for legislative policies at provincial and federal levels that support renewable energy development in order to attract investment dollars.

"We are pleased to see Ms. Mehta assume her leadership role with CanWEA," says Robert Hornung, president of CanWEA. "She is passionate about the organization's mission to build a thriving wind energy industry in Canada and she brings a wealth of experience both in the industry and with CanWEA, making her ideally suited for this position."

Mehta began her 10 years of work in the wind energy industry by conducting academic research of wind flow over complex terrain. At GPCo and ORTECH Power, Mehta performed wind resource assessment and conducted

technical due diligence. After joining GDF Suez to lead western Canadian business development, Mehta ran her own management consultancy while gaining an executive MBA. She joined ACCIONA in May of 2010 and has been an active member of CanWEA for five years already serving on various caucuses and special steering committees.

ACCIONA Energy has already installed and operates 136 MW in three wind farms in Canada with local partners Suncor and Enbridge. Two of these farms—Magrath Wind Power Project and Chin Chute Wind Power Project (each with a capacity of 30 MW)—are located in Alberta, and the third, Ripley Wind Power Project (76 MW), is in Ontario. The Lamèque Wind Power Project (45 MW), located in New Brunswick, will be completed in early 2011 and will increase ACCIONA's installed capacity in Canada to 181 MW. ACCIONA's presence in Canada includes the company's infrastructure business, where it has been contracted for five projects under a public-private partnership. Learn more at www.acciona-na.com.

SERVOCLASS COUPLINGS FROM ZERO-MAX

Design engineers looking to reduce heat transfer from servo motors to driven shafts will find ServoClass® couplings from Zero-Max an ideal solution. The ServoClass coupling design minimizes heat transfer and reduces variations in system accuracy caused by thermal expansion. The coupling features stainless steel discs designed into the center of the coupling that dissipate heat generated from a connected servo motor. By minimizing heat transmission to the connected shaft, thermal expansion is prevented.

With today's servo motor applications more demanding than ever, system accuracy is critical to precision positioning. The ServoClass coupling, with this low thermal transfer design feature, helps ensure the required accuracy in these systems. The couplings also provide high torsional stiffness, zero backlash, and low hysteresis, further ensuring repeatable precise positioning. "Thermal transfer is a growing concern in servo motor system design," according to Robert Mainz, sales manager. "ServoClass couplings provide a superior solution. As cycles become faster and heat is increased, especially in tightly enclosed designs, the ServoClass coupling minimizes heat transfer through the shaft components."

ServoClass coupling applications include virtually any system using ball screws and servo motors. Three new sizes have been added to the line. They handle bore diameters from 0.875 in. (20mm) to 1.378 in. (35mm) and operating torque from 3937 to 9843 in. lbs (100 to 250 Nm). Many additional sizes are available starting with the smallest bore size 0.157 in. (4 mm) and larger. All ServoClass couplings are manufactured of RoHS compliant materials. They are lightweight and designed with 304 stainless steel disc packs and 7075-T6 aluminum hubs and center members. They are available in single and double flex models in inch and metric sizes. All models and sizes feature clamp style hubs with corrosion resistant socket head cap screws. To learn more call (800) 533-1731 or (763) 546-4300. Go online to www.zero-max.com.

OSHA, LAKE REGION STATE COLLEGE PROMOTE WIND INDUSTRY SAFETY

The U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) recently announced an alliance with Lake Region State College in Devils Lake, North Dakota, focusing on safety training for workers in the wind power industry. OSHA will provide assistance in the development of training related to working safely when exposed to hazards inherent to the wind power industry. Lake Region State College will offer training for students on the commissioning, operation, and maintenance of electrical generation equipment and control systems for wind turbine generation systems. "This is a great opportunity for OSHA and LRSC to work together to heighten the awareness of the hazards associated with the wind power generation industry," says Greg Baxter, OSHA's regional administrator.

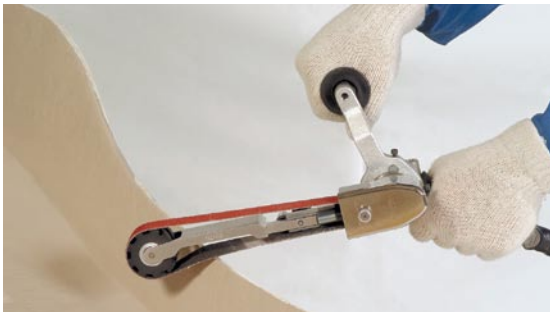
Through the Alliance Program, OSHA works with groups committed to worker safety and health to prevent workplace fatalities, injuries, and illnesses. These groups include unions, consulates, trade or professional organizations, businesses, faith- and community-based organizations, and educational institutions. OSHA and the

groups work together to develop compliance assistance tools and resources, and educate workers and employers about their rights and responsibilities. Alliance Program participants do not receive exemptions from OSHA programmed inspections.

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing a safe and healthful workplace for their employees. OSHA's role is to assure these conditions for America's working men and women by setting and enforcing standards, and providing training, education and assistance. For more information, visit www.osha.gov. Also go to www.lrsc.edu.

MINI-DYNAFILE II ABRASIVE BELT MACHINE FROM DYNABRADE

Dynabrade's Mini-Dynafile II is a lightweight air-powered abrasive belt machine for grinding, blending, and deburring in normally inaccessible areas. Running at 25,000 RPM, the Mini-Dynafile II utilizes 1/8" to 1/2" wide x 12" long abrasive belts. The tool accepts coated and abrasive impregnated non-woven nylon belts. The multi-positioning grinding head pivots 180°, ideal for grinding into hard to reach areas. The lightweight, composite housing reduces vibration and is thermal insulated to prevent cold air transmission to the operator's



hands. The air motor is also adjustable to the most comfortable throttle lever position. Eight different contact arms are also available for a wide variety of distinct applications. The tool is excellent for finishing and deburring within narrow openings. It is also ideal for blending stainless steel and grinding right angle welds. The lightweight, compact design of the tool suits a wide range of users. A Mini-Dynafile II Versatility Kit is also offered that includes the tool, contact arms, various abrasive belts, and a threaded collet for easy conversion to a die grinder.

Dynabrade has been supplying quality industrial abrasive power tools for use in industries worldwide for more than four decades. Call (716) 631-0100 or visit www.dynabrade.com.

Sammy Germany, Ph.D.
Henkels & McCoy

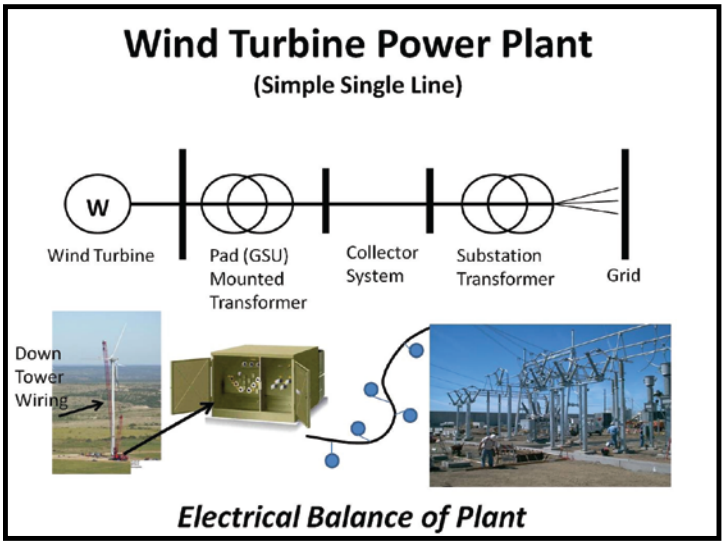
There are many challenges to be overcome during wind farm electrical "balance of plant" work, which includes full wind park electrical integration. Here, the experts share helpful tips.

A PRIVATELY HELD NATIONAL INFRASTRUCTURE engineering and construction firm, Henkels & McCoy has been involved in the construction of wind farms for many years. Our expertise includes, but is not limited to, wind farm electrical "balance of plant" work, which includes full wind park electrical integration. The hard work starts from the nacelle and down-tower basic wiring. This includes the lighting systems, installing conductors in the cable tray, and bringing through a vast and complicated conductor gathering system outside the tower area. This is coupled to a low-to-medium wiring harness and tracked to a central point of interconnection. From this point the conductors are laid over to a medium voltage transformer system. The last objective is to install the remaining conductors to the switchgear, at the substation. This will regulate, control, and monitor the wind park during operations.

Many design and engineering changes have occurred since the early days of low-output, low-efficiency equipment during the early eighties. In the wind power technology sector it has been said that the larger the power system is, the more unique issues you'll find associated with it. Sometimes these issues could start with power electronic designs, pitch and yaw wind controls, bed-plate integration, and the larger picture of the nacelle versus tower design and packaging.

The conventional wisdom on inverter design contains three characteristics. The first could be referred to as software control board programming. The control board programming is a critical path using a variety of algorithms for total power control. The second could be called a gate drive programmed Switching Frequency (SF) on an IGBT (Integrated Gate Bipolar Transistor). SF impacts every aspect of power performance. This will include efficiency, cost, harmonics, ripple rejection, size control stability, audible noise, and utility connection performance. Normally higher frequency is better for all components, parts, and equipment performance. Higher power applications have historically kept switching frequencies to a lower value, less than 10kHz. This is shown in older inverter/converter systems.

There are multiple reasons, and they could range from the base cost of the IGBTs to the cooling plate with the thermal methodology, coupled with the design of the "breadboard," or installation frame and, last, the total packaging of inverter with all auxiliary essential equipment. The IGBTs and gate drive programming language of controls/firmware is one of the most decisive paths in creating a smooth power conversion system. In the IGBT gate drives, direct hard switching without any soft switching will always lead to a high dynamic/thermal loss during the gate drive "turn on and turn off." The third and last characteristic will be thermal management for the IGBT's thermal plate, coupled with the mounted inductor/capacitor requirements for proper backend grid frequency cleanup and power quality.



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Merritt Brown
Rev1 Power Services, Inc.

Wind project owners, site managers, and technicians alike need to understand the value of troubleshooting skills, passing them along to new entrants in this growing workforce.

MANY WIND TECHNICIANS BEGIN their career having already been taught skills in servicing rotating machinery and bring a modest background and understanding of mechanical and electrical principles. Further on-the-job training in such areas as safety, wind turbine operation, bolting, rigging, and electrical systems present a well-rounded service technician who can skillfully perform routine and major repairs for modern wind turbines. High levels of proficiency come from years of experience working through the varied issues encountered on a wind farm, leading to the development of senior technicians who have the capability to quickly understand and resolve a problem. Being able to leverage this experience to impart troubleshooting skills to junior technicians is what separates successful projects from those that struggle.

The profession that once only required basic skills in mechanics and electrical systems now requires high performance work standards and advanced skills. In fact, to remain competitive a wind project needs technicians who immediately have proficient skills in resolving complex issues, unable to afford the luxury of learning these aptitudes over time. Unfortunately, traditional classroom instruction doesn't always teach essential troubleshooting skills. Training is typically conducted on turbines that are fully functional, and while technicians can follow schematic diagrams and perform routine maintenance tasks, eventually the systems they work on will malfunction. In the field, as turbine components break and are repaired, only those who work on it will gain valuable troubleshooting knowledge. Other technicians would have to learn this process independently and repeat for each turbine component. The loss of experienced staff can have a grave impact on the team's learning curve and, equally of concern, smoothly operating projects with few issues result in few chances to keep troubleshooting skills sharpened.

What makes a good troubleshooter lies in the idea that, in spite of their understanding of the component they are working on, they approach each problem systematically. Systematic thinkers have a good understanding of basic operating parameters and use a disciplined troubleshooting methodology. Being a system expert is not necessarily a prerequisite for being a troubleshooting expert, since if you know enough about the turbine to know what tests to conduct you can use a systematic process to narrow the problem down to the root cause. Often, simply understanding and being able to use the turbine technical manual will provide the technician with enough expertise to begin a logical troubleshooting process. Documentation review is just one of the factors in resolving turbine issues, and it involves not only pulling technical manuals from the shelf but also alarm history, past service reports, and parts usage history. Problems always leave clues for the savvy troubleshooter.

When all documentation has been researched without a solution being found, systematic steps are taken to create and test a technician's own theories. Getting an accurate description of the problem and then reproducing it assures that the technician is attempting to fix what needs to be fixed, often discovering the solution by recognizing how a component malfunction is repeated. The low hanging fruit, as it were, are the steps that a technician uses to quickly test theories and narrow the problem down while continually constraining the issue into ever-smaller possibilities. From a systematic approach, tests that cover the most possibilities at once are the quickest route to resolution of the problem, and good troubleshooters are adept to recognize this. On the other hand, troubleshooters who approach a theory and test method with a preconceived idea and fail to follow the systematic steps to reduce possibilities will have thought they had proved the solution in one area when it was actually in another. When this happens tests become unproductive, the troubleshooters begin to question themselves, and time will be wasted.

In our modern wind industry, system experts who fail to use a methodical troubleshooting process will always struggle to attain the same success status as those with expert troubleshooting skills. Wind project owners, site managers, and technicians alike need to understand the value of troubleshooting skills, not only from the perspective of competitiveness but also from where to focus training efforts for new entrants to the growing workforce. Even for existing projects, time and experience are going to be rare commodities in the future.

Merritt Brown is vice president of Rev1 Renewables, an energy services company supporting wind, solar, and biomass clients worldwide. To learn more call (866) 738-1669 or go online to www.rev1renewables.com.

Sven Schmitz, Ph.D.
Penn State Wind Energy

When President Obama visited Penn State to introduce a new energy conservation initiative, he signaled the administration's support for the future of renewable energy in this country.

ON FEBRUARY 3, UNITED STATES President Barack Obama unveiled the "Better Building Initiative" to help the country "Win the Future" in a talk on the University Park campus at Penn State. The vision is to improve the energy efficiency of commercial building space by 20 percent over the next nine years. Cutting-edge energy research and development form the new frontier of reducing the energy consumption of buildings that currently amounts to 40 percent of the entire energy used in the United States. Many of those efforts will be conducted at the Energy Innovation Hub for Energy Efficient Buildings at the Philadelphia Navy Yard. The entire effort referred to as the Greater Philadelphia Innovation Cluster (GPIC) includes 11 academic institutions, two DOE laboratories, five global industrial partners, community colleges, and regional economic development agencies. In total, GPIC includes more than 90 organizations aiming at national energy independence and economic development.

This federally funded initiative is led by Penn State and includes 23 faculty members from five Penn State colleges including Engineering, Arts and Architecture, Earth and Mineral Sciences, Health and Human Development, and the Smeal College of Business. The biggest challenge will be to make new technologies economically viable. Some examples are materials that can remove humidity without lowering temperatures below uncomfortable levels, sensors that can control air filters as needed in order to remove harmful air particles, and building facades that adjust to changes in outdoor temperatures and sunlight.

The centerpiece for the Philadelphia Navy Yard will be the Clean Energy Campus, offering researchers an area with an independent electric grid and diverse building stock waiting for future development. Two other national Energy Innovation Hubs will focus on nuclear energy and developing fuel from sunlight. Penn State and the state of Pennsylvania expect the initiative to spur job growth not only in Philadelphia, but also in the region and beyond. President Obama said that if the goals of the Better Building Initiative are met it will save the nation's businesses nearly $40 billion annually on energy bills by 2020. That money could be spent growing those businesses and hiring new workers, according to the president. Furthermore, Obama projects that the plan would be paid for by a variety of tax incentives as well as financial opportunities, and by ending existing subsidies for gas and oil companies. For more information about the Greater Philadelphia Innovation Cluster visit www.gpichub.org.

Penn State was also proud to host the "Community Wind across America" Mid-Atlantic region conference held in February. This event was presented by Windustry, with support from the U.S. Department of Energy (DOE). Prominent keynote speakers included Jacques Beaudry-Losique, the director of the DOE's Wind and Water Program. The goal of the event was to bring together national and regional experts to focus on simplifying policy structure and to give practical "how to" information on wind project development to interested individuals and land owners. Success stories about harvesting America's wind were shared in terms of overcoming barriers in finances, community permitting, and environmental issues including visual, noise, and avian impacts. Best practices for siting wind turbines on a property were shared, a relevant topic with regard to the upcoming NABCEP Small Wind Site Assessor Certification. The Permitting and Zoning Panel addressed present challenges in zoning and local permitting, and what can be done to streamline the process. Examples from ordinance cases were presented that took projects from "stalled" to "installed." Furthermore, guidance was given to potential investors in small wind with a vivid discussion on how to choose an installer and what timeline to expect for project realization. A technology discussion from the installers' perspectives about the current state of small wind turbines and everyday installation problems followed earlier presentations about the "Unrealities of Wind" that aimed at giving advice on how to choose a machine from the wide variety of new machines available in conjunction with the Small Wind Certification Council (SWCC). A broad range of exhibitors included manufacturers, installers, educators, and national agencies.

From a technology perspective it was intriguing to see that machines are simply starting to "look" more efficient and well designed—the small and community wind market is on the rise. It is one more example of why wind is probably the most prominent renewable energy source. The market is there, the process just has to be streamlined and communities will build toward energy independence with regional job creation. For more information visit www.windustry.org/cwaa.

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Anne Puhalovich
Professional Logistics Group, Inc.

How do you minimize the risks and costs associated with market uncertainty? Change past behavior and innovate!

ACCORDING TO PRESIDENT OBAMA, the first step in winning the future is innovation, but what does that mean for wind logistics? The latest wind energy headlines indicate a decrease in wind development in the U.S. and Europe as compared to 2009, and the high upfront financial investment, increasing competition, and the uncertain regulatory and demand environment are putting severe cost pressures on all projects. The good news is that tough challenges such as these drive businesses to think and act in new ways.

Businesses often get trapped in a mentality of focusing on short-term savings that end up costing them in the long term. For instance, it is a common industry practice to put off serious logistics planning until the final development planning stages. At this late stage logistics costs become spot costs. In some cases spot costs can provide savings, but in other cases businesses can become trapped. On the trucking side, many wind components require specialized transport equipment, and there is a fixed supply of equipment and asset owners. At the same time there is a shrinking pool of qualified drivers to handle heavy load cargo, and their skills and expertise are critical to safely transporting the components. Overexpansion several years ago, coupled with a recent drop in demand, has resulted in equipment decommissions, driver exists, and a shrinking pool of asset providers. When demand picks up it will not be easy for the asset owners to ramp up due to the high investment costs and a lack of market certainty. These owners have been burned in the past and may be reluctant to reinvest.

Exacerbating the fixed equipment situation is the larger turbine sizes expected to enter the market in the near future. For instance, heavier nacelles require precise load distribution to meet legal weight requirements and longer blades require special devices to handle overhang. These conditions may lead to significant fixed investment costs for equipment and engineering services. Although shifting transport to rail or water may help alleviate some of the concerns, all logistics deliveries have a final mile truck component. As demand increases, it is important to plan creative logistics solutions to avoid the past cycle of problems.

Select a preferred supplier, and bring them into the early planning stages. While many businesses resist the idea of exposing their fate to a limited number of suppliers, there are cases where the positive benefits outweigh the risks. The benefits are enhanced when a domino effect occurs. For instance, recently a major OEM developed a firm supply agreement with a tower manufacturer. Both the OEM and the manufacturer used this agreement to build a highly cost effective long-term supply chain solution with service providers. If the agreements are executed correctly, the payoffs are high. It is crucial that risks and liabilities are shared in the most appropriate place. Objective measures of performance and success should be reported to the entire extended supply chain.

Provide your partners with a down payment as a way to share financial risks. The down payment is an investment and commitment towards future success. For instance, a specialty transportation provider entered into a project agreement with a developer for guaranteed service. The asset provider received a down payment for services that was used to plan preventative equipment maintenance, secure escort services, develop advanced route studies, and provide driver security. Individuals and supporting companies planned their schedules to meet the needs of the project. Once the deliveries start, "all hands are on deck" to ensure the project success. A second method to ensure availability is to assume a limited financial stake in assets leases or guarantee volumes.

Design products and services for mode flexibility. This concept includes designing oversized component's to be "rail ready" and having detailed logistics plans to ensure multi-modal delivery options. For instance, a major OEM recently changed their design criteria to allow for their next-generation turbine to be transported via rail. This consideration is crucial for their delivery success since the weight of the turbine exceeds most available road transport equipment. In addition, locating manufacturing plants close to strategic infrastructure or developing connecting infrastructure from the plant to major transit systems creates modal flexibility and increases transport options.

Wind energy may have been down in recent years, but smart businesses will use this time to plan for the future. Every indication is that wind power is going to be part of the world's comprehensive long-term energy solution, so now is the best time to find creative solutions.

Anne Puhalovich is project manager with Professional Logistics Group. For more information go online to www.prologisticsgroup.com.

BS ROTOR TECHNIC U.S.A.

By Russ Willcutt

GL certification proves that this company's blade inspection and repair services are second to none, and available to help keep your turbines spinning.

ANYONE WHO'S WAITED TOO LONG to change the oil in their car and experienced an expensive—and avoidable—meltdown is fully aware of the high price one can pay for procrastination when it comes to preventive maintenance. The same holds true for wind-farm owner/operators, according to Patrick Parmelee of BS Rotor Technic U.S.A., but with much more drastic consequences.

"We encourage owners to consider allowing us to conduct a detailed blade inspection when the turbine is erected, especially since they can incur damage during shipping to the site, and then every couple of years beyond that point," says Parmelee, who oversees sales. "As is the case with an oil change, the cost is minimal when compared to what you'll pay for a new engine block—and especially a new blade, or a gearbox destroyed by a catastrophic blade-related event."

Founded in 2009 the company is a separate, cooperative entity associated with BS Rotor Technic GmbH of Germany, which was launched by Jeremy Sheppard in 2003. "Jeremy had been involved with blade repairs for years before he started his own company, working for LM Wind Power as a service technician," Parmelee explains. "We met at a tradeshow and began discussing setting up operations in the United States, eventually choosing Anaheim, California, since it's near so much wind activity. The great thing about having Jeremy as a colleague is that he possesses an incredible amount of knowledge and experience from his years spent in the European wind market, which is more mature than it is in North America. He has worked on literally thousands of blades, and he's familiar with every type of turbine out there."

As is the case with many European companies that are establishing themselves in the United States and Canada, they bring with them information and benefits resulting from long years spent servicing the wind industry. One that BS Rotor offers is certification by Germanischer Lloyd (GL), which is the gold standard for any company providing services to the wind industry. "What you'll find in the early days of any industry is a certain 'Wild West' mentality, which has certainly been the case with some U.S. blade repair companies in the past," Parmelee says. "But once you achieve a certain maturity it's time to get serious, and our GL certification stands as proof that we are."

Other benefits include possessing knowledge of the intricate details of blade repair that will lead to a successful outcome despite the make, material, or design. One of the leading causes of blade damage is erosion of the leading edge and tip, according to Steve Elrod, general manager. "What happens is that during operation the blades are flexing back and forth, and the adhesive on the leading and trailing edge begins breaking away and accumulating in the tip, where it rattles around and erodes the shell. That imbalance caused by loose materials can eventually lead to a cascade of damaging events, so we'll go in and make the repairs and apply a coating to the edges, rather than the tape some companies use. Then, once our work has been completed, we provide the customer with a two-year warranty on the blade."

Depending on the extent of the damage BS Rotor will either dispatch a two- or three-man team uptower, working from a specially designed platform that has room for all the necessary tools, materials, and equipment. In more serious cases blades can be lowered to the ground, where they are housed beneath tents while repairs are completed. Apart from lightning strikes or manufacturing defects, the vast majority of repairs can be conducted uptower, and Elrod points out that regular maintenance generally keeps blades operating in excellent condition for many years.

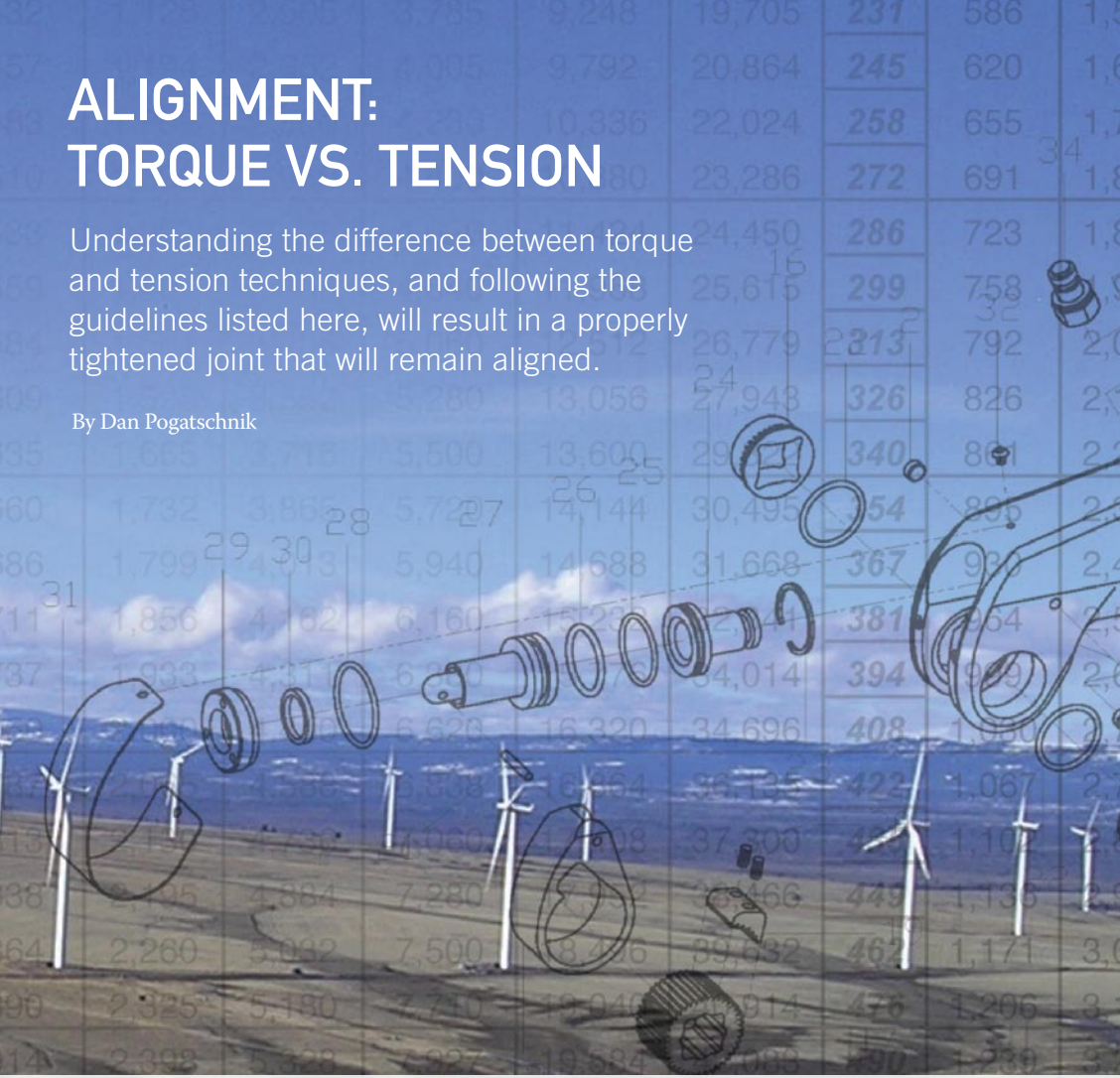
With future plans including establishing satellite locations around the country, preparing to service offshore turbines as that market develops throughout North America, and expanding services to include repairs to generators and gearboxes, etc., BS Rotor Technic U.S.A. is poised to help keep its customers' turbines operating and productive. "We will continue reaching out to the industry and building our reputation for quality and safety," according to Sharad Mehta, the company's managing partner. "We want to become the first company that comes to mind whenever blade inspection or repair is required."

Call (888) 44-Rotor, e-mail info@bs-rotor.com, or go online to www.bs-rotor.com.

ALIGNMENT: TORQUE VS. TENSION

Understanding the difference between torque and tension techniques, and following the guidelines listed here, will result in a properly tightened joint that will remain aligned.

By Dan Pogatschnik



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PROPER ALIGNMENT OF ANY BOLTED JOINT can be achieved by the use of either torque or tension methods of bolting. While both methods of securing the joint produce the same end result, the debate continues about which method delivers the most accurate and consistent bolt load value. If the proper bolt loads are not achieved during installation the integrity of the joint will be compromised, leading to misalignment and, if not checked, ultimate failure of the joint. These two methods of bolting are used in wind turbine installation and maintenance through the use of hydraulic torque wrenches and hydraulic bolt tensioners. The method used is typically determined by the turbine manufacturer and can include the use of one or both of these techniques.

TORQUE TECHNIQUES

To begin, look at the function of a bolt. The purpose is to hold or clamp two surfaces together. In order for the bolt to successfully achieve this function it has to be installed properly, which means applying the correct torque or tension to the bolt. The bolt can be thought of as a spring since it is stretched by either turning a nut through the use of torque, or by stretching the bolt through the use of tension. If the bolt is not stretched enough the joint will be loose and ultimately fail. If the bolt is stretched too much the bolt will be weakened and can ultimately fail. The cor-

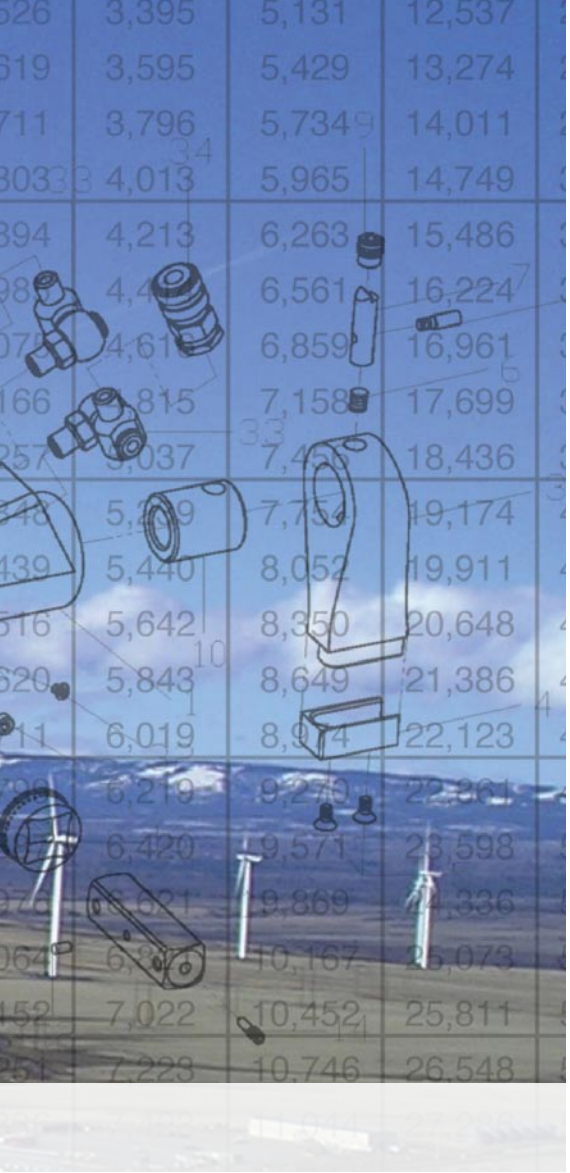


Fig. 1: A critical bolted joint found on windmills.

Fig. 2: A TorcUP tensioning device in use.

rect amount of torque or tension applied will result in the bolt being stretched to a point where it will try to retract to its original shape and keep the proper tension on the joint.

Hydraulic torque wrenches have been commonly used in the wind industry for many years in applications where torque requirements exceed the limits or safe use of manual torque tools. The basic principal of a hydraulic torque wrench is that the torque output is determined by the amount of hydraulic pressure that is applied to the tool. The unit of measure for torque is usually expressed in ft/lbs or Nm. The higher the pressure applied, the higher the torque output of the wrench.

Most hydraulic wrenches operate at pressures up to 10,000 psi. These wrenches come in two basic designs and multiple sizes. The square drive design employs the use of a socket attached to the wrench, and the low profile design is used where there are limited clearances that do not allow the use of a square drive tool. The square drive tool allows for economical flexibility for different size nuts by employing the use of standard impact sockets that are readily available. Low profile tools consist of a drive cylinder and an interchangeable link or cassette that is designed for a specific size nut. Proper tool selection must include torque requirements, bolt and nut sizes, clearances available, and proper reaction points for safe and accurate operation.

Another factor that is critical for proper torque is following the guidelines for fastener lubrication. Some tests have shown that as

much as 90 percent of torque when tightening a bolt is used to overcome friction. Following the manufacturer lubrication guidelines therefore becomes very critical to ensure proper tension or stretching of the bolt. For example, a 1" bolt is selected for a joint. The tension or bolt load required is determined to be 28,300 pounds of force to properly secure the joint. In order to achieve this, the torque that needs to be applied to the nut is 620 ft/lbs and is to be installed with no lubrication. If a moly-based lubricant was applied to the threads, the required torque to achieve the same tension or bolt load value would be only 219 ft/lbs. It is easy to see that if the guidelines are not followed, a moly-based lubricant is applied, and the torque value for a dry assembly is used, the bolt will be over-tensioned and will result in either immediate or future failure of the bolt.

TENSION TIPS

Hydraulic bolt tensioners have also been used in the wind industry for many years, in limited applications. They are becoming more common, and more bolting applications for wind turbine construction and maintenance now require the use of hydraulic bolt tensioners. The basic operation is the same as the hydraulic torque wrenches in that the more pressure applied to the tensioner, the more tension or bolt load is achieved. The unit of measure used for bolt load or tension is usually expressed in either pounds of force or Kn. Tensioner operating pressures can range from 10,000 to 22,000 psi, and in some cases even higher. The basic parts of a tensioner consist of a socket to tighten the nut once tension is achieved, a bridge that the load cell or cylinder rests on, and a puller bar that attaches to the stud.

Not unlike a torque wrench application, before a tensioner can be selected there are several measurements and specifications that need to be compiled—more measurements than required for a hydraulic torque wrench. These measurements typically are more critical for proper fit and tool selection. Some companies supply a worksheet that will assist in gathering the required information. With the exception of some wind turbine foundation tensioners that are designed to fit the two most

Fig. 3: A sampling of TorcUP tensioners.

commonly used foundation bolt sizes, most tensioners are size specific so the stud size and nut size, as well as height and washer thickness and diameter, are needed. The bolt grade and bolt load required should also be recorded. Measurement of the stud protrusion from the flange as well as the protrusion above the nut and washer are also needed. The protrusion measurements are important to ensure that the tensioner will rest on the flange once it is threaded on the stud and thread engagement in the tensioner is at a minimum equal to the diameter of the stud. If the tensioner does not rest on the flange the tensioner will react off of the nut once hydraulic pressure is applied and can lock itself onto the stud. If there is not enough thread engagement the threads can be stripped off of the stud before the proper tension is reached.

Fig. 4: A TU Series hydraulic device in action.

The next measurements have to do with clearances. Measurements from the stud to the tower wall or any other surfaces that are perpendicular to the flange face as well as the distance between the studs are needed to ensure that the tensioner can be attached to the stud easily and be properly aligned. Any special measurements such as recesses in castings should also be noted and recorded. When all the information is gathered it can be determined if a stock tool can be used or if a custom de-

Fig. 5: A TU Ultra square drive hydraulic torque wrench.

sign needs to be produced.

Once a tensioner has been selected the manufacturer's tensioning procedure and specifications should be reviewed. What is the bolt load required? What is the bolting pattern? Can the joint be tensioned to 100 percent of the bolt load required, or does it have to be tensioned in stages? Should more than one tensioner be used simultaneously to tension the joint? These are some of the elements of the tensioning procedure that need to be verified. Basic operation of the tensioner consists of attaching the tensioner to the stud and connecting the tensioner to the hydraulic pump using an appropriately rated hydraulic hose.

The next step is to adjust the hydraulic pump pressure to achieve the proper output of the tensioner. Once the proper pressure has been applied to the tensioner the bolt

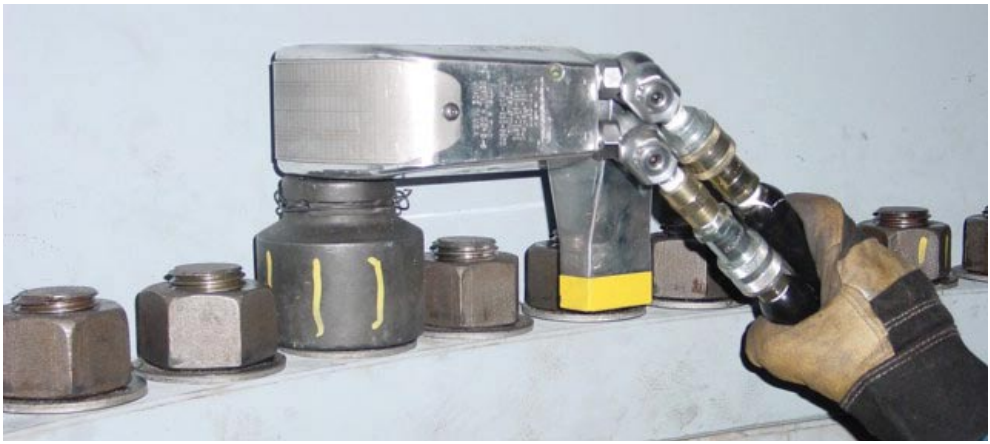


Fig. 6: The TorcUP TU device for windmills.

will be stretched and the nut that is on the flange face can be tightened. Minimal torque is required to tighten this nut, as the tensioner has already stretched the stud to the appropriate tension. The pressure can now be released, and the tensioner removed.

TRAINING CRITICAL

Once the method of tightening a bolt is determined, either torque or tension, it is very important to properly train the personnel who will be performing the work. This is not only important for joint integrity, but also to prevent any injuries to the operators or damage to the application. Proper tool handling and maintenance training can go a long way in preventing these occurrences, and many tool companies will provide this upon request. Inspection of the tooling should include power cords for fraying, hydraulic hoses and couplings for proper rating, and inspection for any hydraulic oil leaks or hose and coupling damage, as well as overall condition of the tools including proper lubrication and calibration. Following these guidelines and procedures will result in a properly tightened joint that will remain aligned and be less prone to failure.

COLD WEATHER CONSTRUCTION CONCERNS

Whether you're installing foundations or involved in any other aspect of wind-farm construction, Mortenson's guidelines encourage safe practices.

By Trent Schon

Trent Schon is director of safety for Mortenson Construction's Renewable Energy Groups and a board-certified safety professional. Learn more at www.mortenson.com.

HEADQUARTERED IN MINNEAPOLIS, one of the coldest metropolitan areas in the United States, Mortenson Construction's Renewable Energy Group has built nearly 100 utility-scale wind power projects in some of the most extreme climates throughout the United States and Canada. The successful building of wind power projects in the extreme cold requires careful preparation for equipment needs and special attention for the safety of those working in the field.

EQUIPMENT AND PROCESSES

Cold temperatures often bring snow, ice, and other conditions that warrant special equipment including personal protective equipment and clothing such as gloves, facemasks, and ice/snow traction devices that attach to heavy boots. Other requirements include enclosures for trailers, heaters, winter fuels mixed with anti-gelling additives, hot water pressure washers and anti-freezing biodegradable washer fluid for washing tower sections, concrete blankets and plastic tarps for concrete placing, and enclosures for tower grouting activates.

Snow and Ice Removal: In order to move forward safely with construction, snow and ice must be cleared from the project site to create a safe walking surface for the movement of equipment and workers. Construction can proceed during the winter and with some snow or ice on the project site. If there is an

ice or snowstorm, however, construction may be halted until weather conditions improve. Once the storm has ended the contractor will remove the areas of snow accumulation before proceeding with construction. When the weather forecast predicts a snow or ice storm it is a good practice to lower the crane boom so any buildup of snow or ice can be removed. This is a must to ensure safe operation of the cranes. Construction team members will use rubber mallets to knock the snow or ice off the boom sections before the crane is placed into production operation.

Foundation Installation: Installing foundations in extreme cold temperatures requires additional equipment such as ground thaw and forced air heaters to make sure materials are within required temperature ranges during each step of the installation process. There are specific accommodations for mixing and placing the concrete. Portable concrete batch plants must be winterized sufficiently, which often means enclosing them in heavy plastic tarps or tents. The sand and aggregate must also be heated and mixed with hot water to correctly prepare the concrete.

Additionally, foundation rebar must be warmed to required temperature ranges before concrete can be placed around it. Under specific conditions the concrete must be secured under supplemental heat. Construction crews will use extra heaters and heavy insulated concrete blankets to ensure that the foundations are cured even in very cold temperatures. This type of planning also affects the placement of grout around the foundation pedestal.

HAZARDS AND CONCERNS

Working in extremely cold temperatures can lead to dangerous conditions, the most significant of which are frostbite and hypothermia. Several factors contribute to the risk of injury including: temperature, wind speed, moisture (sweat or working near water), duration of exposure, clothing, work/rest schedule, work performed, and other individual characteristics.

Frostbite is the actual freezing of tissue. Exposed skin becomes vulnerable to frostbite when the air temperature drops below 0° C/32° F or when wind speeds are high creating a wind-chill effect. If skin is not protected, frostbite can lead to body tissue damage. Symptoms of frostbite vary from swelling and red coloration of the exposed area and slight pain in mild cases to extreme tissue damage with black/dark bluish-purple in severe cases. Depending on the level of exposure frostbite can occur with little or no pain or cause a burning/prickling sensation in more severe cases. If minor exposure has occurred the affected areas of the skin should be warmed slowly until normal temperatures are reached. When higher levels of exposure occur, medical attention should be initiated.

Hypothermia occurs when the body core temperature drops below 35° C/95° F. Once this happens the body loses its ability to prevent heat loss and is losing heat more quickly than it can create heat. Hypothermia is typically a gradual process, with the exception of extreme exposure such as falling through the ice on a frozen lake. As hypothermia develops the victim initially has a sensation of cold followed by pain. As time passes the level of pain increases and the body becomes numb. Symptoms of hypothermia include a decrease or absence of shivering, reduced memory and con-

fusion, drowsiness, slurred speech, impaired coordination, a loss of dexterity, and general muscular weakness. In cases of minor hypothermia the exposed individual should be covered with heated blankets. If not identified and addressed quickly, hypothermia can lead to death. Extreme cases of hypothermia require immediate medical care from experienced medical personnel as quickly as possible.

PREPARING WORKERS

The Layered Approach to Clothing: When selecting proper cold weather clothing a layered approach is best. Too little clothing leaves the worker exposed to the cold. Too much clothing leads to sweat, wetness, and cold, which then can lead to hypothermia. Workers must wear the appropriate amount of clothing to keep their heat loss to heat production rate neutral. When layering clothing it is best to select a windproof outer layer that is at least water resistant, but ideally waterproof. Table 1, taken from the American Conference of Governmental Industrial Hygienists (ACGIH) on Cold Stress, explains the effects of wind chill on the body. Table 2—taken from the Manitoba Work Place Safety and Health Division, Working in the Cold Bulletin-186—provides recommen-

	Actual Temperature (Celsius)										
		5	0	-5	-10	-15	-20	-25	-30	-35	-40
Wind Speeds (km/hr)	5	4	-2	-7	-13	-19	-24	-30	-36	-41	-47
	10	3	-3	-9	-15	-21	-27	-33	-39	-45	-51
	15	2	-4	-11	-17	-23	-29	-35	-41	-48	-54
	20	1	-5	-12	-18	-24	-30	-37	-43	-49	-56
	25	1	-6	-12	-19	-25	-32	-38	-44	-51	-57
	30	0	-6	-13	-20	-26	-33	-39	-46	-52	-59
	35	0	-7	-14	-20	-27	-33	-40	-47	-53	-60
	40	-1	-7	-14	-21	-27	-34	-41	-48	-54	-61
	45	-1	-8	-15	-21	-28	-35	-42	-48	-55	-62
	50	-1	-8	-15	-22	-29	-35	-42	-49	-56	-63
	55	-2	-8	-15	-22	-29	-36	-43	-50	-57	-63
	60	-2	-9	-16	-23	-30	-36	-43	-50	-57	-64
Risk Level		1		2		3	4		5	6	

	Actual Temperature (Fahrenheit)										
		41	32	23	14	5	-4	-13	-22	-31	-40
Wind Speeds (km/hr)	3	39	28	19	9	-2	-11	-22	-33	-42	-53
	6	37	27	16	5	-6	-17	-27	-38	-49	-60
	9	36	25	12	1	-9	-20	-31	-42	-54	-65
	12	34	23	10	0	-11	-22	-35	-45	-56	-69
	16	34	21	10	-2	-13	-26	-36	-47	-60	-71
	19	32	21	9	-4	-15	-27	-38	-51	-62	-74
	22	32	19	7	-4	-17	-27	-40	-53	-63	-76
	25	30	19	7	-6	-17	-29	-42	-54	-65	-78
	28	30	18	5	-6	-18	-31	-44	-54	-67	-80
	31	30	18	5	-8	-20	-31	-44	-56	-69	-81
	34	28	18	5	-8	-20	-33	-45	-58	-71	-81
	37	28	16	3	-9	-22	-33	-45	-58	-71	-83
Risk Level		1		2		3	4		5	6	

Table 1: Wind chill calculation chart.

	No Noticeable Wind		*Wind 8km/h 5mph*		*Wind 16km/h 10mph*		*Wind 24km/h 15mph*		*Wind 32km/h 20mph*	
Air Temperature	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks	Max Work Period	No. of Breaks
-26 to -28 C -15 to -18 F	Normal	1	Normal	1	75 mins.	2	55 mins.	3	40 mins.	4
-29 to -31 C -20 to -24 F	Normal	1	75 mins.	2	55 mins.	3	40 mins.	4	30 mins	5
-32 to -34 C -26 to -29 F	75 mins.	2	55 mins.	3	40 mins.	4	30 mins	5		
-35 to -37 C -31 to -35 F	55 mins.	3	40 mins.	4	30 mins	5				
-38 to -39 C -36 to -38 F	40 mins	4	30 mins.	5						
-40 to -42 C -40 to -44 F	30 mins	5								
-43 C and below -45 F and below	Emergency Work Should Cease in the Black Region									

Table 2: Work/warm-up schedule for four hour shifts with moderate to heavy work activity occurring.

RISK LEVEL (WIND CHILL)	RISK OF FROSTBITE	HEALTH CONCERN	WHAT TO DO
1 (0 to -9) C (32 to 16) F	Low	- Slight increase in discomfort.	- Dress warmly, with the outside temperature in mind.
2 (-10 to -27) C (14 to -17) F	Low	- Greater discomfort - Risk of hypothermia if outside for long periods without adequate protection.	- Dress in layers of warm clothing, with an outer layer that is wind-resistant. - Wear a hat, mittens, and scarf. - Keep active.
3 (-28 to -39) C (-18 to -38) F	Increasing risk: exposed skin can freeze in 10 to 30 minutes	- Check face and extremities (fingers, toes, ears and nose) for numbness or whiteness (frostbite). - Risk of hypothermia if outside for long periods without adequate protection.	- Dress in layers of warm clothing, with an outer layer that is wind resistant. - Cover exposed skin: wear a hat, mittens and a scarf, neck tube or face mask. - Keep active.
4 (-40 to -47) C (-40 to -53) F	High risk: exposed skin can freeze in 5 to 10 minutes	- Check face and extremities (fingers, toes, ears and nose) for numbness or whiteness (frost bite) - Risk of hypothermia if outside for long periods without adequate protection.	- Dress in layers of warm clothing, with an outer layer that is wind resistant. - Cover all exposed skin: wear a hat, mittens and a scarf, neck tube or face mask. - Keep active.
5 (-48 to -54) C (-54 to -65) F	High risk: exposed skin can freeze in 2 to 5 minutes	- Check face and extremities (fingers, toes, ears and nose) for numbness or whiteness (frost bite) - Serious risk of hypothermia if outside for long periods.	- Be careful. Dress very warmly in layers of clothing, with an outer layer that is wind resistant. - Cover all exposed skin: wear a hat, mittens and a scarf, neck tube or face mask. - Restrict outdoor work as much as possible. - Keep active.
6 (-55 and Colder) C (-67 and Colder) F	High risk: exposed skin can freeze in less than 2 minutes	- Danger! Outdoor conditions are extremely hazardous. Severe risk of frostbite and hypothermia.	- Do not work outdoors.

Table 3: Clothing and work-period recommendations based on wind chill.

dations for protective clothing based on the wind chill temperature ranges. Since toes, fingers, ears, and other parts of the face are at risk of frostbite, footwear, gloves/mittens, and face protection must be used to protect the worker, taking into consideration the ability to perform the various tasks on a wind power project during construction.

Warm-up Breaks: Workers who are outside for extended periods in cold environments should take regular warm-up breaks, preferably inside a warm shelter or heated vehicle. Warm-up breaks should still be mandatory, even when appropriate winter clothing is selected and utilized effectively. Table 3, taken from the Manitoba Work Place Safety and Health Division Safe Guideline for Thermal Stress, provides recommendations on the maximum amount of time workers should be allowed to work before taking a break. If excessive sweating does occur during the warm-up break, the individual should change into dry clothing prior to reinitiating work activities.

Individual Factors: Various factors may contribute to an individual's ability to withstand working in cold conditions. Factors such as age, physical health, acclimatization to cold, etc., can all determine the exposure time of worker in cold temperature environment.

INTERNAL EXPECTATIONS

When working on a Mortenson Renewable Energy Group project, all work ceases when the surrounding work temperature and/or wind chill is at -34° C/-30° F as defined in Risk Level 3 in Table 1. This should be based on the strain of the task and location of the work. At no time should work be performed in a Risk Level 4 or higher, as defined in Table 1. Table 2 should be used to define warm-up breaks over a four-hour work period, with maximum cold exposure time and a defined warm location.

At times certain work activities are difficult or impractical to execute with the defined warm-up periods. In these cases a plan must be developed to ensure those individuals remain warm throughout their workday. For example, tower connectors may be exposed to cold wind chill temperatures, but it is infeasible for these workers to climb down the tower for breaks in a dedicated warm location. In this case an alternative approach is necessary. This approach may include utilization of heat producing clothing; chemical heat packs for the hands, feet, and body; and warm-up breaks in an enclosed space at appropriate pause points during the turbine building processes. To manage the cold working environment it is recommended to only work within the green areas of Table 3. This schedule applies to workers wearing dry clothing doing moderate-to-heavy work with breaks of 10 minutes in a location that allows workers to warm up.

For light-to-moderate work (little physical movement), apply the schedule one step lower. For example, at -35° C/-31 ° F with no noticeable wind, a worker at a job with little physical movement should have a maximum work period of 40 minutes with four breaks in a four-hour shift instead of 55 minute work periods and three breaks. After four hours workers should be given an extended break in a warm place. In addition to monitoring the cold conditions ensure that foot traction devices are utilized to minimize slips, trips, and falls when icy/snowy conditions exist.

PREPARING AND PRIORITIZING

Extreme temperatures, hot or cold, bring many necessities for building safely and within given timeframes. Extreme heat is no less dangerous than extreme cold, and preparing adequately for these temperatures is a must for worker safety and best use of equipment. The good news is that the experienced EPC contractor can typically plan for extreme temperatures in the peak winter and summer months. A prepared contractor will budget for and pre-order the proper protective gear and equipment to ensure that construction runs smoothly and safely even in extreme weather.

WIRELESS VIBRATION MONITORING

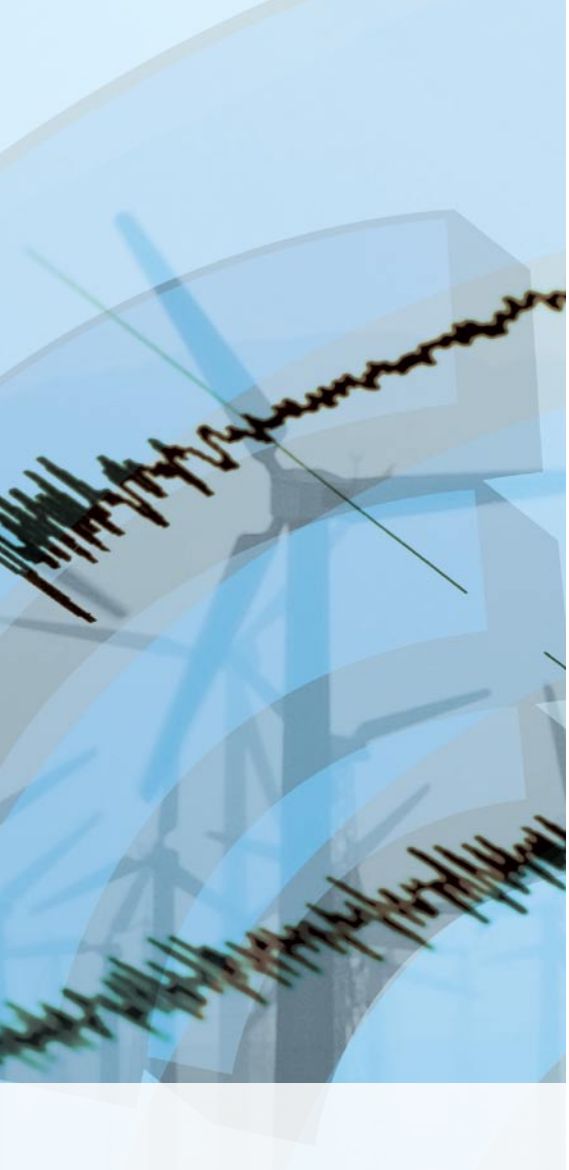
Vibration can be a precursor to turbine failure, and wireless technologies have become an option for monitoring applications, according to FreeWave Technologies.

By Bret Dianich

Bret Dianich is business development executive, renewable energy markets, at FreeWave Technologies, Inc. Go online to www.freewave.com.

IN RECENT YEARS WE HAVE SEEN the use of wind power generation continue to increase as a viable energy solution. With this increase operators are looking for the best ways to maintain wind turbines and prevent failure. There are several ways to monitor a complex power-generation system such as a wind turbine. However, one of the largest indicators of a potential problem is vibration, which is often detected in the nacelle. If a turbine is experiencing a high amount of turbulence vibration it can be a precursor to complete turbine failure, potentially resulting in explosions, turbine blades flying hundreds of yards, and toppling towers.

Think of wind turbines as mini jet engines inside of housings that run 250 feet tall. If there is any sign that something might be going wrong in the turbine, vibration is typically one of the best places to start, as it's a good way to look at the general health of the wind turbine and see if things are functioning the way operators are expecting. The quicker that operations and maintenance (O&M) teams can detect problem signals, the sooner that loss can be mitigated and potential disasters avoided. There's a lot of value in vibration monitoring because it gives more predictive ability for the O&M company and the O&M technicians to look for problems before they come up. The danger in not monitoring for potential issues could result in a loose blade.



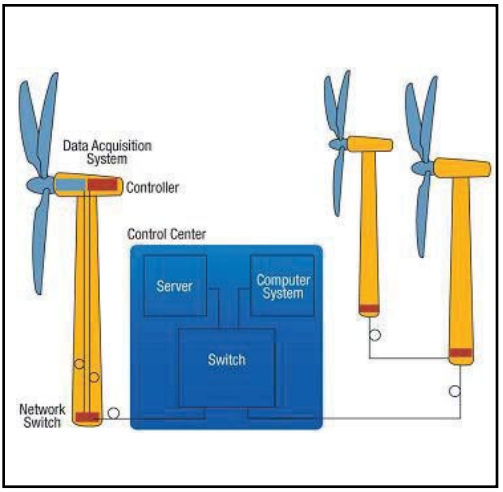


Fig. 1: Traditional use of trenched fiber optic cabling for system monitoring.

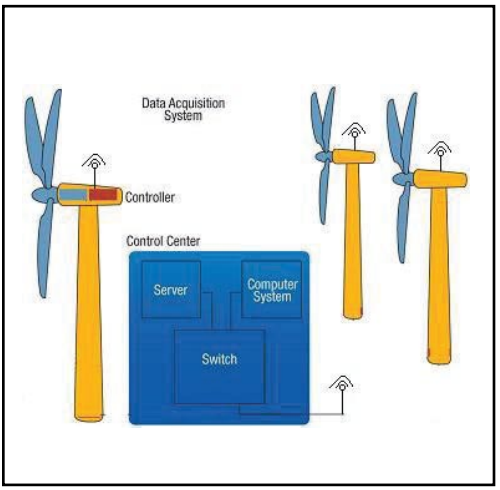


Fig. 2: Wind turbines outfitted with wireless transceivers.

A vibration reading will signal the operator before the blade actually becomes loose, preventing damages in the $2-$5 million range.

VIBRATION MONITORING SOLUTIONS

A common solution for monitoring is a wired, or cable solution (fig. 1). However, many operators are finding that installing additional wire is not feasible. This is mostly due to remotely located turbines and the high costs associated with installing/running additional wire. Sometimes it's simply not possible to run wire back to the O&M office.

Recently, wireless technologies have become an option for various monitoring applications in the renewable industries. Satellite systems, for example, have broadband capabilities and tend to be reliable, but they have monthly recurring costs. Cell phone systems function in a similar fashion as satellite systems, using an existing network of communication devices with associated monthly charges. If users are within range of a cell tower, cell phone systems are a simple solution for sending data back to the O&M office, but the monthly recurring costs associated with satellite or cell phone systems can become a burden on an operating budget.

Now operators can also choose Frequency Hopping Spread Spectrum (FHSS) radios to send critical vibration-sensing data to the O&M office, without the added cost of fiber

installation and without the monthly or reoccurring fees that tend to accompany cellular and satellite solutions. This class of wireless radios has proven its reliability in industries such as military, oil and gas, and water/wastewater, and it is now available as a solution for vibration monitoring in wind turbines (fig. 2). Ideal for installation in remote locations and difficult environments, they can transmit real-time data up to 60 miles line-of-sight reliably.

WHY WIRELESS?

Wind turbines are huge investments, costing millions of dollars. Many are nearing the end of their warranties, which typically last about 20 years. Operators are being proactive about detecting problems in the turbines before the warranty period expires. This has become a great opportunity to install wireless technologies. In order to inspect the turbines for problems, an operator will physically go up and into the turbine looking for potential problems. While they are performing the inspection they can easily install a FHSS wireless data radio and monitor the turbine on a real-time basis.

Cost is another driving force for deploying wireless technologies. FHSS radios are generally much less expensive to install than cable and do not have the reoccurring fees of satellite and cell phone technologies. In addition, if the operator can stop a turbine from a potential disaster by detecting problems before they happen, they can save millions of dollars. With some wireless data radio providers the investment in an RF network isn't only useful for vibration monitoring. The devices can be scaled to monitor wind speed coming from an anemometer, or the RPM of the actual engine itself within the turbine. With these radios, they can be expanded upon without having to add more devices.

Another main driver of wireless implementation is field scalability. Many wireless modems have multiple data ports that can be utilized in the future when additional instrumentation is needed (fig. 3), or if existing devices—lubrication particulate sensors, inverter monitors, in-tower data loggers—need to be accessed remotely later on in the life of the field. And because many RF devices are Ethernet-enabled, expanding on an existing radio network is as easy as assigning a new IP address to a new radio and installing it uptower, which shouldn't take longer than an hour or two.

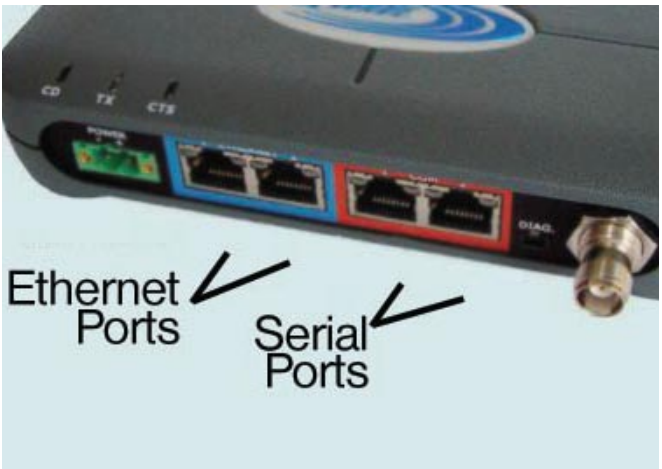


Fig. 3: Example of a radio with multiple data ports.

REAL-WORLD EXAMPLE

A wind power company in the Southwestern United States along the Texas/New Mexico border needed a vibration monitoring solution for dozens of turbines. In this case the property owner and site operator did not want the contracting company to use their existing fiber optic network. They also didn't have the bandwidth or the ability to use their existing fiber optic network to set up the system. So, the question became "how are we going to get vibration sensing data from the turbine back to the O&M office if we can't use the existing fiber optic network that the site operator installed?"

Fiber optic networks are typically installed at the same time as the turbines. They consist of large webs of fiber optic cable that send and receive data all the time. They are very high-throughput and prepared for this type of application from an industrial standpoint, but in this particular case the company did not have the option to use fiber. They began looking at several wireless providers and settled on one that offers FHSS wireless data radios.

There is a class of FHSS wireless data radios that have proven to succeed even in the most difficult environments. In this particular installation all the turbines sat on top of a mesa, which offered a clear line of site. Both pier-to-pier communication and point to multi-point communication was very easy to achieve. However, each one of the turbines is composed of a mast that is about 200 feet tall by 15-20 feet in diameter and is made of corrugated steel. This could have easily created

an issue with line-of-sight. There was a concern that RF would reflect off the turbines like a mirror.

Operators should always work with a wireless company that provides path studies or lender radios to ensure the products will work before they purchase them. In this situation, the tests showed that the wind turbines would not be an issue. When the wind power company did the path study it compared multiple radios, and it was able to determine which ones performed despite the potential obstruction of the huge wind turbines. One of the radios in the comparison would lose data each time a blade passed through the arc link, so they went with the solution that did not have link issues.

The chosen radio provider took the potential obstruction into consideration before installing the radios. In this case they conducted a study using a digital elevation level to indicate potential issues. That was only one way to account for the huge obstruction, however, so it was a bit of a variable. The radio provider did some additional testing by physically climbing to the top of a cell and setting up a radio inside the housing. The signal transmitted through the turbine back to the O&M office without a hitch.

Now that the FHSS wireless data radios have been deployed at this location, most of the vibration monitoring occurs inside the nacelle. In addition, vibration monitoring also occurs on the couplings that the turbine blades feed into, and on the blades themselves. There could be two dozen vibration-sensing accelerometers feeding their data back to a condition monitoring box on any single wind turbine. The accelerometers send data through a FHSS wireless data radio, which reports back to the O&M building that is central to the wind farm. Basically, the radios act like an Ethernet bridge to send and receive vibration data going through the entire network. Each turbine is reporting their vibration data roughly twice a day, sometimes three times a day, and has been doing so successfully for several months.

The deployment of these radios has been such a success that there are 11 different sites planned for installation in the next year and a half. The company is looking to install 450-500 more radios across the country.

SOFTWARE ADVANTAGES

Some FHSS wireless data radios are accompanied by software programs that not only help with configuration, but offer diagnostics (fig. 4). Not all providers offer this type of solution, but

it is something that O&M should take into consideration as they search for the best wireless provider for their particular installation. Some diagnostics software can tell an operator which device is talking better or worse than another; if their data packets are being lost and where; and can track the traffic down to the packet. Software programs like these provide a granular understanding of the RF network; it's actually given many operators additional transparency in their network.

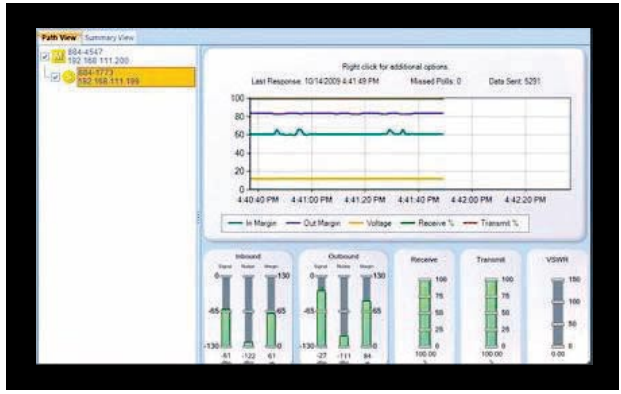


Fig. 4: Example of radio diagnostics showing inbound/outbound signal levels and reflected power readings.

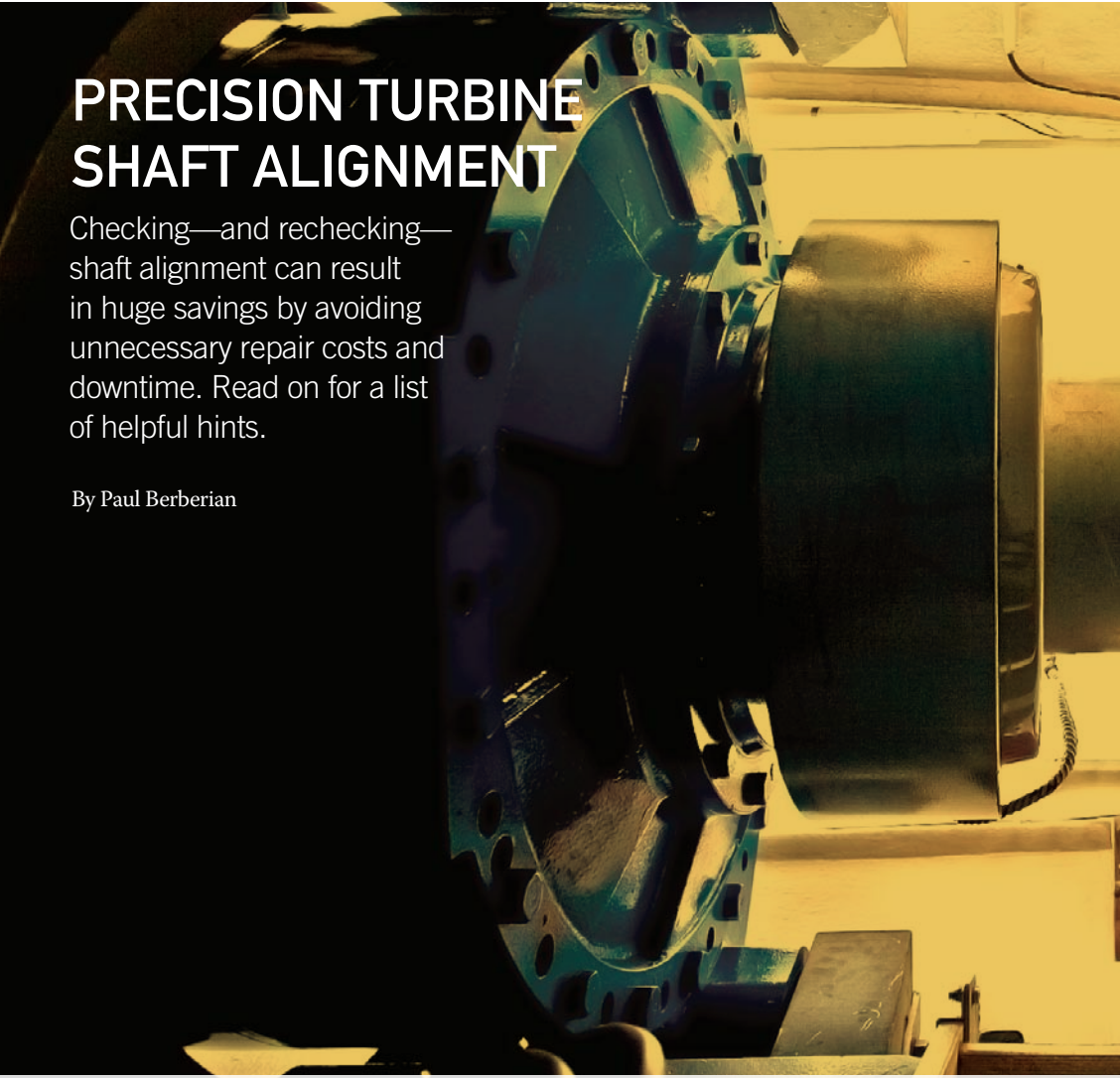
CONCLUSION

FHSS wireless data radios can reliably serve as the Ethernet link between a wind turbine and the O&M office. As a wind power company in New Mexico found, the right wireless provider and installation can be equally effective and far less expensive than a wired solution. Reliable wireless technologies can be easily installed as operators inspect wind turbines that are nearing the end of their warranties. After deployment the turbines are continually monitored on a real-time basis, indicating issues with vibration before they cause devastating damage. As operators learn of successful wireless installations, they are beginning to view FHSS wireless radios as a viable option for vibration monitoring. Now many radio providers offer the option of path studies, diagnostic software, and industrially hardened products that have proven their performance in other industrie.

PRECISION TURBINE SHAFT ALIGNMENT

Checking—and rechecking—shaft alignment can result in huge savings by avoiding unnecessary repair costs and downtime. Read on for a list of helpful hints.

By Paul Berberian

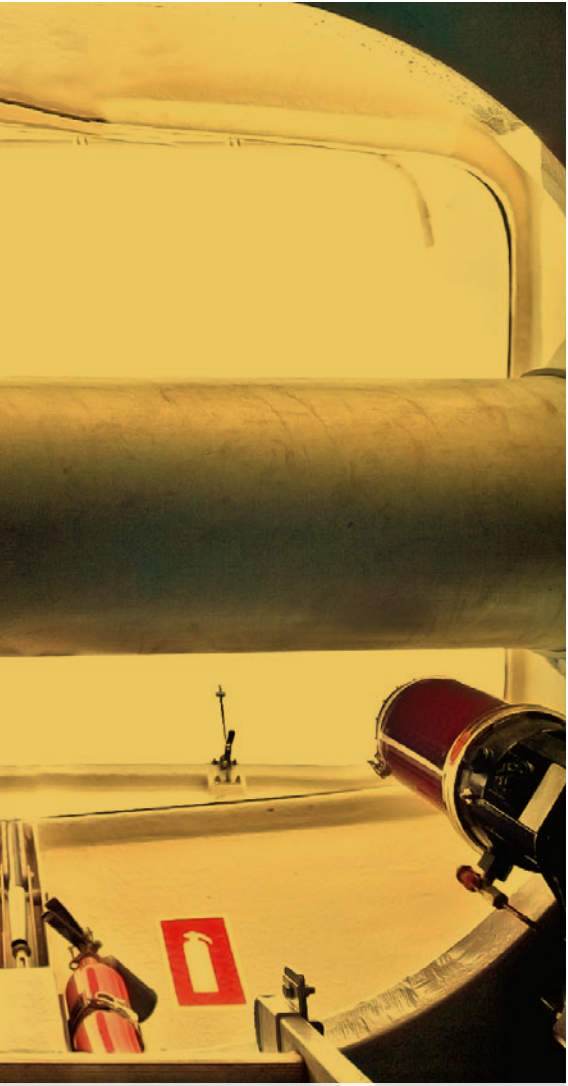


Paul Berberian is national sales manager for Alignment Supplies, Inc.
Go online to www.alignmentsupplies.com.

MECHANICAL FAILURE IN WIND TURBINES presents unique challenges for operations and maintenance. Unlike traditional rotating equipment assets in other power generation plants, wind turbine assets sit on top of a tower 90m in the air. We do not have the luxury of performing maintenance tasks on solid ground. Tools and replacement parts must be brought up to the work site, and if you forget a tool or a part it's not as easy as traveling back to the shop to retrieve it. It is critical to be able to prevent mechanical failure in a wind turbine whenever possible.

We see from the chart in fig. 1 that 60 percent of wind turbine downtime is related to drive train failure: gearbox, generator, main shaft, and their associated bearings. We also know from industry studies that misalignment of rotating shafts is responsible for more than half of all bearing failures.

Precision shaft alignment is the process of aligning the centerline of the shafts of one or more rotating machines. When the shaft centerlines are co-linear they can turn freely, and the external forces that destroy key components of the system—bearings, seals, couplings, rotors—will be mitigated. Misalignment will most affect the main bearings in the gearbox and generator. Left unattended for too long, it will destroy the bearings and then go to work on other components down the line on the shaft such as seals and rotors, etc. Precision alignment at install and periodic checks can help prevent component failure, uptower repairs and catastrophic failure. A bearing failure uptower can cost $10,000-$15,000



to fix. Catastrophic failure can cost an estimated $260,000.00. A good alignment program can prevent these problems before they even start. There are various tools for alignment, some better than others. Consider these options:

Straight-edge mechanical tools
- Not a precision alignment
- Subject to gross interpretation of the user

Dial indicators
- Difficult to learn proper alignment method
- Time consuming process for the inexperienced
- Dials must be mounted on the shafts
- Shafts have to be able to turn to align with dials
- Can be subject to interpretation by user

Laser alignment tool
- Learning curve is short
- Very precise, even for an inexperienced user
- Many mounting options for different turbines
- Shafts do not necessarily have to turn
- No interpretation by the user, the data is the data

Precision alignment means you are using a laser alignment kit or dial indicators. A straight edge is not a precision alignment tool. Lasers have many advantages over dial indicators. Dials are hard to teach and learn. Until you have mastered the art of dial indicators, they can be very frustrating and time consuming. Lasers are a fast, easy, and accurate method of alignment. When you are performing alignment in a wind turbine there are a number of issues to consider.

SAFETY FIRST

First and foremost is safety. Laser alignment tools must be mounted in such a way that they will not be able to come in contact with techs if the turbine brakes give way. Turning the shafts is critical to performing a precision alignment and O&M teams have to be aware under what conditions they can work uptower when the blades will be turned. The requirement to perform a measurement without turning the shaft is becoming more predominant.

A sudden strong gust of wind can catch the maintenance team off guard and cause the shaft to spin freely as the brakes are being released for the alignment process. Some turbine manufacturers have developed solutions for alignment that do not require the gearbox to turn. This requires special fixtures and the coupling needs to be removed to perform the alignment. It is, however, the safest way to perform an alignment in a wind turbine. Know the guidelines that your turbine OEM has set for uptower alignment—maximum wind speed, direction the turbine should face, can the shaft covers be off or on, should the coupling be removed—make sure your maintenance teams are safety trained.

MOUNTING LASER ALIGNMENT TOOLS

In many cases we can't mount with traditional chains and brackets on the gearbox shaft. This leaves us with the decision of where to mount the measuring (S-Unit) with a magnet. First, decide if you want to mount on the brake disc or the mounting flange for the coupler. Look for a place as close down by the shaft as possible. Check for clearance of the brake caliper.

Once you decide where to mount, check the measurement two or three times to make sure it repeats. On some turbines we have found that some components will shift when the brake is engaged. Mounting close to the shaft will minimize the effect. If your results are not repeating, look

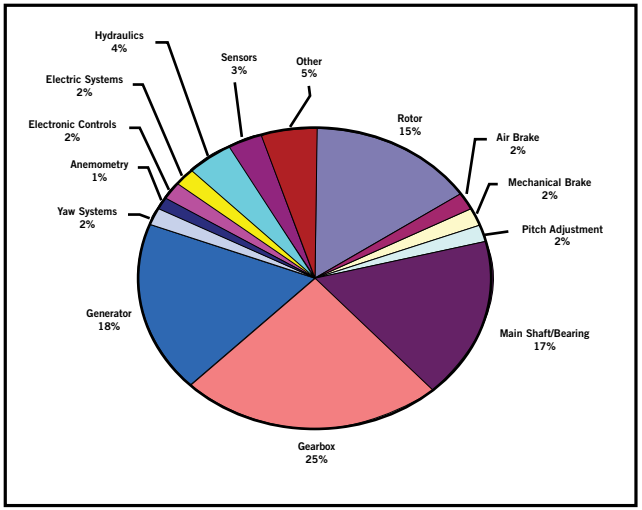


Fig. 1: Wind turbine downtime distribution (Quantification of Condition Monitoring Benefit for Offshore Wind Turbines, McMillan and Ault, 2007).

for an alternative spot to mount and re-test. If they do repeat, you have found a good solution.

FREQUENCY OF ALIGNMENT

The second consideration is deciding how often the turbine needs to be aligned. Many turbine OEMs have set requirements for turbine alignment intervals. Some OEMs only align prior to shipment from the manufacturing facility, some align when the turbine arrives "in-country," and some align when the turbine is installed on the tower. Some do all three. It is never a bad idea to check turbine alignment. A precision alignment check should be included in your intervals of preventative maintenance. A quick check when the alignment is not scheduled to be performed can be done fairly quickly. Once you have determined that alignment is required, you can schedule it in your maintenance plan.

High-speed shafts should always be aligned during generator or gearbox change outs. Best practice says we should come back in three or so months and re-check the alignment. Again, this depends on the turbine manufacturer and their recommendations.

TOLERANCES

Another important consideration is alignment tolerances. Alignment tolerances define how much mis-

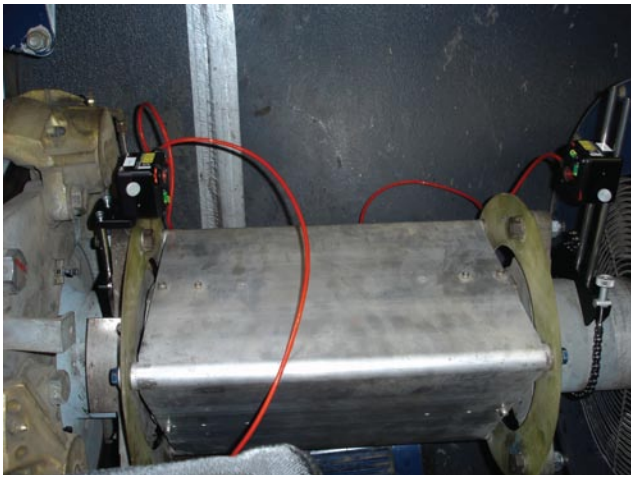


Fig. 2: Alignment with coupler.

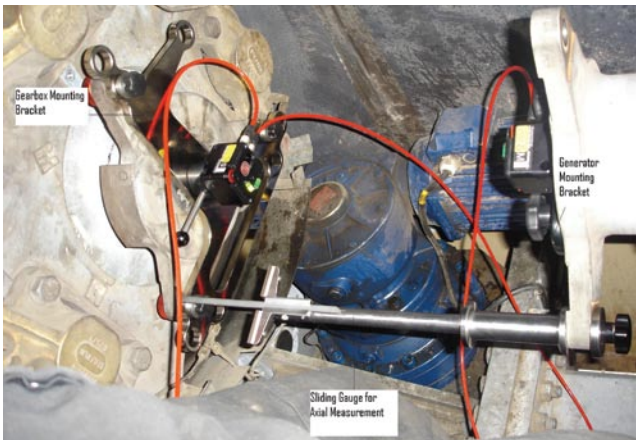


Fig. 3: Alignment with coupler removed.

alignment is acceptable for a given model of turbine. Many turbine OEMs have established alignment tolerances for their equipment. If you don't know the manufacturer's tolerances, or they are not supplied, tolerance charts are available based on speed of rotation.

DYNAMIC MOVEMENT

The last consideration we will talk about in this article is dynamic movement. Dynamic movement is caused when the brake is released and the hub and blades turn freely. The weight and turning forces can cause the gearbox to move slightly, even imperceptibly to the human eye, and cause misalignment. You should consult your turbine manufacturer to find out if dynamic movement is present in their turbines, if they know how much it moves, and whether or not it is critical. In some cases the coupling can offset the movement when the shafts are aligned within tolerance. Once you know the amount of movement, you can add those calculations to your alignment tool. When compensating for dynamic movement, you will actually misalign the gearbox and generator at rest so that when it's running the machines will move into alignment.

Lasers are also used in the wind industry as a valuable tool for measuring flanges on wind tower and blade root flanges. Flatness and taper measurements help ensure that these components will fit together properly during construction.

Precision alignment is a vital first step to prevent mechanical failure in wind turbines. Regardless of whether alignment is performed by the OEM, your O&M contractor, or your own O&M team, good tools and training are not optional. Remember that an ounce of prevention equals a pound of cure, lessening the chance for catastrophic machine failure uptower.

FEATURES AND OPTIONS

In addition to the design characteristics discussed, there are a number of other considerations or desirable features you should consider when building your wind farm grounding transformers.

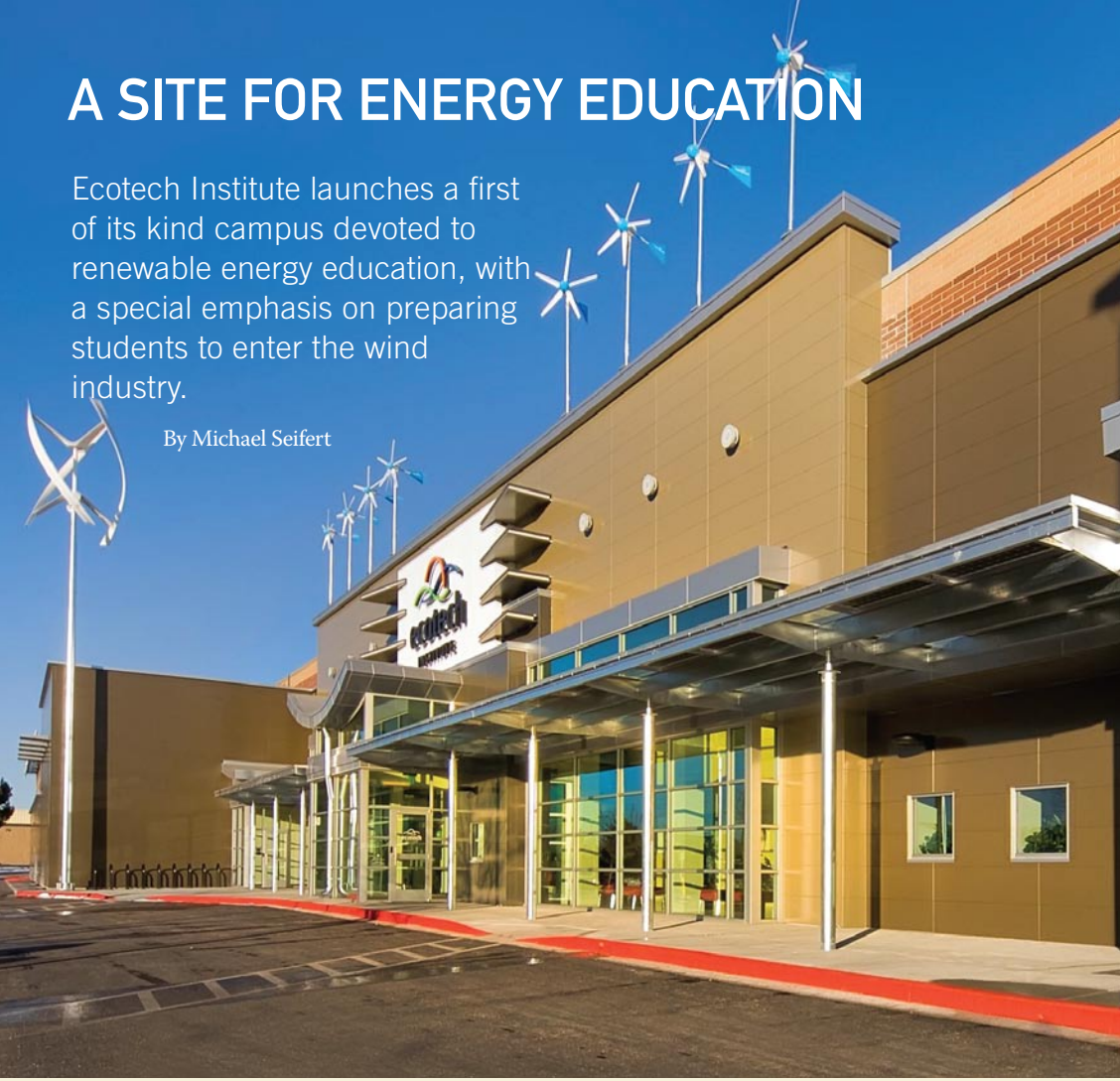
First, advise the supplier whether you need a compartmental pad-mount transformer with integral tamper-proof compartment or substation design. Also consider whether the grounding transformer will be located outdoors or indoors, since even outdoor units need special attention when placed near other structures. Select the proper fluid type for the particular application—options include mineral oil, silicone, and Envirotemp® FR3™ fluid, a natural ester-based fluid with exceptional fire-resistant properties and favorable environmental attributes. Consider connectivity choices, and select the best one for the site. Options vary from dead front, live front, and spade terminals. Terminal location can be under a cover or on a sidewall, exposed or enclosed. In addition, temperature rise is assumed to be 65°C, so adjust design if necessary.

Consider site elevation or any special environmental concerns, and use special paint as required. Last, consider neutral ground resistors. The rated voltage of the NGR should be equal to the grounding transformer's line to ground voltage. The current rating and duration should match the grounding transformer ratings. Remember to set the current rating high enough to be above the cable charging current and grounding transformer magnetizing current.

A SITE FOR ENERGY EDUCATION

Ecotech Institute launches a first of its kind campus devoted to renewable energy education, with a special emphasis on preparing students to enter the wind industry.

By Michael Seifert



Michael Seifert is president of the Ecotech Institute. To learn more visit www.ecotechinstitute.com.

A BRAND NEW 62,000 SQUARE-FOOT CAMPUS has opened its doors in the Denver metro area, changing the face of wind, solar, and renewable energy education in America. Ecotech Institute is the first and only college entirely focused on preparing America's workforce for careers in renewable energy and sustainable design, and the facility is sure to spark interest in these fields.

The architectural team was led by Ecotech's parent company, Education Corporation of America, and Alabama-based Rob Walker Architects. They successfully transformed a vacant, large-footprint building into a progressive campus. The building is home to 30 classrooms, 12 state of the art computer and science labs (e.g. electrical, wiring, solar, wind safety, controls and environmental science), studios, student and faculty lounges, a library, and a variety of other amenities.

SITE SELECTION

Education Corporation of America is often focused on selecting campus sites where they can make a positive impact on a neighborhood. Empty buildings are often an eyesore and can impact neighboring businesses. In this case, an old Amazing Jake's family fun center was the previous tenant. Once transformed, new traffic, additional consumers and a pleasing appearance will continue to yield positive results.

"We were focused on changing the empty commercial building into a community asset that is sustainable, functional, and attractive to its neighbors,"

Fig. 1: The exterior of Ecotech Institute in Aurora, Colorado, featuring wind turbines on the roof.

says Celeste Prestenbach, vice president, facilities planning and new campus development at the Education Corporation of America.

FOCUS ON WIND ENERGY

Although there are energy and resource savings throughout the sustainable design of the building, a major component of the building and the school's curriculum is wind energy. To support Ecotech's commitment to wind, the front of the building is adorned with eight small wind turbines mounted on the roof to generate up to 4.8 kilowatts of electricity. In addition, a vertical axis wind turbine was installed to generate a total capacity of 4 kilowatts.

One unique component is a wind safety lab. The square room is simple, yet revolutionary. The 771 square-foot lab has a 20-foot ladder leading up to an 8x8 platform. This is where Ecotech instructors will teach wind safety techniques and practices. The students will be using the actual harnesses that would be used to go up and down a real wind turbine, helping simulate this significant element of a career as a wind technician. "This wind lab is the first of its kind, offering students a glimpse into a career where physical activity and safety are critical," says Glenn Wilson, academic dean of students at Ecotech Institute.

To carry the wind theme from the outside to the inside, ECA's in-house interior design team integrated the shape and form of the wind turbine blades into the front gallery of the building through the repetition of a similar curve along the walls. This is more evident from a plan view of the interior. In addition to wind elements the building incorporates a variety of solar aspects, as well, including: 12 polycrystalline rooftop photovoltaic solar panels with a system capacity of 2.8 kilowatts; integral thin solar technologies embedded into the glass of the front building canopy with a capacity of 9.4 kilowatts; and two solar trees, each providing 16.9 kilowatts of electricity, which will generate over 50,000 kilowatt hours per year of electricity. All told, the campus will get more than 5 percent of its peak load electricity from wind and solar sources and will generate over 65,000 kilowatt hours of electricity annually.

ADDITIONAL ENERGY SAVINGS

Another key component of the campus is its rigorous energy savings and demand side management processes that will cut demand significantly. Some examples include demand control ventilation to modulate ventilation based upon occupancy levels in classrooms. This will dramatically reduce the cooling/heating during partially occupied periods. All rooftop air conditioning equipment will have economizers to provide 100 percent outside air during ideal outdoor conditions for cooling, and energy efficient lighting will reduce lighting energy consumption by 30 percent below standard lighting energy levels. In addition, a measurement and verification system provides real time monitoring of the campus power, natural gas, and water consumption. This information will be displayed in the lobby for visitor knowledge, but will also be recorded and used to determine further energy saving possibilities in the future.

The building also incorporates water and lighting efficiencies. For instance, motion sensors combined with a programmed lighting schedule limit the amount of time lighting stays on when rooms are unoccupied. The campus also includes four electric car charging stations, capable of delivering a full vehicle charge in two to four hours. The campus embraces the institute's core concerns: exceptional education and commitment to the environment.

Ecotech Institute launched its first round of classes

Fig. 2: The lobby of Ecotech Institute.

Fig. 3: A hallway within Ecotech Institute.

in July 2010 in a temporary facility and the third quarter commenced January 10, 2011 in the new facility with almost 200 students enrolled.

WHY COLORADO?

Ecotech Institute chose to launch its first location in Colorado for many reasons, including its location, entrepreneurial culture, and passion for green job growth. Colorado's culture, natural beauty, and green-leaning attitude fosters greener lifestyles, education, and careers. The campus is strategically located to serve workforce development throughout the Rocky Mountain region, one of the country's fastest growing areas for renewable energy.

In 2009, the Colorado Governor's Energy office, with funding from the U.S. Department of Energy and Clean Energy Funds directed by the state legislature, spent over $25.2 million in fiscal year 2009, with 9 percent, or $2,268,000, directed to renewable energy and sustainability projects.

In 2010, the State Legislature voted to increase the Renewable Energy Standard to a "Best in the West" 30 percent by 2020. The new law will create thousands of clean-energy jobs, further diversify Colorado's overall energy portfolio and lead to 100,000 solar rooftops over the next decade.

Colorado is also home to public and private institutions that are creating innovation and employment. The National Renewable Energy Laboratory (NREL), the University of Colorado at Boulder, Colorado School of Mines, and Colorado State University created the collaboratory in 2007 to research and develop new, cleaner energy technologies.

In wind alone, Colorado makes the grade in national rankings. In 2009 Colorado ranked ninth in wind projects installations by state, adding 178 MW of wind power, ranked eighth in installed wind capacity and eleventh in wind resources. Not only is Colorado a fantastic place to live and work, its culture lends itself to Ecotech's mission: when you live in a state than appreciates natural beauty, it helps people to understand the importance of sustainability.

WHAT'S WIND'S FUTURE?

According to "Clean Tech Job Trends 2010," three clean tech categories in particular held their ground as the dominant innovative leaders throughout 2009, based upon number of patents granted: solar (at approximately 31 percent), wind (at approximately 19 percent) and hybrid vehicles (at approximately 15 percent).

In the report "Green Collar Jobs in the U.S. and Colorado" (2009) by Roger Bezdek, principal investigator, Management Information Services, Inc., for the American Solar Energy Society, U.S. renewable energy and energy efficiency (RE&EE) industries are creating jobs faster than other leading industries.

It stated that "In 2007, the U.S. RE&EE industries generated more than $1 trillion in sales and created more than 9 million jobs—including $10.3 billion in sales and more than 91,000 jobs in Colorado. U.S. RE&EE revenues represent substantially more than the combined 2007 sales of the three largest U.S. corporations—Wal-Mart, ExxonMobil, and General Motors ($905 billion). RE&EE industries are growing faster than the average U.S. industry and com-

Fig. 4: Another view of the sunlit lobby.

Fig. 5: The spacious library area.

prise some of the most rapidly growing industries in the world, including wind, photovoltaics (PV), fuel cells, recycling/remanufacturing, and biofuels."

In 2009, the Executive Office of the President, Council of Economic Advisors, published a report "Preparing the Workers of Today for the Jobs of Tomorrow." Here are a few of its findings:

- Jobs devoted to environmental improvement grew far faster than other occupations from 2000-2006 and the BLS projects fast relative growth through 2016;
- There are growing opportunities in these fields, particularly for workers with technical skills;
- CEA analysis suggests that particular areas of "green" potential (e.g., wind and turbine manufacturing, mass transit, or producing energy-efficient automobiles) pay more on average than otherwise comparable jobs. They also are more likely to be held by primary earners in the household and to be unionized;
- Well-trained and highly-skilled workers will be best positioned to secure high-wage jobs, thereby fueling American prosperity. Occupations requiring higher educational attainment are projected to grow much faster than those with lower education requirements, with the fastest growth among occupations that require an associate's degree or a post-secondary vocational award.

Ecotech Institute, which is accredited by the Accrediting Council for Independent Colleges and Schools, offers seven highly practical degree programs and one certificate program that provide graduates with skills that are valued by today's renewable energy employers. The programs include:

- Electrical Engineering Technology, Associate of Applied Science
- Energy and Environmental Paralegal, Associate of Applied Science
- Energy Efficiency, Associate of Applied Science
- Environmental Technology, Associate of Applied Science
- Renewable Energy Technology, Associate of Applied Science
- Solar Energy Technology, Associate of Applied Science
- Sustainable Interior Design, Certificate Program
- Wind Energy Technology, Associate of Applied Science

Lastly, the research "U.S. Metro Economies: Current and Potential Green Jobs in the U.S. Economy" (2008), prepared by Global Insight for The United States Conference of Mayors and the Mayors Climate Protection Center, published some interesting insights about the wind industry.

The report states that "The bulk of jobs related to wind infrastructure will come in the manufacturing of equipment. The technology of wind electricity is relatively new, but the manufacturing base for its production is very similar to past products. Every state in the country has firms and a labor force with experience making products similar to the blades, gearboxes, brakes, hubs, cooling fans, couplings, drives, cases, bearings, generators, towers, and sensors that make up a wind tower."

"These jobs fall into the familiar durable manufacturing sectors of plastics and rubber, primary metals, fabricated metal products, machinery, computer and electronic products, and electrical equipment. Cities across the country have the capacity to attract job growth in these important manufacturing sectors along the nation's path to a new energy infrastructure."

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development director/ACCIONA Wind Energy Canada

CONGRATULATIONS ON BEING NAMED CHAIR OF THE CANADIAN WIND ENERGY ASSOCIATION'S BOARD OF DIRECTORS. COULD YOU TELL US A LITTLE ABOUT YOUR BACKGROUND?

Thank you, it's quite an honor to be in a position to help support the development of wind energy throughout Canada. This type of professional service is a real passion for me, as it is for all of my colleagues on the board. We all have primary responsibilities to our employers, but we check our "company badges" at the door when we come together knowing that anything we do to strengthen the industry will also benefit our employers. ACCIONA recognizes the importance of involvement in CanWEA. As for my own background, I credit my father with having the foresight to suggest entering the wind industry when I was in university in the nineties. I studied applied math and computer science as an undergraduate student and then focused on environmental fluid dynamics in graduate school, studying how wind flows over complex terrain. I worked for GPCo and later ORTECH Power, performing wind resource assessments and conducting technical due diligence before joining GDF Suez to lead business development in western Canada. It was around that time when I realized I wanted to play a more formative role in the wind industry, especially at this stage in its development, so I launched my own renewable energy consulting firm while working toward my executive MBA. I had been involved with CanWEA for quite a few years by then, participating in various provincial caucuses and steering committees since 2005, then elected to the CanWEA board in 2008, named vice chair the following year, and then board chair at the end of 2010, which was the same year that I joined ACCIONA. My term runs for three years, although it is traditional for chairs to remain on the executive board for an additional year to aid with the transition to new board leadership, or to run for an additional term. So the past few years have been busy ones for me, and very meaningful as well.

WHAT WILL YOU AND YOUR COLLEAGUES BE FOCUSING ON IN THE COMING YEARS?

The role of any board member is to act on behalf of all CanWEA members in providing good governance, supporting the growth of the wind industry, and leveraging their industry experience to help guide strategic planning. We provide advice and feedback to the association's senior executives, and we also participate in the steering committees for the federal and provincial caucuses that meet to discuss their wind-related concerns. We support CanWEA staff in reaching out to policy makers and politicians, and also to other industry organizations so that we can speak with a united voice. One of our top priorities involves helping build public support for wind energy in Canada. We've recently mounted a campaign in which we've placed wind-related advertisements in about 68 local newspapers in Ontario focusing on individuals who are benefiting from their association with wind energy, such as a landowner who is generating additional income by hosting a wind farm. We want to share the stories of individuals in the community whose lives are positively affected by wind farm development. We targeted Ontario because there's significant growth there at the moment, and with that comes a certain degree of concern from people who don't really understand wind energy and are somewhat adverse to change. We want to correct any misinformation that is being propagated, and also to help people understand the many benefits to the surrounding community. Wind energy is the fastest-growing source of new electricity generation in the world, so our federal and provincial governments need to be realistic about the global competition to attract investments such as wind farms and manufacturing facilities. The only way to achieve that is to embrace the future and provide stable policies that will attract those types of investments. CanWEA has taken steps to provide a guide for the future of the wind industry with a collaboratively developed position paper, "Wind Vision 2025," which states our goal of producing 20 percent of Canada's energy from wind by 2025. The full paper is available for download on the CanWEA web site. Through our marketing campaigns, discussions with key political figures, public and professional outreach, the development of position papers, and shows like the annual CanWEA Exhibition and Conference, we're doing everything we can to help accelerate the growth of this important renewable resource both here in Canada and around the world.

Go online to www.canwea.ca or www.acciona-na.com.

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for hard part turning

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with high pressure coolant

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the deepest and
widest grooves

CoroMill® Plura mini
Small ball-nose end mills

Contact your Sandvik Coromant representative for
more information about these and other new solutions.

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