AUGUST 2010

WIND SYSTEMS

FEATURES

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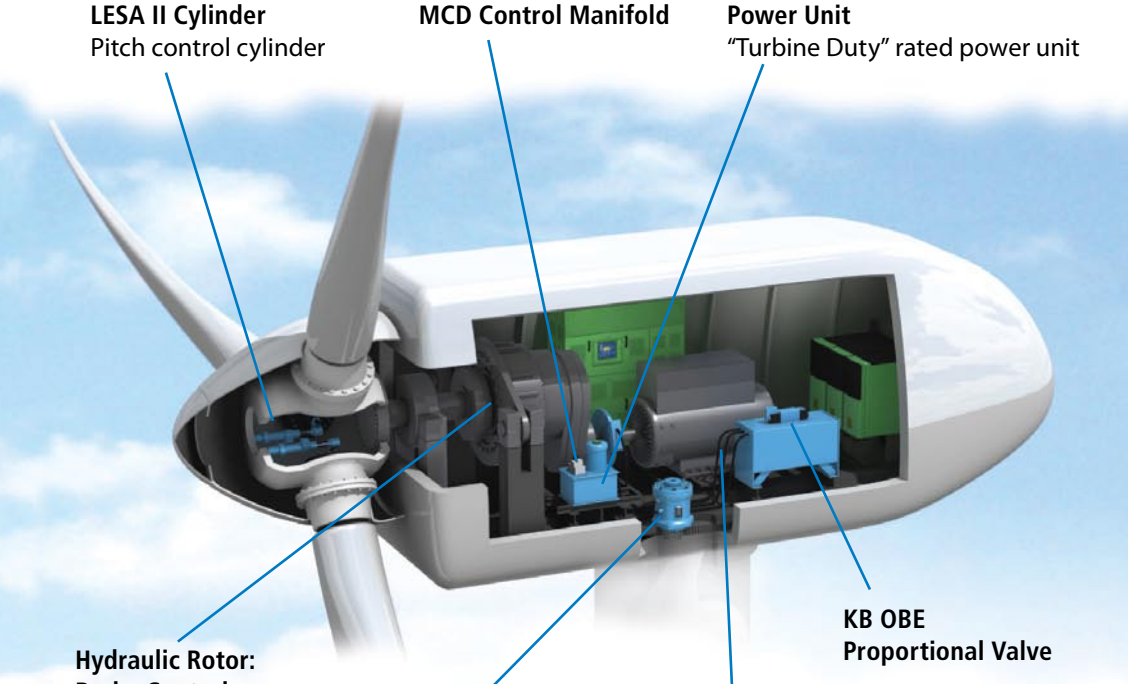

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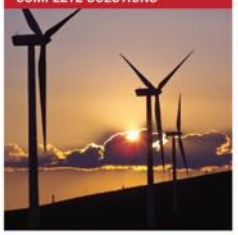

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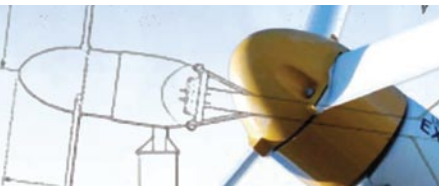

DEPARTMENTS

VOLUME 2 NO. 12

RESOURCES

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Cover Photo: World Wind Services

EDLETTER

More often than not, wind energy companies based in the United States are relatively young. Some originated in other countries, or as divisions of larger corporations, but it's a simple fact that the wind industry has a longer history overseas and is at an earlier stage of development throughout North America. That's why it's so interesting to find that three of the articles appearing in this issue focus on companies or projects that have been around for decades. This month's profile, for instance, is on the Bergey Windpower Co., which was established in 1977 and has been at the forefront of small-wind development ever since. In addition, Q&A subject Susan Giordano—general manager of Second Wind, which manufactures wind-measurement devices and provides related services—shares the company's history dating back 30 years to 1980. And our cover story by Nikki Cummings, co-owner and president of World Wind Services, is devoted to the Tehachapi region of California, which is also celebrating its 30th anniversary as what the author describes as "the birthplace of wind in North America." We hope you enjoy reading the perspectives provided by just a few of the people who've had a front-row seat to the growth and development of the U.S. wind industry.

As for the rest of our features, Scott Starr of Firetrace International has written an excellent piece titled "Turbine Fire Protection" discussing fire detection and suppression techniques and equipment, and Carolina Osorio Gil of International Climbing Machines (ICM) describes her company's robotic service devices in "Remote-Controlled Tower Maintenance." Hermann Siebert of Klüber Lubrication has contributed "Lubricating Gears with Synthetic Oils" outlining the properties of that particular blend, and Belinda Jones describes Hexagon Metrology's precise and extensive line of measurement equipment in "Metrology for Wind Applications." Taking the mile-high view, Ronan Murphy of VB/Research discusses the current state of wind development around the world in "Clear Skies for Global Wind Activity." Jose R. Zayas and David Wilson of Sandia National Laboratories address wind turbine controls in their technology column, and Eric Drooff of Hayward Baker describes how rigid inclusions are used on his column on construction. Remote monitoring is the subject of Merritt Brown's maintenance column—he's with Rev1 Power Services—and Hüseyin Kizilagac of BDP Project Logistics makes clear the importance of developing emergency logistics plans in advance of unexpected delays.

With articles providing glimpses into the past, present, and future of the global wind industry in this issue, we hope you'll consider contributing your own story in the coming months. I look forward to hearing from you!

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Operations

Maximum availability is on the horizon.

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Times are changing. As rotor blades and tower sizes increase and manufacturer warranties expire, wind turbine operators have to review their O&M strategies. With more than 150 employees and backed by 30 years of wind related experience, SSB Service is positioned to take your wind turbines to the next level of performance. Our goal is to help you achieve maximum availability over the life span of your wind turbines.

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HIGH-SPEED TRANSFER VESSELS FOR OFFSHORE WIND FROM AUSTAL

Austal's Wind Express series of vessels combine fuel efficiency with advanced sea keeping characteristics to deliver a premier transportation solution for offshore wind farm operators. By utilizing Austal's world-renowned advanced hull design and engineering capabilities, each vessel is purpose-built to deliver a rugged, reliable, multipurpose workboat platform. Among the many significant features of the Wind Express series is the option to install Austal's patented Ride Control System (RCS)—a first for offshore wind farm vessels—to ensure a safer, more-productive platform, even in rough seas.

Austal Chief Operating Officer Andrew Bellamy says the vessels would introduce new levels of productivity and safety to the growing offshore wind farm industry. "In this industry reliability is paramount; not only in terms of machinery but also in the ability of the vessels to transfer personnel to and from wind turbines in comfort and safety," he says. "With our Wind Express series we have introduced platforms that not only deliver reliability, but also have the capacity to operate in rougher waters at higher speeds and greater efficiency. These are important characteristics as wind farms are constructed further offshore."

Characterized by their optimum passenger comfort and safety, each vessel in the Wind Express series can be further customized to suit specific sea conditions, routes, work space, and payload requirements. The series incorporates four vessels: *Wind Express 17, Wind Express 19, Wind Express 28, and Wind Express 28-Tri SWATH*. These vessels feature a selection of hull forms ranging from a refined catamaran design for added stability and efficiency to the Austal-developed tri-SWATH hull form delivering unparalleled sea keeping and onboard comfort in up to sea state 6. Like all Austal vessels, the Wind Express series offers the peace-of-mind that comes from dealing with an ISO 9001:2008 quality certified shipbuilder with an established network of vessel support and maintenance centres worldwide.

As the largest aluminium shipbuilder in the world, Austal also has the unrivalled production capacity to facilitate fast, cost-effective delivery of multi-vessel fleets.

Austal has delivered more than 220 vessels to over 36 different countries over two decades. To learn more call

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.

61 8 9410 1111, e-mail sales@austal.com, or go to www.austal.com.

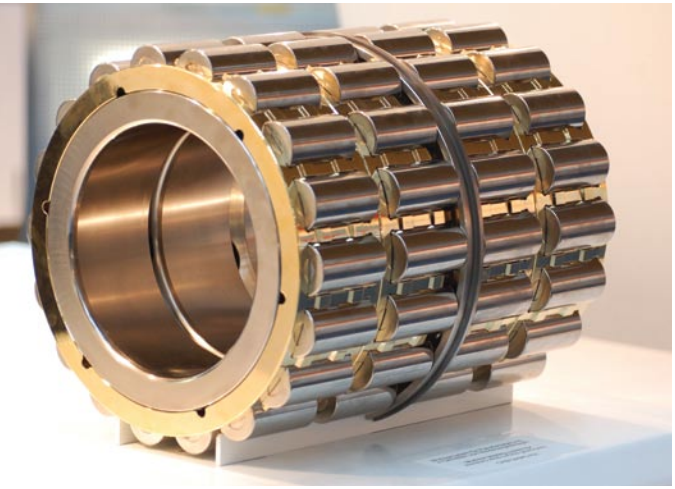
NEW CEO AT REPOWER SYSTEMS

The supervisory board of REpower Systems AG has agreed upon the appointment of Andreas Nauen as member and chairman of the executive board as chief executive officer in its meeting in June. Nauen took office on 1 July 2010. His contract provides for an appointment term of three years as from 1 July 2010 and includes an optional extension for another term of two years. As planned, the current chairman of the executive board, Per Hornung Pedersen, has resigned from his office as chairman and will remain on the board as chief market officer.

REpower Systems AG, a Suzlon group company, is one of the leading manufacturers of onshore and offshore wind turbines. The international mechanical engineering company develops, produces, and markets wind turbines with rated outputs of 2.05 MW to 6.15 MW and rotor diameters of 82 meters to 126 meters for almost any location. The company also offers a comprehensive portfolio of service and maintenance packages. The profitable and reliable systems are designed at the REpower TechCenter in Osterrönfeld and manufactured at its plants in Husum (North Friesland), Trampe (Brandenburg) and Bremerhaven, as well as Portugal and China. With about 2,000 employees worldwide, the Hamburg-headquartered company can make use of the experience gained from the manufacture and installation of over 2,000 wind turbines around the world. REpower is represented by distribution partners, subsidiaries, and participations in European markets such as France, Belgium, the UK, Italy, Portugal, and Spain as well as on a global level in the United States, Japan, China, Australia, and Canada. Learn more at www.repower.de.

BEARING SYSTEMS FOR PLANETARY WIND TURBINE GEARBOXES FROM NKE

Austrian bearing specialist NKE introduces modular bearing systems for planetary gears in wind turbine gearboxes. The new bearing assemblies offer the advantages of a standardization of the bearings used in this application, a reduced diversity of parts and simplified logistics. Many wind turbines are equipped with single- or two-stage planetary gearboxes. Because the bearings of the planetary gears are among the highest-loaded in this specific application, integrated bearing assemblies have decisive advantages. NKE's bearing systems consist of cylindrical roller bearings that are fitted directly into the



planetary gear. The bore of the gear acts as the outer raceway, so that the bearings themselves do not have an outer ring.

The bearing systems are developed to customer specifications. For gearboxes rated 1.5 MW, 2 MW and 2.5 MW NKE has already realised projects with such modular systems consisting of single-row cylindrical roller bearings without outer race. The bearings have bore diameters of 160, 190 and 200 mm, with versions up to 220 mm currently being developed. The choice of bearing depends on the available space—in particular when replacing existing bearings—as well as customer requirements. To further boost their load capacity, the cylindrical roller bearings feature an improved internal design that is even stronger than that of the standard types. These bearings are fitted with an inner race-guided, one-piece brass cage, which contains inspection grooves for endoscopic condition assessment of the inner race surface as standard. For higher loads and wider gears, the bearings can be assembled to sets of two, three, or four bearings.

Beside modular planetary gear bearings, NKE also supplies all other bearings for use in wind turbine gearboxes, main shafts, and generators. These include full complement cylindrical roller bearings as well as cylindrical roller bearings with cage, taper roller bearings, spherical roller bearings, and four-point contact and deep groove ball bearings. For more information call Dick Scott, U.S. representative for NKE AUSTRIA GmbH, at (518) 371-5759 or visit www.nke.at.

ZF TO SUPPLY GEARBOXES TO VESTAS

ZF has signed a contract with global wind energy market leader Vestas to supply wind turbine gearboxes. Production is scheduled to begin in early 2012 at the new U.S. facility under construction in Gainesville, Georgia, with the goal of eventually producing 2,000 gearboxes per year for the growing wind power industry. In addition, ZF will add manufacturing test stands for the wind gearbox industry to its substantial experience in providing engineered end-of-line and development test benches.

ZF has been providing service for the wind power industry since 2007, and is currently investing in service centers for wind turbines in Dortmund, Germany and in the United States. “We will leverage our expertise and leadership in designing and building world-class drivelines for the transportation sector to enter the growing and exciting field of alternative energy,” says ZF Group CEO Hans-Georg Härter. “This will diversify our core business and expand our product portfolio.”

ZF aims to achieve annual gearbox sales of more than $200 million. With more than 40,000 turbines in 63 countries, Vestas is the world leader in wind power. The Danish company has been in the wind turbine business since 1979. ZF is investing about $90 million to build the new Gainesville facility, which will

employ about 200 workers. "We are delighted that ZF has chosen to enter the wind industry and work with Vestas as gear box supplier," according to Soren Husted, president of Vestas Nacelles. "ZF's global position as transmission supplier in the automotive industry and its high quality and productivity standards are fully in line with our manufacturing and sourcing strategy and the cooperation with ZF will strengthen our supply base of gearboxes."

Last year at its Dortmund/Holzwickede site in Germany, ZF invested $9 million euros establishing a service competence center for wind power. By 2012 various brands and models of wind turbine gearboxes will be serviced and overhauled there. By 2014 ZF Services aims for its worldwide wind energy sales to rise to $50 million euros. ZF is also constructing a loading test rig with a four-megawatt performance capacity. More information is available at www.zf.com.

PARKER PISTON ACCUMULATORS FOR CRITICAL WIND TURBINE APPLICATIONS

Hydro-pneumatic piston accumulators from Parker Hannifin Corporation, the global leader in motion and control technologies, provide long-term effectiveness in critical wind turbine applications through significantly lower maintenance and servicing costs. Piston, bladder, and diaphragm hydro-pneumatic accumulators are used in a variety of wind turbine applications, including use with a power unit and pitch cylinder to feather blade pitch that enables the turbine to continually extract maximum power during fluctuating wind speeds. In addition, during excessive wind conditions or power failures an accumulator acts as an auxiliary power storage device to quickly and safely rotate the blade to a null position. Both the high speed shaft brake and yaw brake systems also employ accumulators as a fail-safe source of auxiliary power.

"While all three types of accumulators are used in wind turbine applications," says Mike Schubert, marketing manager. "Piston accumulators, because they have less frequent service intervals and maintenance requirements compared to bladder or diaphragm units, will provide a lower total cost of ownership, saving substantial operating costs over the life of the turbine. As a general rule of thumb maintenance and service requirements for piston accumulators are 1/4 of that for the other two types."

Bladder and diaphragm accumulator operation depends on molded flexible rubber bladders or diaphragms. Should there be a failure, it is sudden and allows the stored nitrogen gas to enter the system. Because of their small seal piston accumulators fail gradually and allow plenty of time for scheduled maintenance. "What most designers don't account for in bladder and diaphragm accumulators is the inherent loss of pre-charge that occurs over time due to gas permeation through the flexible rubber compounds," according to Chuck Taylor, project engineer. "And if a low temperature compound is used because of the wind turbine site location, the tradeoff to its use is higher gas permeation rates through the compound at working temperature, hence more frequent service checks are required to ensure that the proper pre-charge is maintained."

Parker's piston accumulator capability includes 1.5- to 20-inch bore sizes with capacities up to 200 gallons. All are designed to fit specific wind turbine applications utilizing a total custom-based systems approach that includes application engineering and worldwide support. To learn more contact an applications engineer at the Parker Global Accumulator Division at (815) 636-4100. Also visit www.parker.com/accumulator.

LARGEST MMZ G GANTRY MEASURING MACHINE FROM CARL ZEISS

Carl Zeiss Industrial Metrology recently set up the largest MMZ G gantry measuring machine. This highly accurate coordinate measuring machine has a measuring range of 5 x 11 x 3.5 meters which is excellent for the measurements of wind turbine components.

Gearboxes are a major part of all wind turbines, and the quality requirements are high. The industry has to meet these requirements, despite the fact that not many manufacturers have been able to produce such large gearboxes. Also, with the prospect that the new offshore

systems being created, the size of the units will have to increase further. All this means that manufacturers have been faced with the problem of going into large-scale production not knowing the quality requirements for such large pieces of machinery. Gears—ring gear, sun gear, and planets—bearings, and housings have to be produced with tolerances down to 1/100mm on components with 4m and more in diameter. It is no longer possible to machine these parts without specific measures to ensure the quality: The parts are too expensive to produce rejects. So a reliable control of the manufacturing process has to be installed, in real time to the machining. Finally, there is the MMZ G for really large, precision-engineered components. The flexible modular system of the MMZ G line enables full customization. Currently, measuring ranges of up to 5 meters in X, 11 meters in Y and 3.5 meters in Z are available. Additional dimensions are available upon request. On the largest model, the linear measuring uncertainty MPEE is no more than 7+L/250 µm. Combined with proven ZEISS measuring technology, the gantry design ensures the reliability of the results.

MMZ G coordinate measuring machines can accommodate parts on the ground or on a clamping plate. Special loading systems considerably reduce downtimes. For example, a pneumatic pallet system was developed for a manufacturer of printing machines to keep set-up times short and optimally utilize the capacity of the measuring machine. Together with CAD-based CALYPSO® measuring software, VAST® technology from Carl Zeiss optimizes measuring processes. It can deliver form, size, and position information, and also determine the roundness of parts in a single measuring run. Make inquiries by calling (800) 327-9735, e-mailing imt@zeiss.com, or visiting www.zeiss.com/imt.

EXPANDED CAPABILITIES, PROMOTIONS AT GEAR TECHNOLOGY

Gear Technology—a leading international precision gear manufacturer and related services provider—has recently announced the promotion of two senior-level managers. Joe Campa, formerly quality assurance manager, has been promoted to director of engineering. A 10-year veteran of the company, he was previously employed with Boeing Space and Communications Group as a procurement quality specialist and has held quality management positions with Kosmo Gears and Newman Machine Works. In his new position he will be responsible for the company's integrated engineering department. Jerry Flores has been elevated

from quality assurance representative to quality manager. His new management responsibilities will include the implementation and maintenance of the company's ISO9001:2008/AS9100 AMS quality standards, inspection, employee training, safety, internal and external audits, performance monitoring, and lean manufacturing.

"We are pleased to recognize the dedication and performance of these two long-term employees who have demonstrated their commitment to the company's business goals and customer service value standards," according to Tom Marino, president. "Our integrated manufacturing processes, including sophisticated job tracking systems, ensures products are produced with careful attention to the most intricate engineering detail and product specifications. The company also offers gear blanking, engineering consultation, and sophisticated inventory management services."

The company has also acquired a new Zeiss Prismo Navigator Coordinate Measuring Machine; the most advanced measurement technology available that provides highly accurate, complete, and precise gear measuring and analysis. "It's a versatile system that can handle a large range of gear configurations, including spiral bevel gears, Gleason bevel straights, internal and external spur gears, worm gears, helical gears, and internal and external splines up to 25.50 inches in diameter," Flores explains.

In addition to the Prismo Navigator CMM, Gear Technology has purchased a new Fellows CNC Gear Shaper to break into the green energy market. "This advanced gear shaper will allow us to cut gears up to 20 inches in diameter so we can expand our customer base with companies in the clean and wind energy industries," says Tom Cruse, director of operations. "We will now be able to fabricate larger gears, and full gearbox designs and assemblies."

The company has been manufacturing quality precision gears for some of the world's largest and most widely recognized aerospace, military, and commercial manufacturers since 1986. Today the company occupies over 16,320 square feet of modern manufacturing space with state-of-the-art, computer-controlled equipment. Contact Marino at (909) 476-0343 or tmarino@gear-tech.com. Visit online at www.gear-tech.com.

TRANS-UNITED WINS TRUCKING SAFETY AWARD

Trans-United, Inc., of Burns Harbor, Indiana, was named the Overall Grand Safety Winner during the IMTA's (Indiana Motor Truck Association) annual spring council conference

Trans-United

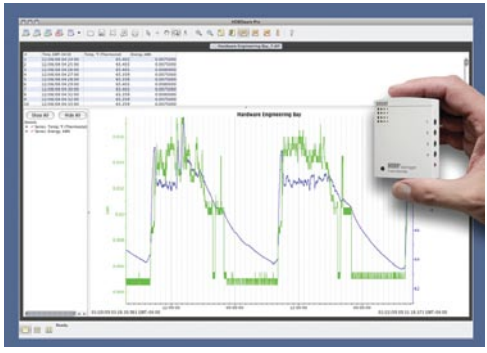
held in May. As seen in the accompanying photo the award was presented (from left) to Tom Boo, director of safety, and Jeff Fleming, president. They were joined by L. Cook of the company's sponsor, Volvo North America. The trucking company qualified for this award by entering in IMTA's 2009 Fleet Safety Contest and winning in the "Over the Road" zero to 1,000,000 miles category and the Local Division," also ranging from zero to 1,000,000 miles.

Established in 1964, Trans-United is a specialized carrier and serves 48 states in the U.S., in addition to Canada and overseeing other international moves. Typical loads are components for wind, transformers, construction equipment, and the military. Trans-United is a C-TPAT (Customs-Trade Partnership Against Terrorism) partner and has taken its experience in hauling oversize loads to the benefit of the wind energy market. The company's permitting department works closely with the states and communities along the route to ensure safe passage to destination. As a Smartway-certified company, Trans-United is excited to do its part in the creation of green energy resources. Learn more by calling (877) 762-3111 or visiting www.transunited.com.

EXPANDED MEASUREMENT OPTIONS FROM ONSET

Onset has broadened its offerings for energy and environmental monitoring by expanding the range of measurement options for its line of HOBO® U12 data loggers. Specifically, multi-channel versions of HOBO U12 data loggers can now measure and record kilowatts, air velocity, gauge pressure, differential pressure, DC current, and other energy and environmental parameters.

The expanded measurements are possible through the introduction of a new, compact power adapter. The adapter enables energy and building management professionals to conveniently power external sensors that require 12 volt A/C excitation power. This augments the company's existing line of measurement options, which includes air temperature, relative humidity, light intensity, AC current, and AC voltage. The adapter can also power any user-supplied external sensor that requires up to 400 mA at 12 VDC. HOBO U12 data loggers are small, durable devices designed for high-accuracy indoor environmental, and energy monitoring. They can record data unattended for days,



weeks, or months at a time, storing up to 43,000 measurements. Using a USB connection, HOBO U12 data loggers offer convenient, high-speed data offload directly to a computer or to a HOBO U-Shuttle data transport device.

For plotting and analyzing data gathered by the HOBO U12 data loggers, Onset offers HOBOware® software, an intuitive graphing and analysis software package for Windows and Macintosh. HOBOware provides a user-friendly interface for graphing, analyzing, and printing data files as well as exporting data to Microsoft Excel and other spreadsheet programs. To learn more call (800) 564-4377, e-mail sales@onsetcomp.com, or go online to www.onsetcomp.com.

SNAP-ON INDUSTRIAL LAUNCHES RENTAL PROGRAM

How do you expand on a product that exceeds customer expectations every time and saves money to boot? Simple, just add a rental program and make it deliverable to anywhere in the continental United States in two days. That's the case with Snap-on Industrial's new mobile tool crib rental program.

The company's existing mobile tool crib product is built around a customized tool container that's available in sizes from 20-40 ft. The crib includes a selection of both Snap-on tools and products specified by the customer, and standalone cribs can be linked together to create an even larger tool selection at a remote site. Now this offering is available in a rental program boasting a container stocked with pre-selected Snap-on tools.

"The mobile tool crib concept has been adopted by diverse industries as not only the solution to a problem, but as the template for asset management going forward," says Dale Alberts, director of business development for Snap-on Industrial. "The rental program takes that idea one step further by making the tool crib available almost instantly for short- or long-term assignment. We have outfitted the rental tool crib to meet the requirements of 90 percent of the tool needs at an industrial, power, mining, or construction site."

A 40 ft. container can provide tool service for up 20 technicians or millwrights, and the 22 ft. trailer provides tools for eight to 10 workers. Rental units are shipped from centrally located Conway, Arkansas, and can be delivered anywhere in the contiguous states within two days. Rental terms extend from one week to a year, and longer-term arrangements are available under a leasing plan. Additionally, Snap-on Industrial offers turnkey service that can include everything from delivery and set up to staffing. Cribs

Continued on page 56 >

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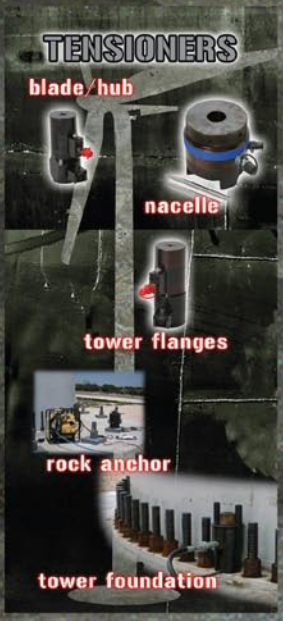

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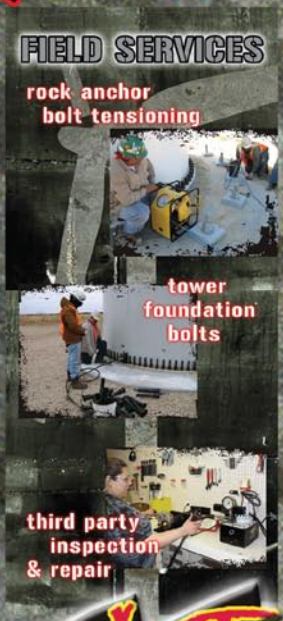

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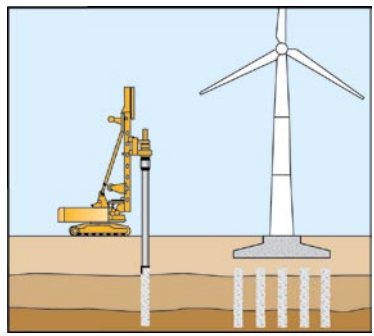
Eric Drooff
Hayward Baker, Inc.

Consisting of concrete columns installed through weak compressible strata, rigid inclusions use upper strong strata to transfer the load to the inclusions.

PLANNED WIND TOWER SITES may appear firm on the surface, only to conceal a buried weak soil stratum. Depending on the depth and thickness of the weak layer, it may provide the planned tower with insufficient bearing capacity or be the cause of excessive settlement. When a weak layer is discovered prior to construction the foundation designer has several options including excavating and replacing the soil, bypassing the weak layer with a deep foundation, or improving the characteristics of the soil in situ. "Rigid inclusions" is a ground reinforcement process that transfers loads through weak stratum to firm underlying stratum, improving the weak layer's load bearing and settlement characteristics.



Rigid inclusions consist of concrete columns installed through weak compressible strata, using upper strong strata to transfer the load to the inclusions. A closed-end pipe is advanced to a designed depth into underlying firm soils. The pipe is then filled with a concrete mix with a high internal friction. The inclusion is then constructed as the concrete fills the void created as the pipe is extracted. Construction sequence is important to avoid damaging previously constructed inclusions that are still curing.

As with the construction of any tower project, preliminary planning must include a geotechnical engineering exploration. The geotechnical report should include an evaluation of the site geological history, soil engineering properties (including density, gradation, and moisture content), and the in situ strength and compressibility characteristics of each stratum within the influence of the planned foundation. Location and information about adjacent structures and utilities should be included.

Rigid inclusions transfer the majority of the load from above the problem soil to below it. The weak stratum thereby experiences little additional load, and therefore has minimal influence on the tower's settlement or bearing capacity. The lengths of the rigid inclusions extending into the firm soils above and below the weak stratum are designed to achieve the required load transfer. When the top of the weak stratum is at or near the foundation bearing elevation, a load transfer platform may be required. This often consists of a geogrid reinforced soil layer that acts as a mat to distribute the foundation loads to the inclusions and provide a more uniform bearing support for the foundation. At sites where fill placement is required to raise the site grade, it may be feasible to construct this relieving platform within the fill.

Although the inclusions may have the appearance of piling, there are many differences. One obvious difference is that the inclusion is not connected to the structure. The structure is directly supported by upper soils, which transfer load to the rigid inclusions. The rigid inclusions transfer the stress from the bearing soils past problem soils and into underlying firm soils. Another distinction is that the inclusions seldom require significant reinforcing steel. However, steel reinforcement is common in the upper portion of the inclusion to avoid damage due to construction of adjacent inclusions or loads from construction equipment.

The diameter and spacing of rigid inclusions varies depending on the loading, concrete strength, and subsurface conditions. Typical spacing ranges from 6-10 ft. During construction of the inclusion, the concrete is not pressurized above the fluid pressure of the concrete itself. Quality control measures include: 1) procedural inspection and documentation of the work activity; 2) testing to ensure proper mix design; 3) monitoring of concrete injection volume, and; 4) strength testing of concrete test cylinders cast during construction. Industry standards now enable owners and engineers to require computerized data acquisition systems to record construction parameters in real time. These systems will document the depth and verticality of the inclusion, the penetration time and resistance (to verify sufficient penetration into bearing stratum), and the volume of concrete. Real-time monitoring and recording of these parameters allow the operator to make necessary adjustments during construction and provide the engineer with documentation that the construction was performed properly.

When applied properly, rigid inclusions can provide the necessary ground improvement for many wind turbine sites, allowing for a shallow foundation system. In most cases, mat foundations constructed on improved soil will provide an economic advantage over deep foundation options.

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Merritt Brown
Rev1 Power Services, Inc.

Remote monitoring allows Q&M professionals to check turbine conditions in real time, spotting problems in advance and avoiding expensive downtime.

TURBINE MANUFACTURERS typically offer a turbine availability guarantee during warranty at 97 percent, and well-maintained projects with the right technology can achieve levels higher than this whether they are covered under warranty or not. In achieving these levels the operator must have a close relationship with the turbines, not only with adept skills in preventative maintenance but also to properly identify and correct potential failures that may impact the turbine's ability to reliably generate power. Remote monitoring, particularly in conducting diagnostics and turbine resets, plays an important role in this effort.

With a modern, MW-class project in the 100 MW range, each percentage point of availability can be worth between $300-500k of revenue per year. Due to the remote location of wind projects and turbine height considerations, it is relatively expensive to visit turbines for maintenance and repair on a regular basis and historically a preventative maintenance approach is utilized in the wind industry. Turbines operate for months between scheduled maintenance visits, all the while being remotely monitored, reset, and diagnosed when performance is out of norm. While for most turbines only a few main vital faults will require an on-the-ground response from technicians, most other faults can be reset remotely, or in many instances automatically by the turbine's own control system. The interface between a remote monitoring center and the operator is critical in identifying the severity of faults, understanding the consequence of the fault, and linking the physical condition of the turbine and its environment to the data itself. There is an intensity in which a turbine can progress from minor indications of faults to near catastrophic failure.

Nearly all OEMs offer centralized remote monitoring and diagnostic services for their turbines under warranty, and many asset management companies and utilities with wind projects generally have 24/365 facilities to monitor the projects themselves. Others that do not fall under either of these scenarios may contract with third party remote monitoring companies to provide such service. Proof abounds, however, that having a remote monitoring and diagnostic center does not always translate into higher levels of performance. A few reasons for this may be the disproportionate size of the projects being monitored, the ability to diagnose and correct problems remotely, lack of training or knowledge of turbine characteristics, and the inability to easily communicate between the remote center and the operator. A closer look at the interface between the remote monitoring group and the operator should be considered for any project that is failing to meet high performance targets.

As unscheduled maintenance visits can account for upwards of 70 percent of the total wind turbine maintenance costs, preventive visits and major planned overhauls account for only about 20 and 10 percent, respectively. Reducing unscheduled maintenance costs and achieving higher levels of availability can be accomplished through a better understanding of operating data and a more intimate relationship between the remote operations team and the operator. One leading U.S. wind asset management company has a credible process for ensuring the association of information between the two; when a technician has completed his field inspection to reset a fault, he is required to inform the remote operator of his findings. This information is entered into an electronic database, linking the fault to the physical condition of the turbine. Both parties benefit from the information exchange as they no longer have a disconnect between the data and the actual environment. Through a collaborative effort that promotes the finding of root cause for turbine faults, recurring events can actually be decreased.

Continuing to maintain high levels of project performance means an organization must work efficiently together, with the capability to transform large amounts of remote monitoring data into actionable information for the project operator. Properly communicated, such information will allow operators to make service interventions that prevent catastrophic failure, perform inspections that are prioritized and accurately focused, and optimize maintenance scheduling and costs. When properly implemented these combined services can significantly increase uptime, improve availability, and even extend the life of the turbines.

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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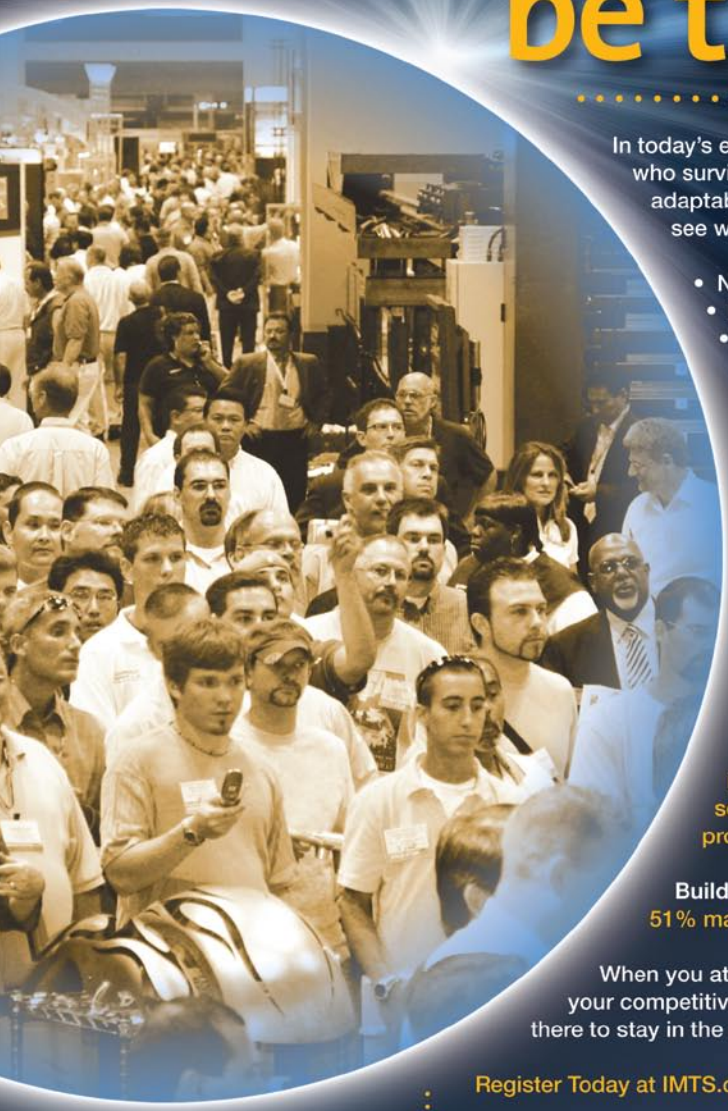

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Jose R. Zayas / David Wilson
Sandia National Laboratories

Wind turbine blades are growing larger, so research must be focused on several multidisciplinary areas—one in particular being wind turbine controls.

AS WIND TURBINES CONTINUE to grow in size, reports such as the "DOE 20% Wind by 2030" capture the advantages of larger and more technologically advanced rotors and their potential for increasing energy capture without having an adverse effect on turbine capital cost. However, increased rotor size is only beneficial if other system costs are constrained and their design and development is done in such a way that they do not affect the viability, reliability, or the associated logistics. Thus, larger rotors must be able to prohibit excess loads from impacting the turbine. These loads can be divided into two categories:

- In-plane loads caused by gravitational forces on the blades;
- Out-of-plane loads caused by the aerodynamic response to wind inflow.

Additionally, the ability of rotors to adapt to inflow and optimally capture the energy in the wind is vital. To address these challenges research efforts must be focused on several multidisciplinary areas, one of particular interest being wind turbine controls.

A MATTER OF CONTROL

In order to continue to reduce wind turbine costs, future large multi-megawatt turbines must be designed with lighter-weight rotors, potentially implementing active controls strategies to mitigate fatigue loads while maximizing energy capture and adding active damping to maintain stability for these dynamically active structures operating in a complex inflow environment. Development, evaluation and testing of advanced controls to mitigate fatigue loads caused by complex turbulent inflow is crucial for future designs.

The wind turbine is a highly nonlinear dynamic machine that operates over a large turbulent wind regime. Current conventional designs are limited to linearized models about nominal wind speed operating points that require gain scheduling to transition between each nominal wind speed operating point. Today, commercial machines rely on either classical single-input-single-output (SISO) controllers or state-space multiple-input-multiple-output (MIMO) controllers based on linearized models. While adequate for controlling the "stiff" machines of the past, these methods are not ideal for stabilizing future large multi-megawatt turbines that will experience greater dynamic coupling due to greater flexibility and lower rotor speeds. To meet these future challenges, advanced control methods and paradigms should be pursued to meet multiple control objectives with a single unified control loop, where multiple control actuators and multiple sensors can be used to greatest advantage to reduce fatigue loading, stabilize the complex structure, and maximize power.

Using the full nonlinear dynamical system in a nonlinear/adaptive control design may allow for the potential to capture more energy in below rated-power conditions, efficient transition between below and rated-power conditions, and for above rated-power conditions to mitigate and reduce fatigue loads on turbine components and blades. This results in longer operational life for the wind turbine components (gearboxes, blades, etc.).

ADVANCED ARCHITECTURE

Recent technology innovation in rotor technology—including individual blade pitch control, passive bend-twist and sweep-twist coupling (aero-elastic tailoring), and fast-acting active aerodynamic load control—offer the potential for further enhancing turbine energy capture and decreasing turbine cost of energy (COE). There is a significant amount of research domestically and globally that showcase the value of these innovations, and ongoing research in both controls and sensing will provide the operational architecture to make them a reality. Advanced control architectures that fully take advantage of these innovations can provide the technology pathway to continue to refine these large machines and ensure that safety, efficiency, economics, and reliability metrics are fully realized.

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You don't want an act of nature to turn into an act of desperation by not having an emergency logistics plan in place for replacement components.

WHEN YOU FALL ILL or have a medical emergency, you know whom to call. It is the same with wind power maintenance issues. When your wind components are "under the weather"—perhaps literally—you need to be sure you have the right resources in place to provide emergency service solutions. The list of parts that can suddenly malfunction or break down because of defects, accidents, and stress problems can be lengthy. It doesn't matter if it's a wind blade or a small electrical part, all it takes is one nonfunctional component to shut down an entire turbine. If a blade breaks and has to be replaced, or a gearbox stops functioning, or ice crushes a part, you don't want to wait forever for replacements.

PLAN AHEAD

Due to increasing demand for components, getting those replacements can take months, which means many turbines are motionless and useless. And that means lost revenue. A turbine can be struck by lightning, seriously affected by excessive wind, strain and stress, and even fire. Sea and weather conditions don't play favorites—you don't want an act of God to turn into an act of desperation by not having an emergency logistics plan in place for replacement components. That means rapid response from resources to get those parts to the site; fast, responsive transportation services to get your wind turbines working again.

You should be able to get spare parts just in time, whenever and wherever you need them, whether that be blades or rotors for a wind farm in Europe, motors or shafts for a location in Africa, gearboxes, or drives and brakes for the United Sates. Not to mention components for upgrading purposes. Unfortunately, purchasing can be a major issue. The price tag for replacements can be even higher without a reliable supply chain management plan in place—global delivery service through a logistics provider that can get you the parts you need at any time and by every mode of transportation necessary: ocean, air, rail, road, or inland waterways.

While standardized processes are the answer, there are few reliable options in place right now. Logistics management for emergency parts is still very much in the early stages of development. The majority of wind component producers are still new to the development and implementation of supply chain design. As OEMs enter the market they may know how to source equipment, but they often do not have an organization in place to handle the logistics. Plus the number of wind power OEMs is growing fast, which will put additional pressure on inventory and the ability to deliver. It could be a problem without the in-house expertise or access to resources that can source components.

PROACTIVE PLANNING

Regional hubs for components are an option. They could deliver key shipments within a targeted time period. In area one, for example, within a specific radius delivery could be within 24 hours, and in area two it could be 48 hours. With agreed-upon dispatch points, proactive planning can be brought to bear on what is currently a reactive process. There should be a pre-calculated routing for each region so you know who to contact and where the shipment is coming from. At the moment calls go from the developer/OEM to someone who then contacts someone else, which then generates an order. The process slows down.

Outsourcing warehousing for components is another solution, especially if the wind farm is large or if the location and weather conditions present an increased need for replacement parts. A request could be issued directly to the warehouse; the logistics resource managing the process only needs the coordinates of the wind turbine that requires the part. Thanks to geopositioning systems, the logistics company doesn't even need the location or even the country.

THE RIGHT RESOURCES

Time and again it comes down to selecting the right resource. A reliable supply chain resource that doesn't need to be managed, knows where the parts are, and who can get them to you fast.

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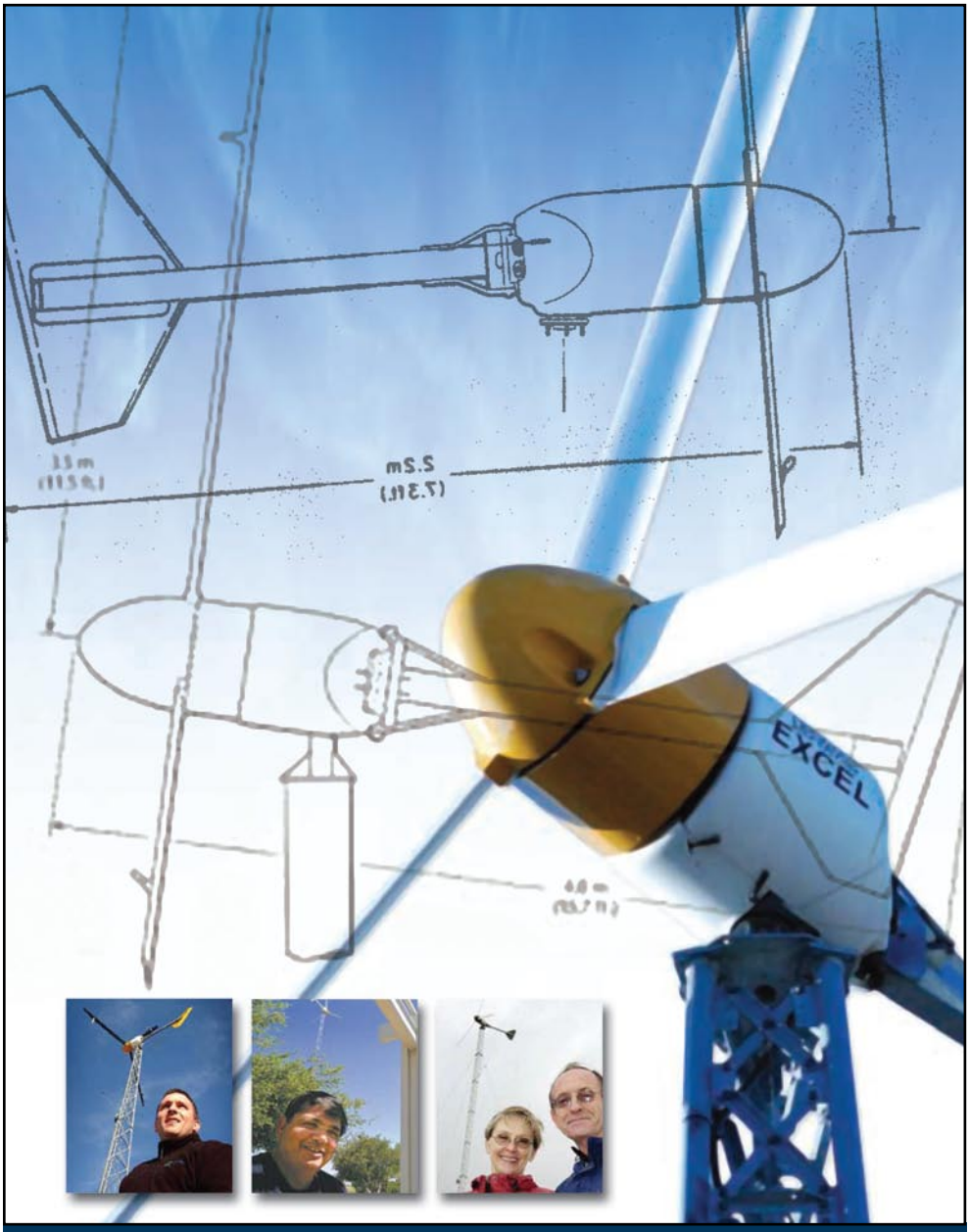
PROFILE

BERGEY WINDPOWER CO.

By Russ Willcutt



For more than three decades this company has stood at the forefront of the small wind industry, developing simple and elegant designs in use the world over.

AFTER SERVING AS ASSISTANT CHIEF ENGINEER at the Piper Development Center, where he designed aircraft such as the Piper Cherokee, and then working in the General Aviation Division of North American Rockwell, Karl Bergey—an aeronautical engineer with degrees from Penn State and MIT—was teaching at the University of Oklahoma in the late seventies. He'd become interested in small wind turbines, writing a number of feasibility studies, when he decided the market was ripe for entry. As luck would have it, he didn't have to look far for a partner in this venture.

"I was working on my degree in mechanical engineering at Oklahoma at the time," according to Mike Bergey, president, "and my research involved some really interesting designs for small wind turbines. My father told me that he was growing increasingly interested in the field, so we attended a couple of wind conferences and decided to go into business together."

Known as the Bergey Windpower Co., or BWC, the father—now chairman and CEO—and son team launched the enterprise in 1977 and had its first small wind turbine on the market three years later, in 1980. "We were really part of the third iteration of a small wind movement in the States," Bergey explains. "There had been a small wind industry in the late 1800s for pumping water on farms, and then in the twenties and thirties centering around rural electrification, and then the Arab oil embargo of the early seventies set the stage for developing new energy sources, which helped us get our company off the ground. There were federal and state incentives available at the time, too. Then, in the mid-eighties, when the price of oil fell to less than $10 per barrel, the government lost interest in supporting renewable energies and general interest waned, which really decimated the industry."

In its early years, BWC was one of about 40 small wind turbine manufacturers, all of which went out of business, leaving the company standing alone in its field. As Bergey explains it, they had been around long enough to take the lead in the field, which definitely helped it stay afloat, but there was more to it than that. "For one thing, we had a lot of customers using our products and depending on us for service, so we just couldn't leave them in the lurch," he says. "But more than anything we really believed in what we were doing, and we were convinced the market would eventually turn around, even though we'd lost 92 percent of our revenue."

In the meantime, however, generating revenue was the primary concern, and the Bergeys soon realized they would need to range beyond the United States to find work. This began a period of intensive travel to sites around the world such as Australia, Bangladesh, Chile, Mexico, Russia, and even Afghanistan. For some 15 years every week was a mad scramble to meet payroll, and the principals even went without a salary at times. "When dad and I first started the company, he'd asked me how little money I needed to live on," Bergey recalls, "but that really wasn't what either of us had in mind."

Still, the company's involvement in every conceivable small wind application—rural electrification, development aid projects, water-pumping projects for agriculture—and in an incredible variety of geographic extremes led to a depth of knowledge and expertise few other companies can rival. "We're the third-largest small wind manufacturer in the world," he says, "but I doubt anyone else can lay claim to the depth of firsthand experience we've amassed over the years."

These days the company is prospering, with headquarters and U.S. manufacturing conducted in Norman, Oklahoma, and another assembly plant located in Beijing, China. As deeply as it has penetrated the small-wind market from a geographic standpoint, it has also played a central role in supporting the industry itself. A member of the American Wind Energy Association since 1978, Mike Bergey has twice served as its president, and also as chair of its Small Wind Certification Standards Committee. "The small wind certification standard we developed has been adopted in the UK, as well," he says. "We're giving consumers independently verified performance specifications for the first time. It's the equivalent of the EPA's estimated gas mileage for cars, and it's really going to drive quality and value in the industry."

As to the central reason for the success of BWC's products, it all has to do with simplicity. "The fewer moving parts you have, the less chance there is for equipment failure," Bergey says, "and you'll now find that most small wind turbines are designed along similar lines. My father has always quoted Antoine de Saint-Exupery in saying that 'a designer knows he has achieved perfection not when there is nothing left to add, but when there is nothing left to take away,' and that's remained a central philosophy for us. And while the energy business has always been cyclical, this is the best business environment that we've seen for small wind in our 33 years, so we're prepared to continue applying the expertise we've developed to creating intelligent, trouble-free designs to the benefit of our clients here in North America and around the world."

TEHACHAPI: PLANNED FOR PROSPERITY

One of the first U.S. sites to be developed for wind power, the Tehachapi region of California celebrates 30 years of successful growth. Those involved tell their story.

By Nikki Cummings

Nikki Cummings is co-owner and president of World Wind Services. Call (800) 378-8714, e-mail info@worldwindservices.com, or go to www.worldwindservices.com.

THE TEHACHAPI AREA is considered the birthplace of wind in North America, and as we celebrate the 30-year anniversary since the first turbines were installed you can expect to see more milestones. Repowering and new development will flourish thanks to the first-of-its-kind transmission line and a 20-year contract with Southern California Edison. It represents the largest wind energy contract ever signed by a United States utility.

DECADES OF DELIVERY

A number of wind farms call Tehachapi home, including Terra-Gen Power, enXco, NextEra, Cal Wind Resources, Coram, Oak Creek Energy Systems, GE Energy, AES, Mogul Energy, and Windland. It's been three decades since the first wind turbines were installed in the Tehachapi-Mojave Wind Resource Area. It is considered one of the premier places in the nation for wind power, and one of the windiest places in the world. The winds average 14 to 20 miles per hour through the pass from one year to the next, and they vary with the terrain, season, and time of day. Average wind speeds approach nearly 9 meters per second (about 20 miles per hour). This places much of the Tehachapi Pass in wind power class 6 (these classes range from class 1, the lowest, to class 7, the highest).

The first turbines erected in Tehachapi were about 45-60 feet in height, and they produced

about 25-60 kilowatts. Today they stand about 400-500 feet, producing about 1-2.4 megawatts. The area is enjoying a new breath of life thanks to the new transmission line and a 20-year contract with Southern California Edison and Terra-Gen Power for the Alta Wind Energy Center, 1,550 megawatts (MW) of wind energy development. It represents the largest wind energy contract ever signed by a United States utility, and it also means that wind developers have better access to the California grid and the ability to sell to multiple utilities.

It also represents a major hurdle since a group of visionaries installed the first machines in the early 1980s. Multiple generations of wind turbine technology are still up and running in Tehachapi. There are the single- and double-blade turbines that generate between 25 and 60 kilowatts, to the more modern three-blade turbines that generate up to 4 megawatts. It's four generations of turbines with an installed capacity of about 785 megawatts.

A lot has happened since the first machines were installed. After overcoming numerous regulatory hurdles, SCE officially began the construction of its Tehachapi Renewable Transmission Project (TRTP). The first phase of the TRTP cost $1.8 billion and will ultimately result in a high-voltage transmission system capable of delivering 4,500 MW of clean energy into the Los Angeles metropolitan area, which is located about 100 miles south of Tehachapi. Executed power purchase agreements to date will allow up to 1,500 megawatts or more of power generated from new projects to be built in the Tehachapi area. It represents the first construction of a "public" transmission line that carries electricity generated at the park straight to the grid. This state initiative to upgrade the transmission out of Tehachapi began in 2008 and is expected to be completed by 2012. It has proved to be a catalyst for multiple projects including: Coram Ridge, consisting of 34 Vestas V90s, developed by Coram Energy Group & Brookfield Renewable Power; Windstar, consisting of four Gamesa G52s, 37 G80s, and 16 G87s, developed by Western Wind Energy; and Alta I-V, consisting of both GE 1.5s and Vestas V90 Turbines, developed by Terra-Gen Power. The Windstar project, whose general contractor is RMT, will bring the first Gamesa turbines to the region. These projects are all slated to see construction begin in 2010.

According to SCE, the TRTP will allow them to more than double its wind energy portfolio and envisions connection of more than 50 square miles of wind projects in the region, which is triple the size of any existing U.S. wind farm area. Officials estimate that it will eventually provide 4,500 megawatts of electricity, which could make it the largest wind project in the nation. The new wind farms are expected to eventually comprise 1,750-2,000 turbines. Not only does this triple the size of any existing U.S. wind project, but it is also expected to outperform the world's current largest wind farm. Phase 1 of the TRTP, which includes segments 1 through 3 out of 11 planned segment improvements, is expected to be completed in 2010.

Randy Hoyle, vice president and head of wind development for Terra-Gen Power, LLC, has this to say. "Terra-Gen Power is excited to be the first renewable energy company to utilize Southern California Edison's (SCE) newly constructed Tehachapi Renewable Transmission Project. The 720 MW first phase of the

project will increase California's installed wind capacity by nearly 25 percent and contribute substantially to the state's renewable energy needs."

The transmission line has definitely strengthened the industry here. "According to the Kern County assessor's office, by the year 2030 the wind industry will have assessments equal to that of the oil industry in Kern County," says Linda Parker, executive director of the Kern Wind Energy Association. "This is a big deal. We never imagined when we started that we

Fig. 1: A series of roads weaves through the Pine Tree Wind Project.

Fig. 2: Towers are erected at the Pine Tree Wind Project.

would rival the oil industry."

The approval of the TRTP is a notable exception to difficulties with long-distance transmission in America. In fact, it's the first major transmission project in California being built specifically to access renewable generators in a remote, wind-rich resource area. "Prior to that system coming we weren't growing, and we weren't going to. We couldn't take one more watt," says Parker. "The construction of the transmission line is a major accomplishment that many people have worked tirelessly on. It gives the wind industry options and the ability to contract with other electric utility companies."

COLLABORATIVE CONSTRUCTION

Numerous entities, companies, and individuals played a major role in the conception, planning, development, and approval process for the transmission project, which has involved a number of precedent-setting decisions, both regulatory and in the courts. It is showing the way and sets an example for other badly needed transmission infrastructure projects in this country. Hal Romanowitz, president and COO of Oak Creek Energy Systems, was one of these key players. He says it is important that transmission expansion facilities be well planned and scaled to serve the large regional needs if they are to succeed.

"TRTP progressed from our local development and planning efforts into the state-wide planning, and on top of that it took five studies to get the right focus onto a solution that was good for the entire state, not just a limited group, and the TRTP that is being constructed is very good for serving a substantial range of clean energy projects and to the overall grid reliability as well," Romanowitz says. "TRTP planning in California was the start of a superior process for regional planning that continues and which will ultimately do well for the electric needs of the state on a proper scale."

"Getting the transmission expansion scaled to the proper level and getting the costs rolled into rates paid by users of the system is extremely critical," he continues. "This is one of the biggest problems blocking transmission expansion success across the country. To be proper, such user funded expansion needs to be part of a regional transmission planning process so that the expansion is properly scaled and will best serve broad needs. One issue is that in some states users are strongly objecting to pay for transmission used to transport new renewable energy across their state to others in remote locations. A strong national transmission grid is critical for our country, however, and we are not getting what we need with so much provincialism."

Edison is not the only utility involved. As other utilities embrace wind power, the recently completed Pine Tree Wind

Fig. 3: Dynamic weather systems at Tehachapi.

Fig. 4: California Governor Arnold Schwarzenegger tours Tehachapi.

Project is another example to note. The Los Angeles Department of Water and Power just brought the Pine Tree Wind Project online after overcoming significant obstacles during the project development and approval process. In a project implementation process that began in earnest in 2003, LADWP has added 120 megawatts of wind to its distribution grid. "It's another precedent," Parker notes, "Los Angeles coming to Kern County for wind."

The Pine Tree project is able to deliver energy directly into existing LADWP transmission system lines that already run through Kern County to bring in hydro-electric power from points north. In these times of droughts and reduced production from hydro projects, it's a great match of complementary clean technologies.

A key player in this project is AECOM, a global leader in renewable energy. The international consulting firm assisted LADWP with implementation of the Pine Tree project by conducting the initial resource surveys and constraints analyses, preparing environmental documents meeting both federal and state laws, preparing applications, and providing assistance to LADWP to obtain regulatory and land use permits. The firm also provided resource monitoring support and compliance services during project construction. Prior to the beginning of construction, LADWP had to secure 12 regulatory permits containing nearly 400 separate mitigation measures and conditions of approval.

"The development process for Pine Tree had to face numerous regulatory challenges, including endangered species, federal, state, and local agency

Fig. 5: Sunset marks clouds against a moonlit backdrop at Tehachapi.

involvement, military flight corridors, and a lawsuit by an environmental group," says Jane Chang, an environmental planner in the Irvine, California, office of AECOM.

POWER PERMITTING

Though the process of permitting wind energy in Kern County has been generally good, like anyplace Tehachapi has its share of permitting issues like anyplace, and they're getting even tougher according to Ed Duggan, executive vice president of Oak Creek Energy. "The biggest challenges facing wind energy

Fig. 6: Turbine blades emerge through the mist at Tehachapi.

development in Tehachapi and elsewhere in California are environmental concerns that seem to be running somewhat amuck and government agencies that are afraid of being sued as a result."

For example, the recent success of the California condor breeding program has resulted in concerns about this endangered species expanding into the Tehachapi Wind Resource area, and this has resulted in recent calls to restrict development here.

"If it's not the condors on the mountain ridges, it's the desert tortoise and ground squirrel on the flats," Duggan says. "The problem is that some environmental groups seem to be focused on single issues and not looking at the big picture. The reality is that there are risks and consequences from all types of energy generation—just look at the environmental disaster in the Gulf of Mexico being caused by oil right now."

We need to push permitting agencies to look at the big picture and factor in the national security benefits of home-grown energy and the potential of mitigating global warming, and job creation. Luckily, the county and the community seem to get the big picture. "One of the great things about Tehachapi is that the wind industry has been here for so long now that we have a lot of people rooting for us," Duggan observes. "The businesses, residents, and government leaders have long recognized the benefits of wind."

It's this support from government officials, residents, and stakeholders that has allowed companies such as Oak Creek Energy Systems (OCES) to endure the real test—time. OCES is a wind energy pioneer that began in the early 1980s and developed one of the first projects in the Tehachapi area. The company has long played an active role in the wind energy industry and was instrumental in advancing wind progress and policies. Steve Cummings, who is my father-in-law, is the former president and founder of Oak Creek. He installed some of the first wind turbines in Tehachapi, and in North America for that matter. He was also the first president of the Kern Wind Energy Association.

He describes some of the hurdles his generation faced. "At that time there wasn't a lot of product availability, so you had to take what you could get," he says. "You may want a certain turbine, but it might not be available for more than a year. The American manufacturers had to play catch-up since the Danish had a head start. Plus we not only had to import turbines from other countries, but we had to bring the technicians over, too."

AVOIDING CONFLICT

Tehachapi leaders were also the first to realize that proper planning and engaging stakeholders would help preclude conflict, and today we all benefit from the ongoing public dialogue that started back in the 1980s. "The county was fairly easy to deal with back then," says Jim Watkins, a wind energy consultant and one of the early pioneers in the Tehachapi wind industry. "Since this was unprecedented there weren't any guidelines, so they established an ad-hoc committee that consisted of people from the wind industry and environmentalists, which proved to be very helpful," he says. "Since this was all agricultural land we had to create new guidelines and zoning, and we didn't have a model to follow—we had to create the model."

Of course the federal and state tax credits played a major role in spurring the wind energy industry back then. Some of the first companies include Zond, Oak Creek Energy, WindLand, Windridge, SeaWest, Difko, FloWind, Cannon, CalWind Resources, Mogul Energy, and AB Energy, just to a name a few, although many of these original companies have sold or changed their name.

"For the first four years it was all about the tax credits, and when they expired this was a major setback," Cummings recalls. "The machines could not stand on their own. Since no one had contracts with SCE, we had to hammer these out. In my mind this was the most challenging aspect. It wasn't so much an infrastructure issue since they were able to carry the loads we were producing pretty easily. It was more of a negotiating issue. Initially there was a lot of discontent between the wind industry and Edison. I can remember our first dealings well. A question would come up and we didn't have an answer. There were long moments of silence in those meetings when no one knew what to say. This was new to everyone."

Pioneers like Cummings definitely paved the way. Thanks to the concentration of wind, its second largest industry, Tehachapi has been responsible for impacting the wind power industry on a national and global level. Founder of Zond—a Tehachapi-based turbine manufacturer that was acquired by Enron and ultimately GE—Jim Dehlsen and his son James went on to establish Clipper Windpower, which has become a major turbine manufacturer worldwide and is one of few American-based manufacturers.

In addition to manufacturing, Tehachapi has spurred construction businesses including Wind Energy Constructors and World Wind Services, whose CEO is a second-generation wind power entrepreneur and is one of the few women owned business in the industry, as well as the highly acclaimed wind technician training facility, Airstreams Renewables. "More capacity and less impact are the key changes since wind was introduced here," says Parker. "I should point out that yesterday's technology is not today's technology. We have fewer turbines that produce more energy, yet we have fewer access roads and intrusions to the land. Since the 1980s we've progressed to a technology that's competitive with the rest of the world."

What does the future hold for this wind-rich region? Repowering and new development are sure bets. Duggan breaks it down: "Oak Creek is an example of a wind project that is repowering and producing more energy as a result," he says. "This repowering of smaller turbines with bigger, more efficient turbines has been going on for over 10 years now and it will continue at Oak Creek and on other older existing wind farms until most of the early eighties generation of turbines, which are now approaching 30 years in age, have been replaced.

"The potential upside of newer, bigger, better turbines is too great to ignore. As far as new development goes, we'll see a lot more on the Mojave side of the Tehachapi Pass and a little more on the Tehachapi side, but much of the new capacity will also be in the nearby Antelope Valley area," he says. "This region will grow to about 4,500-5,000 megawatts of total capacity in the next 5-10 years; it's going to happen quickly. After that we'll continue to expand at a slower rate, and by the year 2040 we should be somewhere around 10,000 megawatts of total capacity."

FUTURE DEVELOPMENTS

A look back reveals that some of the same challenges we faced then are the same challenges we're facing today—regulatory hurdles, environmental concerns, costs, and negotiating with the utilities. Another thing that isn't expected to change—expect Tehachapi to continue to lead the way when it comes to both wind power and solar. The rapidly expanding list of solar power project applications and plans includes as many as 63 developers because this also happens to be one of the four best regions for solar development in the world. The actual amount of proposed or planned wind projects is hard to ascertain, but some reports suggest this area could accommodate more than 40,000 megawatts of proposed renewable projects. That's two thirds of California's grid capacity and enough electricity to power more than 20 million homes.

Note: A Tehachapi native, Cummings is currently serving as president on the board of directors for The Wind Energy Center and a board member of the San Diego Chapter to Women of Wind Energy. She was also one of the nominees for the 2009 Rising Star Award for the Women of Wind Energy Association.

METROLOGY FOR WIND APPLICATIONS

Manufacturers of wind components confront quality control challenges with technology and determination, supported by Hexagon Metrology.

By Belinda Jones

Belinda Jones represents Hexagon Metrology. For more information contact Bill Fetter at (847) 931-0100 x234, william.fetter@hexagonmetrology.com, or www.hexagonmetrology.us.

A RENEWED FOCUS ON RENEWABLE ENERGY has global competition heating up again for manufacturers seeking to do business with the wind power industry. There are approximately 8,000 parts in a typical wind turbine, ranging from large-scale gearboxes and blades to electronics, bolts, and fasteners. Nearly 50 percent of wind power components are made domestically, and while other parts are being produced in Europe, India and China are gearing up their capacity for manufacturing as well.

To repair a major wind power component in the field is an expensive line item. The price to repair or replace rotor blades, a gearbox, or a generator for a typical 2 MW wind turbine can be in the range of $350,000-$450,000. Given the staggering cost, wind turbine manufacturers are very reluctant to change their manufacturing process or embrace a new supplier or technology unless there is clear evidence of its impact on maintaining quality.

Hexagon Metrology—a prominent manufacturer of manual, stationary, and portable metrology solutions—has tracked measurement/inspection trends and strategies in the wind power business from the very beginning. The company leverages their broad internal expertise to help OEMs achieve critical quality control goals. As a result their acumen and knowledge base grows as metrology is applied successfully to solve problems unique to the alternative energy industry.

Both stationary and portable coordinate mea-

surement machines (CMMs) have a sound track record of ensuring dimensional control. For instance, wind turbine components such as blades, towers, flanges, nacelles, and cast and forged parts are inspected with portable arms and laser tracking systems. High-tech components like gears, gearboxes, and generators require higher accuracy that coordinate measuring machines provide.

And there are multiple layers of measurement and inspection processes being integrated into the design, production, alignment, and assembly of wind power systems. We will now take a look at three manufacturers who have solved formidable quality control challenges with metrology solutions and engineering know-how.

Fig. 1: Outer diameters are easily checked on the shop floor.

VERIFYING TRANSMISSION HOUSINGS FOR WIND TURBINES

TVL (Toeleveringsbedrijf van Landuyt) in Wetteren, Belgium, finishes thousands of transmission housings for wind turbines each year. The housings are produced with high-precision machined bores with diameters of up to 64.5" (1640 mm). The tolerance for a 25.6" (650 mm) bore is ± 25 µm (±.001"), and this feature must be verified on every single unit. The bores are drilled at 0.08 percent of nominal diameter size.

"We could not measure big transmission housings in-house, so we worked with a service provider in Germany with the necessary equipment," says Managing Director Geert Van Landuyt, adding that as production quantities grew, transportation to the service provider became a very costly proposition. "Ultimately, we needed our own coordinate measuring machine."

Today, each four-ton transmission housing is verified on a Leitz PMM-F high precision CMM. The housings are measured in a room with the identical temperature conditions as the shop floor. This environmental control eliminates the usual waiting times required when parts must adjust to ambient temperatures in a thermally-controlled metrology lab.

The CMM's monolithic gantry design has a length of 14.6 ft (4.5 meters), a width of 14.2 ft. (4.36 meters), and a height of 16.5 ft. (5.09 meters). The machine has a measuring volume of 118" x 78.7" x 63" (3000 x 2000 x 1600 mm). The U-formed CMM body is made of gray granite, which does not absorb as much humidity as black granite, contributing to better overall stability of the measurement results.

TVL transmission housings are transported with a crane to the CMM. The measuring process begins once the automated alignment of the component concludes, and the part's temperature is read by the CMM. The actual temperature of the housing is applied to the inspection program's data points and evaluations, thus ensuring the same measured points are taken at arbitrary temperatures each time. The entire measurement process takes about 30 minutes and includes control points in nearly inaccessible areas of the housing.

Fig. 2: Inner diameters of a wide variety of components are measured quickly and accurately.

METROLOGY-ASSISTED STEEL PROFILE CUTTING

Dutch company HGG specializes in steel profile cutting and manufactures bevel cutting machines that are particularly suitable for processing large components. EEW, a German manufacturer of wind turbine components, placed an order with HGG. They needed to manufacture foundation structures (also known as tripods) using high-quality steel for an offshore wind farm. The task was to produce cylindrical members cut precisely in 3D from 400 ton steel tubes that were 196.9 ft (60 m) long x 19.7 ft (6 m) high.

HGG recognized from the beginning that adopting the correct measuring technique would be the key to the success of the project. "We like challenges," says Peter Tool, HGG R&D manager. "Our greatest strength is that we design our systems and software from the bottom up, so we retain flexibility. Short channels of communication allow us to come up with completely new processes in very little time."

A tube weighing 400 tons deforms under its own weight when placed on the cutting machine. This deformation changes the diameter of a tube by up to 0.787 in. (20 mm) and leads to undesirable drifts. However, the changes in diameter are not constant. When the tube rotates on the cutting machine its ovality varies with the movement of the tube. In addition, a 196.9 ft. tube sags nearly three inches at the midspan between supports. The structural frame of the cutting machine also deforms while supporting the extremely heavy load. In the face of deformations like these, even the most accurate machines are incapable of delivering a clean cut.

And mistakes can be very costly. Each tube comes with a price tag of roughly $57,000. "With expensive material like that, cutting errors cannot be allowed to happen," Tool says. He and his team wanted to integrate a measuring system into the cutting machine. Their main premise was that the user should know the position of the tube relative to the cutting machine at all times. If the exact coordinates and deformation of the tube on the machine were always known, it would be possible to continuously compensate for the movement of the cutting head. Tool found a suitable method of control by coupling a Leica Absolute Tracker with the cutting machine. The high precision laser tracker could not only ensure the necessary accuracy, but had the required measuring range (up to 524.9ft) for the 196.9 ft. long tubes.

"From the start, we had one objective," he says. "The machine had to be operated precisely by a single person." HGG fully integrated the laser tracker into the cutting machine, so the operator did not have to operate the laser tracker. The instrument tracks several reflectors on the cutting head and on the tube. Every section of the tube is fitted with a reflector that tells the cutting machine operator how much the tube is bending. The laser tracker captures the 3D coordinates of one point every 100 milliseconds. Using the acquired data, the machine cuts the enormous tubes into individual sections, and to accuracies of a fraction of a millimeter. The cutting machine software also controls the tracker, which is a task made possible by the emScon programming interface developed by Leica Geosystems, a Hexagon company.

DIMENSIONAL CONTROL OF ROTOR BLADE HUBS

The main rotor hub is a very critical wind turbine component, as it transfers the rotors' energy efficiently to the main bearing and constantly withstands enormous windload. The hub connects three blades to form the rotor and, depending on the model of wind power generator, is holding the motorized pitch mechanism for each blade. The rotor itself is joined to the slowly rotating shaft or main bearing with another flange, thus forming a rigid horizontal rotation-axis into the nacelles' gearbox.

Diameter, flatness, and orientation of each hub flange are subject to very precise quality inspections. At Xinjiang Goldwind Science & Technology Company, one of the largest turbine manufacturers in China, a Leica T-Probe and a portable LTD840 laser tracker enables a single operator to quickly inspect and document the machined "as-built" part directly on the shop floor. Due to its wireless capability the probe can be utilized to measure hidden points without direct line of sight to the laser tracker. The system's large 3D measurement volume (0 -131.234 ft.) enables the inspection of multiple interfaces and hubs with one set-up of the instrument.

The probing device gives Goldwind all the advantages of a fixed CMM, but does not require a measurement lab and a time-consuming logistic process to move heavy parts to the CMM table. Previously, all those inspections were carried out using dial gauges, micrometers, and calipers. Mastered by experienced users, these instruments were very accurate but only provided two-dimensional information. Due to the increased size and numbers of parts to be inspected, the old manual process became a serious bottleneck for throughput

Effective wind energy starts with high part accuracy.

The reliability of wind turbines depends highly on the accuracy of critical parts such as pinion cages and housings of planetary gears. Leading manufacturers around the world rely on Carl Zeiss MMZ CMMs with VAST Active Scanning and CALYPSO software to verify critical components and ensure part quality.

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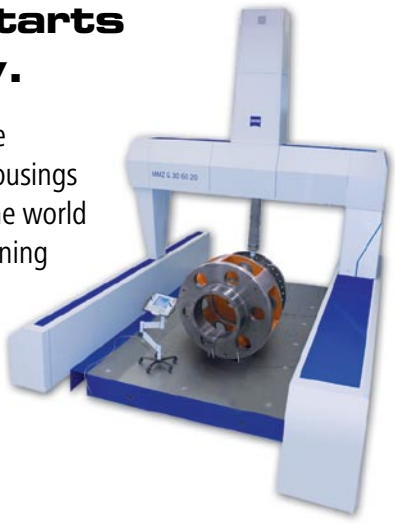

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Fig. 3: CMMs can also be set up in the field to check such components as blades.

design and modern quality management techniques in this competitive business set a new level of expectation, driving their need to implement a 3D metrology device for dimensional verification.

METROLOGY FOR FIELD INSPECTION AND BEYOND

Inspecting wind farm components at an insolated location has been difficult, or nearly impossible, with traditional measurement equipment. Introduced this year, a new line of laser tracker opens the door to remote field inspections for the wind power industry. The Leica Absolute Tracker AT401 was designed with serious portability features: small size, light weight, and long-life battery power combined with an IP54 rating and ultra-long measurement range of 525 feet (1050 feet radially). It is the first laser tracker that can be safely and easily used outdoors, even in the rain. The entire solution packs in case small enough to fit in an overhead luggage bin, giving quality control departments the mobility to follow wind power components from factory to field.

There are also new component developments underway that will significantly change the "manufacturing-to-metrology" landscape, from lightweight materials to longer life cycles for wind power parts. As the rotor size increases on larger turbines, the new designs will likely lean toward lighter, high strength, fatigue resistant materials. The step-up (geared) gearbox used on large turbines today is expected to be replaced in future turbines with direct-shaft-to-generator technology. The nacelle contains an array of complex machinery including yaw drives, blade pitch change mechanisms, drive brakes, shafts, bearings, oil pumps and coolers, controllers, and more. These are areas where simplification and innovation will become very important. Whatever the trend, quality control will play a critical role in the development and final production of wind turbine components.

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CLEAR SKIES FOR GLOBAL WIND ACTIVITY

A worldwide survey of top executives in renewable energy conducted by VB/Research and KPMG indicates healthy, sustained growth in the wind sector.

By Ronan Murphy

Contact Ronan Murphy, editor of *Clean Energy Pipeline*, a division of VB/Research, at ronan.murphy@vbresearch.com or +44 7251 8098. Go online to www.vbresearch.com.

THE OUTLOOK FOR M&A—mergers and acquisitions—activity in the wind energy sector is positive following a return to health in the second half of 2009 and 2010, according to a report by VB/Research. Wind is now established as the most mature renewable energy market, and it will be a major beneficiary of the continued drive by global governments to increase their domestic renewable energy capacity.

These conclusions are based on a worldwide survey of more than 250 senior executives active in the renewable energy industry conducted by KPMG and VB/Research, a specialist provider of renewable energy data, intelligence, and research. The survey was conducted between January and March 2010 and was completed by five different types of respondents: corporates, financial investors, debt providers, government bodies, and service providers. Among the respondents 75 percent were top-level executives such as chairpersons, senior executives, or divisional heads. Surveyed respondents were split among Western Europe (33 percent), North America (29 percent), and Asia-Pacific (18 percent), with Eastern Europe, Middle East and Africa, and South America accounting for the remaining. This research was supplemented by interviews with senior top-level executives from across the whole range of renewable energy sectors.

SIGNS OF RECOVERY

In 2008 and early 2009 the effects of the financial crisis meant funding for new renewables projects

slowed dramatically as lenders withdrew from the risky end of the market. The second half of 2009 and 2010 recorded a major increase in deal flow and volume. In the first quarter of 2010, global deal volume in the renewables sector increased by 245 percent. Wind was a major contributor to this recovery as the largest single renewable market, accounting for deals valued at $1.8 billion, just ahead of the $1.5 billion recorded for solar. This total was boosted by two big Iberian deals, with Enel and Iberdrola recently announcing investments of €860m and €320m, respectively, in wind assets in Spain. Deal flow has been steady since the report was completed in April. Since then the Brazilian investment fund Caixa Econômica Federal and the Argentine electricity provider IMPSA have invested $225 million to acquire a 45-percent stake in Brazilian wind generation power plant developer Energimp, while private equity firm Platina Partners have paid $95 million to buy 52 French wind farms from Infigen Energy. The wind technology sector has also been active in Asia, where the Chinese company Galaxy Semi-Conductor Holdings acquired the wind power equipment manufacturer Power Full Group Holdings through a deal worth $106 million.

Along with the two Spanish giants, other large project buyers in the wind sector over the last 18 months included the UK's Renewable Energy Systems, Ireland's Bord Gais Eireann, and North America's NextEra Energy Resources. The U.S. also saw positive growth, as total wind energy capacity grew by 39 percent throughout 2009. The market in the States has been invigorated by an upsurge in wind investments from large utilities, such as Kansas-based Westar Energy's acquisition of the development rights to a 500-MW wind project from Infinity Wind Power in January 2010.

The UK has been one of the greatest beneficiaries from the first wave of heavy government stimulus. The British government's 2009 budget announced a series of support measures aimed at stimulating renewable energy projects including £525m for offshore wind farms through the Renewable Obligation scheme. Since this announcement a series of transactions have taken place as developers have sought to reduce their risk and attract third-party capital to their offshore wind commitments. Notable transactions included investment company TCW's acquisition in October 2009 of a 50-percent stake in Centrica's Boreas portfolio (total installed and projected capacity of 206-MW) along with a refinancing of the project. At the end of 2009, DONG Energy and Siemens Project Ventures acquired a 50-percent stake in Centrica's 270-MW Lincs project. DONG Energy also announced the sale of a minority stake in its 367-MW Walney offshore wind farm project to Scottish & Southern Energy. The UK remains a highly attractive market boasting the largest wind resources in Europe and a well-defined subsidy regime.

Wind technology is lagging behind the sector at large. It has been impacted by weakening demand in the wind turbine market. The deep backlogs in turbine orders that were commonplace in early 2009 have been replaced by rapidly shrinking orders as the 2008 drop in project financing for developers filtered through to turbine manufacturers in the second half of 2009. Industry players have responded to this trend by reducing their exposure to the sector. For example, Iberdrola divested 10 percent of its holding in Gamesa for over €391.7m in a private placement in June 2009. Later in the year, AE Rotor received £224m for its 35 percent share in Hansen Transmissions, while United Technologies acquired a 49.5 percent stake in Clipper Windpower for £166m.

GOVERNMENT INCENTIVES

The failure to achieve a global agreement on emis-

sions targets at the UN Climate Change Conference in Copenhagen last November will not dent M&A activity in the renewables sector, according to 88 percent of the KPMG/VB Research survey respondents. In the absence of a standardized global structure, regional government incentives and initiatives will be employed to boost renewable investment. Significantly over half of the surveyed respondents predict that these regional regulations and tariffs will accelerate M&A activity during the next 18 months. The most prominent such incentive is the U.S. American Recovery and Reinvestment Act (ARRA), which came into effect in early 2009 and, combined with subsequent stimulus measures, has made North America the preferred geography for acquisitions of renewable energy projects or companies. Almost half of the European and a third of the Asia-Pacific respondents are considering acquisition targets in North America in the next 18 months.

However, the market is keenly aware that such government support is of limited size and duration, and that it must generate activity independent of these incentives. Cord Landsmann, CFO at E.ON Climate and Renewables GmbH, says, "We aim in the long run to achieve grid parity without subsidies... we would not choose locations with poor or uncertain access to the energy source, even though they could benefit from important incentive-based regimes." Other drivers of cross-border M&A in the sector include energy security in the form of reliable energy supply and secure production facilities; volatile fossil fuel prices; market consolidation; and increasing demand within society for a renewable/alternative energy supply. M&A deals will also be boosted by financial backers looking to exit their current portfolio companies. Venture capital investors who reached their investment limit during the downturn by providing follow-on financing to their portfolio companies, and funds that were raised over five years ago are desperately looking to exit some of their investments. With the IPO market still fragile, M&A is the most attractive exit route.

Government incentives, coupled with more liquid capital markets, will ensure that both corporates and investors approach 2010 with a greater focus on M&A. According to VB/Research's survey, more than 90 percent of respondents are considering M&A activity in the next 18 months, compared to an equivalent report from 2009 when 45 percent of the surveyed respondents were either not planning to make any acquisitions during the following 12 months or were undecided. Thirty-six percent of respondents said they are targeting acquisitions in the wind sector.

BOLSTERING TECHNOLOGY CAPACITY

Corporates will target acquisitions that increase generation capacity, leaving technology and equipment company acquisitions to investors. Landsmann says that "We follow our boutique to industrial approach and target projects

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based on scalable technologies that can provide synergies, and reduce costs. The wind sector is at an advanced stage of development and provides such characteristics, while the solar sector is the next to follow with a huge potential of scalability."

As the most mature renewable energy sub-sector, synergistic technology acquisitions and downstream integration is less critical to corporates active in the wind sector. Financial investors are expected to be the major players in takeovers and investments in technology and equipment companies. Few of the surveyed corporates plan to acquire onshore wind technologies and equipment or onshore wind management and installation companies during the next 18 months, whereas investors are expected to be more active in these markets, driving efficiency savings through market consolidation.

"The onshore wind sector started its consolidation in 2002-2003, but there is still room for deals to be done. If further consolidation does not take place over the next 18 months some companies will disappear," according to Anil Srivastava, CEO of Areva Renewables. Institutions such as pension funds and sovereign wealth funds will facilitate the access to finance for highly capital-intensive industries such as the offshore wind sector, where single projects can require in excess of €1 billion of capital expenditure.

Alongside these financial investors, the institutions that will be most active in the next 18 months are large corporates with strong balance sheets and an international presence, enabling them to pursue deals without needing to secure additional debt finance. An overwhelming majority of survey respondents (77 percent) expect specialist renewable energy companies and subsidiaries of integrated utilities to be the most active participants.

ACCESS TO DEBT MARKETS

There is more good news for the wind sector thanks to an improvement in the disposition of debt providers. After a period during which the debt markets virtually ground to a halt, banks are now set to become slightly less risk-averse. A third of the surveyed debt providers indicated an intention to increase their exposure to the sector in the next 18 months. Onshore wind warms are viewed as the most risk-free proposition for these entities. Seventy-five percent of those surveyed stated that they were interested in financing onshore wind farm projects. However, debt financing will be harder to come by for wind technology companies: 25 percent of the surveyed debt providers said they would be interested in providing solutions to that sub-sector.

Debt financing should be easier to raise in 2010. However, the case for asset financing needs to be stronger than they may have been pre-2008. As Srivastava notes, "Prior to the crisis, renewable energy was an industry of announcements, announcements of projects that would not be feasible to build. Today contractors are required to have a real ability to execute and a large balance sheet." Another symptom of the banks' continued caution is that they are still not inclined to approve debt tenures beyond 15 years. Margins for debt financing have also risen considerably. An onshore wind project in Europe is now financed at an average rate of 300 basis points (bps) over the base rate, compared to 100 bps in 2007.

This means that equity financing remains critical to financing efforts in the renewable space. The survey indicates that North Americans are the most confident of tapping these markets, as 32 percent of respondents from the region indicated their confidence that they can access this form of financing. Although traditional financing sources are reopening, financing M&A transactions may not be straightforward. Acquirers in the sector may well need to continue to find creative financing arrangements to bring their renewable plans to life.

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TURBINE FIRE PROTECTION

Effective fire detection and suppression has become a top priority for turbine manufacturers and wind farm operators. Firetrace International explains why.

By Scott Starr

Scott Starr is director of global marketing at Firetrace International and can be reached at (480) 607-1218. Go online to www.firetrace.com.

WITH GOVERNMENTS ACROSS the globe becoming ever more aware of the environmental benefits of wind-generated power, the number of wind farms and the financial investment in constructing, erecting, and maintaining wind turbines is increasing exponentially. Today the market is estimated to be worth $60 billion annually, with global wind capacity expected to double every three years. According to the World Wind Energy Association's (WWEA) "World Wind Energy Report 2009" the United States is the world leader in terms of the installed capacity of wind power, followed by China, Germany, Spain, and India. WWEA figures show that last year these five countries together accounted for nearly 80 percent of worldwide wind capacity.

Such a high level of investment, coupled with the increased dependence on wind power, has led turbine manufacturers and operators to become acutely aware of the financial implications, safety issues, and environmental impact of fire-damaged or destroyed turbines. Indeed, fire safety has become such an issue that the United States' National Fire Protection Association (NFPA), Germany's Vertrauen durch Sicherheit (VdS), and Germanischer Lloyd have developed recommendations, standards, or codes of practice.

The NFPA has recently added wind turbine and outbuilding fire protection standards to NFPA 850, titled "Recommended Practice for Fire Protection for Electric Generating Plants

and High Voltage Direct Current Converter Stations, 2010 Edition." This document provides fire protection recommendations for the safety of construction and operating personnel, physical integrity of plant components, and the continuity of plant operations. The revised 2010 edition includes detailed recommendations relating to wind turbine generating facilities.

VdS 3523en (wind turbines, fire protection guideline) has also been used as the basis for the CFPA E, or Confederation of Fire Protection Associations in Europe, guideline no. 21.2010 F, which addresses the same topic. VdS is a highly-regarded, independent, international, third-party accreditation and certification body for fire prevention and safety technology. Ger-

Fig. 2: A wind turbine protected by Firetrace in the French countryside.

manischer Lloyd, which specializes in classifications for the maritime and energy industries, has developed Renewables Certification Guidelines: "GL Wind Technical Note Certification of Fire Protection Systems for Wind Turbines, Certification Procedures, Revision 2, Edition 2009."

SCALE OF THE PROBLEM

A report by the AREPA Group—a technical service organization with operations throughout Europe that specializes in the assessment and restoration of damaged technical equipment—suggests that 184 wind turbine components were damaged by fire since 2002, while the Caithness Windfarm Information Forum believes that, as of September 2009, 122 wind farm fire incidents were reported globally. The cost of property damage on each of these reported incidents spans from $750,000 to $2 million.

However, many in the industry believe that these figures grossly underestimate the scale of the problem. A significant number of turbine fires go unreported, possibly because of a combination of their remote location and the fact that the emergency services are not always called upon to attend, and these fires do not form part of any official fire incident statistic.

TURBINE FIRE RISK

The almost inevitable consequence of these industry initiatives has been that a number of detection and suppression systems have been put forward as suitable solutions. While many are effective for what might be regarded as "conventional" appli-

cations, they may not be suitable for the particular fire challenges found in wind turbines.

The majority of turbine fires are started by a lightning strike, brought about by their exposed and often high-altitude location and the height of the structure; turbines are now being built that are up to 320 feet high. Mechanical failure or electrical malfunction also account for a significant percentage of fires that can be fuelled by up to 200 gallons of hydraulic fluid and lubricants in the nacelle, which itself is constructed from highly-flammable resin and glass fiber. Internal insulation in the nacelle, which can become contaminated by oil deposits, add to the fuel load.

Electrical equipment is another high-risk area. Capacitors, transformers, generators, electrical controls, and transmission equipment all have the potential to catch fire, as do Supervisory Control and Data Acquisition (SCADA) systems. There is also the risk of fire due to loose or broken electrical connections or the overloading of electrical circuits.

Braking systems pose a particularly high fire risk. Overheating can cause hot fragments of the disc brake material to break off, rupturing hydraulic hoses and resulting in highly combustible hydraulic fluid being expelled under pressure and coming into contact with the hot disk brake fragments. Hydraulic pumps and connections have also been known to fail, allowing the fluid to erupt into flames when it comes into contact with a hot surface.

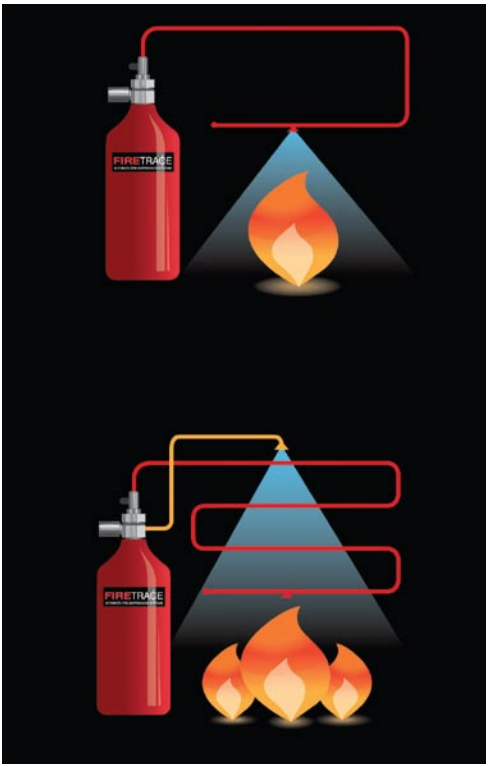


Fig. 3: A schematic diagram of the Firetrace system.

UNIQUE FIRE PROTECTION CHALLENGE

What are the special challenges that an effective fire detection and suppression system for a wind turbine have to overcome? The core issue, of course, is remoteness. This is particularly the case with offshore wind farms, but even onshore farms are routinely in difficult to access or isolated locations. The essential characteristics of an effective wind turbine fire detection and suppression system are that it should:

- Deliver around the clock reliability and 24/7 unsupervised protection;
- Ensure an absence of false alarms;
- Contend with vibration, dust, debris, and airflow through the nacelle;
- Contend with extreme temperature variations;
- Stop a fire precisely where it breaks out, and before it takes hold;
- Require no external power.

The options that are often considered can be generally categorized as air sampling detection; water mist suppression; compressed-air foam suppression; fusible link detection and suppression; total flooding CO_2 (carbon dioxide) suppression; total flooding clean agent suppression; and linear pneumatic detection and suppression.

Air sampling aims to offer early detection by collecting minute smoke particulates in the early stage of fire, but they do require a power source and control panel, which means that the system will fail if the external power or battery backup fails. These systems are also expensive, in part because they only detect a fire, and so need to be integrated with a suppression system.

The major drawback to air sampling in wind turbines, though, is the ever-present risk of false alarms. These can be caused by tiny particles of dust and debris and atmospheric pollution that are propelled around the nacelle due to the turbine housing having a number of openings to allow air to circulate to reduce the internal temperature. While false alarms are the bane of any system owner's life, a false alarm in a wind turbine inevitably involves extensive travel and possibly the hiring of expensive specialist access equipment.

SUPPRESSION-ONLY SYSTEMS

Water mist suppression systems convert water into a fine atomized mist, but they too have limitations when used to protect wind turbines. Due to the turbine's remote location and the distance from the ground to the nacelle, water mist sys-

tems are often impractical, plus they call for considerable space to be devoted to water storage, which increases the weight in the nacelle. These systems are also a costly part-solution to the problem, as they need to be linked to a detection system.

Water mist systems are total flooding solutions, which increase the potential for damage to electrical components and possible corrosion. Also, because in some locations the temperature can fall below freezing point, antifreeze has to be added to the water, and antifreeze is a combustible liquid that is itself a corrosive substance.

Compressed air foam systems work on the principle that compressed air is injected into a foam solution to achieve a quicker fire knockdown when compared with conventional foam systems. While they need less water than conventional systems, the storage, weight, and freeze-protection problems are similar to those of water mist systems. In addition, these systems require considerable extra space for the operating components. After discharge cleanup can be extensive and, like water mist systems, the cost is increased by the need for a separate detection system.

Fusible link systems, however, do combine detection and suppression into one package and work on the basis that heat from a fire will rupture a fusible link—the detection element—that in turn will initiate the discharge of the suppressant. The challenge with these systems is that airflow in the nacelle can seriously impair performance and reliability because heat and flame that typically rise from the source of a fire may be propelled away from the location of the fusible link, critically delaying activation.

TOTAL FLOODING GASEOUS SYSTEMS

Whether using CO_2 or the latest clean gaseous agents, traditional total flooding suppression systems are designed to fill the entire space being protected with suppressant. While an established suppression agent, CO_2 is not without its drawbacks. It is unsuitable for total flooding applications in potentially occupied enclosures, as its discharge in fire extinguishing concentrations would be lethal to occupants. Flooded areas must be adequately ventilated after discharge to prevent accidental exposure of personnel to dangerous levels of CO_2 when investigating the cause of a discharge.

These challenges do not exist with clean agents, however, such as 3M™ Novec™ 1230 fire protection fluid. The suppressant is stored as a low vapor-pressure fluid that, when discharged, vaporizes into a colorless and odorless gas. Typical total flooding applications use a concentration of the fluid that is well below the agent's saturation or condensation level, and its low design concentration means that less space has to be devoted to cylinder storage. Novec 1230 has a negligible impact on the environment, with insignificant global warming potential, zero ozone depletion, and an atmospheric lifetime of just five days. Once discharged it leaves nothing behind to damage sensitive electronic equipment.

Traditional total flooding systems are not without any downsides. Vibration can loosen connections while dirt, dust, and temperature extremes are known to cause unwarranted discharge. Additionally, openings in the turbine housing significantly inhibit achieving the designated agent concenwration. Devising a solution to overcome these challenges can add significantly to the weight in the turbine.

INTEGRATED DETECTION AND SUPPRESSION

The major drawbacks of traditional total flooding suppression systems, and the shortcomings of other technologies put forward for the protection of wind turbines, are overcome in the Firetrace® linear pneumatic system that provides both fire detection and suppression in a single package. It is a self-contained system that, significantly, requires neither electricity nor external power; a solution that is activated automatically around the clock without the need for manual activation or monitoring, and it requires virtually no maintenance. It is an intrinsically safe solution as it does not contain any components that produce sparks, or that can hold enough energy to produce a spark of sufficient energy to cause an ignition.

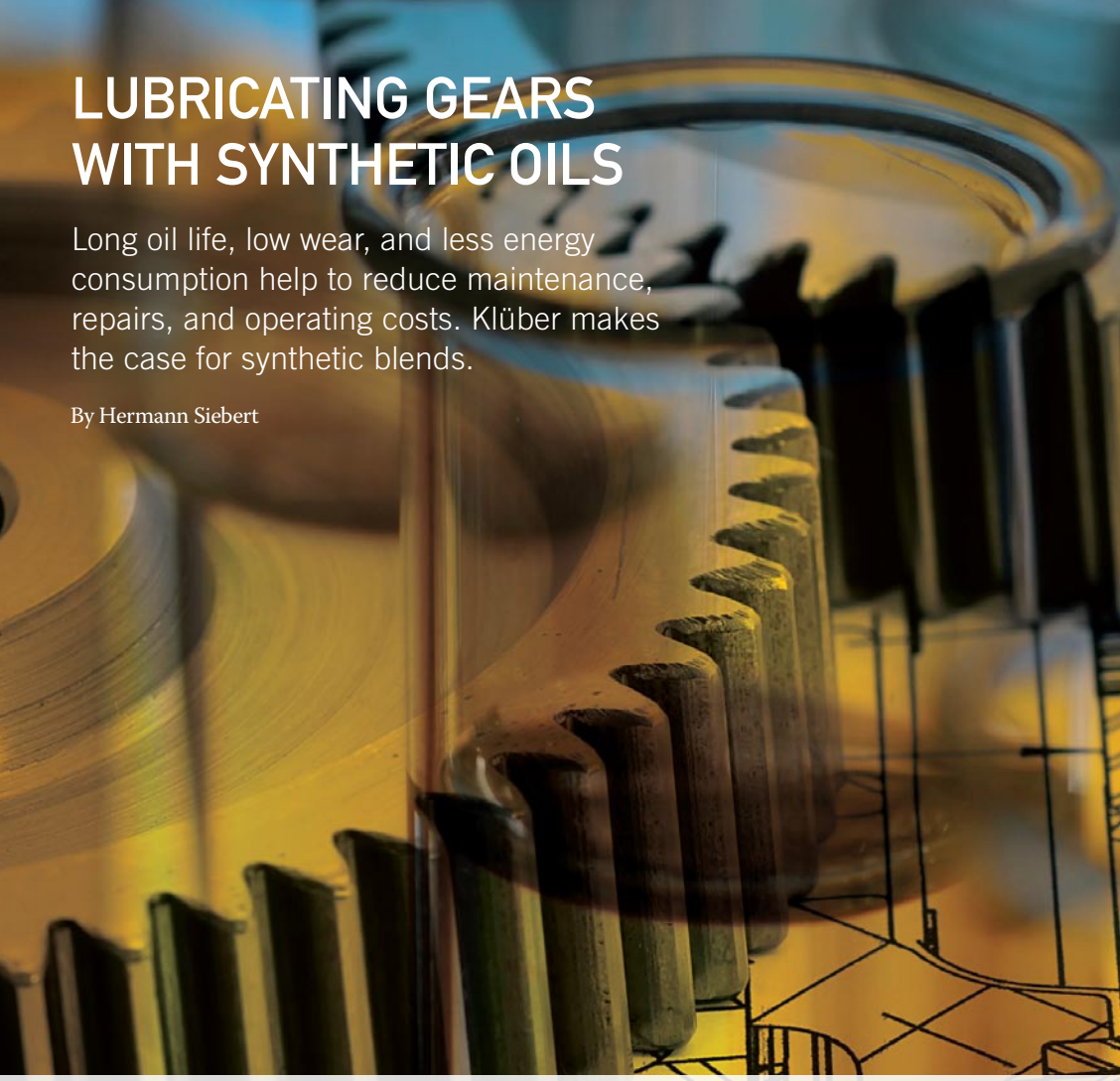
Firetrace is comprised of a cylinder that for wind turbine applications contains 3M Novec 1230 and is attached to a purpose-designed proprietary Firetrace detection tubing via a custom-engineered valve. This leak-resistant polymer tubing is a linear pneumatic heat and flame detector that is designed to deliver the desired temperature-sensitive detection and delivery characteristics. It is routed throughout the areas to be protected and, when the tubing is exposed to heat and radiant energy from a fire, it ruptures and instantly directs the suppression agent at the source of the fire.

With over 150,000 Firetrace systems installed around the world, a key factor in its success is the system's reliability. The fact is that the only thing that will rupture the tube is heat or flame from a fire, so there is no prospect of false alarms. Yet if a fire breaks out, the response is unerringly immediate and accurately targeted. It is the only Underwriters Laboratories (UL) listed, Factory Mutual (FM) approved, and Conformité Européene or European Conformity (CE) marked tube-operated system in the world that is tested as an automatic fire detection and suppression system.

LUBRICATING GEARS WITH SYNTHETIC OILS

Long oil life, low wear, and less energy consumption help to reduce maintenance, repairs, and operating costs. Klüber makes the case for synthetic blends.

By Hermann Siebert



Hermann Siebert is head of application engineering at Klüber Lubrication München KG. He can be reached at hermann.siebert@klueber.com. Go online to www.klueber.com.

WIND GEARBOX TECHNOLOGY is developing at a fast pace, not least due to operators demanding ever more power and efficiency. Experience has shown that the lubricant used is a crucial factor in meeting the wish for ever-increasing performance. Besides strictly technical requirements, aspects of economy and ecology are receiving more and more attention in lubricant selection.

The technical requirements to be met by a lubricant are defined either by the gear manufacturer, by pertinent standards, or the operating conditions. Among the "classic" requirements are a specific nominal viscosity, viscosity index, service temperature range, and minimum scuffing load capacity, as well as compatibility with the elastomers that are used for radial seals. In heavily loaded spur gears, sufficient micropitting resistance and good antiwear characteristics of the gear oil used are today also considered important. What machine operators basically expect from a special lubricant is cost reduction. This is attained by long oil life, simple oil change, wear-free or near-wear-free operation, and high efficiency in all lube points. Consequently, these are the factors that are foremost taken into account for the development of new gear oils by Klüber Lubrication.

BASE OILS DETERMINE TECHNICAL PERFORMANCE

The first important decision is the careful selection of suitable base oils. Synthetic base oils are often chosen since their characteristics can have a very positive effect on the gear oil to be created.

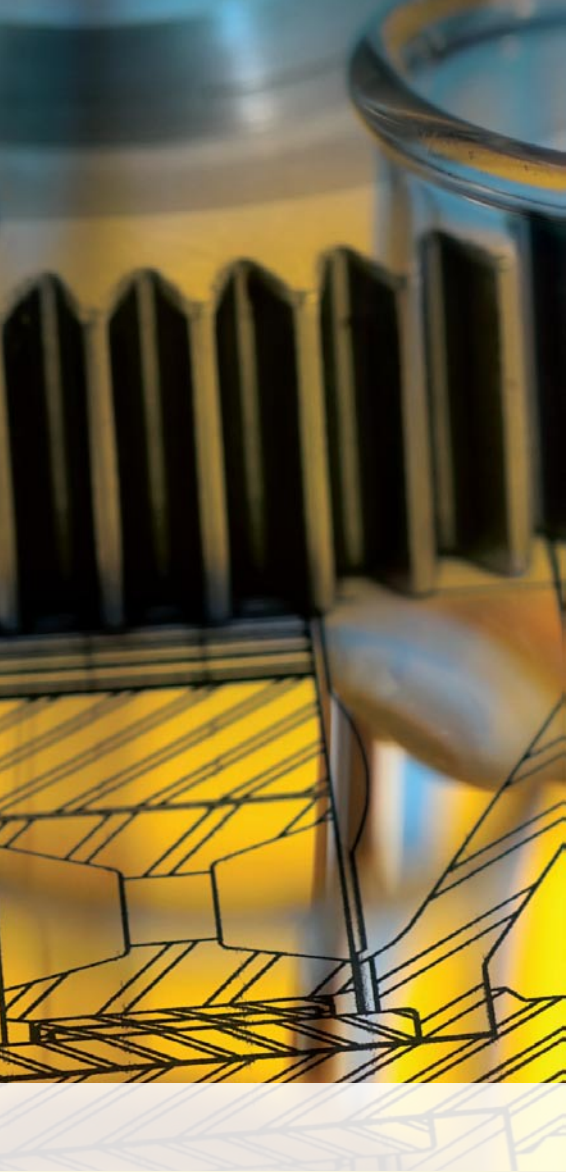


Table 1 compares a number of typical base oil characteristics. The more suitable the base oil is, the less will additivation or other adjustments become necessary at a later stage to attain the desired properties. An example of such adjustments is the addition of so-called viscosity-index-improvers, which can substantially enhance the viscosity-temperature behavior of mineral oils. On the other hand, the chemical makeup of such polymer additives may lead to the breaking of molecular chains under the shear rates commonly found in gear contacts (approx. 10-6 1/s), which counteracts the desired effect of a higher viscosity at elevated temperature. This problem is prevented if oils with a higher viscosity index are used in the first place.

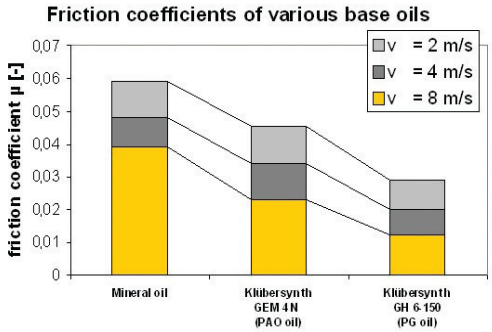


Fig. 1: Friction coefficients of various base oil.

LOWER FRICTION IMPROVES EFFICIENCY

Figure 1 shows the friction coefficients of several base oils measured on a two-disk test rig. This test rig allows friction coefficients to be determined under conditions as prevail in gears. It can be seen that the polyglycol-based gear oil Klübersynth GH 6-150 in particular leads to significant friction reduction. Depending on the type of gears lubricated, this may bring about considerably better gear efficiency. The positive effects of a higher efficiency are manifold. One is lower energy consumption at constant output power. Lower oil temperature and hence longer oil life is another. Obviously, this leads to a reduced oil consumption, but also to savings in terms of time and money to be spent on oil change.

These benefits have been proven in tests conducted on Klüber's worm gear test rig, as shown in fig. 2. Figure 3 shows some exemplary results for Klüber gear oils. When the polyglycol oils are used in heavily loaded worm gears, temperature reductions by more than 40 °C and energy savings of 30 percent are realistic. Whether the oils tested were gear oils for general applications (Klübersynth GH 6 series) or special oils for the food-processing and pharmaceutical industries (Klüberoil 4 UH 1 N series, Klübersynth UH1 6 series) had no effect on these results. The latter can generally be expected to offer the same if not better performance than conventional gear oils. Oils based on polyalfaolefins, e.g. Klüberoil 4 UH1-460 N, do not perform quite as good as polyglycol oils, however they still offer significant advantages over mineral oils. Such polyalfaolefin-based oils might be recommended for use in old gears where compatibility with paints and seals of unknown origin are a particular priority. Polyalfaolefins can also be mixed with mineral oils. What should be noted, though, is that conversion to a food-grade oil always requires thorough cleaning of the machinery since an undefined mixture of old and fresh oil will fail to satisfy food safety requirements.

Additives are particularly important under conditions where no separating lubricant film can form. Such conditions are found, for instance, during the running-in of gears, or in gears driving low-speed machines as well as in stop-and-go operation.

	Mineral oil	Polyalfaolefin	Polyglycol	Ester
Viscosity-temperature characteristics	0	+	++	+
Ageing resistance	0	+	++	+
Low-temperature characteristics	---	++	+	+
Wear protection	0	+	++	+
Friction coefficient	0	+	++	+
++ = excellent / + = good / 0 = satisfactory / --- = poor				

Table 1: Table showing the key characteristics of different base oils.

WEAR PROTECTION FOR LONGER SERVICE LIFE

Figure 4 shows the differences in wear behavior attained with different oils in worm gears. The results shown were again obtained in tests on the Klüber worm gear test rig. The left axis of the diagram represents the weight loss of the worm wheel after the test, while on the right the wear rate of the wheel is shown. Seen in combination, the results allow a differentiation between running-in wear and permanent wear. Under the selected operating conditions it can be assumed for the mineral oil that wear on the worm gear will decrease tooth thickness at a rate of approx. 1/1000mm per hour. With the Klübersynth GH 6-460 oil, on the other hand, there will be only minimal tooth wear. It is obvious that the particular characteristics of this oil cause pronounced running-wear on the gear; however, the permanent wear setting in after a certain time is very low. Naturally, the life of both the gears and the gear oil benefit from these characteristics. If wear on the worm gear is eliminated or kept to a minimum, the replacement of parts or even the whole gear system can be avoided. At the same time less wear particles contaminate the gear oil, which means the latter can be used longer, irrespective of the base oil characteristics.

An oil's service life is primarily determined by certain factors and by the way they interact, which is shown in fig. 5. In this figure, oil sump temperature is indicated as a function of oil service life. The slope of the curves is due to the so-called 10 K rule, saying that a temperature increase of 10 Kelvin doubles the speed at which chemical reactions take place. Applied to the service life of gear oils, this means that their life is cut by half with every 10 K temperature increase. The curves for mineral oil and polyglycol have been taken from the literature, where they have been published on many occasions. Klüber Lubrication drew on their practical experience in the use of polyglycol oils by performing numerous used-oil analyses with this oil type and evaluating them. Some of them are shown as symbols in the diagram.

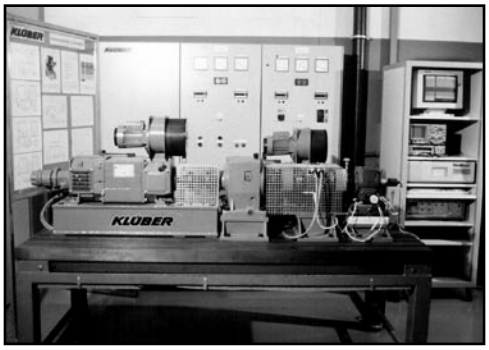


Fig. 2: Klüber worm gear test rig.

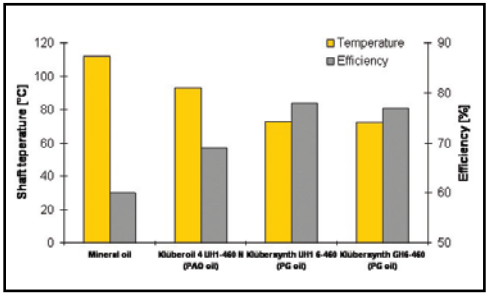


Fig. 3: Temperature and efficiency measurements.

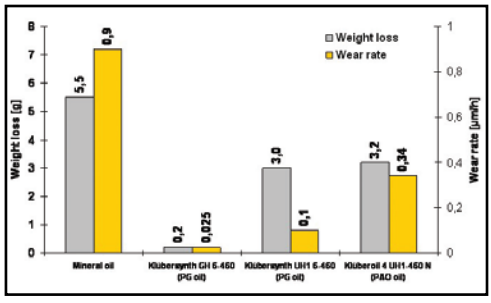


Fig. 4: Wear measurements.

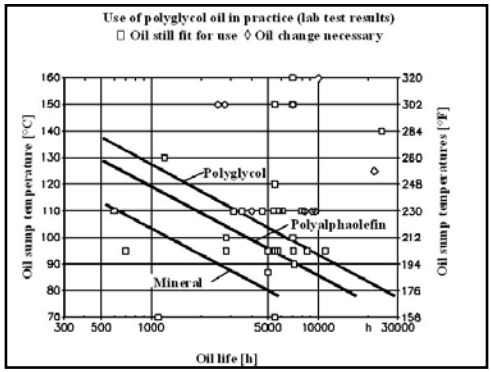


Fig. 5: Polyglycol oil used in practice.

APPLICATION BENEFITS

- Higher efficiency due to lower friction
- Lower energy consumption at constant drive power
- Longer oil life due to lower oil temperature and minimum contamination by wear particles

All results stem from applications where there was clearly no gear damage due to the gear oil being past its service life. The results of this evaluation show that the selection of the right base oil can contribute decisively to attaining a longer service life. A polyglycol oil used in a gearbox application can last five times longer than a mineral oil. This is without taking into account that if, for example, a Klübersynth GH 6-460 oil is used, the operating temperature will go down considerably and the amount of wear particles be reduced, which will additionally extend the oil's lifetime.

The fact that the oils discussed can be used both in spur gears and in worm gears greatly facilitates maintenance in that it allows a streamlined product range. Fewer oils are kept on stock, which helps to avoid confusion. Hence, the consistent use of synthetic gear oils leads to significant cost savings for the operator, which may justify the higher purchasing costs for synthetic oils compared with those of mineral oils. It makes therefore sense to choose a more global approach to cost considerations, and in particular to include maintenance and repair.

REMOTE-CONTROLLED TOWER MAINTENANCE

Robotic climbing machines provide an alternative to traditional methods for wind turbine inspection, repair, and maintenance. ICM explains.

By Carolina Osorio Gil

Carolina Osorio Gil is knowledge coordinator at International Climbing Machines (ICM). To learn more call (607) 288 4001, e-mail info@icm.cc, or visit www.icm.cc.

INCREASING GLOBAL RELIANCE on wind energy means that more wind turbines are being built each year, and these massive structures require regular maintenance and repair. International Climbing Machines (ICM) has developed a remote-controlled device that provides a safe alternative to traditional methods for the inspection, repair, and maintenance of wind turbine towers and blades. ICM climbers are small (approximately 24" length x 24" width), lightweight (40 lbs.), remote-controlled devices that can adhere to steel, composite, ferrous, or nonferrous surfaces. They can access both wind turbine towers and blades and they are extremely flexible, maneuvering over obstacles like bolts and weld seams with ease. Moreover, ICM climbers have high payload capacity to deploy cameras, ultrasonic testing sensors, cleaning heads, coating removal tools, epoxy injection equipment, paint spraying guns, and other devices the job requires.

CURRENT CHALLENGES

Blade maintenance and repairs are rapidly becoming a considerable portion of a wind turbine's maintenance costs. To keep them turning and producing at their optimum output, wind turbine blades need to be inspected and maintained regularly. Damaged, dirty, or faulty blades can reduce the overall productivity of a turbine and should be repaired and cleaned as part of the operator/owners preventative maintenance program. By carrying out a thorough inspection of the wind turbine blades each year, the owner/operator is reducing the risk of a catastrophic

failure by highlighting issues early and taking action immediately. The damage is often found long before it spreads, allowing for a much smaller repair and ultimately less downtime.

Wind turbine blades can be damaged or degraded by several factors. Working at optimum wind conditions, a blade tip could be turning at speeds well over 100 miles an hour. Over time sand, ice, rain, UV rays, and insects—just to name a very few—can have serious adverse effects on the leading edge. Lightning and bird strikes can also lead to serious damage and reduction in productivity. Over time the blade is subjected to a serious amount of damage, often starting with a small problem that if caught early enough could save a huge amount of money, downtime, and lost revenue. Blade inspections and regular maintenance are not a luxury, they are a necessity.

Fig. 1: The ICM Climber.

Fig. 2: The ICM Climber in operation.

CURRENT APPROACHES

Wind turbine towers and blades present unique challenges to "access" the surfaces. They are very high off the ground, after all. Until now wind turbine towers and blades have been serviced either by removing the blades and transporting them to a facility for repair, in the field using cranes or, in some cases, rappelling to allow workers access. In-house blade repair is costly and requires downtime. Repairs and services using cranes to lift technicians and loads is a common requirement for turbine operations and maintenance work. This work is performed in windy conditions, and at extreme heights. Conventionally, accessing the surfaces of the towers and the blades has been achieved by rappelling workers from the nacelle, or using cranes or "cherry pickers" to lift the workers and their equipment to the surface. This is expensive, dangerous, and time consuming.

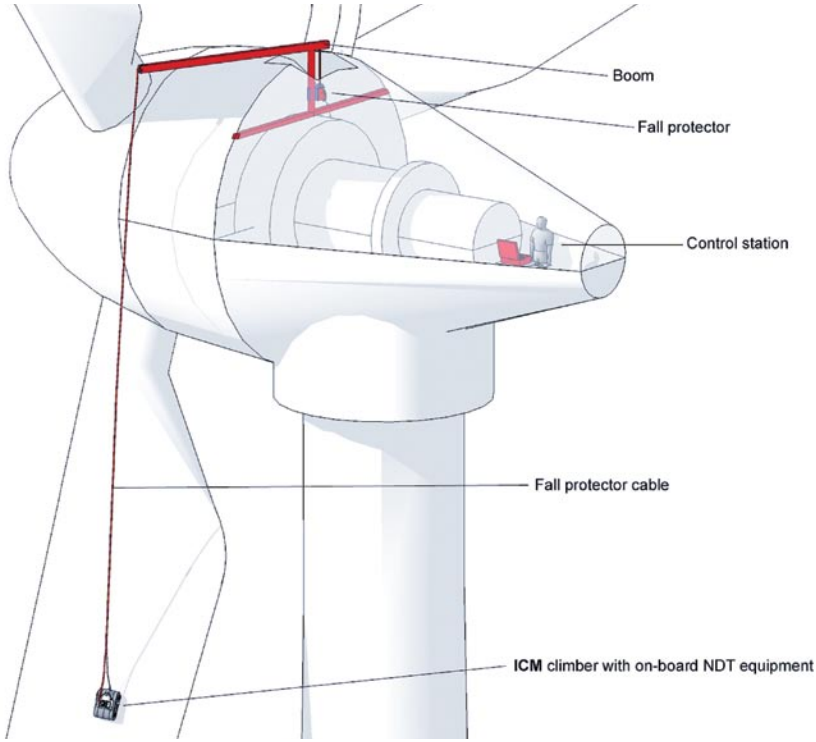


Fig. 3: System diagram for ICM wind turbine deployment.

DESIGN ADVANTAGES

Due to the inherent danger of current methods for wind turbine maintenance, ICM climbers present a clear advantage by keeping the people making repairs on the ground instead of climbing the heights themselves, using what is essentially a gaming controller to guide a machine to do the work. Using cameras as virtual eyes in the sky, the operator can see what the climber is doing and remotely use it to make repairs, inspect for faults or cracks, and perform any other tasks they would otherwise be doing themselves. Because the ICM climber is a free-climbing device, it does not require any scaffolding or cranes, both of which are costly and time consuming.

The ICM climber is not the only robotic device used to climb surfaces, but it presents many advantages over other devices. The ICM climber is held to the surface with a patented technology. Essentially, the ICM technology is an onboard vacuum chamber surrounded by a rolling, flexible, and locomoting seal. This exceptional approach achieves what no other method can: It establishes adhesion to virtually any surface, ensures the climber can negotiate weld seams, surface irregularities, etc., and it locomotes the machine with the seal itself, whereby all the force provided by the vacuum is transferred to the locomoting assembly. In short, this provides surefooted traction unlike any wheeled or tracked crawler where the method of adhering the device to the surface and the method to drive it are separate or individualized. With the ICM technology the vacuum seal around the chamber and the locomoting element are one in the same, and its advantages are significant and very real.

This unique adhesion seal allows the climber to scale ferrous or nonferrous metals, concrete, brick, and composites, etc. Magnetic crawlers are obviously limited to ferrous metals, but the ICM climber is unaffected by the degree of rust that may be on the steel walls. Magnetic crawlers are highly affected by the rust layer, to the degree where they can fall off the vertical wall if the rust is too thick. Moreover, magnetic-type crawlers often have a buildup problem where metal and ferrous particle debris accumulates on the magnetic wheels or tracks, rendering the vehicle ineffectual at adhering to the vertical surface. ICM climbers cannot and will not be adversely affected by rust or debris.

ICM technology also has the ability to transition from floor to wall, and from wall back down to the floor if needed, and it is conducive to attaching an array of tools and/or capabilities to the same climber. For example, it is feasible for the same ICM climber to have onboard camera, cleaning tool, EMAT sensor, and other UT sensors. Also, it is possible for tools to be attached, detached, and reattached with minimal time and/or exposure to workers.

In addition, the manner in which the ICM climbers traverse the surface—rolling along at a speed that can be accurately and evenly controlled from 0 to 3

inches per second—makes them conducive for regular and uniform surface cleaning, scanning, and measuring. The other approaches, using an inchworm or "fasten-move-refasten" approach for traversing along a surface, are not at all favorable for surface cleaning, scanning, or measuring.

Plus, the ICM climbers are very lightweight since they are primarily constructed of carbon fiber and epoxy. The rolling seal elements are made of highly durable yet lightweight composites of closed cell foam wrapped around open cell foam. The base ICM climber weighs approx 25 pounds. The tools and capabilities then mounted onboard the climber always employ the most strict weight-shaving regimen to keep the overall weight as low as possible.

ICM climbers are ideal for any type of work being conducted on wind turbine towers and blades. With the imminent growth of the wind energy market, and the growing demand for more-efficient and safe approaches, ICM climbers are proving to be the future for the field of wind turbine inspection, repair, and maintenance.

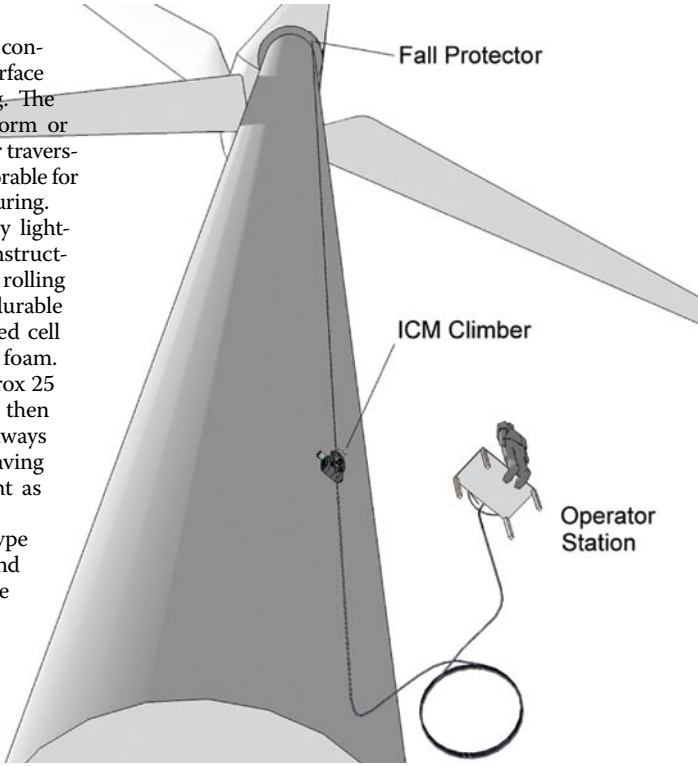


Fig. 4: ICM wind tower cleaning system.

are available in sizes and configurations that can fit any worksite footprint.

"The tool crib is an important component of any job site, but especially in large operations or in remote locations," Alberts says. "It needs to be well stocked and ready to go. But maybe the crib only needs to be at a location for 30 days. It doesn't make sense economically to purchase an asset like that for short-term deployment. But rental makes a lot of sense."

Mobile tool cribs from Snap-on Industrial can be purchased, rented, or leased. Customers also can have an existing tool crib retrofitted with the Level 5 Tool Control System, add the Level 5 Asset Management Software to an existing tool crib or hire a Snap-on consultant to organize an existing tool operation. For more information call (877) 740-1900 or visit www.snapon.com/industrial.

VIBXPERT II PORTABLE VIBRATION ANALYZER FROM LUDECA

LUDECA, Inc., introduces VIBXPERT® II, the latest addition to the PRUEFTECHNIK family of portable route-based vibration data collectors. VIBXPERT II is rugged and lightweight and combines the advantages of a rapid processor with a brilliant energy-efficient color VGA display. Enhanced with an Fmax of 51KHz and up to 102,400 lines of resolution, all machinery problems can be captured and easily analyzed on the large color screen.

< Continued from page 15

The VIBXPERT II basic platform is a one-channel device that can be upgraded at any time to two individually configured channels via a special passcode—user upgradable, does not require hardware changes. All forms of machine vibrations, bearing conditions, process data, and visual inspection information can be collected and stored on the expandable compact flash card (up to 8 gigabyte) for report generation or for later transfer to the powerful OMNITREND® software for further analysis, reporting, and archiving. The VIBXPERT II provides an easy to use icon driven platform that offers comprehensive analysis functionality for the diagnosis of simple or very complex vibration problems.

Capabilities include order spectrum, phase, cepstrum, cross-channel phase, orbits, run-up and coast-down measurements, bump test, negative averaging, and more. Analysis tools—including various cursor types, machine-specific frequency markers, signal post processing, and extensive bearing databases—are included for evaluating each spectrum. Alarm notifications based on ISO standards or user-defined standards are visually identified with the aid of colored LEDs. It also features modular functionality including dynamic field balancing, extended time waveform recording, transient data capture, UFF file export, and modal/ODS support. For more information go to www.ludeca.com/vibxpert.

SUPERSIZE VERTICAL TURNING CENTERS FROM MAG

Receiving market introduction for IMTS, MAG's new vertical turning centers with 5 to 8 meter tables are engineered to make short work of large-part manufacturing for a variety of industries, including wind and nuclear, offering multiprocessing machining capabilities with high-end specifications like 2500 mm ram travel and 1500 mm minimum height under the rail. The modular machine design is built for high metal removal rates on large parts, with twin columns mounted to the base, 150,000 to 250,000 kg table load capacity, and 350 mm cross-section ram for extreme rigidity and chatter-free machining. Four models, with table diameters of 5, 6, 7 and 8 meters, are being introduced in fixed and adjustable-rail styles. All are engineered for full ram travel to either side of the table center, providing facing capacity that is one meter greater than table diameter for any given model. Powered by a 142 kW (190 hp) table drive, the 5- and 6-meter models have a maximum speed of 72 rpm and constant torque rating of 160,000 Nm (118,000 lb ft), while 7- and 8-meter models have 45 rpm maximum speed and 255,000 Nm (188,000 lb ft) constant torque.

These new VTC models continue MAG's design tradition of building on an extremely rigid platform, with excellent ergonomic and operating features driven by "voice of the customer" research. Customer-driven features include use of standard modular tooling, including KM and Coromant Capto C8; green design with minimal hydraulics; energy-conservation with selectable "sleep" capability; minimal foundation requirements; and innovative chip management and removal that minimizes operator intervention. Ergonomic features include an operator platform that provides an excellent view of the cutting zone, as well as access to the tool and tool magazine. Options for the platform include fixed position, or moveable in vertical, or horizontal and vertical directions. A full machine enclosure meets CE specifications and ensures a dry floor environment. To learn more visit www.mag-ias.com.

NEXT-GENERATION LASER SHAFT ALIGNMENT TOOLS FROM SKF

New SKF® TKSA shaft alignment tools introduce highly affordable and easy to use solutions to align the shafts of rotating machinery quickly and with pinpoint accuracy. The tools represent the latest generation of SKF laser-enabled technology to align shafts properly in a fraction

of the time compared with traditional methods.

This latest family in the SKF laser-technology toolbox includes the TKSA 20 and the TKSA 40 versions. Both are competitively priced to deliver a quick return on investment, simple to use, and display real-time alignment values to confirm results of alignment corrections as they are performed. No special training is required and a quick-start guide promotes their ease of use. Among features, the TKSA 20 integrates a quick-start guide and fast measuring unit positioning capabilities and the TKSA 40 is designed with built-in tolerance checking and a memory facility enabling results to be stored and shared. These tools can help reduce energy consumption and the potential for machinery failures typically encountered when shafts are misaligned. Their use can contribute to reduced stress on mechanical components, enhanced equipment reliability, and extended machinery service life.

The TKSA series is the latest innovation in a growing family of laser shaft alignment tools available from SKF Maintenance Products. Contact Joe Marcin, SKF USA Inc., at (267) 436-6766, joe.f.marcin@skf.com, or www.mapro.skf.com/alignment.

WINDINGEN LAUNCHES WIND TURBINE SERVICES

WindIngen—a new division of Mechanical Dynamics and Analysis—has launched its wind service business from their new offices in Fort Collins, Colorado. This division has hired experienced technicians with extensive industry knowledge and multi-OEM technical and mechanical expertise in preparation for fulfilling their wide range of service offerings. WindIngen also announced that their highly-trained technicians have completed a nine-day safety program.

All WindIngen technicians have completed OSHA 30-hour training, which exceeds the 10-hour OSHA wind specific course being proposed by the AWEA safety committee. The technicians are also qualified on the industry's two most commonly used high-angle rescue devices, as well as personal self-rescue and evacuation techniques. The completed training comes on the heels of MD&A's commitment to improve safety performance across their entire business.

MD&A is one of the largest non-OEM steam turbine service providers in North America. Many of MD&A's clients have expanded their portfolios to include wind assets, and MD&A has committed to growing its business in direct response to their customer's developing needs. WindIngen's comprehensive maintenance services are backed by MD&A financial strength as well as 25 years of service industry experience. With "Quality, Reliability and Ingenuity" as its core values, WindIngen delivers premier wind turbine service, repair, parts and engineering for both scheduled and unscheduled maintenance. For more information call (970) 224-3139 or go to www.windingen.com.

MINERAL-INSULATED THERMOCOUPLE CABLE FROM ARI INDUSTRIES

ARi Industries, Inc., a longtime market leader in temperature measurement, announces immediate availability of its AerOpak mineral-insulated (MI) thermocouple cable in an expanded assortment of sizes and sheath materials. MI cable offers thermocouple fabricators, instruments designers, process engineers, and various equipment builders a unique solution to the challenges of temperature measurement and electrical signal-sending in harsh, corrosive, and other hazardous environments.

Offered as thermocouple and conductor cable, AerOpak products comprise thermocouple or conductor wires insulated with compacted ceramic powder, drawn, and encased in a seamless metallic sheath material. Standard thermocouple or conductor cables up to 10-wire configurations are available in various stainless steel, Hastelloy, and Inconel sheath materials in OD sizes ranging from 0.020" to 0.750" diameter. Cable can be supplied for temperatures up to metal melt points of 2600°F and over 1000 ft. in length, making these products suitable for all types of process operations and very large equipment. Owing to the strict manufacturing and production standards of ARi, MI cable signal integrity is consistent over the longest length applications. Thermocouple cables in Types K, E, J, T, N, R, S, and B are stocked in calibration tolerances to meet all applicable ASTM, IEC, and ANSI standards.

MI cable from ARi can be welded, brazed or soldered in the field, relative to the application and techniques used. Please consult the manufacturer for details or installation assistance. Custom wire configurations, other sheath materials, and assorted insulation ingredients are also available on request to suit virtually all applications. For more information call (800) 237-6725, e-mail sales@ariindustries.com, or visit www.ariindustries.com.

WINDSPIRE ENERGY ENTERS THE AUSTRALIAN WIND MARKET

Windspire Energy announces a partnership with Australian-based AllSafe Energy Efficient Products to be the sole distributor of the Windspire® wind turbine in Australia. AllSafe is recognized as one of the leading and fastest growing energy efficient product providers in Australia. The partnership will now begin the process of certifying the Windspire for the Australian market for an expected sales launch later this year.

Wind energy is the fastest growing renewable energy industry in Australia, driven by government initiatives to reduce greenhouse gas emissions by 60 percent by 2050 and a commitment to ensure 20 percent of Australia's electricity supply will come from renewable energy sources by 2020. The market for small-scale turbines is expected to grow through rebate programs that can offset the costs for customers by as much as 50 percent. AllSafe is introducing a unique business model that addresses the desire for customers to maximize energy efficiency due to rising energy costs. Unlike most companies that specialize in just one product type, AllSafe offers a complete line of efficiency products including insulation, skylights, solar hot water, solar power, and ventilation. The Windspire was chosen by AllSafe for its innovative and small-scale design, and it will be the company's only wind turbine product.

"Given their desire to cut emissions and focus on renewable energy solutions, Australia is a very important market for us," says Windspire Energy President & CEO Walt Borland. "We are pleased to have found a partner in the market who is not only a leader but values innovation as much as we do."

"Australians are famous for quickly adopting cutting-edge technologies from the U.S.," says Sean Cochrane, managing director of AllSafe. "The Windspire is a wonderful departure from the old-style windmills and will give our customers a truly unique way in which they can reduce their energy use."

Windspire Energy, Inc.—formerly Mariah Power, Inc.—is developer of the innovative Windspire wind turbines, which are designed for use in urban, suburban, and rural settings.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The propeller-free, vertical-axis design enables silent operation and features patented technology that maximizes energy conversion from wind into electric power, regardless of changing wind speed and direction. Learn more at www.windspireenergy.com.

GE UNIT INVESTS IN 183-MW IDAHO WIND POWER PORTFOLIO

Maintaining momentum in its renewable energy investing, GE Energy Financial Services, a unit of GE, has made an equity investment in Idaho's largest wind power project. The almost half billion dollar portfolio of 11 wind farms under construction was developed by Exergy Development Group.

GE Energy Financial Services made the announcement at the American Council on Renewable Energy's Renewable Energy Finance Forum in New York City. The GE unit will own a majority equity interest in the Idaho Wind Partners project. Exergy Development Group will own a minority interest along with manager and operator Reunion Power. The wind farms will sell all of their power to Idaho Power Company under 20-year agreements. Once completed, the portfolio is expected to qualify for the Federal Treasury Grant program designed to stimulate renewable energy projects. Additional financial details of the transaction were not disclosed.

"Through our investment in Idaho's largest wind power portfolio, GE Energy Financial Services is putting millions of dollars to work to bring jobs and clean energy to Idaho and help the country meet growing demand for domestic, renewable sources of energy," said Kevin Walsh, managing director and head of Power and Renewable Energy at GE Energy Financial Services.

Construction company Fagen, Inc., initiated project construction earlier this month and expects to complete the wind farms located on farmland clustered near Hagerman and Burley by year's end. Using 122 of GE's 1.5-megawatt turbines, over 13,500 of which have been installed worldwide, these wind farms will have the capacity to generate 183 megawatts, enough to power approximately 39,700 average Idaho homes and—according to US Environmental Protection Agency methodology—avoid approximately 331,000 short tons a year in greenhouse gas emissions—the equivalent of taking about 57,000 cars off the road. In addition to supplying the wind turbines, GE will provide seven years of operational and maintenance services to the project.

The project is expected to create approximately 175 construction jobs as well as permanent employment for operations and ongoing seasonal maintenance requirements. In addition to those employed directly, a wind project of this size would typically support the equivalent of over 2,200 full-time jobs in the United States for one year—about half of which would be in-state—and create 25 permanent jobs, based on a National Renewable Energy Laboratory model. Go to www.geenergyfinancialservices.com, or to www.ge.com.

AVANTI BECOMES CRESTO/RESQ DISTRIBUTOR

Avanti Wind Systems is now a strategic distributor and service partner for Cresto ResQ products in the wind energy industry. Previously named ResQ, Cresto has sold more than 25,000 sets of evacuation and rescue equipment for wind turbine towers around the world. The agreement means that Avanti will establish training and service centers for Cresto equipment in Germany, Great Britain, Spain, the United States, India, Australia, and China, where Avanti already has offices and factories. "Safety in wind turbine towers always has top priority at Avanti, so it is natural for us to have entered into this partnership," says Avanti's Training Manager, Ole Jensen.

Cresto and ResQ have until now been trademarks for fall safety equipment. Henceforth they will be marketed under the Cresto brand. However, ResQ will be kept as the product name for rescue equipments and related training.

Regulations require that there be an alternative exit route from the top of wind turbine towers so that technicians can get down should fire or other causes block the normal route up and down, for example. Therefore there should be rescue equipment in the nacelle so that technicians can descend externally.

As with everything related to wind turbine tower safety, the evacuation equipment must be inspected and tested at least once annually. But Cresto has developed approved packaging that makes it possible to test the safety equipment just once in 10 years. "The safety equipment is vacuum packed," says Jonas Cedaas, managing director of Cresto. "That is, put into a foil bag from which all air is pumped out. And when a rescue device, ropes, and other accessories are not in contact with oxygen they last longer, since the materials cannot wear down. The vacuum packing also safeguards the equipment against the wind turbine tower vibrations. However, wind turbine owners must continue to inspect the vacuum packing for air-tightness at least once annually."

The Avanti-Cresto partnership also means that the two companies will jointly launch new series of harnesses and other personal protection equipment for technicians working on wind turbine towers. Go online to www.avanti-online.com.

ADINDEX

Susan Giordano
General Manager/Second Wind, Inc.

AS YOU CELEBRATE THE COMPANY'S 30TH YEAR IN BUSINESS, TELL US HOW IT ALL BEGAN.

Second Wind was founded by two men who had known each other since childhood, Kenneth Cohn, who trained as a metallurgist, and my husband Walter Sass, who is an electrical engineer and the company's executive chair and CTO. They decided that they wanted to be involved in something that was good for the environment, and wind power was clearly the right choice. Remember that this was in 1980, and they found that people were making siting decisions by walking around feeling the breeze on their faces, looking for trees that had been bent over by the high winds, or by mounting anemometers onsite for a short period of time. They saw a need to fill, and a year later they introduced the AL-2000, which was the first data logger designed specifically for the wind industry. A few years later they realized that, just as wind turbines weren't being sited with good information prior to the AL-2000, they weren't being operated very efficiently either. There were no data networks available then, and O&M technicians were literally driving from tower to tower in a pickup truck making notes on a clipboard. So they designed a monitoring system for wind farms that would allow customers to view data from a collection of turbines, which came to be known as the Second Wind System and was the first third-party monitoring system available in the United States. We offered both product lines for about two decades, but when the Triton sonic wind profiler was introduced in 2007 we decided to begin focusing on the wind-measurement side of the business. At this point our product line consists of the Triton, the Nomad 2 data logger systems, and SkyServe, a satellite wind data service.

HOW DOES THE TRITON COMPARE TO OTHER TECHNOLOGIES, AND HOW HAS IT BEEN RECEIVED?

I would say that the current methodologies are divided into two categories, which are tower-based wind measurement systems and remote sensors such as the Triton. While there's nothing wrong with a well-implemented tower—and you still need at least one on any wind farm to be seen as "bankable"—there are a lot of moving parts that can fail if they're not wired correctly, such as anemometers and other types of sensors. And since the typical wind tower is 80 meters high, and met towers are generally 60 meters tall in the U.S., they're only measuring about 20 percent of the rotor disk circumference. So developers have to extrapolate their wind measurements, which can lead to bad performance predictions. Triton operates very differently, using sodar technology to capture accurate wind data from any height, in any weather, anywhere, and without being attended. Plus you can easily move it from location to location, which isn't the case with a met tower, so you can get a return on your investment fairly quickly since the Triton is so portable and versatile. As for how it's being received, we already have more than 150 systems in the field, in deserts and arctic environments alike, and we've accumulated more than a million hours of data, which proves that our customers are continuing to use their Tritons, which again increases their ROI. And customers can access this information via our SkyServe service, which makes their wind data available online.

THAT'S IMPRESSIVE. I UNDERSTAND THAT YOU'VE ALSO COMMISSIONED SOME PRETTY INTENSIVE INDEPENDENT TESTING.

That's right, we want to gather as much information as we can to increase our customer's confidence in this technology, so we've had two independent studies conducted, one by the National Renewable Energy Laboratory, or NREL, and another by the Energy Research Centre of the Netherlands, or the ECN. One of the recent achievements we're proudest of, however, is the fact that GL Garrad Hassan has begun accepting Triton wind data as part of their clients' application packages for financing. So with 30 years of experience in the field, and growing acceptance of our technology by customers and consultants around the world, we're in a great position to help wind professionals make informed decisions as this market continues to grow and evolve.

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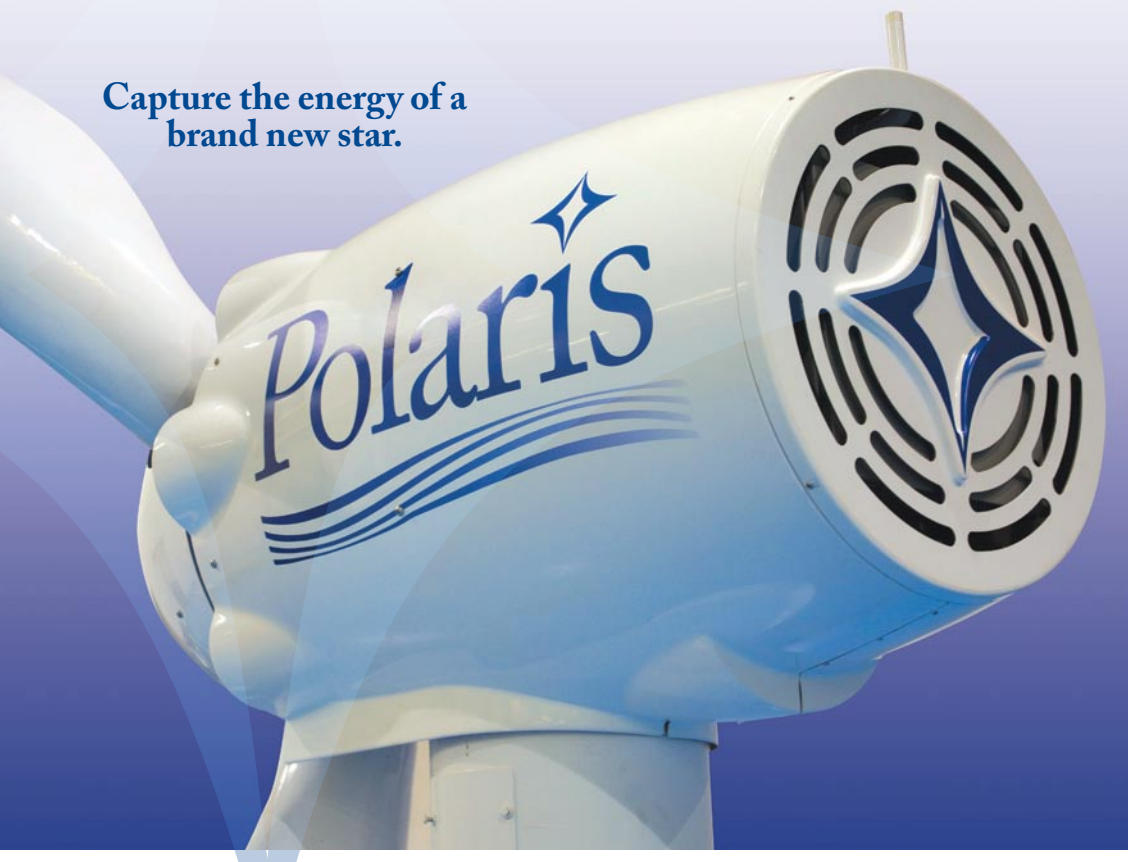

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