



uptime

megazine

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Uptime Megazine is a newsletter published by Brüel & Kjær Vibro to keep you up-to-date with new machine monitoring trends and technologies. This issue focuses on reciprocating compressors.

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APPLICATION SPECIFIC PROJECTS – RECIPROCATING COMPRESSORS

**Theo van Santen**

Head of the Brüel & Kjær Vibro
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Much of the turbo-machinery in the process and energy industries such as pumps, motors, centrifugal compressors, turbines and fans have potential failure modes that can be readily detected and diagnosed using time-proven standard condition monitoring techniques. These techniques, which include spectra, narrow-band frequency analysis, envelope analysis, orbit and transient analysis, require minimal configuration and are quickly implemented. Many machines are being successfully monitored this way by comprehensive plant-wide condition monitoring systems such as Brüel & Kjær Vibro Compass 6000™.

There are some machines, however, that may require an application-specific customization or monitoring techniques that are different from those listed above. This is primarily due to special operating conditions or a special machine construction that results in other potential failure modes occurring in the machines, or other descriptors being needed to detect and diagnose these impending faults. The type of monitoring techniques and the degree of customization done on these machines depends also on other factors such as the machine criticality and the resources and expertise of the mainte-

nance and condition monitoring team. Application-specific projects are an important part of our condition monitoring business, and this includes monitoring solutions for reciprocating compressors. In this issue of Uptime we will focus on gated vibration monitoring techniques, which can be used to detect and diagnose a number of faults for this type of compressor, such as rider ring wear, crosshead damage, rod and piston condition, worn seal, valve damage and liquid carryover. In the next issue we will look at the polytropic exponent function for cylinder leak detection. This two-part series will give insight on how we meet and exceed the challenge of monitoring specialized machines such as the reciprocating compressor. These machines, incidentally, are highly maintenance intensive but surprisingly not sufficiently monitored in many applications.

I am pleased to launch this issue of Uptime with the application-specific monitoring theme focusing on reciprocating compressors and hope you will enjoy reading the technical article about gated vibration and the other articles on projects and new products. Please contact info@bkvibro.com if you need more detailed information on any of these topics. ■

GATED VIBRATION AND ROD POSITION MEASUREMENTS – ADVANCED CONDITION MONITORING AND PROTECTION OF RECIPROCATING COMPRESSOR CYLINDER FAULTS

TECHNICAL
ARTICLE

Gated vibration and rod position monitoring are some of the least intrusive monitoring installations of all monitoring techniques for detecting and diagnosing reciprocating compressor cylinder faults, and yet some of the most effective in terms of the number of potential failure modes that can be detected. Faults can be automatically detected early and do not require a specialist to analyze the results.

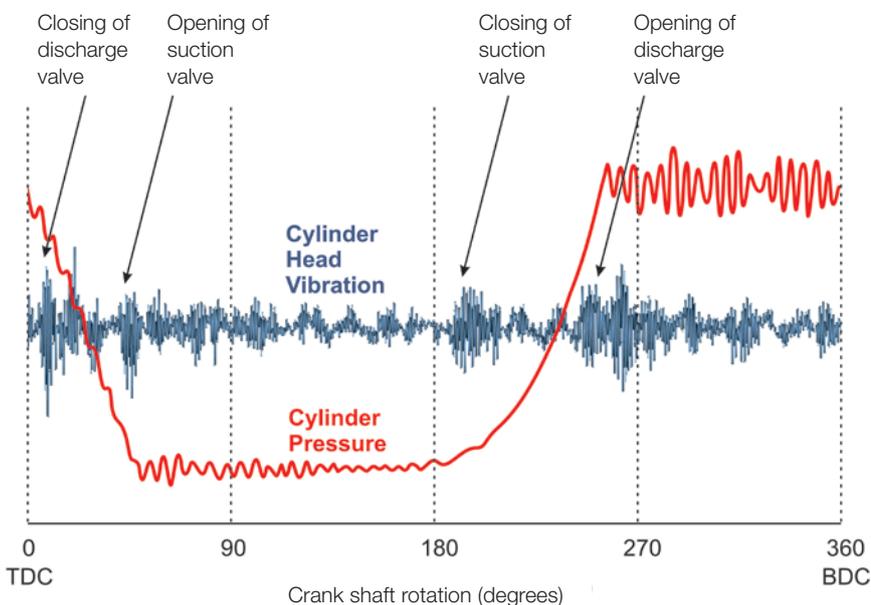


Figure 1. The cylinder head vibration time signal plotted against the cylinder pressure showing individual valve opening and closing events. Other vibration events not indicated here include pressure dynamics, pulsations within the cylinder and kinematics of the piston assembly movement.

CYLINDER FAULTS

Reciprocating compressors are very maintenance intensive in relation to turbo-machinery, and the cylinders account for most of the failures. These faults can be process related, such as liquid carryover, overpressure, excessive pulsations, insufficient rod reversal, or wear/damage related to the running components. If unchecked, faults can lead to component breakage, leaks or even complete machine failure.

There are a number of monitoring techniques available for detecting cylinder faults, but there is a big difference in terms of system cost, installation difficulty, kinds of faults that can

be detected, how early the faults can be detected, and the amount of expertise required for diagnostics. Gated vibration monitoring and rod position are some of the best techniques from an overall perspective for cylinder fault detection.

WHAT IS A GATED MEASUREMENT?

Gated vibration and rod position are extensions of the impact and rod drop vibration measurements that are traditionally done for cylinder monitoring. Gated vibration and rod position are monitoring techniques where vibration is measured with respect to crank angle instead of time or speed (see Figure 1). The measurement is based

on dividing all the vibration data samples for one rotation of the crank into a number of segments (gates), such as 18 or more for condition monitoring (i.e. 20 degrees of crank rotation or less) or as few as 6 for protective monitoring (see Figures 2, 3 and 4). Each of these segments relates the vibration to specific positions of the crank. The root mean square of the vibration (or peak) is calculated into a single bandpass value for each segment, which can be monitored to individual alarm limits and trended (see Figure 5).

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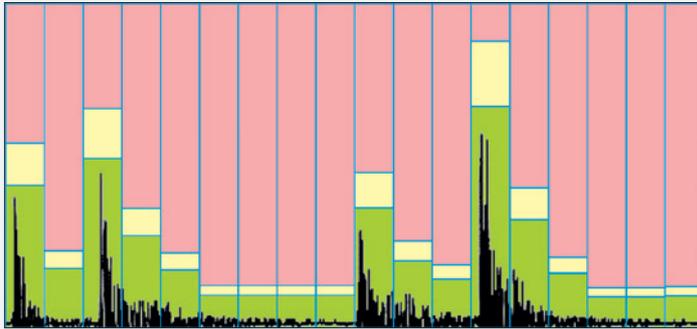


Figure 2. The individual events may be concentrated in a single segment or spread out over several. Each segment can be individually monitored to alarm limits (red is danger, yellow is alert and green is the reference). The segments shown are equally spaced for one complete rotation of the crank. It is also possible to have segments with varying widths.

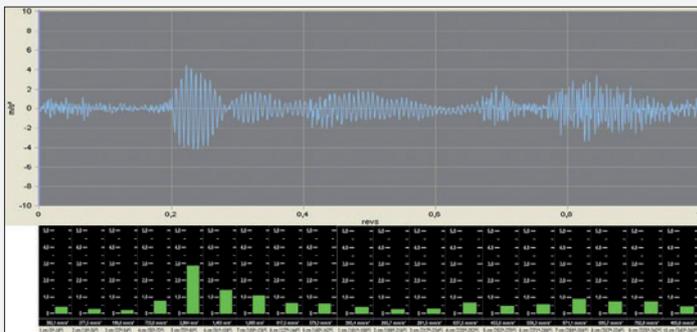


Figure 3. The vibration signal of the reciprocating compressor cylinder for one complete rotation of the crank. 20 RMS vibration bandpass segments at 18 degree crank position intervals for the cylinder head.

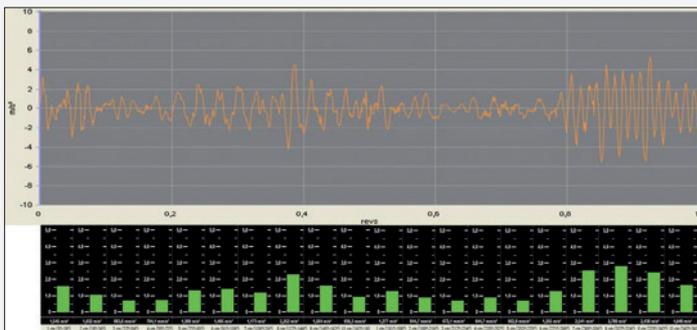


Figure 4. 20 segments for the crosshead vibration.

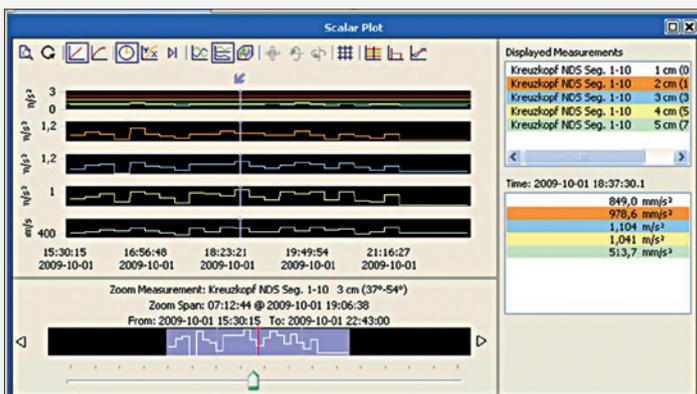


Figure 5. Gated vibration trend shown for the first 5 segments.

The intention with gated vibration and rod position is to isolate the vibration events into individual vibration segments so any changes that occur in these events can be attributed to a developing fault, such as malfunctioning valves, changing process conditions or worn, loose

or damaged piston assembly components. Because the changes from one specific event are isolated from the other events, individual faults can be detected and trended earlier and diagnosed more accurately compared to a vibration signal that has been averaged for the entire crank rotation.

Moreover, considering all operating conditions constant, the measurement signal variations are also constant during the course of a crank rotation. Gated vibration and rod position monitoring techniques are described in Table 1.

| Technique | Sensor type | Location | Faults that can be detected |
|-----------------|---|------------------|---|
| Gated vibration | Accelerometer | Crosshead | Worn or damaged crosshead, valve, piston ring, piston bolt, seal, rod, rod bolts, liquid carryover |
| | | Cylinder head | Same as above, but more sensitivity to valve and piston problems and liquid carryover (e.g. for a long cylinder, this sensor will be used together with a crosshead sensor) |
| Rod position | Displacement sensor (sometimes X-Y sensors) | Distance section | Rider ring wear, crosshead wear/ excessive clearance, rod condition, loose piston bolt, loose rod bolts or worn seal |

Table 1. Gated vibration and rod position monitoring techniques.

FAULT DETECTION MONITORING STRATEGY

Gated vibration and rod position are mostly used for condition monitoring applications but there are some customers who require a gated vibration solution for their protective monitoring application also (but typically not rod position). The type of faults detected and the monitoring configuration for the two monitoring strategies are different.

Condition monitoring – The gated vibration and rod position monitoring technique is intended to detect developing faults at an early enough stage such that the compressor can still keep operating with minimal production loss. This enables maintenance to be cost-effectively planned ahead of time without stopping the machine. Condition monitoring focuses on maximizing machine uptime and minimizing maintenance costs. The types of faults

that are typically condition monitored are those that have sufficient lead-time to failure and can be trended in a predictable manner.

The gated vibration condition monitoring function of Compass 6000™ can be easily retrofitted without adding hardware.

Protective monitoring – Protective monitoring is intended to shut down a machine if there is an imminent component failure that could in itself cause a catastrophic failure of the machine. Another important function of the protective monitoring system is to monitor failure modes of critical components which have little or no advance warning, and therefore cannot be monitored by a typical condition monitoring strategy. This could be liquid carryover, bolt/nut fracture, crosshead wrist pin seizing, loss of lubrication, etc.

In principle, a protective gated vibration monitoring system uses fewer segments compared to a condition monitoring application, in order to avoid false trips due to varying process conditions. When an imminent failure is occurring, however, the vibration energy of these fewer segments for many faults is typically high enough to be seen also in a traditional impact vibration measurement that is averaged for the entire rotation. Therefore the need for a gated protective monitoring strategy as compared to a traditional vibration impact measurement depends on the specific application and customer requirements.

Brüel & Kjær Vibro offers a VIBRO-CONTROL 6000® monitoring module with protective gated vibration monitoring capability.

MONITORING EXPERIENCE

Brüel & Kjær Vibro has several years of experience with gated vibration and rod position for different types of reciprocating compressors, including horizontal and vertical machines. A couple of examples of monitoring results is shown in Figure 6 and Figure 7.

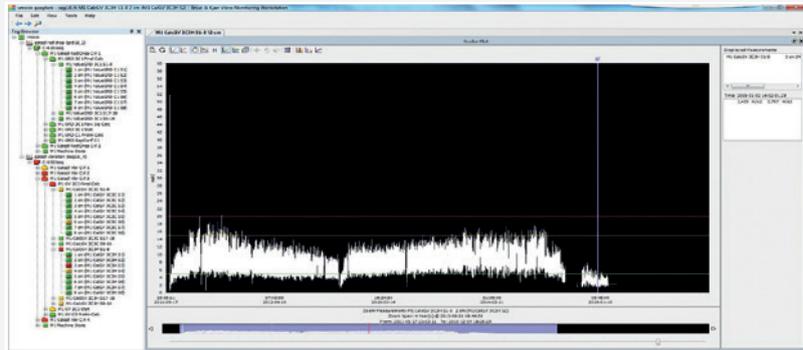


Figure 6, top. Long-term gated vibration signal from segment 2 of cylinder 3-HE of a 4-cylinder. The valve was replaced in October 2014.

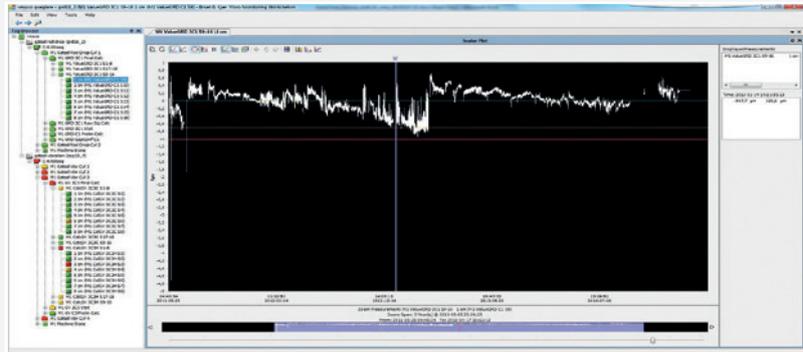


Figure 7, bottom. Long-term rod position signal from segment 9 of cylinder 1 of a 2-cylinder compressor.

BENEFITS AND CONCLUSIONS

Gated vibration and rod position are ideal monitoring solutions for detecting cylinder defects at an early stage of development, especially on compressors where it is not feasible to install valve temperature sensors or dynamic cylinder pressure sensors. The gated vibration technique can be used on its own, or preferably together with the other cylinder fault detection methods.

Some of the benefits of gated vibration and rod position are:

- More accuracy with greater lead-time for detecting, diagnosing and trending developing faults
- More versatile for detecting a wide range of faults, such as valve leaks, damaged or worn piston rings, seal, piston bolt, rod, crosshead, crank bolts, wear rings and liquid ingestion
- **CM Retrofit:** Easy extension to Compass 6000™ with no extra hardware needed. Uses the same sensors as for used for traditional monitoring applications.
- **New Installation:** Sensors for gated vibration measurement are easier to install and less costly than that for other cylinder monitoring techniques.
- No specialist knowledge is needed to interpret the results.
- Several years of experience on different types of compressors ■

ALL THE ACONCAGUA RIVER BASIN HYDRO PLANTS IN CHILE WILL NOW BE MONITORED BY BRÜEL & KJÆR VIBRO

FIELD NEWS



Colbún has awarded a contract to Brüel & Kjær Vibro for retrofitting four cascade hydropower stations on the Aconcagua river basin for protection and condition monitoring. Colbún, the second largest electric utility company in Chile, is generating a total of 3.278 MW of energy, of which 1.589 MW come from 16 hydroelectric power stations. Construction of the Aconcagua river basin hydro plants has had an important impact on the local economy. More energy is available for increased commercial activity and new bridges and roads were built to give access to the semi-isolated villages in the region. Environmental impact has been minimized since no dams were built and there is less dependence on the coal and natural gas thermal power generation in the Central Inter-connected System grid.

The Aconcagua river basin hydropower stations to be monitored include:

- Chacabuquito – Run-of-river plant with 4 Francis turbine units, 30 MW, in use since 2002
- Los Quilos – 3 Pelton turbine units, 39 MW, in use since 1943
- Aconcagua (Blanco and Juncal) – 2 Pelton turbine units, 88 MW, in use since 1994
- Hornitos – 1 Pelton turbine unit, 60 MW, in use since 2008

The hydro-generating units in these power stations, from five different manufacturers, originally had different monitoring systems already installed. The Hornitos and Blanco units already have fully functioning Brüel & Kjær Vibro monitoring equipment installed (VIBROCONTROL 4000 and VIBROCONTROL 6000® machine protection systems), which will be re-used. The competitor systems will be replaced by Brüel & Kjær Vibro monitoring systems.

The project also involves installing vibration monitoring sensors on the guide bearing and the combined thrust bearings on all the machines except those where the existing sensors will be re-used. The Brüel & Kjær Vibro Compass 6000™ condition monitoring platform will be centrally installed at the Los Quilos hydropower station for remotely monitoring all machines. Upon project completion, all units from all four hydropower stations on the Aconcagua river basin will have exclusively Brüel & Kjær Vibro protection

and condition monitoring systems. Brüel & Kjær Vibro was selected by virtue of both commercial and technical benefits. The Brüel & Kjær Vibro VI-6080 data link interface plays an important role for the installation since it enables data to be transferred from the buffered outputs of the existing protection systems to Compass 6000™, to provide full condition monitoring capability. The comprehensive service and training offered by to Brüel & Kjær Vibro was also considered crucial to the project. ■



© Photo courtesy of Colbún

Chacabuquito hydroelectric power station.

CAPSTONE INFRASTRUCTURE SELECTS BRÜEL & KJÆR VIBRO FOR RETROFIT MONITORING OF ERIE SHORES FACILITY WIND TURBINES

FIELD NEWS



Capstone Infrastructure Corporation has awarded a retrofitting contract for its Erie Shores Wind Farm to Brüel & Kjær Vibro. The project involves installing a drive-train condition monitoring and diagnostics solution for the 66 GE 1.5 MW wind turbines on site. The 99 MW wind farm, operating since 2006 and representing approximately 2.8% of the Canadian province of Ontario's installed wind power capacity, is located on the north shore of Lake Erie near the town of Port Burwell.

The comprehensive retrofit project includes a three-year contract with Brüel & Kjær Vibro to take care of all fault detection monitoring, diagnostics and action reports for the

wind turbines. The scope of work also includes training and certifying Capstone's own technicians in installing and maintaining the monitoring system hardware in the wind turbines.

John Kirby, Director of Operations at Erie Shores Wind Farm, says his organization is focused on quality and delivery performance, and emphasizes that an effective condition monitoring solution is an essential part of this strategy. This retrofit is the result of very close collaboration between the two organizations in assessing the wind farm's requirements and providing the monitoring solution and service based on these needs. ■



10,000TH WIND TURBINE MONITORING SYSTEM SOLD!

FIELD NEWS



Yet another important milestone has been met in Brüel & Kjær Vibro's extensive wind turbine monitoring solution business: As of June we have reached the incredible level of 10,000 condition monitoring units sold to our global customers. It was only 12 years ago that Brüel & Kjær Vibro, a pioneer in monitoring the drivetrain of wind turbines, developed one of the first dedicated wind turbine monitoring systems in the world. The unique monitoring concept of specifically dedicated equipment, software and diagnostic service was developed in close cooperation with customers and their service teams, and continues to evolve over the years. "Thousands of alarm reports with actionable recommendations, provided by our diagnostic experts, have already prevented catastrophic failures and unnecessary downtime of wind turbines all over the world" says Torben Ekvall, CEO at Brüel & Kjær Vibro.

Out of these 10,000 wind turbines, many different types of wind turbines and wind parks are currently being monitored world-wide.

We currently serve two primary groups of users:

- Wind turbine OEMs - They typically offer end-users complete monitoring coverage with the Brüel & Kjær Vibro remote monitoring and diagnostic services during the initial warranty period or an extended service period (LTSA – long term service agreement), and during retrofits.
- Owner/Operators – They select either complete monitoring coverage or alternatively opt for the Brüel & Kjær Vibro stand-alone VibroSuite condition supervisory solution with or without services. In either case, the monitoring system equipment and software is the same. Even the diagnostic engineers at the Surveillance and Diagnostic Service Centres in Denmark, China and the USA use VibroSuite to monitor faults, evaluate alarms and issue actionable reports, thereby maximizing lead-time to maintenance for customers and offering a strategic tool to streamline wind farm operation and maintenance best practices. ■



BRÜEL & KJÆR VIBRO LAUNCHES EXCITING NEW MONITORING SOLUTION AT **THE AWEA WINDPOWER 2015**



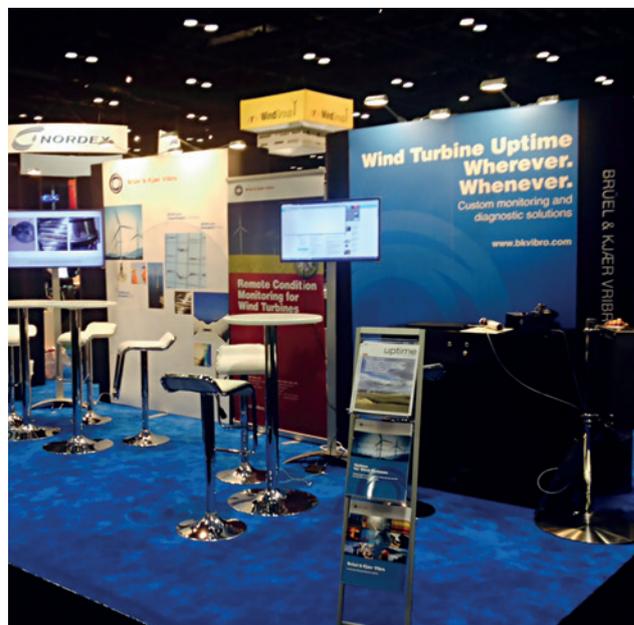
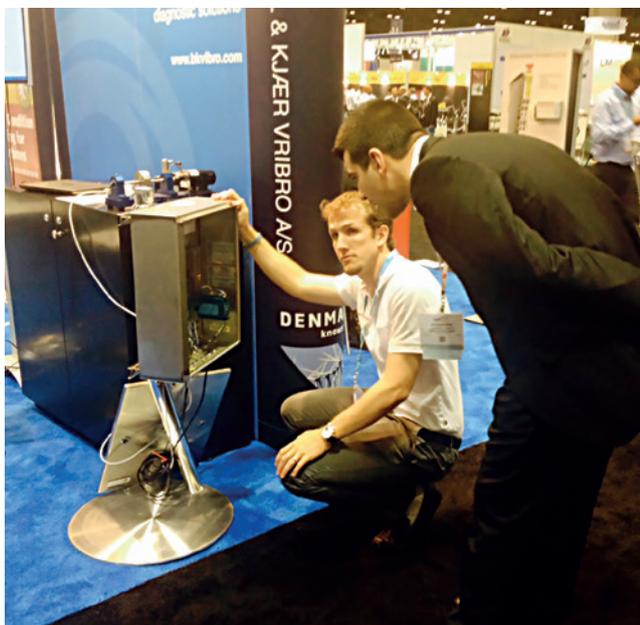
The annual American Wind Energy Association (AWEA) WINDPOWER conference and exhibition took place in Orlando, Florida (USA) in May this year, attracting nearly 6,500 attendees and 450 exhibitors. Wind energy professionals from around the world met at this forum to network, learn more about the new technology, capitalize on the business opportunities and seek business collaboration partners.

We hosted a booth in the “Danish Pavilion” area where we presented our new wind turbine surveillance and diagnostics solution called Condition

Monitoring System as a Service (see our Product News article in this issue of Uptime for more information). At the same conference our diagnostics specialist Alexandros Skrimpas made a poster presentation called “Advantages of Monitoring Wind Turbine Nacelle Oscillation” (see the Renewable Energy article in this issue of Uptime). The interest level at the booth and the poster presentation was high!

According to AWEA, 2500 wind turbines were installed in the USA in 2014 with a total capacity of 4854 MW. The USA is currently the world’s largest

producer of wind energy and it is growing fast. We are happy to play an important part in this phenomenal growth in North America (see our articles on the Capstone and Sempra projects). ■



Left: Robert Gomez and Alexandros Skrimpas with the DDAU hardware (data acquisition unit).
Right : The Brüel & Kjær Vibro stand at AWEA Windpower 2015.

BRÜEL & KJÆR VIBRO PRESENTS SCALABLE, PLANT-WIDE CONDITION MONITORING SOLUTIONS TO INTERNATIONAL AUDIENCE AT ACHEMA 2015

FIELD NEWS



The Brüel & Kjær Vibro stand at Achema 2015.

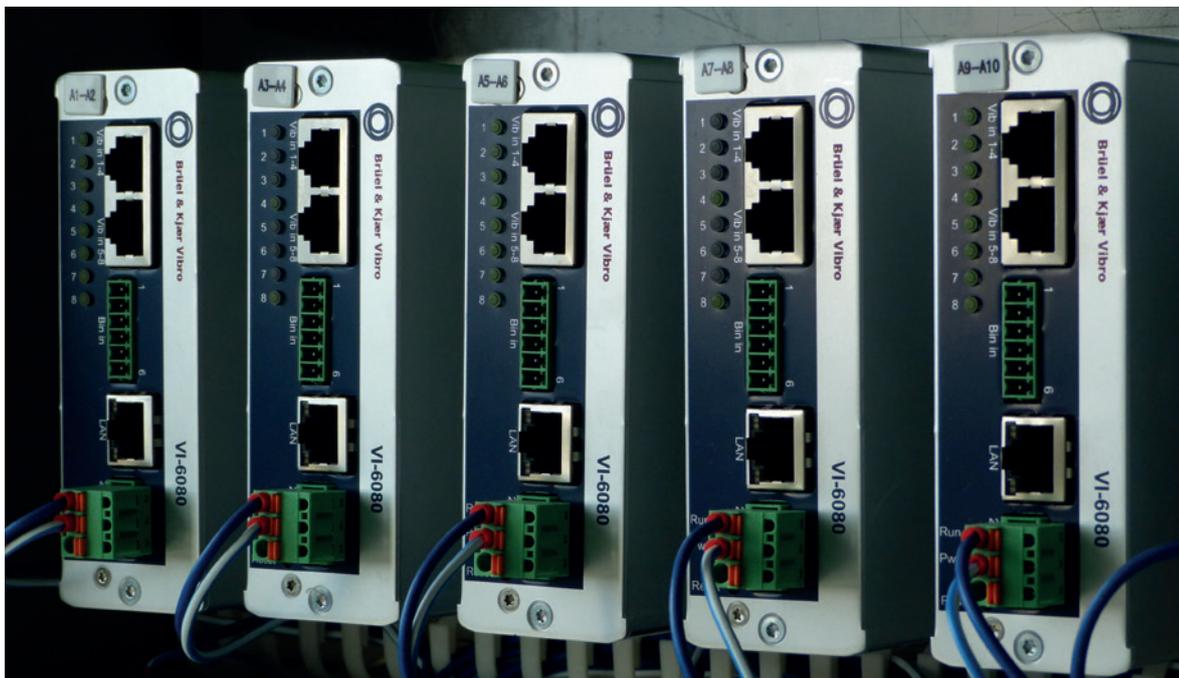
This year, the world forum for chemical engineering and the process industry attracted more than 3,800 exhibitors and around 166,000 visitors from all over the world.

The theme of our booth was “scalable, plant-wide condition monitoring” and the “integration of any machine protection system”, where we presented the new VI-6080 vibration

data link interface (see the Product News article in this issue of Uptime). A lot of interest was generated at the booth as a result of this campaign in upgrading existing Brüel & Kjær Vibro or other suppliers’ protection systems to condition monitoring solutions, so both the Brüel & Kjær Vibro sales and the product management team members were on hand to support the visitors. ■

COST-EFFECTIVE SOLUTION FOR UPGRADING ANY EXISTING PROTECTION SYSTEM TO CONDITION MONITORING

**PRODUCT
INFO**



There are many machines in the industry that are under the watchful eyes of a protection system but there are a surprisingly large number of critical machines that are not condition monitored at all. Part of this is due to the common misconception that a retrofit condition monitoring installation is an enormous endeavor. To dispel these fears, a remarkably simple solution was recently developed by Brüel & Kjær Vibro to make it even easier to upgrade a protection system to a complete condition monitoring system.

While a protection system protects machinery from a catastrophic failure, it does little to protect the plant from lost production due to an inadvertent shutdown, which can also be costly. Studies and experience have shown that an effective condition monitoring strategy can significantly minimize machinery life cycle costs while at the same time optimise plant maintenance and production, and understandably there are few who dispute this. However, there are surprisingly many plants that do not implement a condition monitoring solution simply because the rotating equipment engineers and maintenance managers think it would be too difficult to select, install, operate and maintain such a system, despite the potential value it could bring.

SELECTING, OPERATING AND MAINTAINING A CONDITION MONITORING SYSTEM

Condition monitoring systems have evolved significantly over the last 10 years, and not only by becoming more powerful, but also becoming more flexible and easier to use.

Brüel & Kjær Vibro has pioneered much of this technology over the last 20 years to meet this challenge, often together with end-users and machine manufacturers.

Compass 6000™, our flagship condition monitoring platform, is being successfully used in many applications throughout the world. Its comprehensive monitoring and diagnostic capability is both powerful and scalable, so it can be used by many types of users and applications, and can also grow within the plant as monitoring experience grows. It is designed as a one-stop shop solution that fulfills all condition monitoring requirements. Many services are available to ensure users with any level of experience to get maximum benefits of using the system and maintaining and upgrading it. Such a system takes the worries out of selecting, operating and maintaining a condition monitoring system.

INSTALLING A CONDITION MONITORING SYSTEM

For many plants, the biggest obstacle is not the actual selection, operation and maintenance part of implementing a condition monitoring system, but the initial project phase of retrofitting a complete condition monitoring system on top of an existing protection system. There have been several different approaches for doing this and none of them particularly appealing to potential users. Brüel & Kjær Vibro has been keenly aware of this challenge, and has recently developed a remarkably simple solution to address this need. The [VI-6080](#) data link interface has been specifically designed for this purpose.

DATA LINK INTERFACE

The VI-6080 is a new interface that takes in measurement data via the buffered outputs of any existing protection system (in accordance with API 670) or directly from the sensors, and links these to the Compass 6000™ condition monitoring platform. Compass then processes this data automatically for condition monitoring trending and storage, while providing tools for diagnostics, visualization and reporting. The VI-6080 can also be accessed by a web interface, independently from the Compass 6000™.



The VI-6080 can be utilized in two specific retrofit scenarios:

- Adding condition monitoring to an existing protection system (Figure 1 overleaf)
- Adding condition monitoring where there is no protection system (Figure 2 overleaf)

Even if the plant has some machines that were delivered with an OEM protection system, while others were retrofitted, this presents no challenge to upgrading the installation to condition monitoring with Compass using the VI-6080. It may be acceptable for the plant to have several different types of protection systems since all conceivably comply to the same relevant safety standards, but a single plant-wide condition monitoring system installation is vital in order to enable uniform system configuration, monitoring and diagnostic

functionality for all the machines. It also ensures that machine maintenance decisions based on condition monitoring information is more reliable.

Non-critical machines that are not equipped with a machine protection system, but are important from a predictive maintenance point of view, can also be integrated into the condition monitoring fleet by installing additional sensors and sending their signals directly to Compass 6000™ via the VI-6080, as shown in Figure 2.

The VI-6080 together with Compass provides complete condition monitoring capability with minimal effort to implement. If your plant has a number of machines that are not properly condition monitored yet, talk to your local Brüel & Kjær Vibro sales representative or look at our website (www.bkvibro.com) to see how the VI-6080 can simplify adding Compass 6000 condition monitoring capability to your plant! ■

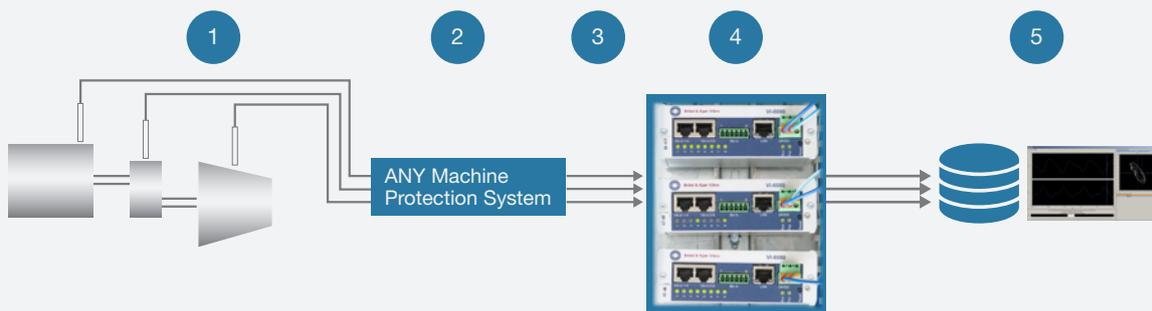


Figure 1. **Upgrading an existing protection system to Compass 6000™ condition monitoring capability:** Sensors (1), existing protection system (2), buffered outputs (3), VI-6080 (4), Compass 6000™ server (5).

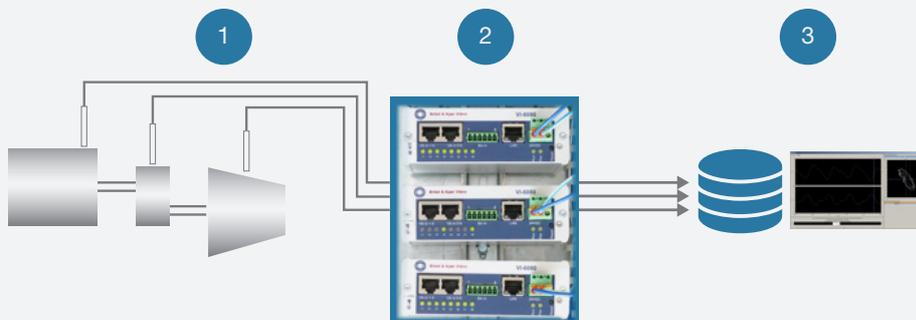


Figure 2. **Installing Compass 6000™ condition monitoring capability without a protection system:** Sensors (1), VI-6080 (2), Compass 6000™ server (3).

DATA COLLECTOR SOFTWARE FOR THE VIBROTEST 80/VIBROPORT 80 PORTABLES IS UPGRADED



VIBROTEST 80 and VIBROPORT 80 machine condition monitoring portables are Brüel & Kjær Vibro's Allrounders for machine diagnosis, field balancing and data collection. A new version of the **"Report & Route Manager"** host monitoring software has just been released making data collection more versatile, reliable and powerful, yet much easier to perform.

Some of the new features include:

- **Off-Route & Reports** – This new module manages measurements that are to be made off the defined data collection route.
- **Multiple measurement configuration** – Change one or more setup parameters for a multiple selected group of measurement points.
- **Cut and paste of routes** – Existing data collection routes can be cut, copied and pasted within the route groups.
- **Backup and restore function** – The entire database can be backed up and restored anytime and anyplace.
- **Comments legend** – Enhanced overview of comments to measurement points.
- **Alarm and reference spectra editor** – The baseline and alarm limits can be set according to the frequency components of the reference spectrum.
- **Enhanced time and date/measurement data filter** – Historical measurements can be searched more quickly for display.
- **Measurement data export** – Multiple selected measurement data can be exported to Microsoft™ Excel spreadsheet format (xlsx or csv)
- **Enhanced cursor read-out** – All cursor values are displayed in a table, i.e., "Standard cursor", "Delta X cursor", "Delta Y cursor", "Harmonic cursor", "Side band cursor", "Symptom cursor" and "Gearbox cursor".

These time and cost-saving features further enhance the powerful "Report & Route Manager" host monitoring software, which enables the generation, storage, analysis and reporting of an unlimited number of routes with up to 5,000 measurement points each. ■



VIBROPORT 80 (left) and VIBROTEST 80 (right) portables.

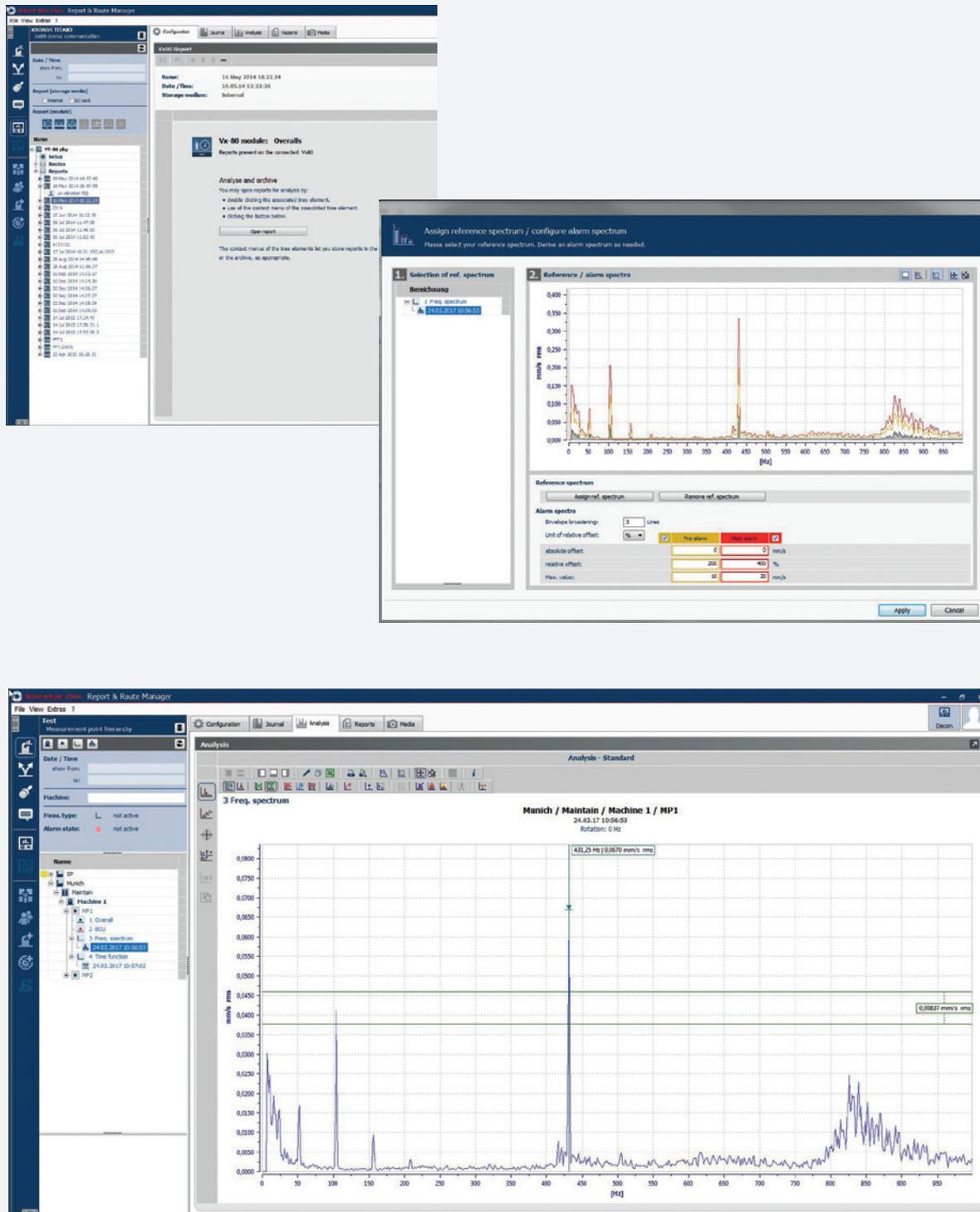


Figure 2. Example of some screens from the Report & Route Manager host monitoring software.

BRÜEL & KJÆR VIBRO NOW OFFERS “CMS AS A SERVICE” – A COMPLETE RETROFIT CONDITION MONITORING SOLUTION FOR WIND TURBINES WITHOUT THE FINANCIAL BURDEN OF UPFRONT CAPITAL INVESTMENT



Wind farm operators and owners are under increasing pressure to deliver power at maximum installed capacity and availability to gain competitive advantage. It is generally accepted that a condition monitoring-based maintenance strategy provides the most effective means for reducing lost production and maintenance costs. However, some find it difficult to finance the capital expense related to retrofitting existing wind farms with a

condition monitoring system (CMS) solution. Should their business be penalized because of this? Absolutely Not!

Brüel & Kjær Vibro now offers an advanced CMS solution supported by a unique leasing program, where there is no capital investment or significant client CMS expertise required. This service includes fault detection, diagnosis and operation and maintenance

service recommendations for wind turbines retrofitted with a CMS.

The around-the-clock monitoring of the wind turbines is provided by Brüel & Kjær Vibro’s certified vibration specialists located in our Surveillance and Diagnostic Service Centres located in the US, China and Denmark.

In addition to preventing significant capital investment, other “CMS as a Service” benefits include:

- Robust and powerful CMS equipment, designed specifically for the harsh and ever-changing conditions in wind turbines
- A dedicated monitoring platform for efficient analysis and storage of massive amounts of data coming from thousands of turbines simultaneously
- A unique monitoring service provided by our dedicated diagnostic engineers who interpret the data and convey the results to our customers as actionable maintenance advice. This has consistently contributed to thousands of hours of uptime for wind farms world-wide.

Once the CMS hardware has been installed and commissioned, it will be remotely operated by Brüel & Kjær Vibro with minimal intrusion to the client’s own operation and processes. At the end of the contract period, the CMS equipment can be purchased and the monitoring and diagnostic services be taken over by the client, if desired. Alternatively the CMS hardware can be upgraded and the “CMS as a Service” contract renewed. ■



BRÜEL & KJÆR VIBRO VIBRATION EXPERTISE: PAPER PRESENTATION ON THE BENEFITS OF MONITORING WIND TURBINE NACELLE OSCILLATION

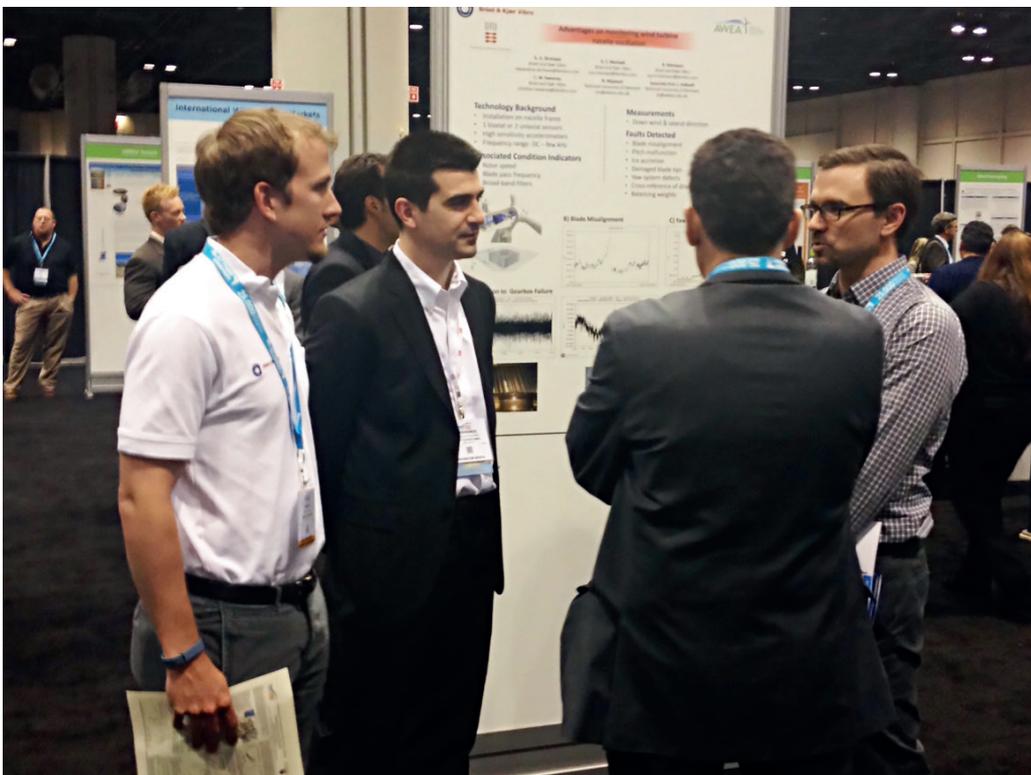
Two vibration diagnosticians from the Brüel & Kjær Vibro Surveillance and Diagnostic Service Centre in Denmark, together with two co-authors from the Technical University of Denmark, presented a paper at the American Wind Energy Association (AWEA) Windpower 2015 conference in Orlando, Florida (USA), 18-21 May, 2015. The title of the paper is “Advantages of Monitoring Wind Turbine Nacelle Oscillation” (Alexandros Skrimpas, et al).

The paper deals with the benefits of monitoring the wind turbine nacelle, for detecting abnormal behaviour

associated with the blades, tower and drivetrain components, which could jeopardize their working condition. Nacelle monitoring, using accelerometers mounted on the nacelle frame, is an essential part of a holistic condition monitoring approach for wind turbines. The paper presents a comparison of vibration signals from wind turbines subject to various failure modes and operating conditions, such as blade misalignment, pitch malfunction, ice accretion, damaged blade tips and yaw system defects. The theoretical analysis that results in accurate detection of the aforementioned faults

is also presented. Additionally, the paper discusses the employment of nacelle accelerometers for cross reference of faults in the drivetrain components, where other sensors are also mounted. This cross reference is normally beneficial for assessing the severity of the faults, where propagation of vibrations from a drivetrain component to the nacelle frame usually indicates a late stage failure.

If you would like to know more about this or other papers from Brüel & Kjær Vibro, please contact us at wind@bkvibro.com ■



Author Alexandros Skrimpas (second from left) discussing the paper with some delegates.

REMEMBERING A SOUND AND VIBRATION PIONEER



Having just celebrated his 100th birthday, Per V. Brüel passed away on April 2, 2015. He was a visionary engineer and inventor, responsible for engineering breakthroughs in the late 1930s and early 1940s with the development of the world's first acoustic analyzer and the first commercial piezoelectric accelerometer (Type 4303). It is no exaggeration to say that the entire discipline of sound and vibration can be traced to these and other innovations developed by Per Brüel and his partner Viggo Kjær.

On his 100th birthday on March 6, we can look back on a century during which he played multiple larger-than-life roles: engineer and visionary inventor, founder of a major global corporation, enthusiastic pilot and explorer who personally pioneered new markets and whose accomplishments continue to help us expand our most exciting frontiers. ■



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Per V. Brüel, visionary engineer and inventor.



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Every year, EWEA brings together over 60 nationalities from across the world, making the EWEA Annual Event truly international and a great place to find new suppliers, check out new developments and build partnerships. Europe's premier wind energy event gathers high-level decision makers. With an array of insightful sessions, bustling exhibition, impressive networking events and the whole of the value chain present, it provides the ideal platform to meet valuable contacts and achieve great business performance. Meet our team at the Danish Pavilion, booth K10.
www.Ewea.org/annual2015