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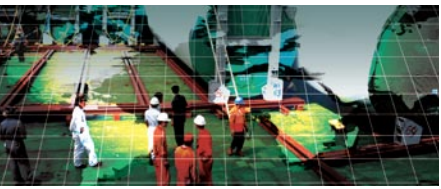

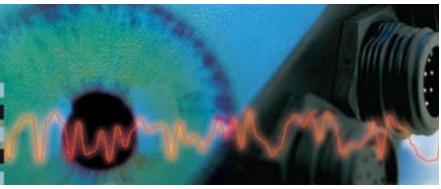

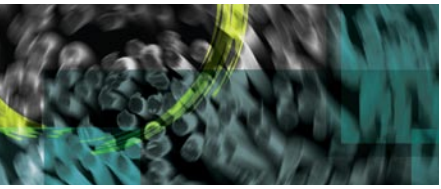

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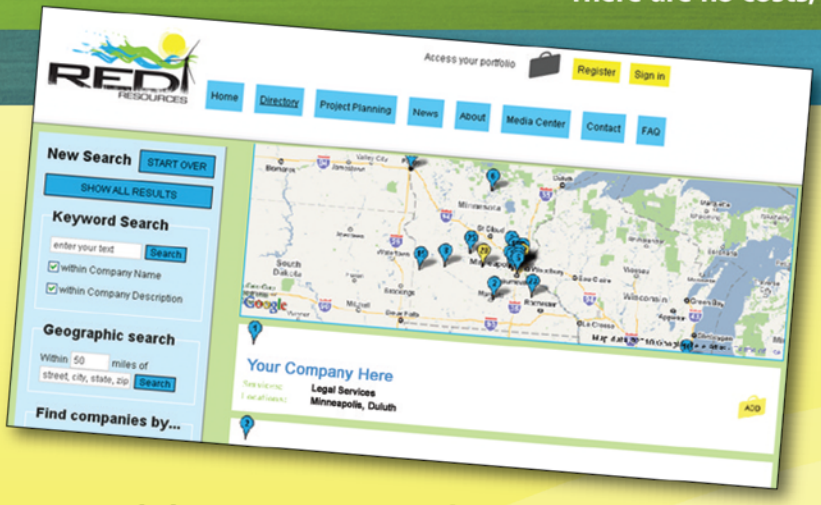

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VOLUME 2 NO. 10

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Cover photo: Korindo Wind

EDLETTER

Having just returned from WINDPOWER 2010 in Dallas, we'd like to thank the American Wind Energy Association for the obvious hard work that went into hosting yet another stellar event. Perhaps you were as impressed as we were by AWEA's professionalism, by the incredible lineup of speakers they assembled, and by how seamlessly everything seemed to fit together. This truly is the United States' premier wind-industry event, providing an opportunity for professionals from all sectors of this market—and from around the world—to come together and begin developing lasting relationships. It was an honor for us to be a platinum media sponsor of the event, and we're already looking forward to next year!

As for this issue of the magazine, Antti Turunen of Moventas Wind Oy has contributed "Remote Condition Management," discussing how the company's CMaS system gathers critical data while turbines are in operation. Representing Korindo Wind, P. Scott Burton writes about the importance of partnering with an experienced tower manufacturer in "A Tower for Power," and Chris Reynolds of the AVX Corporation outlines advances being made in electrolytic capacitor technology in "Film Technology for Wind Applications." Hank Richert of DHi has penned "Brushing Up on Turbine Performance," and Wm. Christopher Penwell describes "The Hidden Costs of Ownership" in his informative article. Scott Rowles of MV Underground Cable suggests ways of developing excellent vendor relationships in "Constructing Cable Confidence."

Our expert columnists have addressed a wide range of wind-related topics in this issue, beginning with Jerry Parola of Hayward Baker, who describes construction challenges to which driven piles provide the solution. Discussing maintenance, Merritt Brown of Rev1 Power Services points to the importance of adequate O&M staffing once your warranty has expired, and Hüseyin Kizilagac of BDP Project Logistics makes clear how companies with both global and local contacts make the best logistics service providers. Jose R. Zayas and Joshua Paquette of Sandia National Laboratories share their thoughts on how lab and field testing enables engineers to continually improve their designs. Our company profile is Safety Supply South, which has developed customized wind energy kits that equip O&M technicians and others with all the gear they need to go to work as soon as they arrive at the job site, and John LaRue of Port Corpus Christi provides us with a glimpse into the inner workings of a facility that is ideally sited and equipped to meet the needs of the wind industry. I would like to thank everyone listed here for taking the time to share their insights with you.

Speaking of which, I am always available to discuss story ideas should you choose to share your own expertise. Please feel free to contact me at the phone number or e-mail address listed below, and I look forward to hearing from you!

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CARL ZEISS OPENS WEST COAST TECH CENTER

Carl Zeiss Industrial Metrology celebrated the official grand opening of the West Coast Tech Center (WCTC) in Irvine, California, in April. Set up as a production inspection facility with metrology systems running in a process support role, the two-day metrology event offered visitors a unique experience. Part measurement on its systems was displayed in a real-time production environment, and other demonstrations were presented as well.

"The goal in opening this 3,800 square-foot facility is to get closer to our customers in this region while providing local support in growing markets," says Drew Shemenski, manager. "Not only does this facility allow us to offer traditional hardware support, but it can also help us focus on a higher level connecting machines together through software to manage inspection requirements and data."

There is a wide range of metrology technology on hand at the Irvine center: optical, touch scanning, CT x-ray, and measuring software. The METROTOM 800 is an x-ray based computed tomography system specifically designed for 3D metrology of small, complex, low-density parts made of plastic, composite materials, or ceramic. The O-INSPECT is a multi-sensor system that features both tactile and optical scanning and provides tremendous flexibility for measuring parts that approach the micro range of size. Zeiss has a variety of surface form and geometry systems to round out its measuring and demonstration capabilities. In addition to this technology the company also offers in-house measuring services, software training, and application support. To learn more call (800) 327-9735 or e-mail at imt@zeiss.com. Go online to www.zeiss.com/imt.

POLARIS TO OFFER FINANCING PROGRAM FOR WIND TURBINE

In an effort to help its dealers and potential customers, Polaris will begin offering financing for all wind turbine projects. The financing program will cover the total installed cost of the unit, minus any federal or state grant money. While many customers pay cash for the Polaris turbine systems, consider those who can't or don't. Presenting them with choices could open doors

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.

for them, and increase sales. For example, maybe they need a wind turbine but can't spend the cash up front. When you offer financing options, your client's purchasing power is increased and his money works harder and smarter.

"Preservation of capital is important to our customers in today's economic environment," according to Gerard J. Sposato, vice president of sales and marketing. "Financing allows them to upgrade their equipment infrastructure without depleting their capital. Polaris is happy to be able to provide our customers with access to financing our wind generation systems at one central location."

If customers have their own sources for financing, the company will offer them an option and give them the opportunity to make a change. Customers are looking for a total business solution, and part of what Polaris sells is customer service. Payment options should be included in that service. The company believes customers will appreciate the one-stop shopping aspect of doing business with Polaris.

Seizing the need for a community sized wind turbine, Polaris America has turned its engineering and manufacturing capabilities loose on a whole class of innovative wind turbine designs that feature exclusive technologies and superior engineering. In introducing this new line of community wind turbines from 10kW to 1MW, the company will be addressing the needs of homeowners, businesses, schools and universities, governmental institutions, and other applications that its feels have been overlooked by current large wind turbine suppliers. Polaris corporate, sales and engineering offices are located in Columbus, Ohio. Financing applications can be handled online at www.polarisamerica.com.

WINDSPIRE ENERGY AND MASTECH WIND ANNOUNCE SUPPLY AGREEMENT

Formerly known as Mariah Power, Windspire Energy—developer of the Windspire® wind turbine—and MasTech Wind have announced the execution of a new long-term supply agreement. The new contract will extend production of the Windspire by MasTech Wind through 2014.

MasTech Wind began manufacturing the Windspire at their Manistee, Michigan, factory in April 2009 after retrofitting a plant formerly dedicated to the automotive industry. The Windspire is the only small wind turbine to be volume manufactured entirely in the United States. "With this new contract in place we remain committed to using American workers to make the Windspire a true 'Made in the U.S.A.' product," says Windspire Energy's president and CEO, Walt Borland. "We are confident that with

MasTech Wind we have the right partner to make the best possible product for our customers around the world."

"The Windspire has breathed new life into the Manistee factory," according to Dave Boothe, one of the owners of MasTech Wind. "We are excited to be able to continue this strategic relationship and be in a position to demonstrate to the rest of the world what Michigan ingenuity is still capable of accomplishing."

The Windspire wind turbine is a 30-foot tall, propeller-free, vertical-axis wind turbine designed to harness wind power in urban, suburban and rural locations. It is eligible for a 30-percent federal tax credit off the total cost of the installation and many local rebates. Homeowners, businesses, schools, and museums across the country and increasingly around the world have installed their own Windspire wind turbines to save on energy costs and reduce their impact on the environment. Adobe Systems recently announced completion of the installation of 20 Windspires at its corporate headquarters in San Jose, California. MasTech specializes in the design and manufacture of material handling equipment for systems involving automotive and other general assembly processes. To learn more contact Amy Berry, director of marketing at Windspire Energy, formerly Mariah Power, at (775) 857-4888 x231 or aberry@windspireenergy.com. Go online to www.windspireenergy.com. Also go to www.mastech-inc.com.

BROADWIND ANNOUNCES NEW PRESIDENT AT BRAD FOOTE GEAR WORKS

Broadwind Energy, Inc., has appointed Daniel E. Schueller as president of Brad Foote Gear Works, Inc., the company's gearing systems business, effective April 12, 2010. He will report to Broadwind Energy CEO Cam Drecoll. "We are delighted to have Dan join our leadership team and expect that he will lead the gearing systems team with a robust combination of deep manufacturing experience, leadership skills and customer focus," according to J. Cameron Drecoll, CEO. "As the anticipated upswing of the U.S. wind energy market creates new opportunities for Broadwind's precision gearing system business, Dan's proven success as an executive leader in manufacturing will be an asset to our customers and stockholders."

Prior to joining Broadwind Energy, Schueller served as vice president and general manager of Vactor Manufacturing, Inc., a subsidiary of Federal Signal Corporation and a leading manufacturer of municipal combination catch basin/sewer cleaning vacuum

trucks. He previously served in positions of increasing responsibility in operations with Tecumseh Products Company, a leading global manufacturer of compressors and related products. He holds a bachelor's degree in mechanical engineering technology from the Milwaukee School of Engineering and an MBA from St. Ambrose University. "I look forward to working with the Broadwind team as we capitalize on a rich heritage of more than 85 years of gearing leadership at Brad Foote," Schueller says.

Broadwind Energy provides technologically advanced high-value products and services to the U.S. wind energy industry. Its product and service portfolio provides customers—including wind turbine manufacturers, wind farm developers, and wind farm operators—with access to a broad array of wind component and service offerings. They include wind turbine gearing systems, wind turbine structural towers, industrial products, technical services, precision repair and engineering services, and logistics. For more information go to www.broadwindenergy.com.

SME APPOINTS NEW DIRECTOR OF MEMBERSHIP

The Society of Manufacturing Engineers (SME) has named Joe LaRussa, P.E., as its director of membership. He will be responsible for increasing awareness of the value the society has to offer manufacturing professionals. Debbie Holton, who was previously responsible for SME's membership activities, will be assuming a leadership role as director of industry strategy and product development, focusing on both existing and new event strategies which engage SME members and outside organizations.

"Joe will be a tremendous asset to the SME management team," says Mark C. Tomlinson, executive director and general manager of SME. "His work as a volunteer and his understanding of manufacturing at a practical level will assist in the nurturing and development of existing and future members."

Before joining SME LaRussa was project manager, customer quality office for Chrysler Group LLC. Prior to that, he held various positions in product development, project management, and manufacturing engineering at Visteon Corp., culminating with his position as a mobile electronics project manager. During his tenure at Visteon he was responsible for generating profitable revenue and achieving production cost savings for the organization. He holds a bachelor's degree in electrical engineering a master's degrees in automotive systems engineering and engineering management. He has been an SME

member since 1994, previously serving as an SME membership consultant, and he was appointed to the SME member council in 2009. In 2008, he received the SAE Foundation's Young Manufacturing Leadership Award.

Founded in 1932, the Society of Manufacturing Engineers is the premier source for manufacturing knowledge, education, and networking. Through its many programs, events, and activities SME connects manufacturing practitioners to each other, to the latest technology and the most up-to-date processes spanning all manufacturing industries and disciplines, plus the key areas of aerospace and defense, medical device, and motor vehicles, including motorsports, oil and gas, and alternative energy. More information is available at www.sme.org.

AERO BOLT TENSIONING TOOLS FROM TENTEC

Tentec, a leading UK designer and manufacturer of bolt tightening equipment for wind turbines, recently exhibited its Aero range of bolt tensioning tools for wind turbines at AWEA's WINDPOWER 2010. The complete series was on display, with Tentec being the only company in the world to offer a full load, positive stop safety feature on the entire range of wind equipment. The new elliptical tool, designed for foundation tooling where there are space restrictions and accessibility problems, is the latest tool to be launched with this feature.

Overstroke protection is one of the most important factors to consider when assessing bolt tensioning tools. Without this feature engineers are prone to keep stretching, and this can result in the failure of seals and other parts. More importantly, any failure could create a critical safety hazard. Once this occurs the operation has to be stopped as, at a minimum, the seals have to be replaced, along with other work that needs to be carried out to rectify any further damage. This results in costly downtime that could be crucial for completing profitable job on time and within budget. Tentec's in-house engineers have designed this unique full load, positive mechanical stop system so that just fractions of an inch over the required extension and engineers will hit a mechanical stop and stretching will cease.

As well as the range bolt tensioning tools for wind turbines, Tentec offers a choice of electric driven high pressure pump units that can generate pressures of up to 2000 bar. For more information call + 44 (0) 121 524 1990, e-mail sales@tentec.net, or go to www.tentec.net.

SPX ACQUIRES TORQUE TENSION SYSTEMS

SPX Corporation announces that its SPX Hydraulic Technologies business unit, part of the company's Industrial Products and Services segment, acquired UK-based Torque Tension Systems Ltd. (TTS), a leading global supplier of hydraulic torque wrench and tensioner tool products. The terms of the transaction were not disclosed. The addition of TTS's line of high-performance industrial bolting tools will expand SPX Hydraulic Technologies' product portfolio offering to the global energy infrastructure markets, particularly the oil and gas and wind sectors.

"SPX is continually seeking opportunities to enhance its product offerings to better serve its customers and provide them with best-in-class industrial solutions," says Lee Powell, SPX segment president. "Torque Tension Systems' line of high quality, high performance tools utilized across multiple industries represents a powerful addition to our growing portfolio of industrial tools."

Based in Northumberland, UK, the company's hydraulic bolting product lines include Dura-Lite hydraulic torque wrenches, LDF torque wrenches, subsea bolt tensioners, hydraulic nut splitters, flange pullers, and flange spreaders. All of TTS's products are engineered using computer-aided technology to deliver first-rate performance and durability in even the most demanding operating environments. In addition to serving the power and energy market, TTS's tools are utilized in the petrochemical, automotive, chemical, railways, and shipbuilding industries. The company has additional offices in Australia and Malaysia.

"TTS has built a strong reputation as an innovator by developing products and software packages for the energy infrastructure market," says Thom Farrell, president of SPX Hydraulic Technologies. "By combining our premium Predator series hydraulic pump product line with TTS's leading bolting tool offering, customers utilizing hydraulic bolting systems will be able to get the best of both aspects of a bolting system. The combination results in an extremely fast and durable system."

SPX's Hydraulic Technologies is a global manufacturer of high-force hydraulic pumps, cylinders, jacks, pullers, and tools, serving customers around the world. More information is available at www.spx.com.

NEW GLEASON OPTI-GRIND PROCESS FOR LARGE GEARS

Gleason's latest generation of profile grinding machines can now be equipped to perform a revolutionary new process called OPTI-GRIND, which significantly improves productivity and quality levels for fine finishing cylindrical gears as large as 6 meters in diameter, and up to module 16. The new process enables end users to achieve optimum productivity and surface finishes by simultaneously

using multiple dressable grinding wheels for profile grinding rather than just the single grinding wheel that is typically used. The process offers end users a number of variations to choose from to meet their specific applications. For example, when optimum productivity is required, OPTI-GRIND is up to 40-percent faster because it uses three grinding wheels to rough grind four tooth flanks simultaneously, as compared to the typical process of a single wheel roughing only two tooth flanks at once. OPT-GRIND is then used to finish grind conventionally with a single wheel that has been dressed to produce the desired surface finishes and flank modifications.

OPTI-GRIND's multiple-wheel configuration offers significant advantages for gear producers serving the wind power and other industries requiring optimum surface finishes. Where a single dressable wheel must be designed for compromise in order to perform both roughing and finishing, the multiple wheel configuration of OPTI-GRIND makes it possible to utilize wheels designed for maximum roughing productivity. Then a finishing wheel is designed to produce the desired tooth modifications including grinding of the root without burning, and to deliver surface finishes up to four times finer than what would be possible conventionally.

In addition to the new multiple wheel design, the OPTI-GRIND process relies on the use of the latest Siemens 840D CNC and Gleason Windows-based Intelligent Dialogue software to greatly simplify setup and operation. For example, a grinding technology database recommends and optimizes the production methodology

for any of the process variations before machining starts, enabling even less experienced operators to produce high quality parts more productively. The OPTI-GRIND process is one of many unique technologies offered in Gleason profile grinding machines for workpiece diameters up to 6 meters. Learn more at www.gleason.com.

3TIER POWERS SMALL WIND DECISIONS

Southwest Windpower and Better Generation will use 3TIER's renewable energy information services platform to better educate customers on their on-site small wind energy potential. The platform enables both companies to integrate the most accurate, scientifically derived global wind resource data from 3TIER directly into tools that will help residential and small business customers more easily evaluate a potential investment in small wind.

"Easy access to accurate and unbiased wind resource information is going to help propel continued growth in the small wind industry," says Kenneth Westrick, founder and CEO of 3TIER. "A small wind turbine is a significant investment, so it's critically important to empower homeowners and small businesses with the information they need to make decisions with confidence. Only 3TIER can offer that anywhere in the world."

Southwest Windpower, the world's largest producer of small wind turbines, turned to 3TIER to help its dealer network better educate customers on their on-site wind energy potential. Dealers will have access to various online tools that tap into 3TIER's global wind resource dataset to instantly forecast location-specific energy production of Southwest Windpower's top-selling Skystream 3.7 small wind turbine. The integrated offering is made possible by 3TIER's renewable energy information services platform, using both a Web interface and an application programming interface (API) to access its global wind dataset at different hub heights recommended for the Skystream turbine.

"Southwest Windpower is committed to utilizing the best technology available to help our prospective customers develop the most robust assessments of their wind energy opportunities worldwide," says R. Dixon Thayer, CEO of Southwest Windpower. "Integrating 3TIER wind resource data into our assessment process ensures customers get the most accurate and reliable picture of the potential power they will receive from our turbines."

UK-based Better Generation, a pioneer in inexpensive wind and solar measurement and energy prediction devices for the distributed market, will directly integrate 3TIER resource data into its Power Predictor product. Power Predictor is a device that enables residential and small business customers to collect on-site wind and solar data, and along with software, helps them select the best technology and products based on observed readings. To learn more go to www.3tier.com.

AWS TRUEWIND ANNOUNCES NEW DIRECTION AND NAME

AWS Truewind LLC—an international leader in renewable energy consulting and information services—announces the official relaunch of the company as AWS Truepower, reflecting an expanded strategic focus on delivering a broader set of renewable energy development and operational solutions to its global customer base. In conjunction with the renaming of the company, AWS Truepower announced a suite of services aimed at helping solar project developers assess, streamline, and maximize the deployment and operations of solar energy systems.

"For nearly 25 years AWS Truewind has been a market leader in science and technology-based solutions that support the complete project lifecycle for renewable energy developers and industry stakeholders," says Bruce Bailey, President and CEO. "This focus, including consulting on some of the Unites States' earliest large-scale photovoltaic projects, has resulted in AWS Truewind becoming a well-known brand across markets and a 40 percent annual average growth rate. Our historical market emphasis on the wind energy industry was reflective of the maturity of wind technology from a utility-scale generation perspective. However, recently we have seen a rising demand from existing and potential customers for an expanded solar solutions set from AWS Truepower. We feel that the new brand, combined with key additions to our team in solar consulting, better reflects the strategic direction of AWS Truepower as we expand our renewable energy customer and solutions portfolio."

AWS Truepower builds on more than two decades of providing renewable resource and energy assessment, engineering, and operational services to wind and solar project developers. Within its wide-ranging solution set to support the complete project lifecycle, AWS Truepower provides comprehensive assessments to help its customers meet the rigorous requirements of solar photovoltaic (PV) project financiers in a timely manner to prevent developers from missing out on beneficial market conditions such as advantageous pricing or

policy environments. Furthermore, AWS Truepower delivers ongoing forecasting and operations services that help maximize system performance and better plan energy delivery. For more information visit www.awstruepower.com.

MNI40 MAGNETIC ENCODERS FROM PEPPERL+FUCHS

Pepperl+Fuchs introduces MNI40 incremental rotary encoders, a robust magnetic, non-contact encoder with intelligent diagnostics suitable for a wide range of applications. The MNI40 delivers resolution up to 3,600 pulses per revolution at speeds up to 30,000 rev/min and operating temperatures from -40°C...+100 °C. Robust, compact, and simple installation of the MNI40 make it an ideal choice for a wide range of applications including machine construction, wind power, mobile equipment, material handling lifts, and conveying technology. Primary features include clear indication via LED display (two-color), easy installation and setup, quality assurance through complete self-diagnosis, and long service life.

"The LED indications are particularly useful during installation and setup because they provide information on proper assembly," says David Rubinski, product manager. "The integration of the LED also reduces installation time and test equipment requirements, and offers greater potential for reducing overall costs of machine and/or system construction."

The MNI40 utilizes a zero-contact (magnetic) connection between the encoder sensor and magnetic wheel, enabling the MNI40N encoder to measure speed without ball bearings. This eliminates bearing wear due to mechanical forces and ensures long operating life. The sensor includes sensing electronics housed in a compact IP67 rated enclosure and an elastomer coated magnetic wheel, so contact with water and oil will not damage the encoder system. Call (330) 486-0001, e-mail fa-info@us.pepperl-fuchs.com, or visit www.pepperl-fuchs.us.

ENHANCED RAIL CAPABILITIES AT PORT CORPUS CHRISTI

Class-I rail services from the three major rail companies can now be offered at the port to move wind turbine components. Last year BNSF Railway and Union Pacific Rail Road (UP) began offering rail services to major manufacturers of wind energy components through Port Corpus Christi. Kansas City Southern Railway Company (KCSR) recently moved their first wind tower train from Port Corpus Christi. With this move all three Class-I carriers are now competing for wind component business in the region.

KCSR worked with Port Corpus Christi to coordinate the move, and Kansas City Southern de México S.A. de

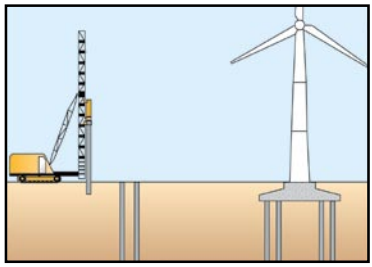
Continued on page 60 >

Jerry Parola
Hayward Baker, Inc.

When the upper soil structure is too weak to support a wind tower foundation, driven piles offer a deep foundation solution.

DRIVEN PILES CAN BE A COST-EFFECTIVE foundation system for some wind tower sites underlain by loose or soft soils, or mine spoils, which can provide insufficient bearing capacity and excessive settlement. The piles are driven around the perimeter of the tower foundation to resist the overturning moment by means of compression and tension loads. Driven piles may be slightly battered outward to resist lateral loads. Since driven piles do not require predrilling, they can be driven into a contaminated soil profile without producing spoil that can require costly removal.

Driven pile types include steel H-piles, pipe piles with concrete fill, precast concrete piles, mandrel driven shell piles, and combinations of the aforementioned. The type is chosen depending upon design capacity, drivability, and material costs. Typical pile size ranges from 12 to 30-inch equivalent diameter and typical design capacity ranges from 50 to 300 tons. The piles are designed for both the required structural capacity and stresses incurred during driving. Steel piles can be provided with epoxy coating when installed in corrosive soil environments.



Piles are typically driven with crane-mounted fixed or swinging leads and an impact pile hammer or vibrator hammer. In general, crawler cranes with capacities from 50 to 150 tons are used. Impact pile hammer types include air, diesel, hydraulic, and drop (gravity), and they provide rated energy from 25,000 to 200,000 ft lbs. The drive head contains a cushion material that is placed between the hammer and pile to prevent damage to the hammer and pile. The drive head also keeps the pile centered under the hammer. Vibratory hammers can also be used to drive piles. Vibrations from any small- to medium-size hammer will generally not harm adjacent structures in good condition. This concern is typically not an issue with wind tower foundations since wind farms tend to be remote or not adjacent to existing structures.

Pile foundation design is based upon an understanding of the hammer-pile-soil interaction during installation and the superstructure pile-soil interaction after construction. Piles must be installed to provide the required foundation behavior with consideration of the feasibility of pile installation controlled by an understanding of the hammer-pile-soil system. Consideration of pile installation in general can be characterized by the pile hammer as a driving energy source, the pile as a transmitting element, and the soil conditions as a resistant force to pile penetration. The pile driving behavior can be simulated by using wave propagation theory as an analytical tool. The analysis can predict the required driving resistance for a specified design pile capacity and a selected hammer-pile-soil system.

Quality control for driven piles includes logging the number of hammer blows per foot of depth. By monitoring the resistance to driving, the pile hammer acts as a measuring tool as well as an installation tool. Full-scale compression pile load testing and/or tension testing is typically performed on one or more production piles to verify the pile driving criteria. If a vibratory hammer is used to drive the pile, verification of the final seating criteria can be accomplished with an impact hammer. Vibratory hammers can be used for final driving criteria with field verification of penetration rate and horsepower, supported by pile load testing. Additional dynamic testing can be done to verify the performance of the pile driving in lieu of additional pile load testing. Two strain transducers and two piezoresistive accelerometers are attached three feet below the top of the pile to determine transferable energy, maximum pile stresses, and to estimate pile capacity during pile driving. Software can be used to further evaluate static pile capacity including relative load distribution along the pile length and toe at a specified pile depth.

Driven pile foundations have been used to support many types of onshore and offshore structures over the past 100 years, including recent wind tower foundations. Driven piles will continue to be an economical solution for future wind turbine foundations.

Jerry Parola is a vice president with Hayward Baker, Inc., the leading specialty foundation and ground improvement contractor. He can be reached at jparola@haywardbaker.com. Go online to www.haywardbaker.com.

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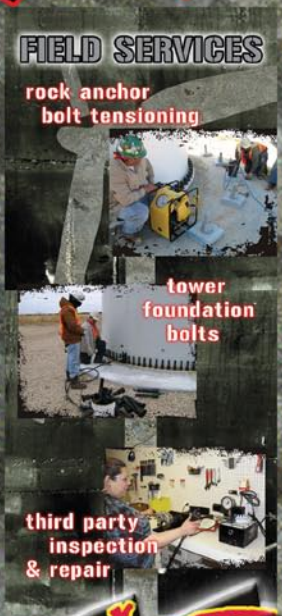

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Merritt Brown
Rev1 Power Services, Inc.

Once your warranty period has drawn to a close, inadequate O&M staffing can lead to unexpected downtime as well as huge repair costs. Here's what you should know.

DESPITE A WIND TURBINE DESIGN life of 20 years, the likelihood of a corresponding OEM warranty is remote, at least from a cost performance perspective. As a project comes off warranty and begins to age owners should expect a steady increase in maintenance duration, cost, and resource needs. Not all project owners are prepared to take on the full work involved in maintaining their wind turbines, however, and in some instances come out of the warranty period with O&M teams that are understaffed and overworked. An OEM providing warranty service is able to easily supplement his operations staff to conduct retrofits and major repairs, yet once the warranty has expired the owner no longer benefits from this exclusive labor arrangement. Owners are instead left to perform O&M based on labor assumptions that had been distorted throughout the warranty period. For a project no longer in warranty, overtime pay can sometimes amount to a higher number than regular wages merely because the project is understaffed. Even when a facility has the technicians it needs to perform routine repairs, unscheduled maintenance puts a noticeable dent in a project's bottom line.

In a conventional power generation facility, the number of technicians required to adequately operate and maintain the project is determined by a time-based distribution of the required operational tasks. For example, it may take three to six technicians to operate a 250MW combined cycle power plant at any given time, wherein each operator has certain tasks to perform. Staffing these projects is fairly straightforward, and plant outages where major maintenance is performed are handled by an "all hands on deck" approach and the utilization of subcontracted maintenance support.

What is the right number of technicians required to safely operate and maintain a wind project? A ration such as 1 crew: 20 turbines is common for the 1MW+ class turbines. This ratio might be lower when longer durations of scheduled maintenance are required on more complex turbines. Such "rules of thumb" are legitimized by many project operators today, but understanding how they are determined will help a project owner to more adequately staff wind projects. The operator might sum the estimated number of hours of daily, routine, and scheduled maintenance and divide by the number of available technician hours in a given month, typically ranging from 145-175 hours depending on the hours required for training, vacation, and personal time off. Inherently flawed, this evaluation process only provides the projected number of technicians necessary to meet the assumed hours of routine maintenance on the project. The approach of using industry rules of thumb or estimating personnel needs in this way does little to accommodate the resource needs of unpredictable downtime; something that can dramatically compromise routine service maintenance and troubleshooting duties. It is quite possible that a more conventional approach to operations and maintenance of wind projects—one similar to power generation facilities—could not only remove the scheduling issues of annual servicing, but also allow the project to achieve higher levels of reliability and availability.

To some degree operators are already moving toward a power plant format of conducting annual and semi-annual maintenance. After the initial 500-hour startup service, operators will try to work their maintenance schedules around annual weather patterns. Ideally these services are performed in anticipation of the windy and/or peak demand seasons in an effort to ensure high performance during these periods. To take it a step farther, if an operator is able to minimally staff a project that adequately addresses routine operations and minor repairs during peak wind season, then augmenting this same staff with qualified outside resources might be a better option for conducting annual maintenance during off-peak periods. The primary staff required to operate and routinely maintain the project is sufficient, annual maintenance is assured and completed in less overall time, and the turbine servicing is not conceded to repairs or troubleshooting. This approach also allows owners to mitigate the effect of unpredictable maintenance by choosing to move scheduled service and maintenance into a specified period and bringing in additional resources to complete this work.

Merritt Brown is director of business development with Rev1 Power Services and Rev1 Wind. To learn more call (866) 738-1669 or go online to www.rev1wind.com.

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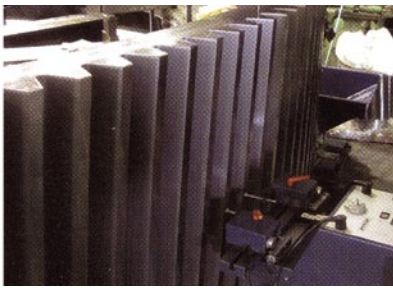

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Jose R. Zayas / Joshua Paquette
Sandia National Laboratories

Lab and field testing enables engineers to continually improve their designs, resulting in the continued viability and resilience of the wind industry.

AS WIND TURBINES HAVE GROWN in size and capacity over the last three decades, the importance of reliability and technology innovation have been quite apparent. Even though these "Gentle Giants" look much like their predecessors of the 1980s—three-bladed, upwind configuration—technology improvements have been vital for the success of this vibrant industry. Every component and subcomponent of the turbine, including airfoils, materials, structures, and sensor and control systems, have to be tested and evaluated prior to being deployed and accepted.

All engineered components and systems must go through a testing phase in order to validate the engineering assumptions made in the design, analysis, and manufacturing processes. The key questions pertaining to testing are why, when, and in some cases, how? As the wind industry has gone through its maturity phase, the trial and error days of going straight to the field and patching flaws in real time are hopefully long gone. This has been driven and enabled by both the fidelity of today's engineering tools and computing capacity, as well as the requirement to certify components and systems to standards and the sheer cost of building and testing structures of this magnitude.

Wind energy components pose many challenges when it comes to testing and evaluation. Not only does wind have a series of unique components, the size of the components and the measurement requirements can make testing quite costly and challenging. Take, for example, a typical utility-scale wind turbine blade, which is 30-60 meters in length, weighs 10-20 tons, and is quite complex in shape. Today's blades have matured immensely from the days when technology and manufacturing approaches were leveraged from other sectors. Modern blades are predominately made of a combination of glass and carbon fibers, resin, and balsa or foam. Each one these materials has to be certified and tested by their respective manufacturer, and must be brought together to design a blade which itself has to be certified. Airfoils are now optimized for aerodynamic and acoustic performance and tested rigorously in wind tunnels to ensure this performance under a variety of simulated field conditions. Moreover, the shape must lend itself not only to localized aerodynamic performance, but must also be coupled to the structural and manufacturing design, where the internal structure is designed to take advantage of the materials available and how they will be organized or stacked to develop a structurally efficient blade. Also, as part of the design phase the manufacturability must be continually evaluated to ensure that the blade can be manufactured to the specifications without the introduction of defects.

Although there will be several sub-scale testing phases throughout the engineering process, the entire completed blade must also be tested for structural strength and aerodynamic performance to validate the computer models and receive certification. These tests can be complicated and costly due to the size of the structure and the complex testing and loading requirements, which must replicate such things as the number of and magnitude of loading cycles that a blade will see over its 20 year life, in the case of fatigue loading. At this point it is key that the tested article is close to the final design, as it can cause significant cost increases and project delays to redesign, rebuild, and retest. Finally, these complex testing processes must also be completed as applicable for other components of a wind turbine, including gearboxes, generators, controllers, etc.

The tools used to develop and evaluate these designs are only as good as the data used to validate and improve the fidelity of the code. Additionally, the tools are only able to model the article to a certain degree of fidelity within a certain operational envelope, and many practical elements can diverge from the model in the as-manufactured, as-installed final product. The lessons learned and data gathered from lab and field testing, at both full-scale and sub-scale enables engineers to continually improve their designs, the result of which can be clearly seen in the viability and resilience of the wind industry.

Jose R. Zayas is program manager, Wind & Water Power Technologies, and Joshua Paquette is wind energy testing lead and a senior member of the technical staff at Sandia National Laboratories. Go online to www.sandia.gov/wind.

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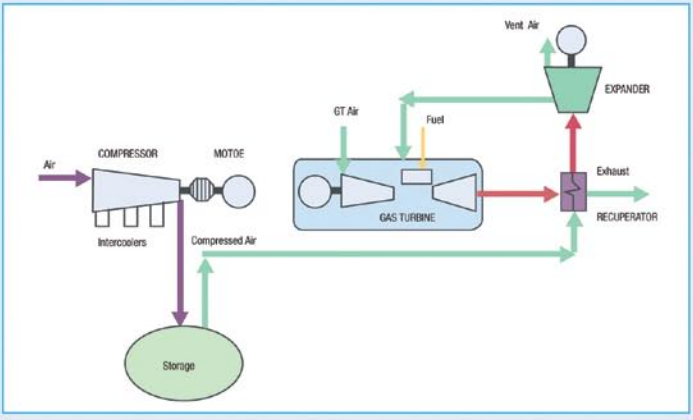

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Hüseyin Kizilagac
BDP Project Logistics

Logistics experts must be able to take both a global and a local perspective, monitoring shipping conditions worldwide while establishing local relationships as well.

THE MANAGERS OF WIND FARM PROJECTS face many challenges. Risk levels for EPC (engineering, procurement, and constructon) contractors are perhaps among the highest, as EPC contracts are often complex and exceptionally demanding. Not only does the contractor assume the risk for the entire schedule, but also the overall budget for the project. That's not an easy task when you consider that the contractor is not only dealing with a client, but also managing a number of supplier resources that could be in multiple locations.

Logistical challenges are high. Any changes that must be made that affect the contract, or any problems that surface, can prove costly and could be devastating to the contractor. Remember that by agreeing to the contract the contractor is basically guaranteeing results and fully responsible for all outcomes of the wind power project, including all activities of the suppliers and vendors participating in the project. Penalties can be severe for any contract breaches, and there are no allowances for cost escalations in an EPC contract.

Contractors must build reliable networks and identify the most experienced resources. By concentrating on their core competencies they should bring in logistics resources that can provide the degree of experience and knowledge necessary for the contractor to meet all obligations. That includes each and every issue that will or could impact the success of the project—locally, regionally, and globally.

Why should EPC companies work with an experienced project logistics provider? Project efficiency. A reliable provider gives the contractor one point of contact, enabling tighter management of all transportation and logistics issues. The provider streamlines the monitoring and coordination of the logistics management process, including sourcing needs, and gives step-by-step accountability.

EPC contractors rely on their reputations, which depend on their ability to deliver on their contractual promises. They don't want to compromise their reputation by working with unreliable sources. All the more reason why contractors should identify experienced partners they can trust and with whom they can build strategic alliances.

When contractors source wind power equipment, transportation is still one of the key factors to ensure the equipment arrives on time, intact and within budget. Because they don't always have deep resources for truck, reloading, transshipment, and sea freight services, contractors often source from local forwarders. In many cases, however, the necessary equipment is not always available through those local sources, which means it has to be brought in from elsewhere. A global resource with wide sourcing capabilities can access the equipment and move it quickly and efficiently.

Due to its wide network, an experienced global logistics provider also knows the local and regional business habits and has an established "on the ground" presence. While local logistics or forwarder resources are familiar with their own areas, they may not be experienced enough to respond to last-minute problems or changes, especially those that require resources beyond their control. It is often a race against time, which is a luxury contractors and their clients do not have. Working with reliable logistics partners will be particularly important over the next few years, due to transportation capacity and equipment shortages. As we mentioned in an earlier issue of *Wind Systems*, general equipment availability and transport capacity will continue to tighten up as demand outstrips supply, adding more pressure to supply chains in the wind power industry. The fight for shipping capacity promises to be immense. It's not just equipment and capacity challenges, however, but also a cost issue. Contractors have commitments to their wind power clients, who are on a fixed schedule, so time and speed are key components. Schedules must be met. If time is lost and penalties are incurred, the result can be failure and loss of credibility by the contractor in the wind power marketplace.

Within the next 12 months we expect significant increases in freight costs, adding more strain to an EPC contract. A logistics provider with access to and agreements with global transportation partners can make a positive difference. Just as contactors must be experienced in many areas, so must their logistics resources. Time is money, after all, and reputations depend on the success of each and every wind power project.

Hüseyin Kizilagac is director of business development for BDP Project Logistics. Call + 49 911 965223-19, e-mail hueseyin.kizilagac@bdpprojects.com, or go to www.bdpprojects.com.

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By Russ Willcutt

When work crews aren't adequately equipped, downtime occurs and money is lost. This company will help you to avoid that scenario.

WHETHER IT INVOLVES THE ERECTION of new towers or O&M services for existing turbines, wind farm project managers know that when their crews arrive, they should be ready to go to work. Safety Supply South understands this as well, and a longstanding relationship with an existing customer led them to address the situation in a novel way.

"We have a client who had gotten involved in the wind industry, and as we worked with them to meet their needs we realized that many of the items we were pulling together would be required by anyone who's working on a turbine," according to Smoke Matthews, president and owner. "That's when we decided to put together a kit for each crew member containing everything they would need to tackle a particular job once they'd arrived onsite. It was a huge hit, to say the least, so we decided to make these kits available to companies looking for an easy way to make sure their workers were equipped to do their jobs from the moment they reached the wind farm."

For more than two decades Safety Supply South has been in the business of anticipating its customers' needs, and then surpassing them. A full-line safety equipment and supply house headquartered in Irmo, South Carolina, the company stocks an expansive inventory of items; everything from fall protection, respiratory and hearing protection to work gloves, rainwear, and gas detection instrumentation, just to name a very few. Having this stock on hand puts them in an ideal position not only to fill orders for wind kits and ship them quickly, but to customize each kit according to the customers' exact requirements.

"There are standard items that any turbine O&M crew member will need, such as fall protection, lanyards, eye protection, hard hats, and first-aid kits," says Rob Greene, sales and customer service specialist. "But every job is different, so we'll work with the customer to tailor each kit accordingly."

There is no limit to what the company can do, he explains, which is particularly helpful to purchasing agents. "All they have to do is give us a list of what they need, and we'll make sure each kit we ship meets their specifications exactly," he says. "Some companies may require each of their workers to have an anemometer, for example, or a torque wrench, so that's what their kit will contain, and that even goes for the sizing of harnesses or protective clothing."

In addition to this level of customization, Safety Supply South also offers private labeling so that each kit bag features the customer's logo, along with many of the items the kit contains such as hard hats and vests. This is especially useful in light of the fact that many different crews might be working on a single project, so anything that can be done to eliminate confusion in advance is a good investment. "That has also worked to our advantage," Matthews explains, "since other workers see the kits we've prepared and ask where they came from."

Just as these customized wind kits have aided the company's clients immeasurably, they have also allowed Safety Supply South to grow into new markets, both in terms of activity as well as geography. "We've begun working with wind companies that have contacted us about these kits, so we've landed new accounts, but we've also started shipping to parts of the world that we really hadn't reached before," Greene says. "In the past couple of years we've shipped to job sites in Australia, China, Qatar, Canada, Mexico, and the Middle East. There's really nowhere we can't reach thanks to the abundance of overnight shipping services that we have available these days."

Apart from the standard safety equipment and tools that workers need to do their jobs, additional items are sometimes required, such as winter survival gear. "If you think about the remote locations where these wind farms are sited, and the fact that O&M services must be conducted all year round," Matthews points out, "it's a good idea to have emergency equipment on hand in case something goes wrong."

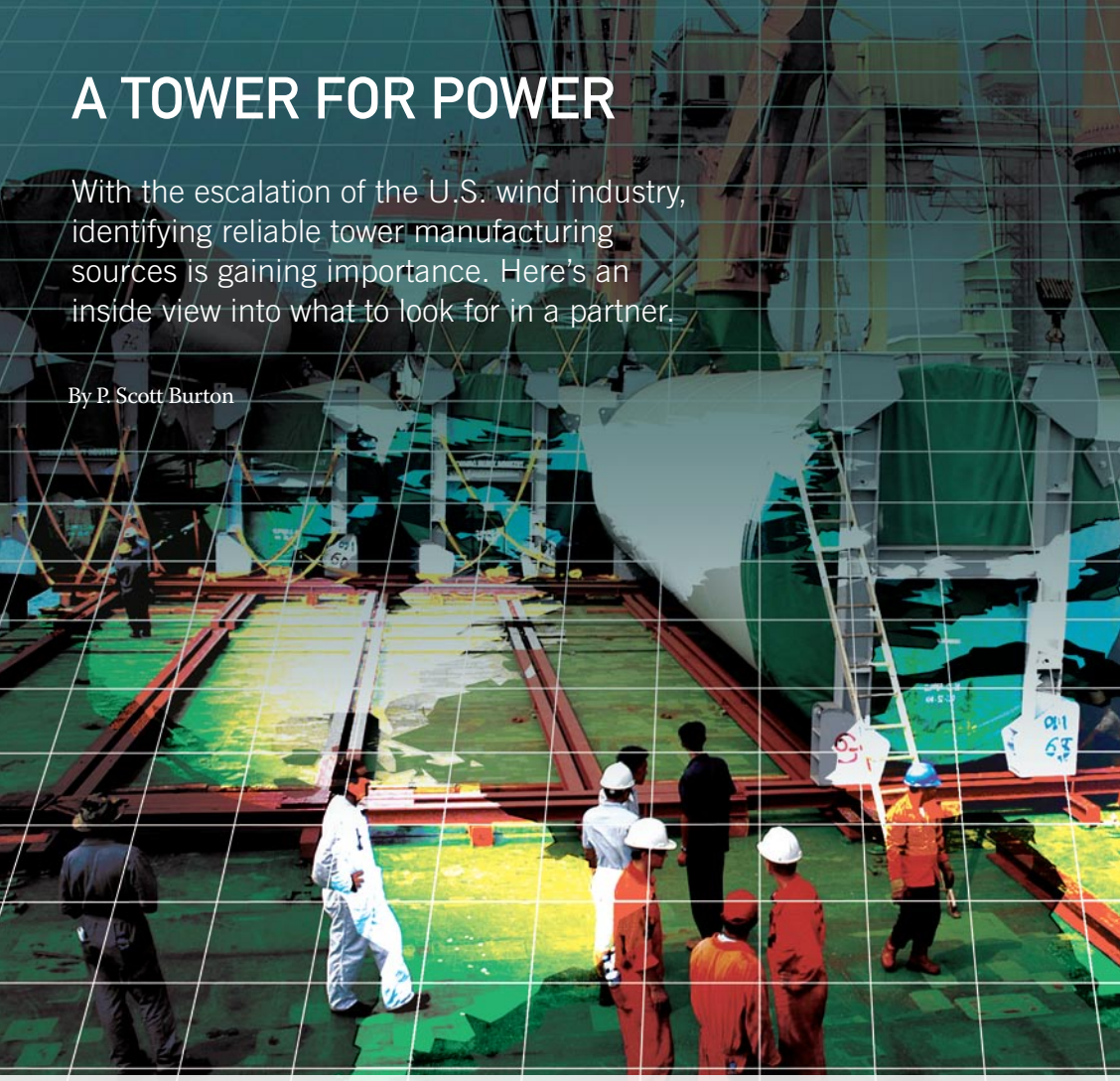
Bundled in a backpack, these winter survival kits contain such things as space blankets, glow sticks, a shovel and hatchet, and water and rations. "It's all about being prepared," he says, "and we're here to help make that happen in advance."

Even beyond these details, Safety Supply South also keeps up with all the latest wind-industry requirements, making sure the equipment and supplies they provide are current. "We're big enough to make this happen," Greene says, "and small enough to take the time to do it right."

A TOWER FOR POWER

With the escalation of the U.S. wind industry, identifying reliable tower manufacturing sources is gaining importance. Here's an inside view into what to look for in a partner.

By P. Scott Burton



P. Scott Burton is a Los Angeles-based environmental regulatory attorney, a partner in Hunton & Williams, and counsel for Korindo Wind. For more information go to www.korindowind.com.

IN THE LOS ANGELES OFFICE OF KORINDO WIND, a division of Jakarta-based multinational Korindo, President Ricky Seung and his staff put in at least two days every single day. The first coincides with the workday at the Indonesian plant where Korindo Wind manufactures towers for wind energy development. The second is in line with business hours kept by the company's European customers. Through it all they work with their main priority, contacts in the United States where most of the towers are installed.

Seung and his staff are working around the clock to fill the capacity of Korindo Wind's manufacturing facility in Ciwandan. The ISO 9001:2000 certified plant can produce 800 towers annually, the equivalent of more than 2 gigawatts of installed capacity.

Since 2006, more than 500 U.S.-bound towers have rolled off Korindo Wind's highly efficient line, manufactured and delivered for some of the biggest global names in wind turbine manufacturing. That surprises some in the industry, given that the company's primary competitors do not have to ship their towers across the Pacific Ocean. But combine less-expensive steel in Indonesia and lower operating costs in Asia with Korindo Wind's comprehensive delivery package, and the company has built-in advantages that allow it to offer favorable contracts and highly competitive pricing for the U.S. market. Even compared to domestic suppliers, Korindo Wind's landed price often is equivalent to or less than the cost of getting towers from a U.S. factory to the project site.

Fig. 1: Tower sections in production on the shop floor.

Cost is only part of the equation, though, says Seung, who adds that success in the United States requires three things: indisputable quality, unsurpassed service from plant to project site, and overall value to the customer.

QUALITY COUNTS

The value starts with quality. Every wind tower supplier claims it manufactures high-quality towers, and some can back it up, but few can prove it to the extent of Korindo Wind. "Quality, quality, quality," says Henry Kim, wind quality manager. "Our overall quality system, including the quality management we do in our factory, is many steps above where most tower manufacturers are today. Since we are one of the few ISO certified tower manufacturers in the world, of course we meet those requirements, but we go beyond that at every stage."

Kim has the qualifications and experience to pass judgment. He is an American Welding Society (AWS) certified welding inspector and, prior to joining Korindo Wind in 2006, he was the head quality manager at one of the company's competitors. He is one of two quality managers in the Ciwandan plant, and together they have more than 20 years of experience in wind tower welding and fabrication.

Their quality team does inspections at every single point of the process: raw material receiving, cutting, beveling, rolling, fit-up, submerged arc welding, blasting, painting, and assembly. Every step is documented with precision to ensure traceability. If there is a problem down the line, the company can pinpoint where it originated and address it immediately. Then there is a final shipping inspection before the sections leave the plant, a surveyor at the port ensures the integrity and quality of the sections has been maintained during transport, and another inspects them when they arrive in the United States.

Korindo Wind also has the credentials to back up its quality claim. The ISO certification guarantees customers that the company adheres to or exceeds the most stringent quality documentation requirements in the industry. Every Korindo Wind welder is AWS certified, and the 33-person quality team includes certified welding, coating and nondestructive testing inspectors

Donald Rawson, an independent coatings inspector with a Level 2 National Association of Corrosion Engineers (NACE) certification, has inspected towers manufactured by four different companies. "I'd put their coating quality right up there with the top tower manufacturers," he says. "The last inspection job that I went out on for them was probably the best I've ever seen."

The real proof, though, is in the performance of Korindo Wind towers. In more than three years of manufacturing and delivery, there has not been one significant quality issue. That's important, especially in a market that has shifted its focus from capacity and volume to quality and performance.

Fig. 2: A worker prepares a tower section.

UPSIDE OF THE DOWNTURN

The recent worldwide economic downturn has impacted tower manufacturers that supply the U.S. market in obvious and often painful ways. Many have been forced to cut workers and others have had to halt production entirely. But there have been less-obvious consequences, as well. The level of quality that turbine manufacturers and developers are now demanding is an excellent example.

Anton Hirsch, Founder
Cobra Metal Works Corp.
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Fig. 3: Tower sections awaiting packaging.

Fig. 4: Packaged sections being loaded at the dock.

Even two to three years ago, turbine manufacturers couldn't find enough tower suppliers to meet their needs, so capacity was the primary driver for placing orders. Those companies worked with anyone who could meet their volume demands. In general, tower manufacturers focused on completing as many towers as possible as quickly as possible, sometimes to the detriment of quality.

Today, with tower plants sitting idle and others with significantly reduced volumes, turbine manufacturers have the luxury of being more selective in supplier selection and are demanding higher quality and better service at lower prices. They also have time to more thoroughly evaluate potential suppliers for those attributes.

Korindo Wind welcomes the new, heightened standard. "Turbine manufacturers have raised the bar to a new level, and we think it's great," Seung says. "Korindo Wind has been manufacturing to the higher level since the beginning, so we have no problems meeting the new expectations. We have tremendous confidence in our quality systems, our people, and our factory, so in many ways the situation makes our greatest strength even stronger."

As other companies rush to play catch-up with their quality control systems, Korindo Wind continues to do what it's been doing all along while gaining ground in research and development.

EFFICIENT SYSTEMS

Korindo Wind has been exacting in the development of its operation from the beginning. The management team that runs the Ciwandan plant brought nearly 50 years of combined experience in wind tower manufacturing and quality assurance to designing the facility. That team has been

a key to developing the quality that has become Korindo Wind's calling card.

"Because of our depth of knowledge and experience in manufacturing towers, we were schooled in potential defects before we even built the plant. We've been able to take a pre-emptive approach and apply lessons learned to our layout and processes," Kim says. "That saves time and money, and not just for Korindo Wind but for our customers, as well."

The plant features all the same high-tech, precision manufacturing, and measuring equipment that can be found in competitors' facilities, and the quality team does ultrasonic and non-destructive testing on site. The plant's linear production line is a model of efficiency. Raw materials enter at one end and completed tower sections exit the other with zero waste of time, effort, or material in between.

That allows Korindo Wind to produce more towers faster while maintaining its stringent quality requirements and, overall, charge less. And, with its location only one kilometer from the Port of Ciwandan, the company can cost-effectively ship towers anywhere in the world.

CONSISTENT DELIVERY

Korindo Wind has never been late on a delivery, which carries a lot of weight in an industry where timing is everything and delays can cost millions a day. But it's all in a day's work for Korindo Wind; if the plant falls behind, the sections will literally miss the boat.

"We actually can't be late because the vessels are scheduled in advance and we have to pay thousands a day just to have them sit in the port," Seung says. "Whatever it takes to stay on schedule, we're going to get it done."

To make sure that happens every time, Korindo Wind has developed a "comprehensive tower solution" that encompasses everything from sourcing raw materials to manufacturing and assembly to delivery duty paid (DDP) transportation. The company also owns and handles reverse logistics for the specialized H-frames that are needed to safely stack sections on ships.

With DDP the seller retains all risks and is responsible for all costs until the sections reach the agreed-upon destination. That can be a port, or because the company has strong ties with a domestic heavy hauler, all the way to the project site.

The logistics package addresses any concerns that customers may have about getting Korindo Wind towers to their U.S. project sites, according to General Manager David Choi. "It's a full-service deal," he says. "We provide the stacking frames and insurance, we coordinate the ships and

Fig. 5: Secured tower sections prepared for shipping.

handle the ocean freight, we take care of the duty and clearing customs, and we handle all of the port work and storage. It's almost as if you've purchased from a domestic supplier, but you have the option of going to the port closest to your project site in the States or anywhere in the world."

Choi says the logistics services also give customers certainty in what can be a highly volatile shipping market because Korindo Wind has negotiated a maximum rate with an ocean freight business partner. In addition, since all the towers arrive at the port closest to the site, domestic logistics and state-by-state permitting challenges are minimized. It also reduces inland transport costs, which can be substantial. Just to load a section and go down the street can cost $10,000 and, depending on the distance, can be as much as $50,000-$100,000 to haul it from a U.S. plant to a project site.

Another advantage that's not quite so obvious is that all the sections arrive at the same time, ready to install. "It's a project manager's dream," according to Seung. "He knows exactly when 20 towers will be arriving in the Port of Houston, for example, and he can schedule cranes accordingly. Those cranes cost an incredible amount for every day they are on site. With Korindo Wind, they're not going to be sitting idle waiting for a top section that's still on the line in a plant somewhere."

Korindo Wind inspectors go over the sections

at the port, and the company takes care of repairing any minor handling damage that may have occurred in transit. The company works with independent maintenance and repair providers to address issues once the towers are installed. "We do everything in our power to ensure customers get exactly what we've promised," Seung says. "It all flows from Korindo, which has kept customers at the center of its corporate philosophy and vision more than four decades.

STRENGTH FROM STRENGTH

Founded in Jakarta in 1969, Korindo is a multibillion-dollar company comprising 14 divisions that serve diverse industries worldwide. They are engaged in timber and forest management; paper manufacturing and recycling; and the manufacturing of buses and trucks, parts for commercial vehicles, chemicals, palm oil, heavy vessels, and containers. They are also in trading, financial services, insurance, real estate development, logistics, and shipping. Overall, Korindo companies employ more than 30,000 people who export products and services to every corner of the world, including the United States, Japan, Korea, China, Singapore, Taiwan, Malaysia, India, the Middle East, and Europe.

In 2006 Korindo built the Ciwandan plant and entered the global wind energy market. It was a natural extension for a business that has long focused on sustainability and conservation. One of Korindo's guiding principles reads that "We must not only provide great service and value for our customers, we must also respect and protect the environment." Seung says every division is held to that standard.

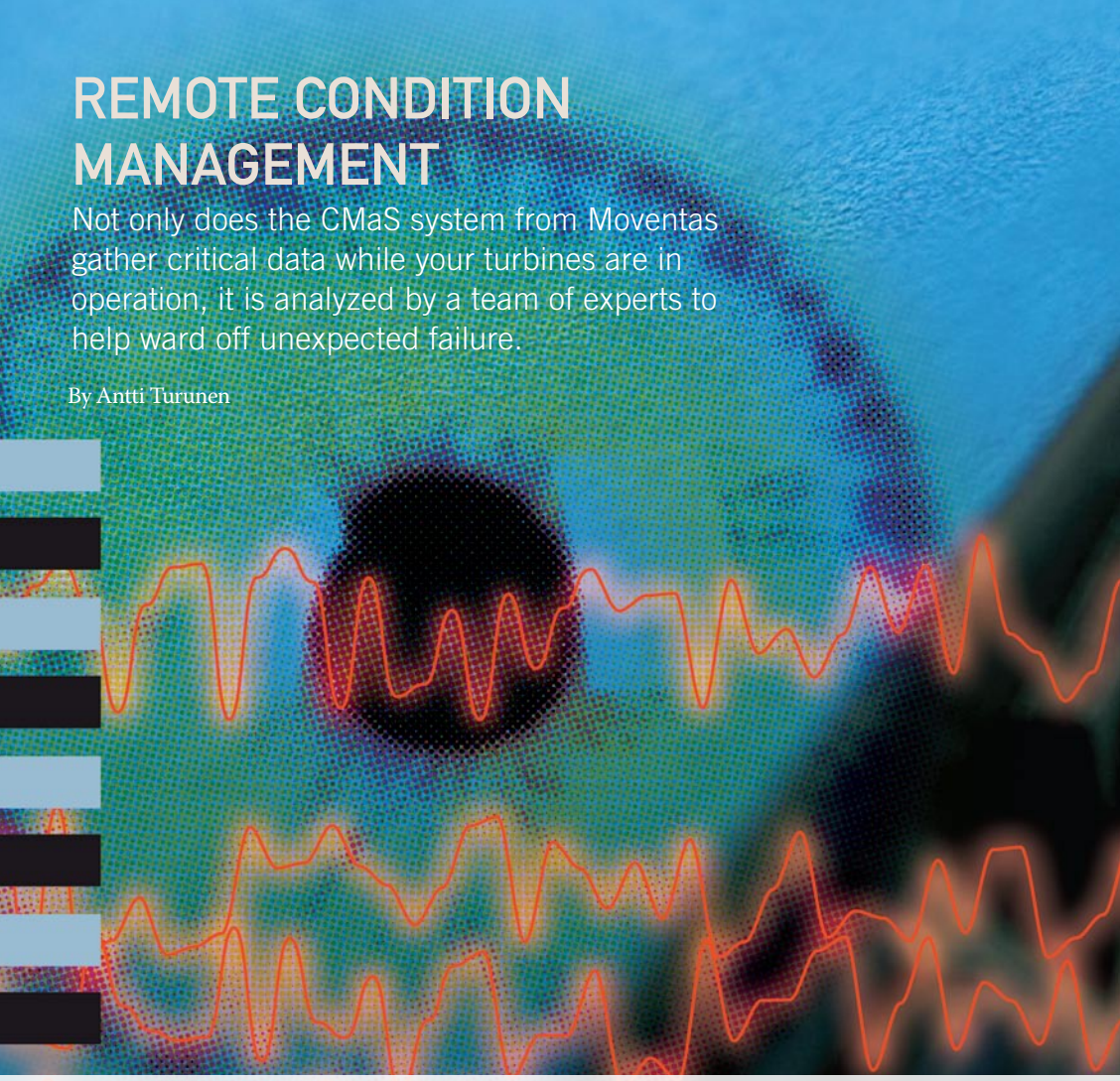
"Sustainability is a general theme and way of doing business throughout all of Korindo," he says. For example, when the timber division takes trees from a tropical forest, the company replants multiple new trees for each one harvested. "Anything that's taken out and used is replaced by fivefold. Korindo has re-cultivated hectares and hectares of land, basically creating another forest in the process."

Seung says that Korindo's environmental and customer-friendly approach, financial strength, and multinational experience provide significant advantages in a tight market. "With Korindo behind us, we are able to take reasonable risks in putting together pricing and logistics packages that other suppliers can't match and that help make projects feasible," he says. "It also helps people understand we're not a fly-by-night start-up. Korindo companies have decades of experience in heavy manufacturing, logistics, and other areas that are crucial to wind energy customers. We've brought all of that to bear in shaping Korindo Wind."

REMOTE CONDITION MANAGEMENT

Not only does the CMaS system from Moventas gather critical data while your turbines are in operation, it is analyzed by a team of experts to help ward off unexpected failure.

By Antti Turunen



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THE MOVENTAS CMaS (condition management system) is a remote monitoring system for wind turbine gears. It recognizes possible damages in gears and other mechanical components in advance, even before they start to interfere with the turbine operations. The system consists of different sensors and the main unit, which collects and processes the measured data. The measured data is then transferred to a server, where it will be analyzed in greater depth.

FROM MONITORING TO MANAGEMENT

There are several products on the market that focus on gear condition monitoring. CMaS enables a broader review of the whole entity, embracing the preventive condition management approach. A significant portion of the system was developed by a Moventas R&D team, which allows us to offer very competitive pricing.

Wind turbine gears are exposed to extreme changes, both in terms of load and environmental circumstances. No wonder that the gear is one of the most sensitive components in the turbine, and that monitoring its condition is so welcome. Traditional products focus mainly on measuring vibrations from rotating components. CmaS, on the other hand, is based on a profound understanding of the malfunctioning process of gears. In addition to vibration CMaS monitors a variety of dif-

Gear unit for 1.5MW wind turbine

ferent quantities, especially the physical and chemical qualities of oil, oil wear particles and pressure, revolutions per minute, torque, and temperature.

Early changes are visible in oil lubrication properties long before they can be measured in vibration. If those changes are not addressed they generate metal contacts and abrasion, and after a single year they may cause a serious damage that requires thorough service and new components.

For end users, planned and anticipated service breaks are by far a better solution than repairing the damage. During the warranty period OEMs may have to pay for downtime hours. Even at the quickest an unforeseeable reparation in the turbine can take two weeks, which means paying out a great deal of money just for lost production, not including the service work with associated costs. If the damage has to be repaired at the workshop, a lead time of several weeks can be expected. CMaS has a short return of investment time. CMaS itself can be installed to new and old gears alike.

EXPERT ANALYSIS

The data CMaS produces is analyzed by remote diagnostics experts at Moventas service locations, but customers also have access to the CMaS net service, even with mobile connection if necessary. This access includes all measured data from their turbines. Moventas currently has a team consisting of engineers with a long history and experience analyzing powertrain phenomenons.

Although traffic light warnings from turbines can be sent directly to customers if desired, the traditional way to operate with CMaS involves all warnings being handled and analyzed by Moventas specialists. All generated reports—along with conclusions and recommendations—are then provided to the customer. This is the preferred method, since Moventas can best serve its customers by sharing its expertise with its clients. This type of cooperative model guarantees the shortest response time for onsite service and the shortest lead time for factory services, and it also helps in planning maintenance actions and spare part inventories.

CMaS is developed to monitor a large number of wind turbine gears very effectively by using sophisticated analyzing methods, algorithms, and intelligent sensors. These sensors are used especially for vibration monitoring, and also in

some cases intelligent oil particles and oil condition monitoring are used. By using intelligent sensors CMaS is exceptionally scalable, and the analysis provided by intelligent sensors is a key issue for the effective monitoring of large numbers of turbines.

INTELLIGENT DIGITAL SENSOR

Moventas has already been using intelligent vibration sensors for five years in serial production. The development of an intelligent vibration sensor began about seven years ago, when the first prototypes of intelligent vibration sensor were made.

Based on the prototype testing period in 2003, Moventas decided to move its first-generation vibration sensor, the VIB-100, into serial production. Production of the VIB-100 sensor lasted from 2005 through 2010. During this period Moventas monitored the behavior of these intelligent vibration sensors, and in 2007 design of the second-generation sensor, the IVS-20, began. The IVS-20 is based on VIB-100 technology. IVS-20 prototypes were ready in early 2009, and during that year prototype tests were conducted. At the beginning of 2010, the IVS-20 was moved into serial production.

Traditional vibration sensors measure data passively, and the signal is transferred to main unit as a charge signal. The main unit then conducts signal processing, calculations, and analyses. In an intelligent vibration sensor the measurements, processing, calculations, and analyses are conducted inside the sensor. This means that signals don't have to be transferred long distances to the main unit, which provides a very high-quality signal.

When the sensor has processed and analyzed the data, it is then transferred to the CMaS main unit. Data transfer is conducted over a field bus. This means that in a normal operation mode only key figures/parameters are transferred. Spectrum and time domain data is also transferred regularly, but daily analyses are based on monitoring key figures. When something outside of the normal occurs, more-detailed data/raw signals are transferred. An important point is to successfully transfer key figures without losing any information. When daily monitoring is based on the analysis of key figures, monitoring is extremely cost effective.

The IVS-20 is an intelligent vibration sensor that measures in three dimensions. It has an inner calculation power of 500 MHz, which is a great advantage in many situations. Moventas has integrated many signal processing algorithms within the unit, and it uses traditional methods such FFT and envelope. The IVS-20 also has many other algorithms, such as:

- RPM scalable follow-up frequencies; fixed follow-up frequencies;
- crest factor;
- time domain peak detection;
- vibration severity;
- optimized detailed vibration severity.

In addition, IVS-20 software can be updated remotely. For example, the Moventas analyzing and CMaS R&D teams are currently designing new highly effective vibration analyzing algorithms. These new software algorithms can be updated to IVS-20 online,

even when CMaS is already installed in a turbine.

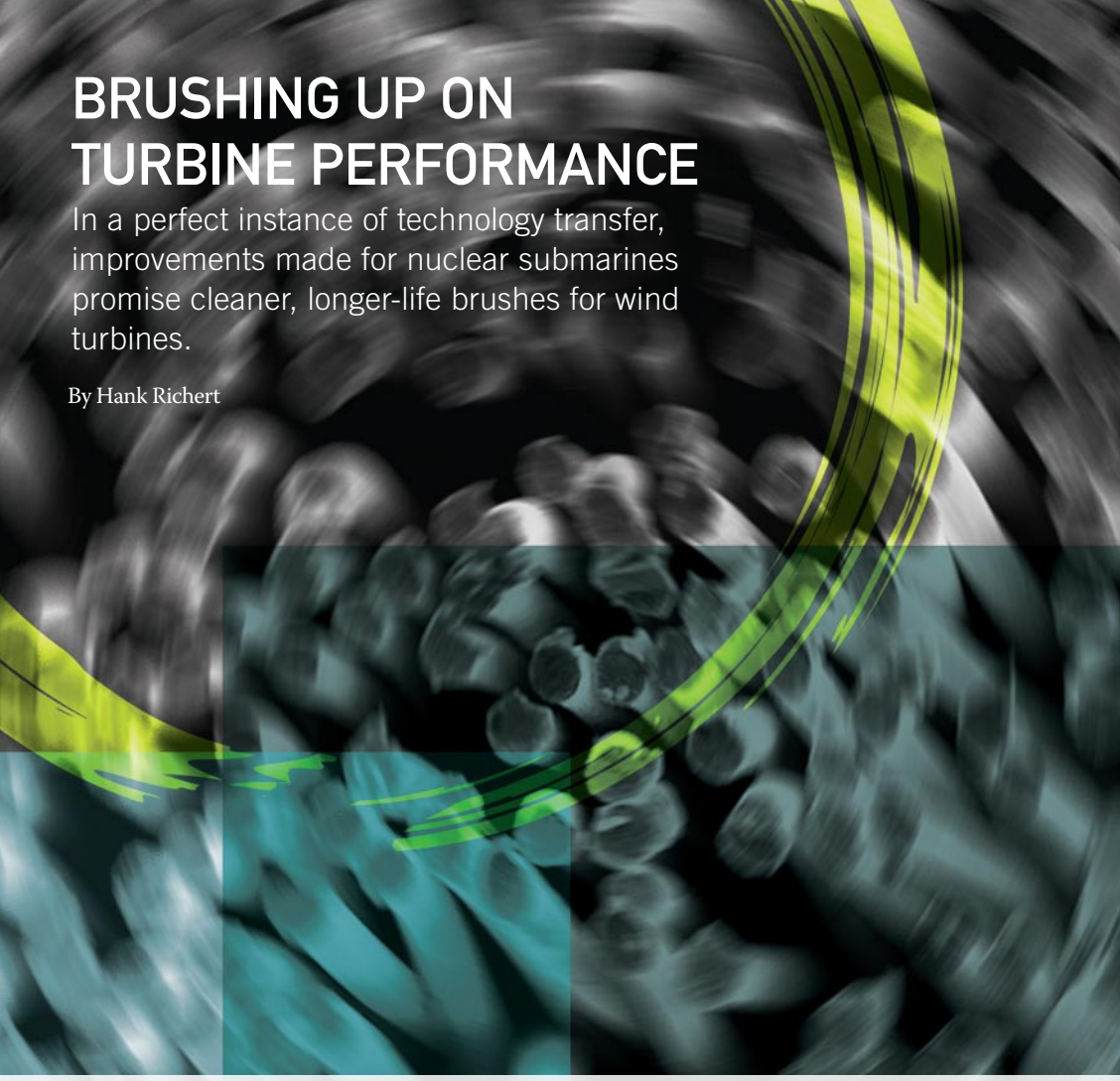
SENSOR SCALABILITY

Another important feature is scalability. With intelligent sensors, the main unit doesn't need powerful signal processing power, and the cost of the main unit is quite reasonable. This is very important in cases where only a couple of vibration sensors are installed, since CMaS doesn't cost extra for unused calculating power. The intelligent sensor has its own digital signal processor (DSP) as well. For instance, the IVS-20 has DSP with a calculation power of 500 MHz, which is nearly as much as that found in a smaller laptop computer. When it comes to signal processing power, it's even possible to calculate 524288 points FFT. This is just another example of the many features built into this efficient, accurate, and economic unit.

BRUSHING UP ON TURBINE PERFORMANCE

In a perfect instance of technology transfer, improvements made for nuclear submarines promise cleaner, longer-life brushes for wind turbines.

By Hank Richert



Hank Richert is vice president of sales and marketing at DHi. He can be reached at (703) 682-5560 x4201, info@dh-inc.com, or www.dh-inc.com.

SLIDING ELECTRICAL CONTACTS used to transfer electrical signals or high current between two surfaces in relative motion can pose a significant maintenance burden. Traditional carbon- or graphite-based brushes used in most slip ring systems generate significant amounts of conductive wear debris, and the use of these brushes often results in electrical shorts to ground, reduced service life, susceptibility to contamination, low signal quality, restricted operating current, and the occasional fire. In the past there have been many unsuccessful attempts to solve these problems. Now, new military technology originally developed for the demanding needs of the U.S. Navy's nuclear submarine fleet promises cleaner, longer-life brushes for wind turbine slip ring systems.

While many suppliers of "high performance" graphitic brushes add significant metal content to the brushes to improve the electrical performance, they are still burdened with the other known fundamental liabilities of carbon brushes. Some manufacturers have introduced what they term "metal fiber brushes." These brushes are typically made from expensive gold alloy. These brushes address some of the shortcomings of carbon-based brushes, but since the fibers are oriented tangentially across the sliding surface and sequentially wear through the fibers in a transverse direction, they have relatively short service lives and are therefore not particularly suitable for high speed and high current applications.

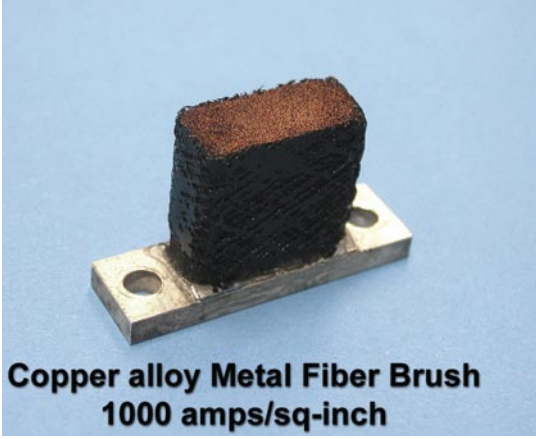


Fig. 1: Patented tip-contact metal fiber brushes.

COMMERCIALIZING MILITARY TECHNOLOGY

Since Navy submarines operate independently in remote regions and remain submerged for long periods of time, their electrical machinery demands high reliability with low maintenance. Several years ago the Navy teamed with the University of Virginia, HiPerCon, LLC, a Virginia small business, and DHi (Defense Holdings, Inc.) to develop a new electrical brush that could offer high reliability, longer life, and reduced wear debris having very low conductivity. The effort was successful and the new technology—a brush consisting of a bundle of thousands of very thin, flexible metal fibers (a "metal fiber brush") running on their tips under very light spring pressure—is now being commercialized. What was originally developed for submarines is currently in use or under test in aircraft, power generation, shaft grounding, and other current transfer applications where clean, long-life power, and data transfer is important.

The patented tip-contact metal fiber brushes (MFBs, fig. 1) made by HiPerCon are much different from traditional monolithic carbon, silver-graphitic types of metal fiber brushes where the fibers make tangential contact. As might be imagined from the name, tip-contact MFBs run on their fiber tips.

Each brush contains thousands of hair-fine (50 micron) metal fibers that can flex so they stay in contact with the sliding surface (fig. 2). Since each fiber tip is in contact with the sliding surface there are literally thousands of contact points per brush, as opposed to monolithic carbon brushes where there might be between six and 12 contact spots at any given time. Since the carbon brush only makes contact at a few places, the brush is exposed to localized heating and higher wear at those locations. As these contact spots wear off the current is transferred to other contact spots, and then still others. This shifting of contact spots creates a significant amount of electrical noise and conductive wear debris. The hardness of carbon brushes also makes them susceptible to chattering and vibrations, which adds to the signal noise. Traditional carbon brushes don't work well in a variety of conditions including very low or very high humidity, high runout where there are long periods of low or no current operation, or where they are required to sit for long periods of time with no current and no rotation. Tip-contact MFBs also avoid these problems.

Tip-contact MFBs can be made from copper, silver, gold, or other metals. The material selected for the fibers is based on sliding surface material, environmental conditions, and performance requirements. The fibers can be conditioned for extreme conditions such as <10 percent relative humidity or to inhibit oxidation of the sliding surface. Once

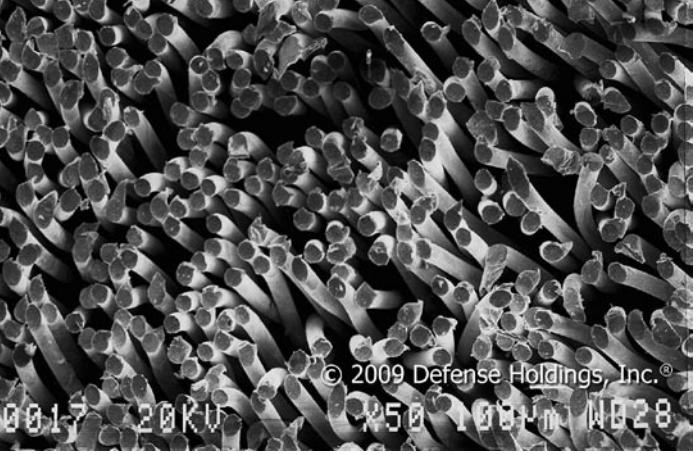


Fig. 2: Each brush contains thousands of hair-fine metal fibers that flex and stay in contact with the sliding surface.

conditioned by this patented process the fibers never need retreatment, eliminating the need to reapply brush lubricant during maintenance.

The specially-processed fibers in a tip-contact MFB are formed into a loosely-packed bundle. A brush is typically 1/6 fibers and 5/6 open space between the fibers. Since each fiber is in contact with the sliding surface and each fiber flexes with the sliding surface imperfections, very light spring forces can be used on the brushes. The fibers used in tip-contact MFBs do gradually wear, but because the spring pressure is so low that wear occurs very slowly. Typical MFB spring pressures are 20 percent of an equivalently sized carbon brush. Testing has shown that the wear particles produced resemble a microscopic curved oak leaf, and while the fibers themselves are highly conductive, tip-contact MFB wear debris is not particularly conductive unless the particles are compressed together tightly. As a result of all of these factors, tip-contact MFBs produce far less wear debris than competing carbon brushes, and the largely non-conductive debris causes far fewer problems and is easier to collect and remove.

With tip-contact MFBs, an outer wrap (fig. 3) retains the shape of the brush and can be made in nearly any shape or form factor. This outer wrap wears at the same rate as the internal fibers and can be made electrically conductive or insulating depending on the application. The stiffness and thickness of the wrap can be increased to handle severe vibration and runout conditions of up to 60 mils at sliding speeds of 20 meters/second.

WIND SYSTEMS

Just as its name implies, *Wind Systems* magazine addresses all aspects of this booming industry, providing information pertinent to landowners and managers, site developers, maintenance workers, economic development professionals, construction companies, tower and component-parts designers and manufacturers—in short, everyone involved in the systems central to and surrounding wind power generation. Brought to you by Media Solutions, Inc., publishers of *Gear Solutions* magazine (www.gearsolutions.com).

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Fig. 3: An outer wrap for the tip-contact metal fiber brushes.

ADVANTAGES OF TIP-CONTACT MFBS

Service life: Since the fibers run on their tips (fig. 4) almost the complete fiber length is available for brush service, so in many cases brushes can be made longer if a longer service life is desired. Also, the very low spring pressures result in very low friction and correspondingly low brush and slip ring wear rates. Below are actual service life examples of HiPerCon's tip-contact MFBs:

- A brush with 0.4" of fiber wear running on a coin silver 3" diameter slip ring will last 300M revolutions;
- A brush with 0.78" of fiber wear operating on a 3.5" diameter slip ring will last 400M revolutions;
- A brush with 1" of fiber wear running on a gold-plated 12" diameter slip ring will last 1.24B (1.24E9) revolutions;
- A brush with 2" of fiber wear operating as a grounding or potential energy brush running on a 1" carbon steel shaft will last 13.5B (1.35E10) revolutions.

Wear debris: Long brush service life reduces maintenance requirements only if the equipment using the brushes does not experience grounds as a result of brush wear debris from these longer-life brushes. It is counterproductive to develop a brush that can last forever if it produces so much conductive debris that maintenance personnel

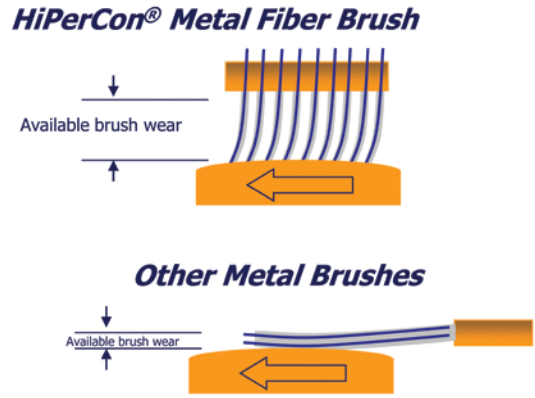


Fig. 4: Since the fibers run on their tips, most of the fiber length is available for brush service.

must frequently open, inspect, and clean the equipment to prevent grounds and shorts. Anyone who has ever worked on a carbon brushed slip ring assembly knows the burden of cleaning carbon brush debris. Figure 5 demonstrates the results of a comparison of the wear debris after 10M revolutions between a single silver-graphite brush on the left and a single HiPerCon tip-contact MFB on the right.

Electrical performance: HiPerCon's MFB's baseline capacity is 250 amps/inch2 of brush surface area, with 1000 amps/inch2 possible under certain conditions. These high current capacities are achievable because there are thousands of contact spots in each brush and each contact spot has its own parallel current path through the brush. In fact, the limiting factor in the brush is generally not the brush itself, but rather the brush shunt. The data transfer capacity is also aided by these multiple contact spots. Instead of only a dozen contact spots, a HiPerCon tip-contact MFB measuring .25" X .25" has approximately 4,000 contact spots. This results in very low contact drop and very low noise. HiPerCon's MFB's typically exhibit an order of magnitude lower contact drop and noise compared to silver graphitic brushes.

Environmental performance: It would be nice if all carbon brushes could operate under pristine laboratory conditions, but the real world requires brushes to operate in less than ideal environments. Anyone who has replaced carbon brushes operating in an oily or hydrocarbon-filled environment will attest to the mess carbon brushes create. The oil breaks down the binder material used in monolithic carbon brushes, turning the once-solid and hard

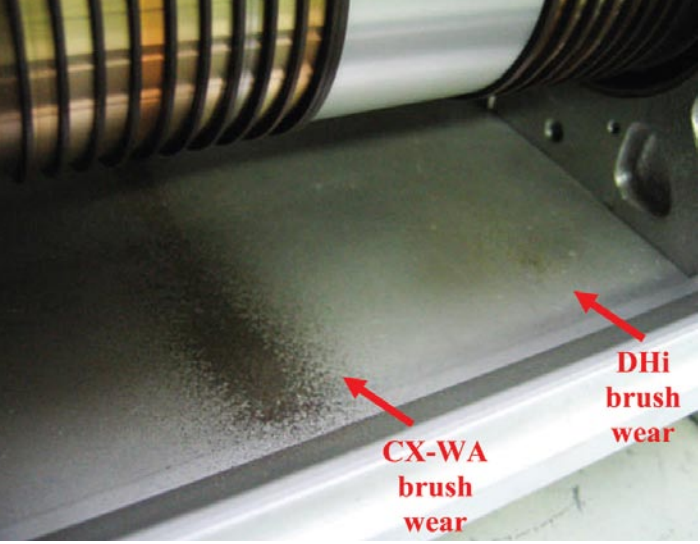


Fig. 5: A comparison of wear debris after 10M revolutions between a single silver-graphite brush (left) and a single HiPerCon tip-contact MFB, at right.

brush into a soft tar-like mess. MFBs are impervious to oily environments, and they don't break down. Other atmosphere containments that destroy carbon brush films such as silicones and sodium chloride do not affect MFB operation.

Applications: Since tip-contact MFBs can be shaped like carbon brushes, they can be easily retrofitted to most carbon brush applications by simply reducing the spring force. HiPerCon MFBs have been retrofitted to replace carbon brushes in field excitation slip rings in Navy submarine motor-generators and for power and data transfer slip ring systems. Retrofit brushes have been designed for—but not yet deployed in—Army Black Hawk helicopter main rotor de-icing systems, E-2C & C-130 aircraft propeller de-icing systems, and hydro-electric generator excitation systems.

WIND SPECIFICS

With its exclusive value-added reseller DHi, HiPerCon is presently introducing tip-contact MFBs for two applications of interest to the wind system community. These are: 1) brushes for wind turbine blade pitch control slip ring systems and; (2) shaft grounding brushes.

Blade pitch control slip rings: HiPerCon-DHi is offering blade pitch control slip ring systems with brushes designed to last 20 years. Since HiPerCon's

metal fiber brushes deposit so little wear debris and require no periodic lubrication, the slip ring service interval can be extended to five years and simply requires inspection and cleaning.

Grounding brush: This shaft grounding device (fig. 6) is a cost-effective means of preventing bearing damage as a result of stray shaft currents induced in shafts. This problem is particularly acute in variable frequency drive (VFD) motors. HiPerCon's patented MFB technology allows it to offer a grounding brush system that can withstand severe operational environments with a very long life:

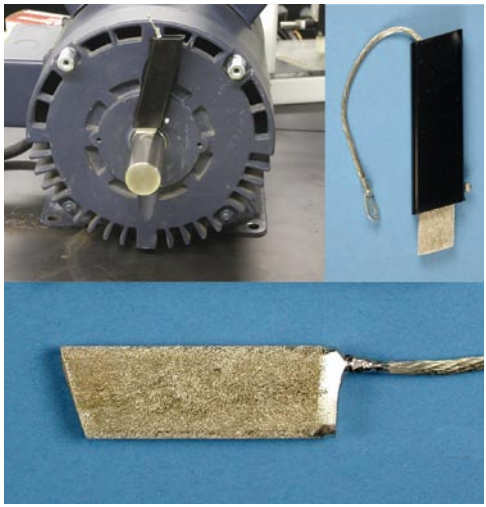


Fig. 6: Shaft grounding devices are a cost-effective means of preventing bearing damage as a result of stray shaft currents.

- Operates in oil-soaked environments;
- Service life in excess of 20 years or 1.8M miles of sliding distance at shaft speeds up to 20 meters/sec;
- Total system resistance when operating on an unconditioned bare steel shaft is ~3.7mΩ;
- One brush is capable of carrying 40 amps continuous current;
- Very small footprint and can be easily adapted to any motor or shaft with standard mounting options;
- Uses silver alloy fibers which are much less expensive than competitors' gold fibers and can run directly on a steel shaft without shaft modification;
- Can easily be replaced during operation.

No shaft grounding system lasts forever, since any shaft grounding device must make contact with the rotating shaft to conduct current. The contact of two metals in relative motion always results in friction, and friction results in wear. These brushes, however, do have a long service life because they incorporate the very low wear rates of a light spring pressure metal fiber brush with very long fibers.

FILM TECHNOLOGY FOR WIND APPLICATIONS

The high-voltage power systems required by cutting-edge wind energy applications depend on improvements made in electrolytic capacitor technology. Learn how that has been achieved.

By Chris Reynolds

Chris Reynolds is technical marketing manager at the AVX Corporation. He can be reached at (843) 444-2868 or creynolds@avx.com. Go online to www.avx.com.

WHILE WIND POWER INVERTER SYSTEMS have traditionally used capacitors with application voltages around 500VDC, the trend today is toward higher-voltage systems. Film capacitor technology offers significant advantages over other technologies in these new higher-voltage applications due to improved life expectancy, environmental performance, and power handling capability. This paper compares both the mechanical and electrical characteristics of film and aluminium electrolytic capacitors, in terms of their ability to address the challenges for the designer of high-voltage power systems required in the very latest wind energy applications.

Wind power is a fast-growing market around the world, with higher prices for fossil fuels and concerns over environmental impact being two of the main driving factors. Furthermore, the improved efficiency of wind-power generation is also developing at a rapid pace. One element of this is higher voltages in generator systems, where the capacitors are actually located inside the converter.

As previously mentioned, many wind-power systems have used capacitors with voltages around 500VDC in the past, but today the "sweet spot" is in the range of 600-1350VDC, depending on the output AC voltage from the alternator. This is because higher voltages are increasingly used to reduce power loss in the alternator and converter of the windmill. Higher voltages allow lower RMS current for the same power. In this

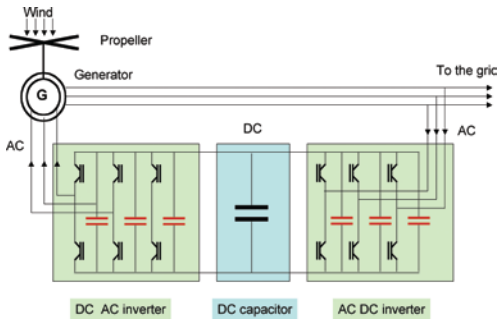


Fig. 1: Schematic diagram of current path.

area, non-gas impregnated film capacitors offer significant technical advantages over previously used electrolytic capacitors. AVX power film capacitors are able to provide a real boost to wind-power stations, with extremely high capacitance values of up to 48,000 µF available.

CONTROLLED SELF-HEALING

One major advantage is the ability of film capacitors to overcome internal defects. The latest dielectric films used for DC filter capacitors are coated with a very thin metallic layer. In the case of any defect the metal evaporates and therefore isolates the defect, effectively "self-healing" the capacitor. As wind power systems are normally located in remote locations, this feature can significantly reduce ongoing maintenance costs and ensure higher efficiency of usage in the installed system. Although a quick search will show a number of "segmented metallized film technologies" on the market, they don't all achieve controlled self-healing. Non-optimized segmentation can generate unexpected results, such as loss of controlled self-healing if under segmented or very low lifetime expectancy if over segmented.

With 30 years of experience in manufacturing controlled self-healing capacitors, AVX can claim extensive knowledge in this area. The main advantages of this technology are proven field reliability with zero catastrophic failures even under severe usage conditions, providing a competitive solution while maintaining the highest electrical and mechanical specifications, and long lifetime expectancy.

Over the last 10 years AVX TPC has developed a wide range of products that incorporate all the benefits of controlled self-healing technology. Ideally suited to all new energy applications, AVX is the first worldwide supplier of controlled self-healing DC link capacitors for windmill applications. The main power film series are FFVE/FFVI, FFLI, FFLC (dry technology), and Trafim (oil filled technology). These provide a wide range of form factors and capacitance/voltage options that cover most applications, with custom solutions available for specific design requirements.

COMPARING FILM VS. ALUMINUM

With today's dry film technology the voltage gradient can reach more than 500V/um for discharge applications and 250V/um for DC filtering applications. These film capacitors are designed to CEI 1071 standards. This means they are able to handle multiple voltage surges of up to twice the rated voltage without significantly decreasing product lifetime. It also means that the designer need only account for nominal voltage requirements when specifying his system.

By comparison, due to the process technology, the thickness of aluminium foil used in electrolytic capacitors is key to reaching higher voltages. There is a trade-off, however: the higher the volt-

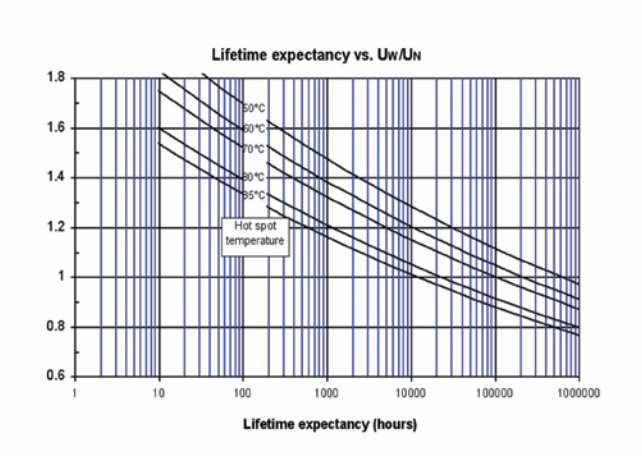


Fig. 2: Life expectancy projections.

Fig. 3: The AVX FFLI capacitor.

age, the lower the available capacitance. In addition, higher voltage (500V) electrolyte conductivity reaches 5kohms/cm compared to around 150kohms/cm for lower voltage versions. This also limits RMS current values to about 20mA per µF, compared to 1A per µF for film capacitors. A major requirement for DC link capacitors is their ability to handle ripple current. Here, film capacitors have a major advantage. Using aluminium electrolytics would require banks of several capacitors being used; and not because a higher capacitance value is required, but simply to handle the current. Using film capacitors would mean that the designer need only consider the minimum capacitance value required for the system. As a result, designs that use film technology frequently save space.

In order to reach the higher voltage requirements of the

Fig. 4: AVX capacitors.

systems being designed and deployed today, it would be necessary to connect multiple electrolytic capacitors in a series. This would require balancing the voltage by connecting resistors in parallel with each capacitor because the IR (insulation resistance) of each individual device will vary. This results in an overall increase in direct leakage current, equivalent to lowering the overall IR of the system.

Another concern in using electrolytic capacitors would be that, if a reverse voltage or over voltage higher than 1.5 times rated voltage occurs, it can cause a chemical reaction. Should it last long enough the capacitor may suffer catastrophic failure, to the extent of developing a short circuit breakdown or suffering a pressure release where the internal electrolyte may evaporate. To overcome this the system designer would need to connect a diode in parallel to reduce the potential problem. So, although it is technically possible for aluminium electrolytics connected in series to attain the necessary higher voltage levels required by today's wind energy applications, the circuit design can be problematic, requiring the use of additional components or protection to ensure successful operation.

Fig. 5: The AVX FFLC capacitor.

Surge voltage is another important consideration. The capability of aluminium electrolytics to withstand surge voltages is limited to approximately 1.2 times the nominal voltage. This means designers must take surge voltage into account when specifying these types of capacitors. By contrast, higher voltage film capacitors (above 1350V) utilize non-toxic organic oil filled technology and can operate up to 100kV. These capacitors, along with the dry film technology discussed earlier, can be considered environmentally friendly solutions because they do not use acids and therefore do not represent a risk to the system itself. Both types of film capacitors can also be stored without concern, as, unlike electrolytic capacitors, they have no "dry out/wear-out" mechanism.

LIFE EXPECTANCY

Ultimately, the main advantage of film capacitors over aluminium electrolytic is life expectancy. Our internal data shows that AVX controlled self-healing DC filtering capacitors exhibit a maximum capacitance drop (ΔC) of just 2 percent after 100,000 hours of operation. When added to the fact that, compared to aluminium electrolytics complete device failure is very unlikely to occur, it means that during the full lifetime of an installed wind power system it will not be necessary to change the capacitors. This represents major maintenance savings for the user.

Since the early 1980s significant improvements have been made in the application performance of DC filter capacitors. This has been achieved through the use of either combinations of metallized films or by using different segmentations of metallization on the dielectric films. In fact, power film capacitor manufacturers continue to develop much thinner films and improved segmentation techniques, which will result in the continued release of superior performance devices.

SUMMARY

System voltages are continuing to increase in wind power/windmill applications. As these voltage requirements have risen they have passed the 600V barrier, which represents a major hurdle for aluminium electrolytics. These are limited in voltage and require connection in a series to successfully address this application, which can add significant cost in terms of space as well as being much more complex to design and install.

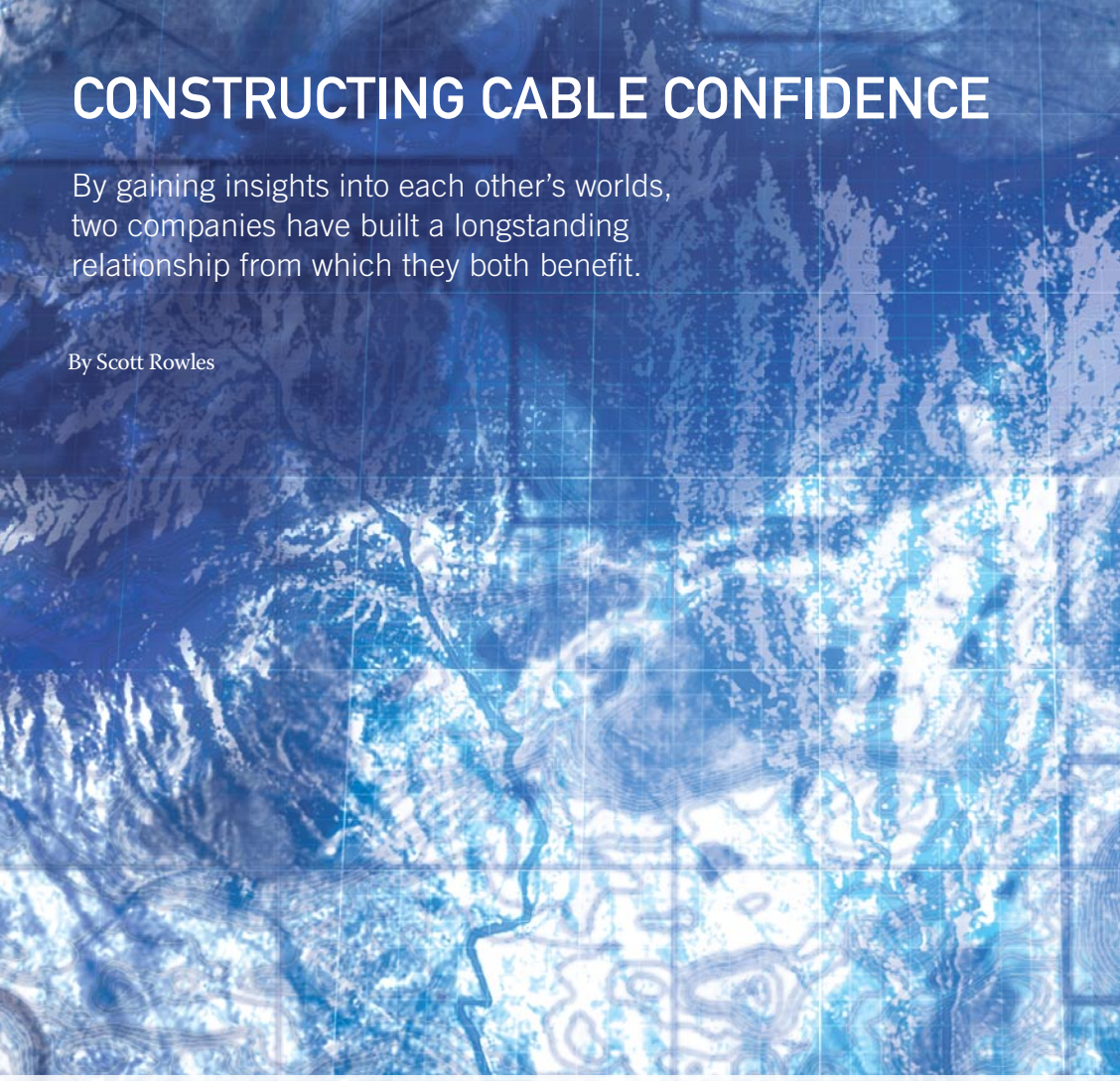
Film capacitors (both dry and non-toxic organic oil-filled) offer significant technological advantages, including superior life expectancy and environmental performance, as well as the ability to handle the various types of "in-application" technical issues (over-voltage and reverse voltage) that can easily occur. Considering that these systems are often deployed in remote locations, and given the fact that they require minimal maintenance and downtime, the advantages of using of film capacitors in this type of DC filtering applications are very significant. As a worldwide manufacturer of capacitors for power electronics, AVX is in a position to offer products best suited to these applications. Indeed, since 1980 great improvements have been made in DC filter capacitor technology by a combination of different segmentation schemes of the metallization matched to specific film dielectrics. Both volume and weight have been reduced by a factor of 3 or 4 over the last few years.

As a result of these key developments, several families of products have been generated over a wide range of capacitance values as represented by the AVX product families FFB, FFV3, FFVE, FFLI, FFLC. All of these products are widely used by AVX customers due to the advantages that they offer. For higher volume applications customers will often request a capacitor with specific characteristics tailored to the circuit. Again, AVX offers this type of solution, based on our long-time experience of capacitor design/manufacture for power electronics, typically producing more than 500 specific design studies each year. AVX also offers full design support in order to devise the optimum performance solution for a new project.

CONSTRUCTING CABLE CONFIDENCE

By gaining insights into each other's worlds, two companies have built a longstanding relationship from which they both benefit.

By Scott Rowles



Scott Rowles is director of marketing at MV Underground Cable. More information is available at www.hendrix-wc.com. Also go to www.cegengineers.com.

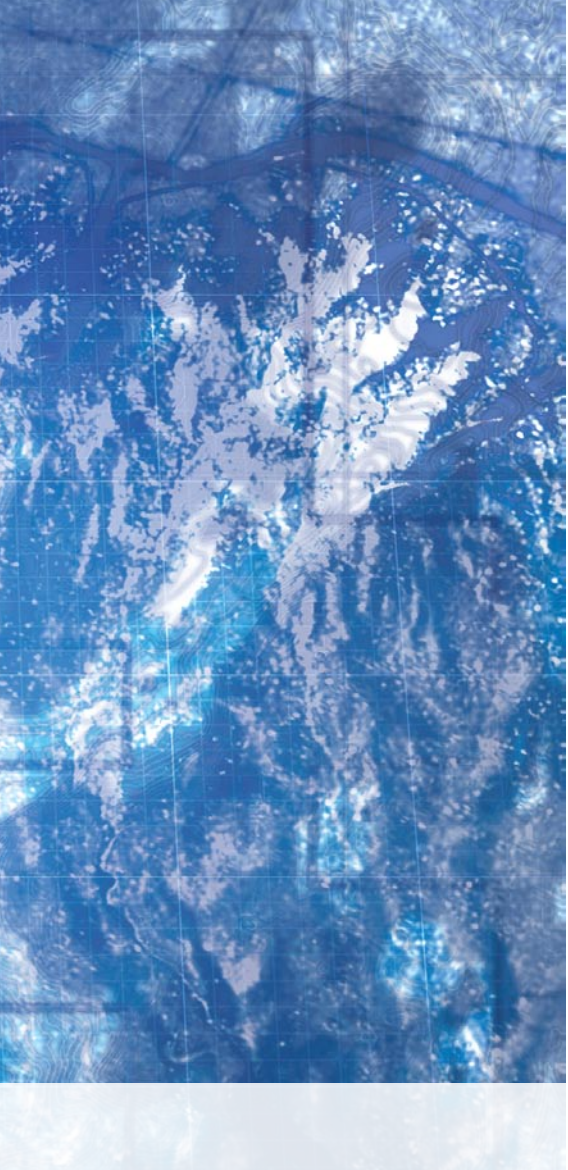
THE WINDS OF CHANGE have definitely been blowing at Consulting Engineers Group (CEG). A wholly owned subsidiary of Dakota Electric Association that provides high-quality, high-tech transmission and distribution engineering to the utility market, CEG has turned its attention to the burgeoning wind power market over the past five years, focusing on design and build work for wind farms in particular.

"It is far and away our biggest area of growth," according to Vince Granquist, a vice president and senior project engineer with the Minnesota-based firm. "At this point it's probably more than 75 percent of the company's focus."

Asked how this came about, Granquist says "I happened to see that a wind turbine was planned for Carleton College, which is a private liberal arts college in Northfield, Minnesota. I live in Northfield and know these people. Once we got interested in that project it kind of snowballed as we talked to other people building other small wind-related projects in Southwestern Minnesota."

CRITICAL COMPONENT

Once CEG began its journey down the wind farm road it gained valuable expertise that could only be acquired through firsthand experience. A key finding of CEG engineers is that designing and installing collection systems—including the 35kV cable portion, the substations, and the transmission line work



that accompanies it—is one of the most critical aspects of a wind farm project. To support this function CEG purchases hundreds of thousands of feet of 35kV TRXLP underground cable. Although the cable is a critical component of the system, it is a standard utility product that is used to connect the turbines, both to each other and back to the substation.

Given that this cable is viewed as a commodity, there are numerous reputable suppliers capable of providing a reliable product. Regardless of whether the end product is a cutting-edge wind farm or a traditional electric facility, the standard utility cable will do the trick. But how does a company determine which supplier is best? One thing that Granquist knows for certain is that while pricing is important, it is by no means a "make or break" purchasing parameter.

"Certainly you're always looking for the best price possible to lower total project cost," he says. "For a typical 100-megawatt wind-farm you can be talking about a million dollars worth of underground cable, so the pricing difference between two suppliers can be noticeable. On the other hand, for a 100-megawatt wind farm there's going to be about eight million dollars in total electrical work, so the decision is not entirely price-sensitive. The level of service matters much more than another tenth of a cent reduction in product price."

VALUE-ADDED VENDOR

Back in 2005, a time in which CEG was relatively satisfied with its cable supplier, Granquist became familiar with Hendrix Wire & Cable, an MV Underground Cable business. Hendrix's local representative, Chuck Healy of ElectroTech, Inc., began talking with CEG and asked that they listen to what Hendrix had to offer. Feeling that Hendrix might be a good fit with CEG, Granquist agreed, and found himself pleased with the quality and pricing of Hendrix's 35kV cable. What's more, Hendrix was excited about the prospect of bringing on another wind-farm customer. The first purchase order from CEG came in June 2006, and Hendrix eventually began providing two value-added services to its customer: "Bill and Hold," and "Capacity Planning."

Quite simply, Bill and Hold is a means of adjusting for the uncertainty in project lead times versus cable lead times. "Hendrix builds the cable based on the scheduling needs of a given project," Granquist says, "and then the company holds the cable on-site at no charge for an agreed upon timeframe. This program has provided CEG the certainty of cable availability combined with the flexibility to react to unplanned events."

> "It helps that Hendrix has been doing it long enough to know how the wind-power industry works in terms of the cable requirements for projects that are out in the middle of nowhere and released on a variable schedule."

This option gives CEG the ability to work within its clients' production schedules, which are often erratic at best, by providing what is essentially "just in time" delivery of the cable to the jobsite when the time is right. And not just in terms of actual installation, but ensuring that someone is at the site to take delivery.

"Cable manufacturing will consume a fixed amount of plant production time from when you issue a purchase order," Granquist explains. "You usually issue a purchase order

with a 'notice to proceed' contract, but without necessarily having everything nailed down as to when work will begin at the site. It becomes necessary to get the cable on order with the distinct possibility that even though the cable is ready, the site won't actually be available until the following month. In some cases the delay may be as much as two months."

The typical process would call for the vendor to manufacture the cable and deliver it to the jobsite, despite the fact that the site might be unprepared and nothing but a cornfield. This would require companies like CEG to make alternative storage arrangements. Furthermore, it means locating someone with equipment capable of unloading and moving thousands of pounds of cable. In this case the cable could sit for a month or more at the jobsite with no one to watch over it, exposed to damage or theft.

"Delivering the cable directly to CEG's offices would be a possibility, but it would have to be moved a second time to the job site," he adds. "Few people want to pick up and handle cable twice, incurring further cost."

OVERCOMING UNCERTAINTIES

Capacity Planning is another service that provides CEG with a greater measure of control over the sometimes uncontrollable scheduling of wind farm projects. This option provides CEG with access to the Hendrix production schedule on a regular basis, allowing it to modify items and quantities to respond to multiple wind projects in development.

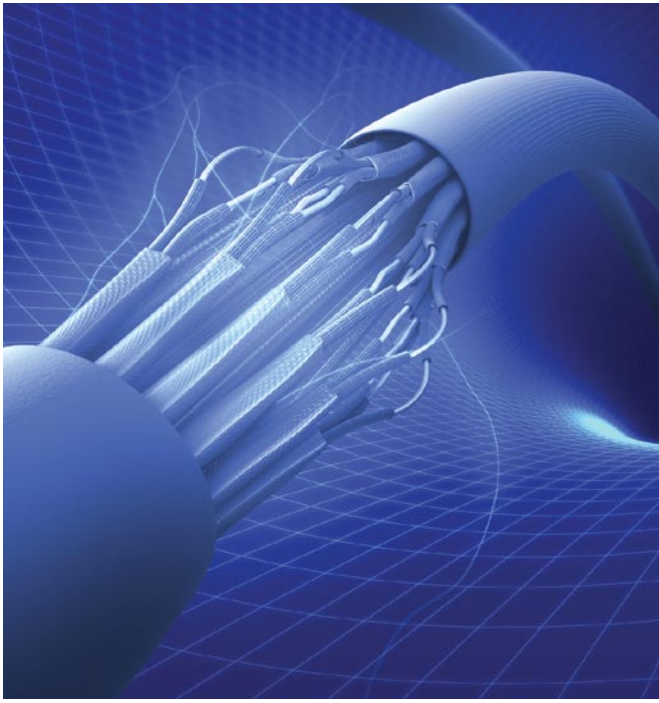
"If I suspect that a few projects are likely to be released over the course of the summer and fall, I can work out what I think might be the basic cable order, even if the projects aren't definite," Granquist says. "I can say to Hendrix, 'from a capacity planning point of view, plan on taking up a couple of slots in late July to deliver cable to me in early August, and I will confirm it on June 1.' That way Hendrix can have an idea of what CEG needs for possible production. In the event that one of those slots doesn't work out, we have at least established a 'fish or cut bait' date so that it doesn't become an economic problem for Hendrix. We essentially needed a procedure to address the fact that we know we're going to do something, but frankly until people stop moving turbines and tell us to go ahead we don't know exactly what. So a vendor with flexibility, in terms of how we fit things through their system and get it out the other side, is extremely useful."

These two programs—along with the consistent quality of the cable and the ability to produce specific lengths with virtually no overage costs—have helped Hendrix and CEG forge a mutually beneficial partnership. Hendrix's knowledge of the wind farm market and the challenges faced on the jobsite is an advantage that can't be overstated.

"Most of the firms that supplied primary cable to the electric utilities now supply it to the wind farm industry as well," Granquist observes, "but it helps that Hendrix has been doing it long enough that we can have shorter, more-productive conversations. We no longer have to work through the same issues over and over again. They know how the wind-power industry works in terms of the cable requirements that are unique to an industry whose projects are out in the middle of nowhere and released on a variable schedule. That's pretty handy to have."

CONCLUSION

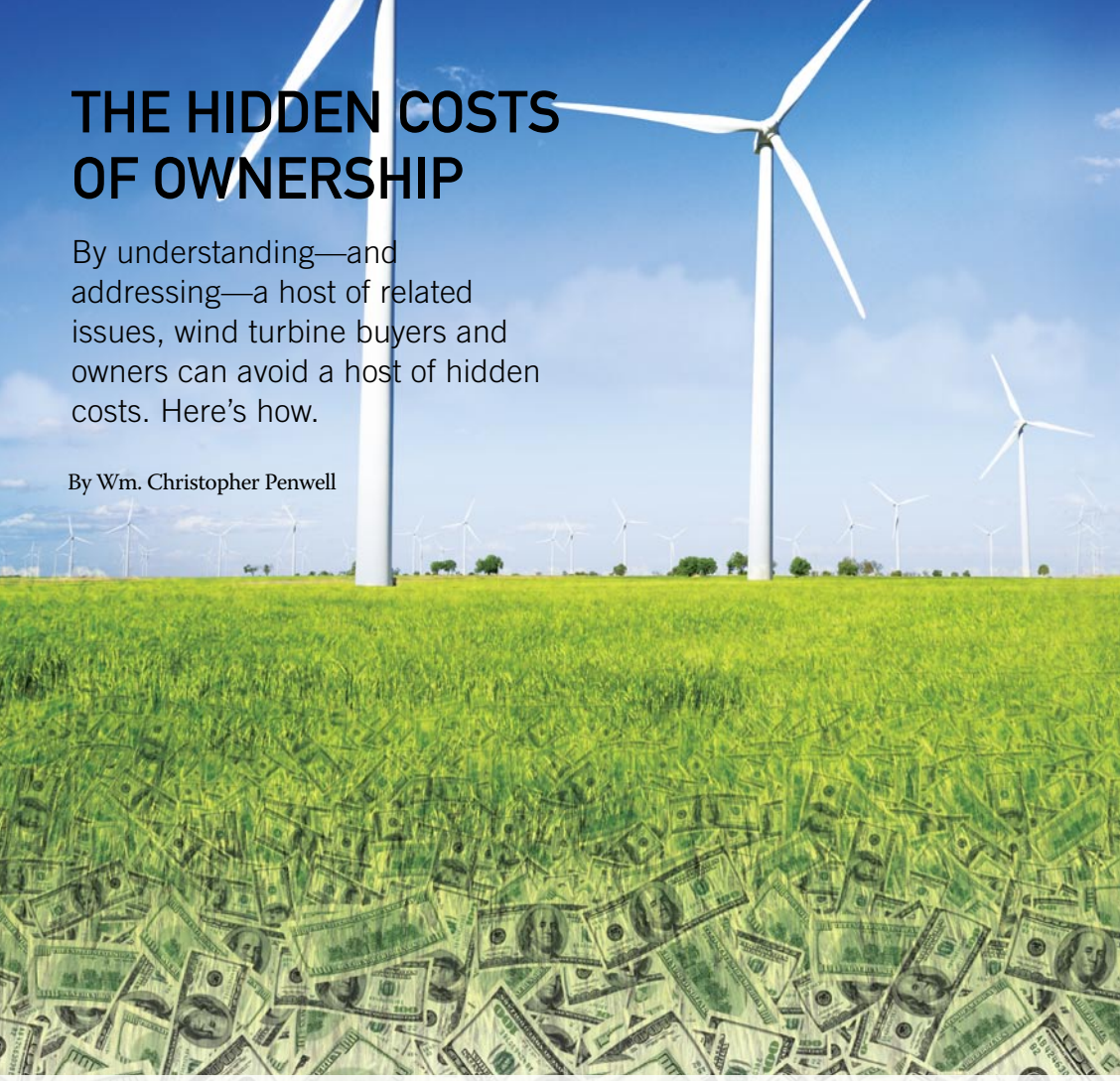
In the end, CEG and Hendrix have both gained insights into each other's world. CEG has learned about cable manufacturing, and Hendrix has become more knowledgeable about wind power project management. Through this close-knit relationship, both companies have crafted a unique approach to serving the wind power market.



THE HIDDEN COSTS OF OWNERSHIP

By understanding—and addressing—a host of related issues, wind turbine buyers and owners can avoid a host of hidden costs. Here's how.

By Wm. Christopher Penwell



Wm. Christopher Penwell is a shareholder with Siegel, Brill, Greupner, Duffy & Foster, P.A. He can be reached at (612) 337-6104, chrispenwell@sbgdf.com, or www.siegelbrill.com.

THE PURCHASE OF A WIND TURBINE is obviously a major financial commitment, not simply in terms of the cost of purchasing and erecting the wind turbine but also the ongoing cost of maintenance and repair. Beyond the costs that are plainly spelled out in the turbine supply agreement and service and maintenance contract, there are a number of potential hidden costs that could multiply the amount of your initial purchase many times over. This article is intended to help you avoid, or at least reduce, some of these hidden costs by addressing them before you enter into the turbine supply agreement, when your negotiating power is strongest. This article will also help you understand how other costs can be avoided or reduced by diligently monitoring the service and maintenance of your wind turbines. Finally, this article concludes with a discussion of the critical importance of conducting a thorough and independent inspection of your wind turbines before the warranty period expires.

HISTORICAL DATA

The manufacturer's marketing material for a particular make and model of wind turbine may not be the most accurate predictor of how it will actually perform. The material may state, for example, that the expected life of the turbine is 20 years, but historical experience may show that it is much shorter, on average. Other information may not be covered at all by

the manufacturer's published material, such as the average cost to maintain a particular make and model of wind turbine or the failure rate of the major components of that turbine. If, for example, the gearbox fails every six years on average as opposed to every 10 years, the cost of replacing the gearbox will significantly increase your overall cost over the life of the wind turbine. Historical data should be obtained from the manufacturer on the particular make and model you are researching, especially the failure rate of major components, including the total replacement cost and estimated downtime. A current price list for major components will also be useful for comparison purposes.

In addition to the manufacturer's historical data, information can also be obtained from other wind farms. Don't simply ask the manufacturer for their contact information, as they may "cherry pick" the wind farms that will give the most favorable report. Instead, ask for a list of wind farms that excludes specific contact information but includes geographic location, number of wind turbines and their MW capacities, the annual fee paid by the wind farm to the manufacturer and the services included in that annual fee. Then, assuming the wind farm consents, the manufacturer can provide contact information for the wind farms you pick. AWEA also has information about wind farms throughout the U.S.

ANNUAL/RENEWAL FEES

The wind turbine supply agreement will contain a two-year warranty, which you should extend by three or more years, and an annual fee for scheduled maintenance that is paid by the wind farm to the manufacturer. Once the warranty expires you will have to decide whether to enter into a service and maintenance agreement with the manufacturer or with a third party service provider. Significant factors in that decision will be the amount of the annual fee charged by each, what services are covered by the fee, and the capabilities of the provider to both respond quickly and obtain potentially scarce parts to minimize downtime. Before you purchase a wind turbine you should understand how the manufacturer calculates the renewal fee that will be charged in the event that you elect to have the manufacturer provide service and maintenance following expiration of the warranty. You should also know the manufacturer's standard length of the renewal term. Both the renewal fee and length of the term can often be negotiated.

The fees you pay to a manufacturer for maintenance and repairs generally have three components: the base cost component, the site-specific component, and the turbine-specific component. The base cost component is the starting point for determining the amount of the fee that will be paid by a specific wind farm. The site-specific component will adjust the base cost component by factoring in the number of wind turbines, the distance the manufacturer's service personnel will have to travel to reach your site, the weather conditions in the geographic area where your site is located, the ease or difficultly with which your site can be accessed, and other site-related considerations.

In addition to these first two cost components, the manufacturer will factor in the condition of your wind turbines at the time of renewal. The poorer the condition of your wind turbines, the higher the renewal fee is likely to

be. Ironically, the condition of your wind turbines at the end of the warranty period is directly tied to the initial design and manufacture of the turbines and the quality of the maintenance and repairs performed by the manufacturer during the warranty period, which we will discuss further. Whatever information you can obtain about these three cost components before purchasing a wind turbine will help you negotiate the amount of, or at least the formula for calculating, the renewal fee that will be charged at the end of the warranty period.

The manufacturer's historical average cost to maintain a particular make and model of wind turbine, and the failure rate of major components in that turbine, can significantly impact the amount of the renewal fee. As discussed in the preceding section, you can obtain from the manufacturer a list of wind farms so that you have a basis to compare annual/renewal fees and the services included in those fees. In order to have an "apples to apples" comparison you will need to look at comparable wind farms, in terms of the number and size of the turbines, site-specific conditions like location and weather, and the amount of the renewal fee paid by those wind farms and the services included in that renewal fee.

Finally, most renewal fees are adjusted annually so you will have to understand how the adjustment is calculated; e.g., it may be tied to a published index, or it may be a straight percentage. The more you know about the renewal fee calculation, the historical data that is factored in, what other wind farms are paying, and what services are included, the better armed you will be to negotiate the most services for the lowest renewal fee.

BUYER VS. SELLER RESPONSIBILITIES

Before you purchase a wind turbine determine whether you or the manufacturer are responsible for site preparation, soil tests, the wind turbine foundation and the transformer pad, constructing access roads, installation of fiber optic cable, and other similar responsibilities aside from erecting the wind turbine itself. To the extent that any of these areas are your responsibility, the manufacturer will not take responsibility if the wind turbine later has performance issues related to problems in these areas. Given the potentially catastrophic consequences of the wind turbine falling over and the enormous cost of correcting soil conditions or a defective tower foundation, the question of who has responsibility in each of these areas has a direct impact on your potential costs over the life of the wind turbine.

Some buyer responsibilities will be plainly set forth in the turbine supply agreement, but the attendant costs may not be. For example, you may be required to obtain permits, connect to the power grid, and install phone and fiber optic lines. These responsibilities should be spelled out in the contract, but you will need to research the cost associated with each of these responsibilities.

MANUFACTURER PERSONNEL, SUPPLIERS, AND SUBCONTRACTORS

It may be common sense that the quality of the service and maintenance that will be performed on your wind turbines depends on the quality of the service personnel who will be assigned to your wind farm, but owners often do not meet these personnel until after the contract is signed. As you are researching and comparing various makes and models, ask for the resumes of the service personnel who will be assigned to your wind farm. Find out who will be the primary contact person for service and maintenance issues, and talk to that person about the resources and support you can expect. In addition to the qualifications and experience of the service team that would be assigned to your location, find out how many other wind farms the team is assigned to, as this will affect their responsiveness. Lost production revenue caused by delays in performing repairs is a significant source of potential cost. Ask the manufacturer for information on the average delivery time for replacement parts and components and the average time to repair or replace parts and components, particularly major components. The unavailability of cranes is one of the most significant potential sources of delay in the service and maintenance of wind turbines. Your wind turbine could be down for weeks or even months if no crane is available. Ask the manufacturer for the name of the crane company it uses in your area, and talk directly with the crane company about response time. If possible, insert a provision in the turbine supply agreement or service and maintenance agreement that provides compensation for lost production in the event that your wind turbines experience significant downtime caused by crane unavailability, the manufacturer's failure to perform proper or timely repairs, or for other reasons that fall under the manufacturer's responsibilities.

This is another area in which talking to other wind farms can provide useful information about the manufacturer's track record of performing timely and proper scheduled service and unscheduled repairs.

CONTRACT WARRANTY AND REMEDIES

Before you purchase wind turbines you must understand ex-

actly what the warranty covers and the length of the warranty period. You must also understand what remedies are available to you if a manufacturer fails to perform under the contract. Oftentimes the contract will exclude certain types of damages such as lost production revenue, and there will be a cap on the total amount of the manufacturer's potential liability.

There are provisions you should attempt to insert into the contract. For example, the manufacturer should be required to maintain your wind turbines to a defined standard of performance. If the wind turbine's performance falls below that standard and the manufacturer fails to restore it to that standard after a reasonable period of time, you should have the right to fix or replace the wind turbine and charge that cost back to the manufacturer. You should attempt to include a clause that provides payment of liquidated damages if the manufacturer's failure to meet that standard causes lost production revenue. A final example is a provision requiring the manufacturer to indemnify you in the event that you breach your power provider agreement for reasons attributable to some failure or nonperformance of the manufacturer.

Before purchasing wind turbines, obtain a copy of the manufacturer's current service and maintenance agreement that goes into effect once the warranty expires. All of the issues discussed previously will have to be reviewed in connection with this agreement: amount and calculation of renewal fees, remedies and damage limitations and calculations, what is covered and what is excluded, and the like. If some of these provisions are not negotiated prior to purchase, you may have very little leverage to negotiate as the end of the warranty period approaches.

Your option to switch to a third party service and maintenance provider may be limited, as well. Most service and repair companies will charge a fixed annual fee for scheduled service calls and will charge on a time and material basis for unscheduled maintenance and repairs. The uncertainty and risk associated with this unscheduled maintenance and repair will heavily influence your decision as to who performs service and maintenance once the warranty expires. This issue is discussed in more detail in the next section.

BUYER BEWARE

After commissioning it is critical that you monitor at some level the service and maintenance that is performed on your wind turbines. Do not assume that such monitoring is unnecessary because your wind turbines are under warranty. At the very least you should have someone on your staff check the service log for each wind turbine to ensure that scheduled service visits are made on a timely basis and performed properly. Ideally that person will have regular and frequent contact with the service team, and will proactively work with them to schedule service and repairs and minimize delays and downtime. You should also hire a technical consultant at least annually to inspect the overall condition of the wind turbines and to identify warranty and repair issues. The technical consultant should also be present at the time of commissioning to identify any design or manufacturing defects, and to ensure that the wind turbines are properly commissioned.

Do not let your warranty expire without undertaking a thorough inspection of the wind turbine and submitting a complete list of warranty repairs. The warranty claims must be submitted to the manufacturer in a way that complies with the contract. For a more detailed discussion of pre-end of warranty inspections see the maintenance column by Merritt Brown of Rev1 Power Services in the March 2010 issue of *Wind Systems* magazine.

Remember, if you are responsible for conducting soil borings, constructing the tower foundation, connecting the wind turbines to the power grid, or other similar responsibilities, any defect or failure with respect to any of these responsibilities could form the basis for the manufacturer to avoid responsibility for mechanical failures in the wind turbines. Similarly, if you fail to identify or properly submit design, manufacturing, or mechanical defects or failures during the warranty period, you may not have a remedy against the manufacturer. Certainly, the condition of your wind turbines at the end of the warranty period could impact the amount of the renewal fee charged by the manufacturer, the amount of uncertainty and risk you face if you switch to a third-party service and maintenance organization, and the overall life of the turbine. Careful attention to all of these details will help ensure that your wind turbines operate for their full expected life.

CONCLUSION

This article is not meant to present an exhaustive list of all the potential hidden costs associated with purchasing and owning wind turbines. It is intended to alert you to issues that, if not addressed early, could result in you paying substantial costs not spelled out in the contract documents.

Note: The author gratefully acknowledges contributions to this article made by Dan Hayes, manager of Renewable Energy and Communications, Southern Minnesota Municipal Power Agency. He can be reached at dm.hayes@smmpa.org.

< Continued from page 15

C.V. helped coordinate transportation and car distribution. Last week the movement of the first two 50-car unit trains by KCSR was its first wind energy component movement from Port Corpus Christi. "We are very pleased to be able to work with KCSR," says John LaRue, executive director (see Q&A in this issue). "Having one more Class-I rail option to move the wind components from our port, along with our deep, uncongested channel and strategic location in the Gulf of Mexico, gives the port a better opportunity to serve the growth of wind energy components and other project cargoes."

The primary economic engine of the Coastal Bend, Port Corpus Christi is one of the 10 largest ports in the United States in total tonnage. The port's mission statement is to serve as a regional economic development catalyst while protecting and enhancing its existing industrial base and simultaneously working to diversify its international maritime cargo business. Strategically located on the western Gulf of Mexico, with a straight 45 foot-deep channel, the port provides quick access to the Gulf and the entire United States inland waterway system. The port delivers outstanding access to overland transportation with onsite and direct connections to three Class-1 railroads and uncongested interstate and state highways. The port is protected by a state of the-art security department and an award-winning environmental management system. With outstanding management and operations staff, Port Corpus Christi is clearly "More Than You Can Sea." To learn more call (800) 580-7110 or go online to www.portofcorpuschristi.com.

AMSC RECEIVES LARGE GRID INTERCONNECTION ORDER

American Superconductor Corporation, a global power technologies company, announces that Vestas Australian Wind Technology Pty Ltd has placed an order for a large D-VAR-based grid interconnection system. Utilizing 24 D-VAR modules integrated with external smart-switched capacitor banks and proprietary controls that are optimized for wind farm applications, this is AMSC's largest order for a grid interconnection system to date. The solution will be utilized to meet local grid interconnection requirements for the 206 MW Collgar Wind Farm under construction in Western Australia. AMSC expects to deliver the D-VAR equipment to Vestas within approximately 12 months. AMSC's grid interconnection solutions are already connecting more than one-third of Australia's wind power to the power grid.

Based in the city of Melbourne, Vestas Australian Wind Technology Pty is a wholly owned subsidiary of Denmark's Vestas Wind Systems A/S. With more than 40,000 wind turbines operating worldwide, Vestas is the world's leading supplier of wind power solutions. The company has more than 20,000 employees worldwide and annual revenues of approximately $9 billion.

"Australia was among the first countries to adopt dynamic voltage control requirements for wind farms connecting to the utility grid," says Timothy Poor, senior vice president of global sales and business development at AMSC. "We expect that additional countries around the world will adopt similar strict dynamic voltage control requirements to more effectively control power flows stemming from the utility-scale wind farms and solar power plants that are being installed around the world. This, in turn, will help expand our addressable market."

Customers utilize AMSC's D-VAR solutions to provide dynamic voltage control, power factor correction, and post-contingency reactive compensation to stabilize the power grid and prevent undesirable events such as voltage collapse. These solutions also augment the overall performance of wind farms and enable developers to meet grid interconnection requirements adopted in countries such as Australia. D-VAR reactive compensation systems are classified as Static Compensators, or "STATCOMs," a member of the FACTS (Flexible AC-Transmission System) family of power electronic solutions for alternating current (AC) power grids. These smart grid solutions are able to detect and instantaneously compensate for voltage disturbances by dynamically injecting leading or lagging reactive power into the power grid. Learn more by calling (978) 842-3000 or going to www.amsc.com.

NEW GROUP CEO AT KENERSYS

Kenersys, a Kalyani Group Company and wind turbine manufacturer, has appointed Paulo Fernando Soares as the Group CEO. Prior

to joining Kenersys he worked as the CEO of Suzlon China in Beijing for a period of five years. Under his leadership Suzlon has successfully negotiated significant amount of contracts in the Chinese market, which have allowed the company to secure a place as one of the leaders among the international players in the industry in China. As the CEO of Suzlon China he was responsible for developing its business from a start-up phase to a completely established plant with a capacity to manufacture 600 MW per year.

Fernando has over 15 years of experience in the hydropower business in Brazil and China. He has worked with Siemens Hydro in Brazil, followed by Voith Siemens Hydro joint venture in Shanghai, China. During his tenure with Siemens he acquired in-depth knowledge across functions such as market development, manufacturing, project management, engineering, and controlling. His last position was vice president of project management at Voith Siemens Shanghai in China from 2000 to 2005. He has a bachelor's degree in mechanical engineering and an executive MBA in general management.

Kenersys presently has two operating entities in Germany and India (Kenersys Europe GmbH and Kenersys India Private Limited respectively) for manufacturing, assembling, marketing, and servicing wind turbines. Kenersys is co-funded by First Reserve Corporation, a leading U.S.-based private equity firm.

"We are happy to have Paulo as a part of our team and the new Kenersys Group CEO," says Baba Kalyani, chairman of the Kalyani Group. "Paulo brings with him rich and unique experience in the area of renewable energy. This will help us create opportunities and take Kenersys to the next stage, both in Europe as well as in India."

"I'm delighted to have been given this opportunity," Fernando says. "Together with the team at Kenersys it will be my endeavour to take this company to greater heights in the wind energy business." For more information visit www.kenersys.com.

DAKOTA WIND ENERGY AWARDED BACKFILL STATUS

Dakota Wind Energy, along with its managing member, National Wind, announces the acceptance by the Midwest ISO (MISO) of its 300 MW interconnection request into the Big Stone II Transmission backfill study group. Regional electrical transmission operator MISO identified wind projects that can utilize, or "backfill," the electrical capacity once reserved for the Big Stone II coal plant. As a result, Dakota Wind Energy's interconnection request will move into a more advanced MISO study phase, in which additional required system upgrades will be identified. Once all of the upgrades are studied and established Dakota Wind Energy can enter into a generator interconnection agreement, allowing us to interconnect the initial 300 MW portion of the Dakota Wind Energy project to the transmission grid.

Dakota Wind Energy was formed by National Wind in partnership with local landowners in January 2008. The project's goal is to develop up to 750 megawatts of community-owned wind energy in Day, Roberts, and Marshall counties in northeastern South Dakota. Currently, Dakota Wind Energy has leased approximately 60,000 acres and recorded over two years of on-site meteorological tower data, which has indicated an excellent wind regime. The project has also completed its initial environmental assessments and filed a draft site permit with the South Dakota Public Utilities Commission. For more information go to www.dakotawindenergy.com or www.nationalwind.com.

NEW RENEWABLE ENERGY BUSINESS UNIT AT MAG

MAG Industrial Automation Systems is powering up on green energy, announcing the formation of a new Renewable Energy Business unit to design/build automated manufacturing systems for solar panels and wind turbine components. The new business's operations are based in Schaffhausen, Switzerland, and Hebron, Kentucky, and are headed by Dr. Siegfried Schmalzried in Europe/Asia and Joe Jones in the Americas. According to Jones, the renewable energy business is off to a strong start. "In recent months we have secured $30 million in contracts," he says, "representing an approximate 30 percent share of our targeted market, putting us on track for our goal to produce 10 percent of MAG's annual revenue," he says.

MAG is currently sharing in a $7 million grant from the state of Michigan to develop a revolutionary wind hub machining cell for high-volume manufacturing and pursue development of carbon-fiber turbine blades. MAG is also focused on expansion to serve customers in emerging sectors in key markets. "We opened a new Composites Technical Center in Göppingen, Germany, in 2009, and a new plant in Changchun, China, earlier this year," Jones says, "so now have 24 worldwide facilities, 15 of them in Europe and Asia." To learn more call Mark Logan at (859) 534-4600, e-mail info-us@mag-ias.com, or go to www.mag-ias.com.

ADINDEX

John LaRue
Executive Director/Port Corpus Christi

WHAT MAKES PORT CORPUS CHRISTI IDEAL FOR WIND-INDUSTRY TRANSPORT?

Our location, first of all. So many manufacturing facilities are being built within our reach, and even beyond the huge number of wind farms that already exist or are currently in development in Texas, we service many other active areas such as Colorado, Iowa, North and South Dakota, and up into the Midwest. You can have all of the other components in place, but if you're not centrally located then you aren't even going to be considered. It's also about the ease of shipping from the port to the job site, and that's another area where we really excel since it's a straight shot from Corpus Christi north to San Antonio, where interstates 10 and 35 intersect and you can basically head in any direction you need to. And when you're leaving port property you don't have to pass through any neighborhoods or areas with tight turns that make trucking large wind components difficult. Not only does that save a lot of time and unnecessary headaches, it decreases the risk of damaging the merchandise. So the unfettered access to the interstate systems is a huge advantage, and rail infrastructure is also critical. We have three class-I railroad companies operating here, including Burlington Northern Santa Fe, Union Pacific, and Kansas City Southern, all of which have shipped wind turbine parts from here to the job site. Kansas City Southern just made their first wind shipment from Port Corpus Christi recently, in fact, and it went so well that they featured the project on their Web site, emphasizing how the close cooperation between the manufacturer, port, and railway really made all the difference. They were very pleased by how well everything went, and so are we.

WHAT ROLE WILL THE PORT PLAY IN SUPPLYING WIND FARMS THAT WILL BE DEVELOPED OFF THE U.S. COAST?

In that case parts will be shipped to us from manufacturing facilities located here in the States or overseas for storage, prepping, and some assembly work before they're transferred to the vessels that will carry them out to the offshore site. It will be a very different situation than what we encounter handling components for onshore wind installations, mostly because offshore blades, towers, and other components are so much larger than what's typically found inland. So that means you need plenty of unrestricted space both for handling as well as storage, and you want it to be fenced in and lighted for security, as our yards are. One thing we'd like to see whether we're talking about onshore or offshore wind farms, though, is for manufacturers to realize the many advantages of building their facilities near the port, which is something our economic development team is really focusing on. That way every one of the benefits we're discussing here would be immediately available to them, with the related cost savings as well.

IS THERE ANY SPECIAL EQUIPMENT OR TRAINING INVOLVED IN HANDLING THESE HUGE PARTS?

We do a lot with the military, so we're accustomed to handling large pieces such as jeeps, tanks, and Humvees, and we already have the equipment we need to lift and position loads of any shape and size. The real secret is in having people handling this sensitive, expensive cargo who know what they're doing. We work with Gulf Stream Marine, which is one of the largest stevedore companies in the Gulf Coast area, and they do provide their employees with specific training on how to work with wind components. Our entire labor force has really been proactive in making wind a priority project for us, and to make sure that we're doing things right. We also work very closely with logistics service providers, keeping the lines of communication open as to when their customers' shipments will be arriving, and what they'll need once they get here. We understand that companies lose money when the parts they need don't arrive on time, so we take our role in all of this very seriously, and we're eager to prove why we're a premier port of entry for shipments destined for the new wind farms being brought online and in development across the United States.

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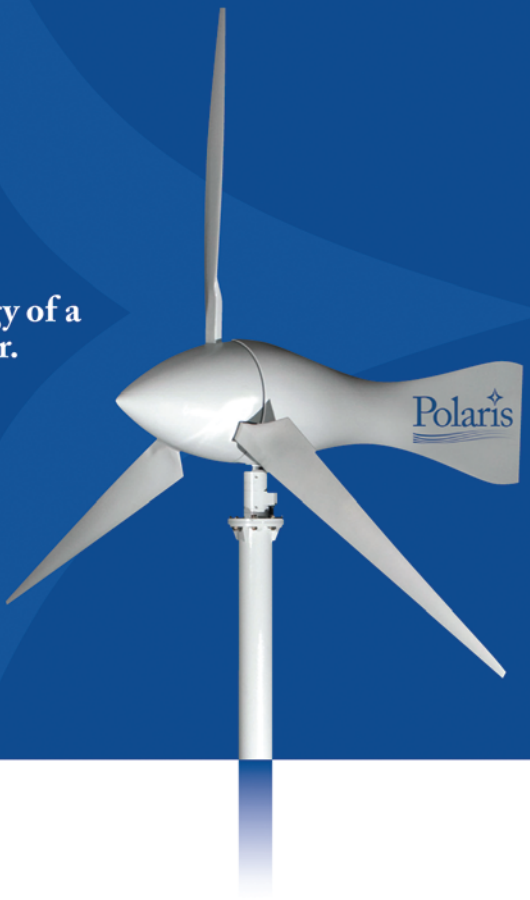

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