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Verifying remote sensing devices

DNV GL and Group NIRE establish new verification site for RSDs.

By Luke Simmons

Edition 2 of the International Electrotechnical Commissions (IEC) 61400-12-1 standard for power performance measurements was released in early 2017. This new standard codified the use of remote sensing devices (RSD) for primary wind-speed measurement in power-curve evaluations in simple terrain. Use of RSD requires verification of each device against a reference meteorological (met) mast before or during the campaign.

In December 2017, DNV GL and Group NIRE Renewable Energy Solutions (GNIRE) commissioned an RSD verification site at the Reese Technology Center in Lubbock, Texas. This is DNV GL's second verification site worldwide. The first site is in Janneby, Germany, which was developed in 2013.

The GNIRE site, established in 2010, covers more than 2,000 acres and provides optimal real-world conditions with consistent wind speeds throughout the year. GNIRE has partnered with GE, Gamesa, Hover Energy, and other manufacturers for prototype wind-turbine testing activities. The RSD verification site has a 125-meter meteorological (met) tower instrumented with six levels of high-quality measurements to offer industry leading RSD verification capabilities. Measurement and verification services offered by DNV GL are accredited by the American Association for Laboratory Accreditation (A2LA) to IEC/ISO 17025.

While the primary purpose of the site is for RSD verification, it is also well suited for research and development activities related to new sensor technology, sensor mounting equipment, mounting uncertainty, verification of other wind speed, and more.

REMOTE SENSING DEVICES

RSDs have been an important part of the evolution of the wind-measurement industry, and DNV GL has been active in ground-based RSD measurements since 2005. The ability to measure meteorological conditions with technologies such as Lidar and Sodar allow for more economical meteorological assessments and have potential to reduce overall measurement uncertainties depending on the configuration and application at the project measurement site.

The economic savings are rooted in the fact that ground-based RSD can measure conditions across typical wind-turbine rotor heights with only a short met mast for monitoring of the RSD. There are no exposed, rotating components at heights, and this keeps operational and maintenance costs down. There are also no costly aviation permits required, and short-term installations can be completed within a few hours with little more equipment than a pickup truck. The value of RSD has been realized for many years with groups such as the International Energy Agency's (IEA) Task 32 being actively involved with publishing best practices and removing barriers to apply Lidar technology.

In 2017, the IEC published Edition 2 of its standard, 61400-12-1 for power performance measurements. This new release cemented RSD's position in the future of the wind industry as a leading technology because, for the first time, an IEC-compliant power-performance measurement of a wind turbine can be performed using

The GNIRE site, established in 2010, covers more than 2,000 acres and provides optimal real-world conditions with consistent wind speeds throughout the year. (Courtesy: DNV GL)

RSDs. However, there are few publications regarding the actual magnitude of the measurement uncertainty when applying Lidar for power performance measurements. The hope of the industry was that RSD would provide a rapidly deployable method for measuring power performance that would also result in a lower uncertainty due to having measurements across the entire turbine rotor. IEA Task 32 coordinated a comparative, or round robin, exercise to allow the industry to practice applying the new uncertainty guidelines and to also get an estimate of the differences in uncertainty when using Lidar with or in lieu of cup anemometers. While already understood by many in the industry, this study clearly demonstrated that standalone Lidar had a higher relative uncertainty compared to using the traditional cup anemometer primarily due to higher verification and classification uncertainty. To reduce the uncertainty relative to a cup anemometer, improvements are needed in the verification and classification process. A high-quality reference mast such as at the GNIRE site will facilitate those improvements.

In the wind-resource field, the application of RSDs has been growing consistently for many years. RSDs are primarily used in conjunction with cup anemometry to reduce wind-shear extrapolation uncertainties. In simple to moderately complex terrain, the RSDs may be used as a primary measurement to help inform the wind flow across a site when certain minimum validation requirements are met. Therefore, before the RSD adds value to the project, high quality, calibrated cup anemometer data are used in some way as the reference against which remote sensing measurements are evaluated to establish a relative understanding of site-specific accuracy.

TEST SITE

The GNIRE verification site provides the necessary high-quality reference mast to minimize RSD verification uncertainties for applications in power performance or wind-resource studies. With verification uncertainties reduced, RSD can be a leading measurement technology for multiple applications. While several such sites exist in Europe, this site is the only high-quality tall reference mast in the United States. Further, the site can support a large number of concurrent RSDs for verifications. The site is well positioned to serve RSD owners in the North American market who want to avoid a longer term overseas logistical challenge to verify a device.

The RSD verification site boasts a 125-meter met tower instrumented with first class anemometers, wind-direction sensors, temperature, pressure, and relative humidity sensors. Ultrasonic anemometry is also included to provide measurements of wind-speed deviations from horizontal. Wind speed and direction measurements are available at six heights with redundant first-class anemometers of different types at each level. All cup anemometers include MEASNET calibrations, and overall, the mast exceeds the requirements of the newest edition (2017) of the IEC Standard for power performance measurements. Sensor data are recorded using a robust industry standard data acquisition system, capable of sampling high data rates and exporting multiple time series averaged

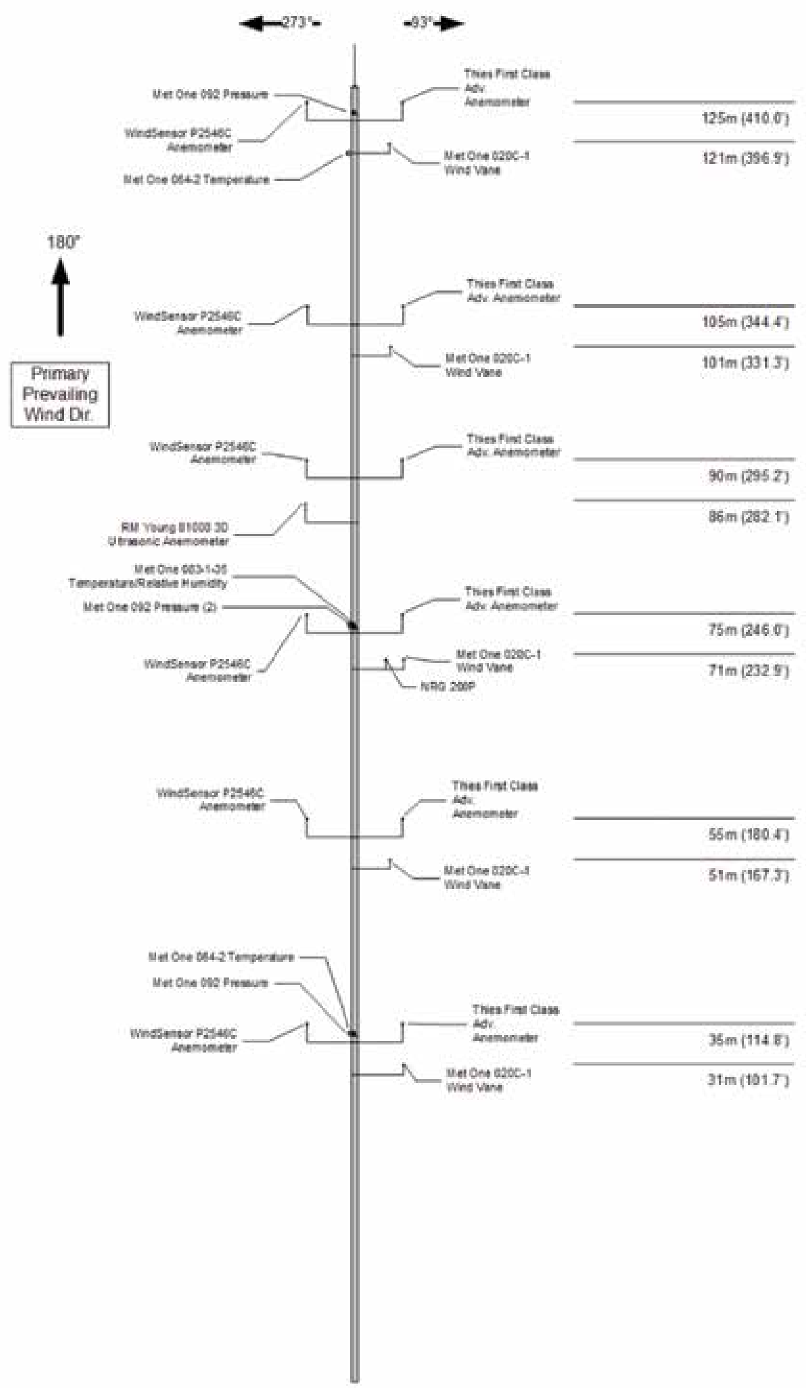


Figure 1. Overview of mast. (Courtesy: DNV GL)

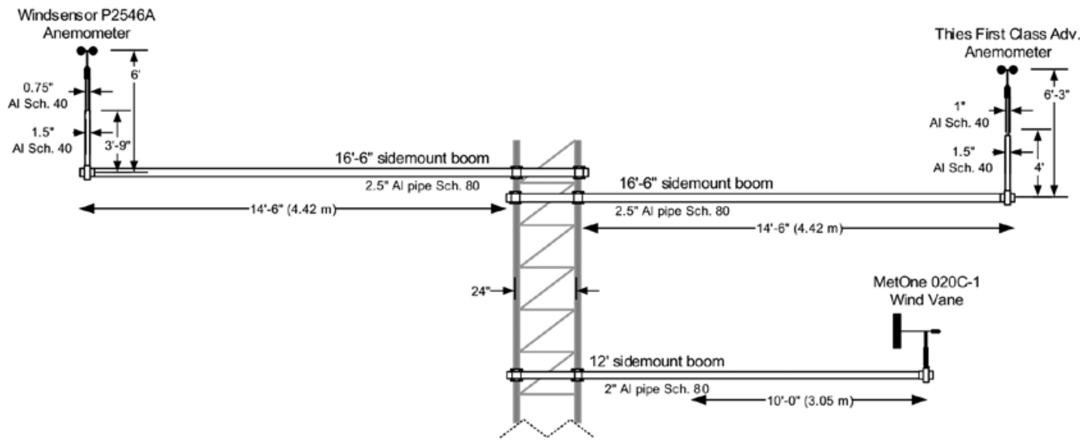


Figure 2. Details for instrumentation at each measurement height. (Courtesy: DNV GL)

Figure 3. The mast prior to installing the full instrumentation package. (Courtesy: DNV GL)

statistics (e.g., one minute, 10 minutes, etc.).

DNV GL is using the industry standard black box concept for verifying and assessing the measurement accuracy of ground-based RSD. Using the black box concept, the performance of the Lidar system is verified by comparing its outputs (e.g., horizontal wind speed and wind direction) with equivalent reference values. The site can also be used for verification of nacelle Lidar RSD technologies. For this type of service, the nacelle Lidars would be mounted at ground level and tilted upward to use the 35-meter level instrumentation.

It is clear the future is bright for RSD in the wind industry. DNV GL expects the new verification site will help enable growth in the application of RSD for various applications in North America and globally.

Luke Simmons is the global lead for Power Performance Measurements. With more than 10 years of experience at one of DNV GL's four IEC/ISO17025 accredited laboratories, he supports more than 100 power performance measurements annually conducted by DNV GL offices in the U.S., Spain, Germany, Australia, China, and India. He is an active member on the IEA Task 32 Advisory Board for the application of Lidar and IEC 50-3 developing a standard for the application of nacelle Lidar for power performance measurements.

LS Cable America/Durocher Marine. (Courtesy: Business Network of Offshore Wind)

Priming the grid for green

Moving from 30 to 3,000 MWs offshore wind means rethinking the transmission grid.

By Liz Burdock

Connecting the East Coast's first offshore wind development (Block Island Wind Farm) to the electric grid involved installing new overhead and underground lines onshore, upgrading substations, installing a new substation and switching station, laying 20 miles (and 5 million pounds) of submarine cable from Block Island to the site, and overcoming those water complications.

To create a viable worksite, crews had to build a cofferdam along the shoreline, then restore the area once the project was complete so it could once again serve as one of Block Island's most popular recreational beaches. Working with a cable vessel and jet plow, crews were able to lay just one mile of submarine cable per day, and weather sometimes impeded that progress. Furthermore, the area had seen some World War II activity, so crews had to take extra precautions to avoid potential sites of torpedo tests.

On land, the grid-connection portion of the development required seven years of project management and permitting work. The interconnection had to clear 20 separate permitting processes from three levels of government and "almost every one of our permits needed some kind of modification throughout the project for something that had changed," according to Mary Ellen Paravalos, director of strategy and performance for National Grid, who spoke at the Business Network for Offshore Wind's International Offshore Partnering Forum on this subject.

A key lesson from the Deepwater Wind project, she said, was that grid connections require meticulous attention from the start of OSW developments because "sometimes the permitting and network upgrades can take as long as the turbine projects themselves."

DESIGN CHOICES, COST DIFFERENCES

"The grid is the last thing that anyone wants to talk about in a project," said Alastair Mills, business development and sales manager of Offshore Grid Access at Siemens. "They think we will go and get some turbines, have some contracts with people to build foundations, get some permits for some cables and then we'll say, 'build me a grid.' It is really the worst place to put the grid people is at the end."

Permitting times alone make that practice untenable. That practice can also preclude project teams from spending the time necessary to make smart design choices that can save money on a costly portion of the project.

For example, decisions about AC or DC transmission, voltage levels, and other specifics can greatly alter the size and price of OSW substations as well as the resources needed to install them.

"When you start talking about high-voltage, direct-current, then we are talking about things that are the height of the Statue of Liberty and the weight of the Eiffel Tower," Mills said. "They are mammoth structures."

One such project entailed 1.3 billion euros of converters and cables. The substations on Statoil's Dudgeon project in 2014 weighed so much they had to be installed by heavy-lift vessels that were European-flagged and not Jones-Act compliant.

"Do you really want to design a grid system where you have to build a vessel or come up with a new, more risky installation method?" Mills said.

There are alternatives. Offshore wind developers have worked to reduce the weight and cost of offshore substations. The substation for the 180-MW Galloper project in 2010, for example, exceeded 2,300 tons. The substation for the 588-MW Beatrice project last year weighed in at 700 tons.

Choices about cable design can also greatly influence project costs. The submarine cables connecting the wind farm to shore are designed to transport high voltages while limiting the EMFs released with layers of insulation. Depending on the amount of electricity generated at the windfarm, the cabling costs for a project can vary.

Emerging technologies could offer new opportunities to optimize productivity and profits at offshore wind installations. Some U.S. developers, for example, are pursuing plans to install storage capacity at offshore sites.

"It is not that easy to do because you need an island or you need to build an artificial island," Bernard said. "But it makes sense."

Offshore wind farms can't always deliver full production to the grid due to lack of capacity on lines, or they deliver power during periods of low demand and low prices.


Block Island wind turbines were connected by undersea cables both to the island and the Rhode Island mainland. (Courtesy: Business Network of Offshore Wind)

Offshore energy storage, Bernard said, would resolve both issues "and reduce the cost of transmission."

MARKET SHIFT

Since the 30 MW Block Island Wind Farm started generating electricity in December 2016, the U.S. offshore wind market has shifted dramatically with 3,960 MW scheduled to be built by 2025 from Virginia to Maine. With such a large amount of clean energy to be generated, there is an opportunity for states and the Federal government to integrate a holistic offshore transmission planned design that leverages opportunities to not only provide generation interconnection but simultaneously to upgrade the existing infrastructure.

For example, an offshore wind export cable could be grid interconnected with an old substation and circuit near the coast that is at the end of its operational life and in need of refurbishment. With careful planning, the facility could be rebuilt in conjunction with providing the interconnection, providing the ratepayer with a new, flood-resistant substation with higher-capacity circuits for a lower total cost than would be available if these transmission challenges were addressed independently.

A BACKBONE APPROACH

Connecting offshore wind to the grid is complicated as illustrated from the Block Island experience. Reflecting on the lessons learned from Block Island Wind Farm and Europe, the U.S. has the opportunity to develop a marine grid with one main line on both coasts.

"We compare the backbone approach to the spaghetti approach," said Pierre Bernard, CEO and chairman of the board of Friends of the SuperGrid. "If you can hook up different offshore wind developments to one, single cable (a backbone), you will significantly reduce the cost of offshore wind … In the spaghetti approach, every wind farm hooks itself to the grid … It is not only expensive for the wind farm, but it is expensive at the end of the day for the consumer."

An offshore wind transmission design would:

- Minimize ratepayer costs.
- Connect a large variable generating resource to load while preserving reliability.
- Capture synergies that advance grid reliability and efficiency.
- Minimize curtailment of offshore wind farms during regular operation and in the event of cable failures.

An integrated, holistic design also would consider the future need to interconnect several wind farms and provide a low-cost way to accommodate future substation expansion and circuit upgrades as the wind projects are built without overbuilding in anticipation of demand. Further, an offshore transmission plan would seek to maximize the standardization of offshore transmission equipment, such as voltages, transformers, and offshore platform design.

BENEFITS OF HOLISTIC TRANSMISSION SYSTEM

An offshore transmission plan would evaluate the need to connect individual offshore wind projects at low cost, while also considering the long-term interest of ratepayers and grid reliability.

An offshore transmission plan would seek to maximize the standardization of offshore transmission equipment, such as voltages, transformers, and offshore platform design. This would maximize U.S. job opportunities as well as the use of standardized, manufactured, and serially produced components help to lower costs. The transmission design should be developed in collaboration with wind-farm developers to determine the parameters for these optimized components.

Today, U.S. submarine cable production is limited. Standardizing cable voltages, transformers, and other equipment would increase product volumes and begin to create the level of demand that will justify U.S. production and the corresponding employment opportunities.

Offshore transmission planning also would improve transmission systems, operations, and maintenance. Within the European market, the lesson has been learned that submarine cable failures do occur, and because they can take a long time to repair, they cause significant wind-farm down-time (i.e., loss of energy production) and financial loss. As has been seen in the German, Danish, Belgian, and U.K. markets, comprehensive transmission planning results in more reliable, lower cost submarine cable systems that are installed right the first time and receive appropriate preventative maintenance.

A marine transmission effort with focused responsibility for design, construction, and operation of offshore transmission in one entity would have the expertise, personnel, and equipment to maintain and repair offshore transmission cables. This capability would reduce the number of submarine cable failures and the duration of outages and their financial cost. As risks are reduced, ratepayers will experience savings.

As a variable resource, wind energy has typically been credited with low-capacity value. Holistic transmission planning would recognize the differences between offshore wind-energy production profiles and other variable clean energy resources such as terrestrial wind and solar. When coupled together and matched with demand response and/or storage, these resources do have the ability to provide reliable capacity. When ratepayers get more capacity value out of variable renewable energy resources, they require less capacity from traditional fossil resources and save money. Planning from multiple perspectives and with a view to achieving multiple objectives will result in the best outcome. A piecemeal transmission approach cannot achieve these goals.

Some of the massive electrical systems powering cranes and other machinery during construction of the Block Island wind farm. (Courtesy: Business Network of Offshore Wind)

CONCLUSION

The long-term success of offshore wind in the United States requires the industry to demonstrate steadily declining costs for the clean, reliable energy that consumers need. Planning and building the transmission interconnections for the state's new offshore wind farms can contribute to the needed cost reduction, can deliver high quality jobs throughout the system life, and cannot be an afterthought. There are many opportunities to reduce costs, create jobs, improve reliability, and deliver greater value for consumers when transmission is done right.

The Business Network for Offshore Wind's 2018 International Offshore Wind Partnering Forum, April 3-6, in Princeton, New Jersey, will gather both industry and regulators. A Smart Approach to Offshore Transmission Networks, will be explored as an idea worth sharing and implementing. With 3,940 MW of offshore wind needing to be grid connected by 2025 and many more to come thereafter, now is the time to prepare and plan — there are no excuses for future inefficiency.

Liz Burdock is the executive director of the Business Network for Offshore Wind. This article is taken from the 2016 IPF presentation and the Network's Grid and Transmission Working Group's White Paper.

DuraGear® W100 is based on nano- and micro-particle bonding components and can be used not only in wind applications but also in industrial, shipping, and automotive applications. (Courtesy: Rewitec)

Improving the friction power of gears and bearings

Proper lubrication can extend the overall contact fatigue life of gearboxes by a factor of 3.3.

By Dipl.-Ing. Stefan Bill

A machine that runs endlessly without any wear and frictional losses — who wouldn't dream of that? Unfortunately, such a machine does not exist yet. However classic car fans know that through solid technology and ongoing service, cars can even outlast their owners. However, this does not happen with machinery of all industries.

In the wind industry, statistics indicate that gearboxes need to be replaced two to three times during a 20-year period. They wear out due to high stress, unsuitable lubricants, and poor maintenance management faster than originally thought.

In the context of tribological properties of gears and bearings, Sentient Science held a presentation in Hamburg in 2016 on the lifetime calculation of wind-turbine gearboxes via the high-tech software called "DigitalClone." Sentient Science introduced its conclusive proof that the lifetime of a WEA-gearbox can be extended by a factor of 2.6 to 3.3 by reducing the friction forces. The results obviously apply not only to gearboxes of a wind turbine but also to a variety of machines where friction and wear occurs.

DIGITAL CLONE

Sentient Science developed a material-science based predictive model of a GE 1.5 SLE Winergy 4410.2. This DigitalClone® gearbox model was used to study the fatigue life impact of Rewitec's surface refinement technology DuraGear® W100. The lubricant is based on nano- and micro-particle bonding components and can be used not only in wind applications but also in industrial, shipping, and automotive applications. In the test with Sentient Science, the treatment was applied on surface-damaged bearings and gears of the Winergy gearbox. As a result of the measured reduction in surface damage, Sentient's DigitalClone® technology predicts that Winergy 4410.2 gearboxes will exhibit a significant improvement in life compared to untreated gearboxes operating under field representative operating conditions.

Specifically for bearings, the treatment shows an improvement of the overall contact fatigue life by a factor of 3.3. For gears, the overall fatigue life is improved by a factor of 2.6.

TRIBOLOGICAL RESEARCH

The first calculations for friction were done by Leonardo da Vinci at the beginning of the Modern Era. Nowadays, tribological fundamentals come from research institutes such as the Institute for Applied Physics of the University Gießen and the Competence Center for Tribology of Mannheim University of Applied Sciences, which investigate the friction phenomena with special testing machines and measuring methods. Dr. Paul Feinle, a researcher at Mannheim University, and his team found that roughness and friction (as well as wear and temperature rise) can be reduced by up to 43 percent with the support of specialty lubrications like the innovative nano- and micro-particle-based surface refinement technology from Rewitec.

The lubricant in this case acts as a means of transportation and carries the silicon coating onto loaded metal surfaces. By using friction energy and crystalline temperatures that arise in the so-called mixed friction range, the products passivate the surface and reduce the roughness. This increases the service life and safety of the systems.

This innovative technology ensures that life and machine performance are enhanced over the long term, and the wear in the tribological systems is reduced. Once added to the lubricant, the Rewitec products, specifically developed for each respective purpose, provide protection over many hours of operation. The concentrated active agents are generally supplied premixed in a neutral oil, which is compatible with practically all standard lubricants.

EXAMPLES OF APPLICATION GEAR TEETH THE MEANING OF ROUGHNESS

Less roughness of rubbing surfaces of bearings and gear teeth results in less friction. Less friction means less wear, and less wear prevents failures and system insecurity. This would certainly lead to positive effects as cost reduction, material and energy savings, less CO2 emissions as well as greater sustainability. If roughness is the origin of the chain of negative effects, how is the problem solved?

The solution is called predictive maintenance, which is based on historical data and maturity calculations. The scientific material data comes from manufacturers of different components, which gain their information through online monitoring on the basis of real load collectives.

In addition to that, research institutes such as Mannheim University investigate the effect of lubrications containing certain additives on special test benches. With the support of this data, Rewitec was able to develop a treatment that contains life-extending properties able to minimize the roughness and its subsequent negative effects. The University of Mannheim and the University of Gießen proved that the roughness on treated interfaces were reduced by up to 55 percent. Equally significant was the reduction in the friction in gears and bearings by up to 43 percent. Corresponding to that was the fall in temperature and undesired vibration, as the results of vibration analyzes showed.

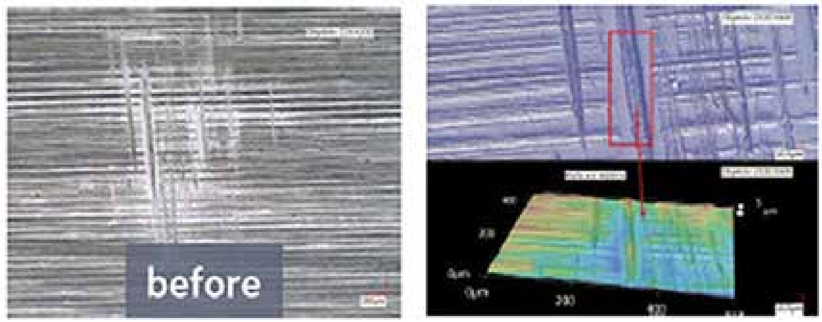


Figure 1: Imprints before the application.

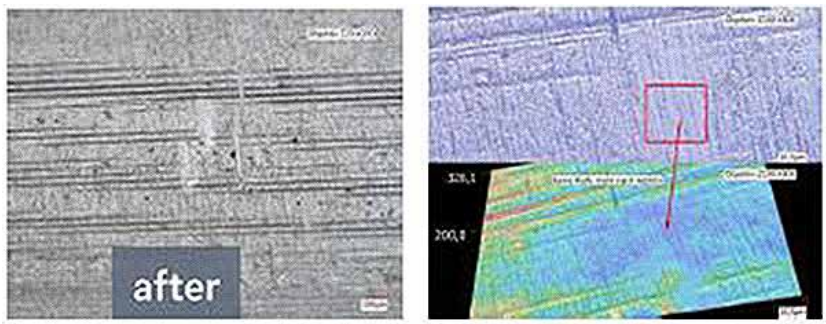


Figure 2: Imprints after the application.

SCIENTIFIC TESTS

The Competence Center for Tribology of Mannheim University of Applied Sciences examined the effect of the specialty lubrication in gear oils under rolling-sliding motion with a rolling wear tester. The experiment was carried out on a modern two-disc test assembly that makes it possible to simulate tooth-flank operating conditions. The evaluation showed the extent of change in friction behavior and temperature after adding Rewitec to different high-performance PAO (Polyalphaolefines)-based gear oils. Each test was performed with and without the addition of the Rewitec® concentrate during 40 running hours. The first 20 running hours were performed without the concentrate and the next 20 running hours with the Rewitec® concentrate. On average, there was a lower surface roughness after treatment of 30 to 50 percent and up to 50 percent less friction.

EXAMPLE RESULT: CASTROL OPTIGEAR SYNTHETIC X320

In the first test round, the friction force increases steadily while running before adding the Rewitec® substance. After the substance is added, the friction force decreases by 22 percent. At the end of the test, the friction force still did not reach its minimum level (blue curve). Test run number two (red curve) shows what happens without adding the Rewitec® substance. The friction force increases steadily. After 40 hours, a constant friction force seems to be reached. In the third round, the Rewitec® substance is added at the beginning of the test run (green curve). The test run shows the effectivity of Rewitec® from the start up through 40 hours, and the friction force steadily decreases.

FE-8 TEST

The FE-8 test is used to examine lubricating oils and greases to gauge their wear and friction behavior under lubricant and bearing-specific in-

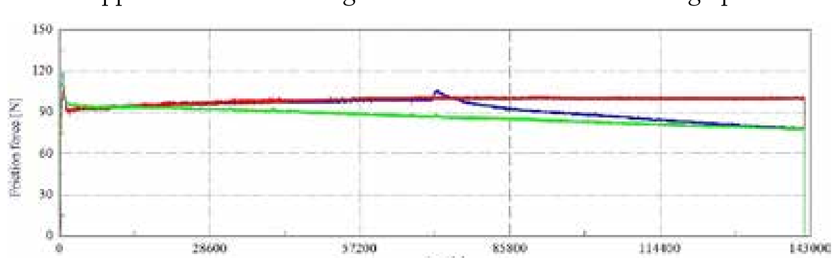


Figure 3: Example Result with Castrol Optigear Synthetic X320.

fluences. To assess the suitability of the lubricant to be tested, the friction, the temperature, and the wear are determined through the resulting weight loss of the bearings in the test arrangement. The tests also allow the ability to perform surface measurements, lubricant performance, and reaction layer analyses. In addition, volume-based wear can be determined through weight measurement.

- Light run marks and smoother surface
- 17 percent less wear with the Rewitec®-concentrate

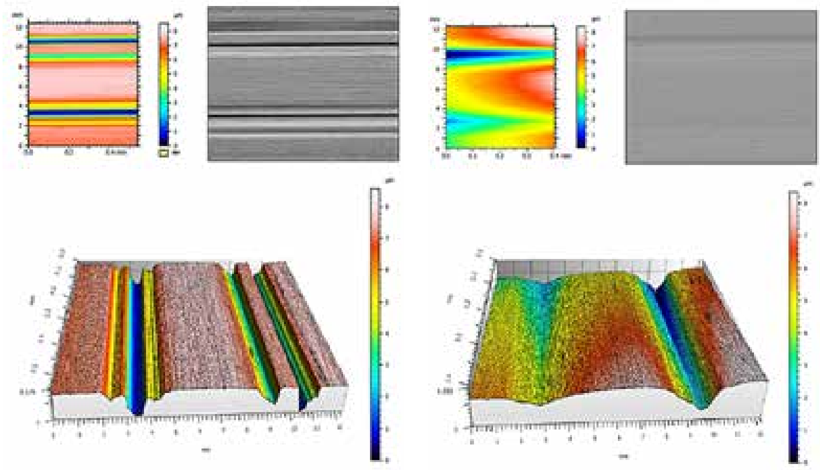


Figure 4: Bearing examination under a microscope without and with Rewitec.

MIXED-EHL MODEL

To take the influence of micro asperity into account for the determination of probabilistic fatigue life, Sentient Science used EHL (elastro-hydrodynamic-lubrication) solver, which uses simulated surface roughness profiles in an explicit deterministic calculation of surface tractions. Surface traction refers to the pressure transmitted between two surfaces through a lubricant.

Outcome: The performance of a given surface finish during the generation, sustainment, and/or failure of an EHL film at the contact zone can directly be determined.

Figure 5 illustrates the surface pressure of two such modeled rough surfaces interacting (left) and two (DuraGear treated) smooth surfaces interacting (right).

FIELD APPLICATION

The company used Rewitec DuraGear W100 Gearbox Surface Protection to a gearbox after 10 months of operation. Based on the evaluation, the application of the Rewitec product resulted in an improvement to the surface structure and roughness of the tooth flanks, a reduction in run through marks, micropitting and seizure and the electrical resistance from the gearbox improved significantly.

"In dealing with Rewitec products, experience has shown that the wear of our wind turbines is significantly delayed," said Jochen Holling, mechanical engineer, global technical support and engineering, Availon GmbH. "In most cases, the progressive damage in certain gearboxes and bearings with pre-mechanical damage was even eliminated."

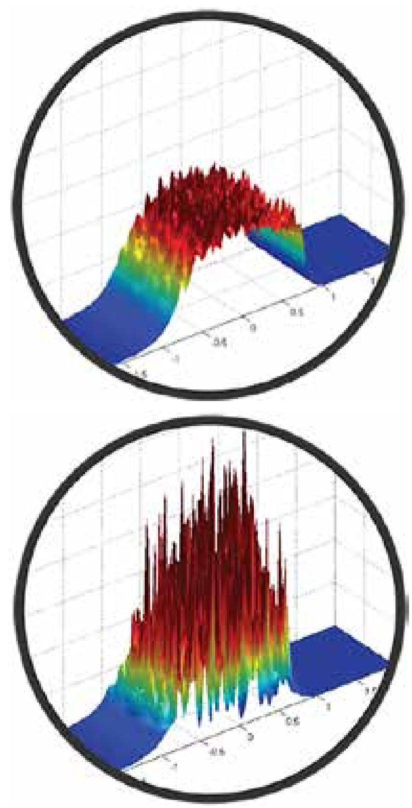
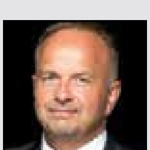


Figure 5: Modeled surface pressure of two rough surfaces.



Dipl.-Ing. Stefan Bill is managing director and an executive partner of Rewitec® GmbH, Lahnau. His company was a finalist in the 28th Innovations Awards of the German Economy 2007. He received the 1st HUSUM Wind Energy Award in 2009, the Industry Award 2014 Category — Best of 2014 for DuraGear®, Finalist Wind Energy Award 2016 — Supplier of the Year.

Small component, big reliability

Fiber optic rotary joints are being considered more and more as a replacement for conventional precious metal contacts in wind turbines.

A fiber optic rotary joint installed in a slip ring. (Courtesy: United Equipment Accessories)

By Jesse Shearer Sr.

When extremely high-speed data communication is a necessity in a wind turbine, one solution is a fiber optic rotary joint (FORJ).

While not a new component, FORJs are becoming more prevalent with the need for reliable data transmissions in even the harshest of environments and applications.

A fiber optic rotary joint is used in wind turbines to transmit data between the top box and the hub of the wind turbine. In most cases, FORJs are used in conjunction with a slip ring that is transferring power and possible other signal lines. They are generally mounted to the slip ring itself and are limited to communications only. For most wind-turbine applications, a single channel FORJ is usually sufficient.

Why switch from conventional precious metal contacts to fiber optic rotary joints? Conventional slip rings are being pushed to the max, and the need for increased data transmissions have challenged engineers to develop more reliable components such as fiber optic and wireless solutions. When compared to conventional slip ring data circuits, a FORJ can be more reliable in circumstances with very high speeds, when high levels of data are being

A fiber optic rotary joint. (Courtesy: United Equipment Accessories.)

A fiber optic rotary joint with mounting plate. (Courtesy: United Equipment Accessories.)

transmitted, or in environments with a lot of electromagnetic radiation. In addition to reliability, FORJs are a good option when it comes to physical dimension restrictions and even cost.

Fiber optic rotary joints are built for, and can handle, the toughest of environments to assure longevity and reliability. They are mounted on the slip ring itself, which is located on the front or back of the gearbox. They can be completely sealed, allowing them to withstand temperatures from -40 degrees C to 60 degrees C as well as high elevations, low to high humidity, and a range of vibrations.

The upfront cost for implementing a FORJ can tend to run higher than with precious metals used in the slip ring circuits it is replacing. The tradeoff of this upfront cost is little-to-no maintenance, saving time and money down the road for customers. Since they are mounted on the top of the slip ring, if maintenance or replacement is necessary, they are easily accessible.

United Equipment Accessories (UEA) has been using FORJ's in conjunction with its slip rings for several years, but recently the company is seeing them being used more often. Some wind customers who have being using precious metal contacts in conventional slip rings are in the process of changing over to FORJ's to allow them to increase the data speed being transferred.

As increased data transfer speed continues to become a necessity, a smart option to consider is a fiber optic rotary joint. Less maintenance, more speed, more reliability, and more savings are just a few of the benefits that can be seen from this small, yet powerful wind-turbine component.

Jesse Shearer Sr. is an application/design engineer at United Equipment Accessories (UEA) in Waverly, Iowa.