Brüel & Kjær Vibro

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Oil & Gas: Case studies; Green ethylene, Aromatics • Renewable energy • New products • Business corner • Field news

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Brüel & Kjær Vibro

Uptime Magazine 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 the oil & gas industry.

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Monitoring in the Oil & Gas Industry

The oil & gas industry represents a large portion of the global power mix and a significant raw material source for many industries including chemicals, pharmaceuticals, solvents, fertilisers, pesticides, plastics, etc.

The production, distribution, refining and retailing of petroleum represents the world's largest industry in terms of financial value.

The face of this important industry is continually changing and adapting to modern technology, products and requirements. What remains constant is the requirement to optimise performance, efficiency, profitability, maintenance and uptime of the rotating machinery.

This issue of Uptime is dedicated to the oil & gas industry. Bruel & Kjaer Vibro have been involved in the monitoring of machines in the oil & gas industry since the very infancy of machine condition monitoring some 30 years ago. With wide ranging application experience in all areas of the oil & gas industry from the production through refining and processing, Brüel & Kjær Vibro have developed many innovative and advanced monitoring and diagnostic products and techniques aimed at maximising machine uptime, performance and reliability.

In this issue of Uptime we will look at two upstream petrochemical plants; monitoring the world's largest "green" ethylene plant and some case studies from an aromatics plant. In addition to these petrochemical plant case stories, we also have stories from other sectors of the industry, including renewable energy.

We are delighted to launch this edition of Uptime and hope you enjoy reading it!

Visit our website for more information on our oil and gas applications, products, solutions and services.

Theo van Santen
Oil & Gas Global Sales Support Manager.

Andy Hardwick
Oil & Gas Business Development Manager.

Figure 1. Braskem's 200k ton/year green ethylene plant at the Triunfo Petrochemical Complex, Brazil.

case story

Monitoring World's Largest Green Ethylene Plant

In operation for over 2 years, this article gives an insight into the machine condition monitoring strategy at the plant and how it was implemented.

End-user

Braskem, the largest petrochemical producer in the Americas and the fifth largest in the world by production capacity, commissioned the green ethylene plant in the Triunfo petrochemical complex in the Rio Grande do Sul state in Brazil in September 2010. "Green" ethylene is derived from ethanol that is produced from a renewable source such as sugarcane, instead of from a fossil oil derivative (see the fact box for more information on the green ethylene process).It is the largest green ethylene plant in the world, producing 200k tons/yr. The Compass system was selected for monitoring this plant. (In fact, Compass has been monitoring machines in the petrochemical complex since 1997).

The machine condition monitoring team at the Braskem Maintenance department in Triunfo, led by Otávio Vescovi for the last 22 years, has significant experience in monitoring and diagnosis of machine faults.

In the early years there was only one steam cracker olefin plant operated by Copesul. The machine uptime was so closely tied to the downstream plants that the original Compass system was extended as a service to the other downstream plants[1]. At that time there were 1910 machines monitored at four different plants. Now there are over 3200 machines monitored at 9 petrochemical plants and one utility (all owned by Braskem).

The team currently consists of six vibration analysts and eight technicians who also utilize the Type 2526 data collector for collecting offline data.

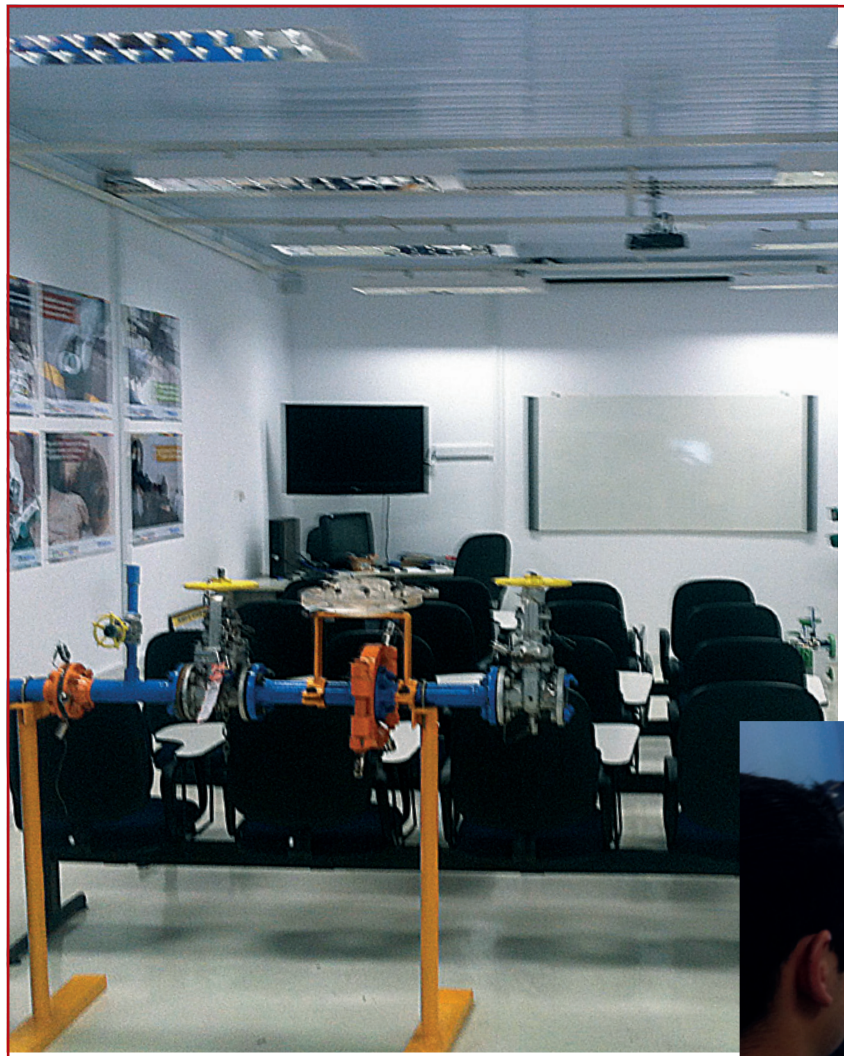


Figure 2. The condition monitoring training room on the left, the condition monitoring office on the right.

Machines

Braskem's proprietary green ethylene process employs the following machines:

- **Charge gas compressor** - Takes the gas effluent from the condensation tower and performs several compression and condensing cycles between the intercooled stages for separating liquefied fractions containing water and oxygenates from the gas. After the last compression stage, the gas stream is sent on to the wash tower to remove water and high oxygenates.
- **Propylene refrigerant compressor** – Compresses the propylene refrigerant gas for the cryogenic distillation part of the process. Gas from the drying columns is cooled to low temperatures so the higher boiling point fractions can be separated to achieve 99.96% pure ethylene
- **Centrifugal pumps** – A number of pumps are used in the entire process; feeding the ethanol to the heat exchanger before the furnace, removing water from the process (approximately 50% of the production), and for transporting the liquid "bottoms" from the various separation phases of the process

An ethylene compressor is not needed in the Braskem green ethylene process as it is for the fossil oil based ethylene plants, because the liquefied ethylene is stored at 17.7 bar pressure in refrigerated spherical tanks.

[1] This is described in the paper "Tele-Monitoramento Utilizado nas Plantas da Copesul e de Empresas de Segunda Geração", presented at the Latin America Power & Gas 2001 Conference, Rio de Janeiro, Brazil, June, 2001

The ethanol-ethylene process

In the Braskem process, ethanol, which is the primary raw material for making green ethylene, comes from fermented sugarcane. The ethanol is catalytically dehydrated in reactors at high temperature and moderate pressure:

$$CH_3CH_2OH \rightarrow CH_2{=}CH_2{+}H_2O$$

Subsequent separation processes remove the water, unreacted ethanol and other impurities.

Green ethylene produced from sugarcane ethanol can save 60 % fossil energy compared to steam cracking of fossil oil (electricity can also be produced from ethanol). The associated greenhouse gas emissions are about 40% less than petro-derived production.

The entire process can be summarized as follows:

- 1 hectare (approximately the area of a soccer pitch) produces 82 tons of sugarcane. The photosynthesis process of the sugarcane captures 7,5 tons of CO^2 from the atmosphere
- This produces 7200 l of ethanol
- This produces 3 tons of ethylene
- This produces 3 tons of polyethylene

The green designation is carried further downstream to the polymer products made from the green ethylene, such as green polyethylene plastic. Green in this case only refers to the process for making the polyethylene (i.e. reduced greenhouse gas emissions during production), not the properties of its composition (i.e. it is not any more biodegradable than ethylene made from fossil oil). In fact, the properties of polyethylene produced by green ethanol are identical to those produced by fossil oil.

Figure 3. Propylene refrigerant compressor (left), charge gas compressor (right).

Monitoring strategy

The monitoring strategy for the machines at the green ethylene plant is very similar to that used in the two Braskem steam cracker olefin plants in the same petrochemical complex. However, because the process for the charge gas compressor and some of the pumps differs across the two processes, the subsequent potential failure modes may also be different. To date the plant has operated fault free so potential short-term process related faults such as surging and liquid carry-over never appeared and therefore are not considered to be a problem (nor were they ever expected to be). Time will tell if long-term process related faults like:

- Fouling in the compressors
- Corrosion in the compressors and pumps
- Erosion due to long-term minimal quantities of liquid carry-over in the compressors

will occur, but this is not expected.

The monitoring strategy for the bearings, shaft and seals of the compressors and pumps in both the green ethylene and petro derived ethylene plants is identical, as the expected machine loading (pressure, temperature and flow) is similar across both processes.

The economic benefits of condition monitoring of the green ethylene plant are enormous. If a bearing fault, for example, is allowed to fail and this consequently results in a catastrophic failure of the compressor, the costs to repair/replace the machine and lost production due to downtime are in the millions. Just considering lost production, a downtime of 7 days will cost € 3.9 M!

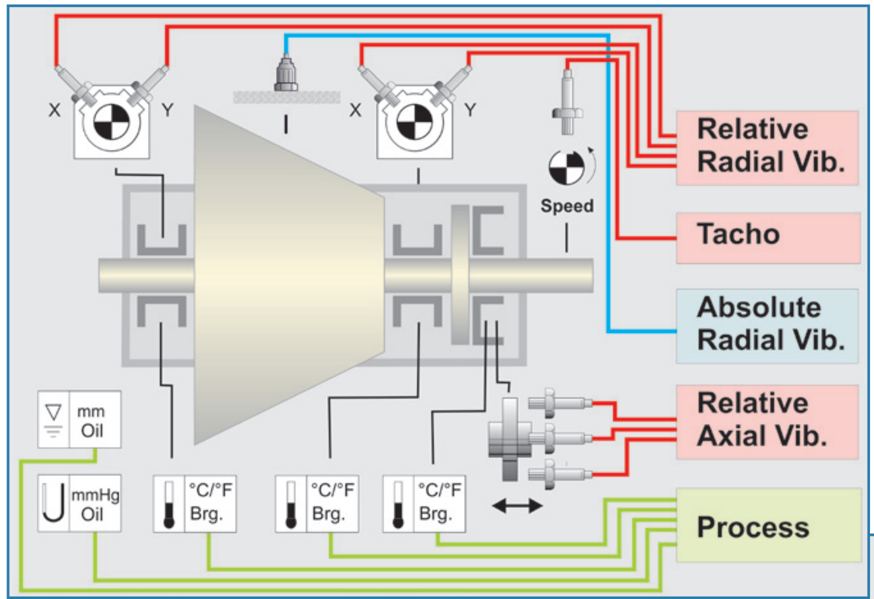


Figure 4. Charge and propylene refrigerant compressor online monitoring inputs: Red: 8x relative vibration sensors (radial, axial and tacho), blue: 1x absolute vibration sensor (casing), green: 5x process sensors (imported or measured).

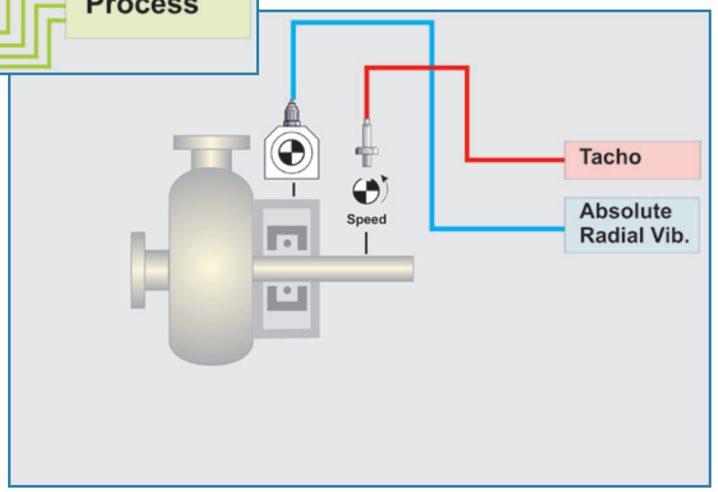


Figure 5. Typical process pump offline monitoring inputs: Red: 1x relative vibration sensor (tacho), blue: 1x absolute vibration sensor (casing).

Sensor (meas. point)	Online Measurements			Plots	Faults that can be detected and diagnosed
	Safety Monitoring	Condition Monitoring			
		Trending	Diagnosis		
Relative radial vibr. (shaft)	▪ **Overall** (ISO:1Hz/10Hz - 1kHz) ▪ $\mathbf{S_{max}}$	▪ **DC** (bearing position)	▪ **Autospectrum** (FFT) ▪ **DC vs. RPM** ▪ **1x, 2x, 3x**	Trend vs. time/ speed, Spectrum, Waterfall, Orbit, Shaft position polar, Transient (Bodé)	Bearing damage, lack of lubrication, overload, wear, misalignment, unbalance
Tacho		▪ **Speed, phase**		Trend vs. time	Phase and triggering used in other measurements
Relative axial displ. (thrust brg)	▪ **DC** (displ.)			Scalar vs. time/ speed	Bearing damage, lack of lubrication, overload, wear
Absolute radial vibr. (casing)	▪ **Overall** (ISO:1Hz/10Hz - 1kHz)	▪ **CPB6%**	▪ **Autospectrum** (FFT)	Trend vs. time/ speed, Spectrum, Waterfall	General faults, flow problems, blade passage
Process (bearing, lube oil)		▪ **DC** (bearing temp. oil level, oil pressure)		Trend vs. time/ speed	Bearing damage, lack of lubrication, overload, wear

Table 1. Charge and propylene refrigerant compressor online monitoring techniques.

Sensor (meas. point)	Offline Measurements		Plots	Faults that can be detected and diagnosed
	Trending SW	Diagnosis SW		
Tacho	▪ **Speed, phase**		Trend vs. time	Phase and triggering used in other measurements
Absolute radial vibr. (casing)	▪ **Overall** (ISO:1Hz/10Hz - 1kHz) ▪ **CPB6%**	▪ **Autospectrum** (FFT) ▪ **Envelope** (bearing)	Trend vs. time/speed, Spectrum, Waterfall	Bearing damage, lack of lubrication, overload, wear, structural looseness, unbalance, misalignment, flow problems, cavitation, blade clearance, rubbing

Table 2. Typical process pump offline monitoring techniques.

Monitoring System Configuration

The Compass system has been monitoring the green ethylene plant since it was commissioned in 2010. Compass was first installed at the petrochemical complex in 1997 and is still being used to monitor the aromatics plant and the two steam cracker olefin plants. The experience gained from monitoring these plants were instrumental in establishing the monitoring strategy used at the green ethylene plant. In general, the Compass system is used for monitoring the critical machines and the Type 2526 Data Collector is used for monitoring the numerous auxiliary and balance-of-plant machines. Due to the large quantity of machines, ADVISOR is also used extensively to automatically scan the database for early detection of symptoms that could indicate a developing fault.

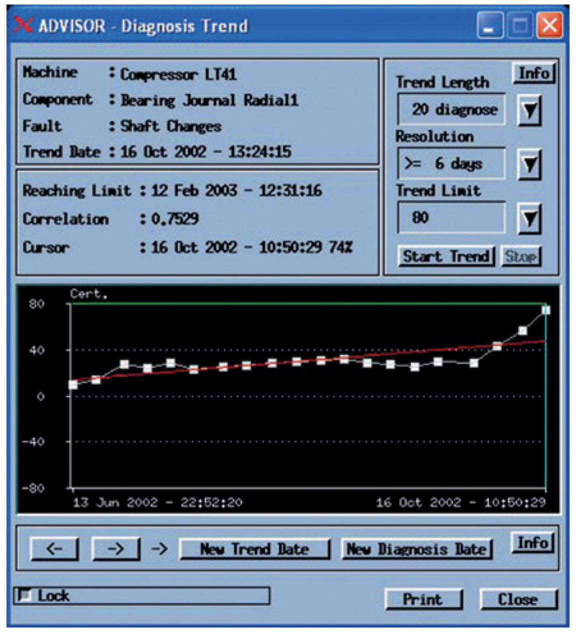
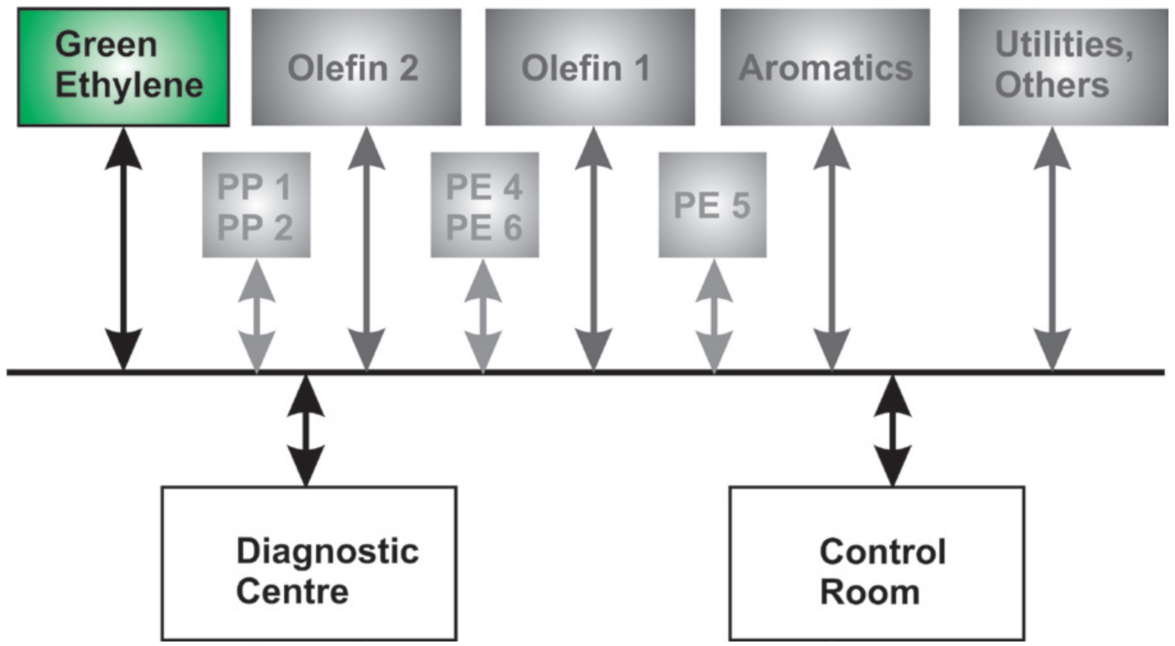


Figure 6. Typical diagnostics trend plot from Advisor for the green ethylene charge compressor.

Figure 7. Monitoring system configuration at the Triunfo Petrochemical Complex. Upstream plants shown on top, downstream plants shown in the middle.



Plant	Machines Monitored	
	Offline	Online
Green ethylene	58	2
Olefin 1	175	8
Olefin 2	150	6

Table 3. Number of machines monitored offline and online at the upstream plants at Braskem. As the green ethylene plant is much smaller than the olefin plants, there are fewer machines in the process. In addition to these upstream plants, there are almost 2000 machines monitored in the downstream polyethylene and polypropylene plants.

Conclusion

The green ethylene plant represents a breakthrough in environmentally friendly industrial processes, but the machines used are actually similar to those used in the petrol-derived ethylene steam cracker plants. Therefore, the monitoring strategy used for the machines is also similar. However, due to the large number of machines monitored, an integrated online/offline monitoring system together with an automatic machine fault diagnosis system is indispensable to economically and effectively track developing faults in such a large fleet of machines. This formula has successfully been used at the steam cracker plants in Triunfo since 1997, and it will continue to be used at the green ethylene plant. There is also a project in the pipeline for producing green propylene in the near future.

Acknowledgement

Brüel & Kjær Vibro would like to thank Otávio Vescovi, Eder Felipetto and Mauro Luíz de Silva from Braskem for their contribution in making this article. ■

case story

Figure 1. Braskem's aromatic plant at the Triunfo Petrochemical Complex, Brazil

Fault detection case studies at an **aromatics plant**

Due to the vast number of machines at an aromatics plant, early machine fault detection and diagnosis of incipient faults is imperative. This allows for maintenance to be efficiently planned ahead of time, reduces the actual maintenance work needed and minimizes the risk of a process shutdown. This article presents some case studies that give a simplified, pictorial glimpse of how early fault detection is done in practice.

The Plant

Operated by Braskem, the aromatics plant is part of the Triunfo petrochemical complex in Southern Brazil which also has other upstream and downstream petrochemical plants. The upstream portion of the complex produces olefin (ethylene, propylene, butadiene, etc.) and aromatic products. This case study focuses on three machines from the aromatics plant. (The monitoring strategy at the Braskem green ethylene olefin plant is described on page 3 of this issue of Uptime.)

The aromatics plant takes in cracked naphtha (i.e. pyrolysis gasoline) and converts this to benzene, toluene, xylenes and some paraffin products. The benzene, toluene and xylenes are called BTX aromatic products, and are the building-blocks for downstream petrochemical products, such as gasoline components, polyester, polyurethane, nylon-6, polystyrene, phenolic resins, polycarbonate and others.

Monitoring Strategy

The aromatics plants' total production capacity is approximately half that of the olefins, and this stream is further divided into several smaller, separate processes. There are over 450 machines monitored, many of which are relatively small and spared machines such as motor driven pump trains. For this reason, much of the plant is cost-effectively monitored by the Type 2526 Data Collector. Critical machines, however, are monitored online by Compass. An integrated online/offline condition monitoring system plays an important role at this plant. It enables data to be correlated and failure modes scrutinized, thereby making the prognostic tasks more effective and efficient as experience is gained. And experience is not lacking! Since 1997, over 1200 machines upstream and almost 2000 machines downstream are being monitored at the Triunfo petrochemical complex using the integrated online and offline Compass platform.

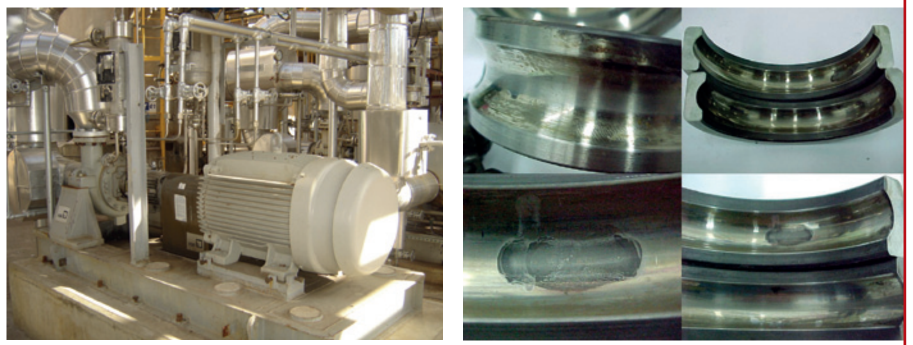
Recently a maintenance program was implemented at the aromatics plant for switching the operation of the principle pump and its corresponding spare for each process line. This practice has minimized the number of bearing faults occurring due to extended periods of inactivity of the spare pump, such as "false brinelling" of the bearing races and the lubricant seeping out and resulting in corrosion. This maintenance program results in consequently less faults detected by the vibration monitoring system, fewer work orders generated and less maintenance done, giving a savings of over € 223,500 per year!

Case Studies

The following examples are provided to give a simplified view into methods for detecting typical machine faults that occur at the aromatics plant. Additional diagnostic expertise is needed to evaluate the fault, its severity and the lead-time to maintenance/failure. However, the present focus in this article will be on the detection of the faults using the simplified graphical plots that are part of the monitoring platform.

Case study #1 Bearing fault on pump DE

Figure 2. Far right: Driven end horizontal bearing showing signs of corrosion on the inner race between the balls, presumably caused by condensation while the pump was stopped for a period of time. The outer race shows abrasion, possibly caused by excessive clearance. Immediate right: Pump used in the Pyrolysis gasoline hydrogenation process. If the bearing was not monitored and continued to run until failure, the consequential damage to the pump could have been several thousand Euros.



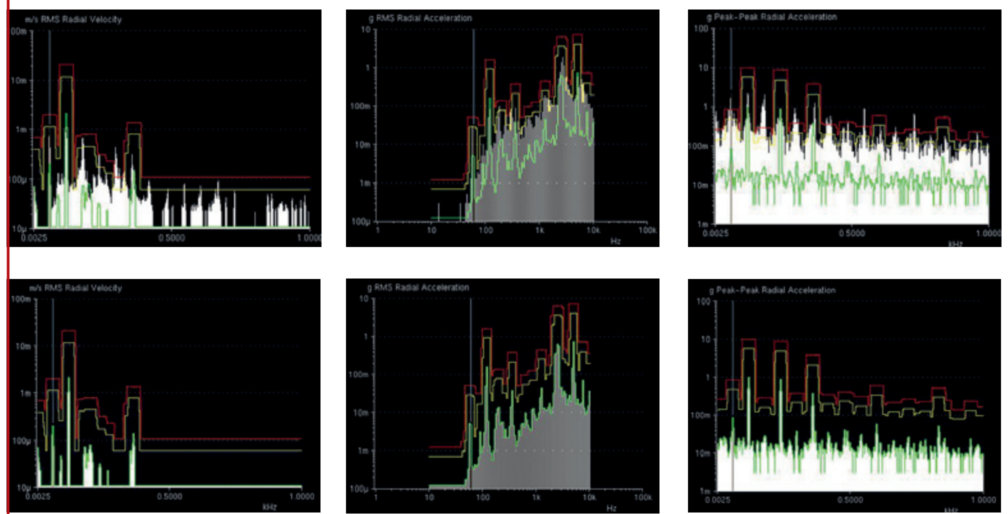


Figure 3. Spectral plots comparing a bearing fault shown in the three plots in the top row, with the repaired condition shown in the bottom row. Left column plots: FFT. Middle column plots: CPB. Right column plots: Envelope. Although the bearing fault shown in Fig. 2 is relatively small, early and significant deviations from normal conditions are evident in all the plots shown above.

Case study #2 Bearing fault on pump NDE

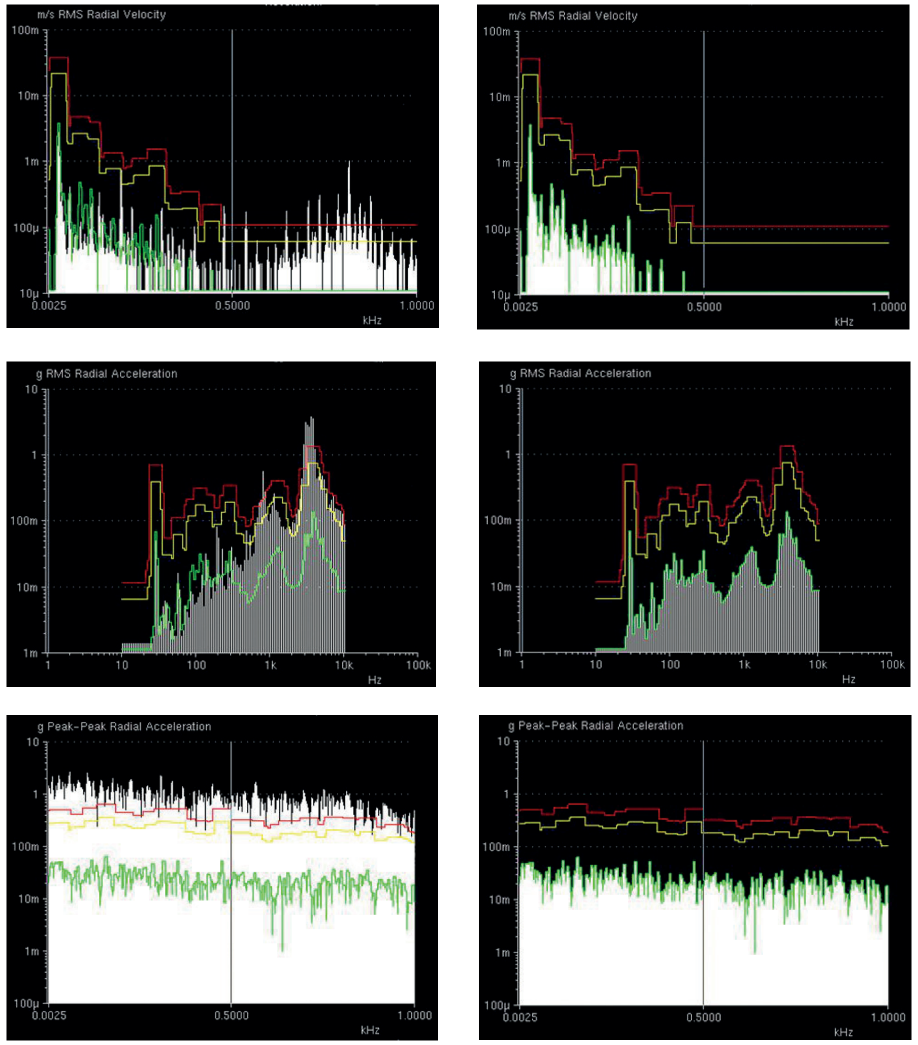


Figure 5. Spectral plots indicating bearing fault on the left column and condition after repair on the right column. Top row: FFT. Middle row: CPB. Bottom row: Envelope. This bearing fault (see Fig. 4) is more pronounced than that shown in Fig. 2, and as a result the deviations from normal shown in the plots are also more pronounced.

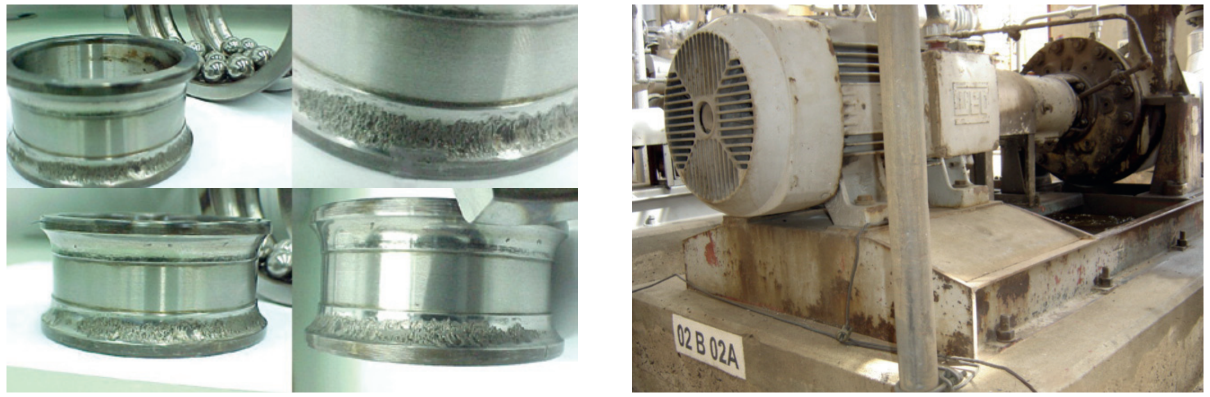


Figure 4. Left: Non-drive end bearing showing signs of fretting on the inner race, due to corrosion and possibly excessive axial load and misalignment. Driven end bearing (not shown) had normal wear. Right: Pump used in the butadiene extraction process. If the bearing was not monitored and continued to run until failure, the consequential damage to the pump could have been several thousand Euros.

Case study #3 Gear fault on cooling tower fan

Figure 6. Left: Damaged pinion gear teeth on the cooling tower gearbox. Right: Cooling tower. If the gearbox was not monitored and continued to run until failure, the consequential damage to the entire assembly could have been thousands of Euros.

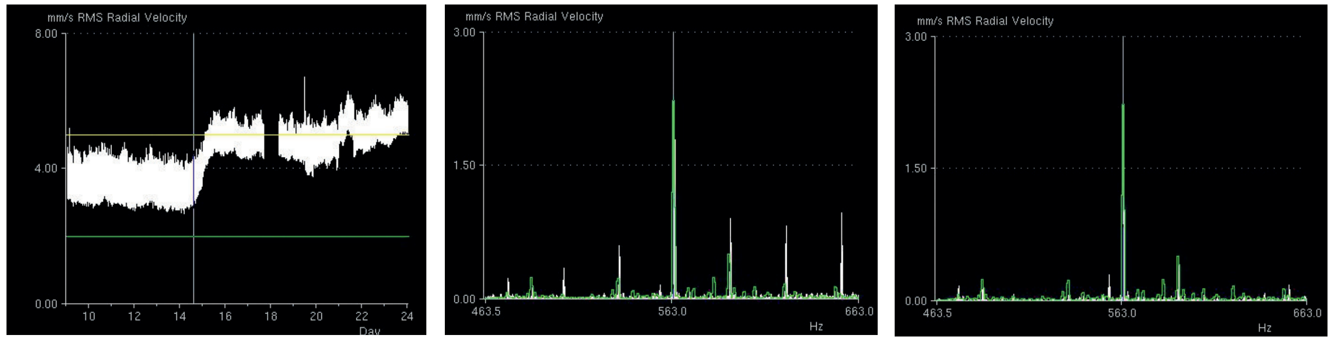


Figure 7. Left: Bandpass trend. Middle: FFT clearly showing the gear tooth meshing frequency with sidebands that highlight a gear problem before repair. Right: FFT after repair.

Conclusion

These case studies give an accurate, though somewhat simplified, view of early fault detection using relatively basic condition monitoring measurements such as FFT, CPB and envelope. Early fault detection and diagnosis is paramount when monitoring a large number of machines, and should be managed in such a way that:

- **Maintenance** can be planned simultaneously for several machines with a similar condition to reduce costs
- **Catastrophic failures** with consequential damage are avoided. Extended time between repairs on a machine means more time operating without a spare (i.e. the machine is critical in this case)
- **Condition of spare machines** have to be known to avoid the risk of an unplanned process shutdown, if the spare also goes down
- **Attention** can be focused on machines with deteriorating condition or less lead-time to service/failure
- **Diagnostic analysis** can be undertaken to determine the root causes of premature faults and failures, to avoid future reoccurrence of the same faults

This requires knowledge on the condition of all the machines and their spare counterparts, which can only be accomplished by an effective condition monitoring strategy and user friendly monitoring system with the ability to both provide a high level machine condition overview and provide the tools for detailed diagnostics.

Acknowledgement

Brüel & Kjær Vibro would like to thank Otávio Vescovi, Eder Felipetto and Mauro Luíz de Silva from Braskem for their contribution in making this article. ■

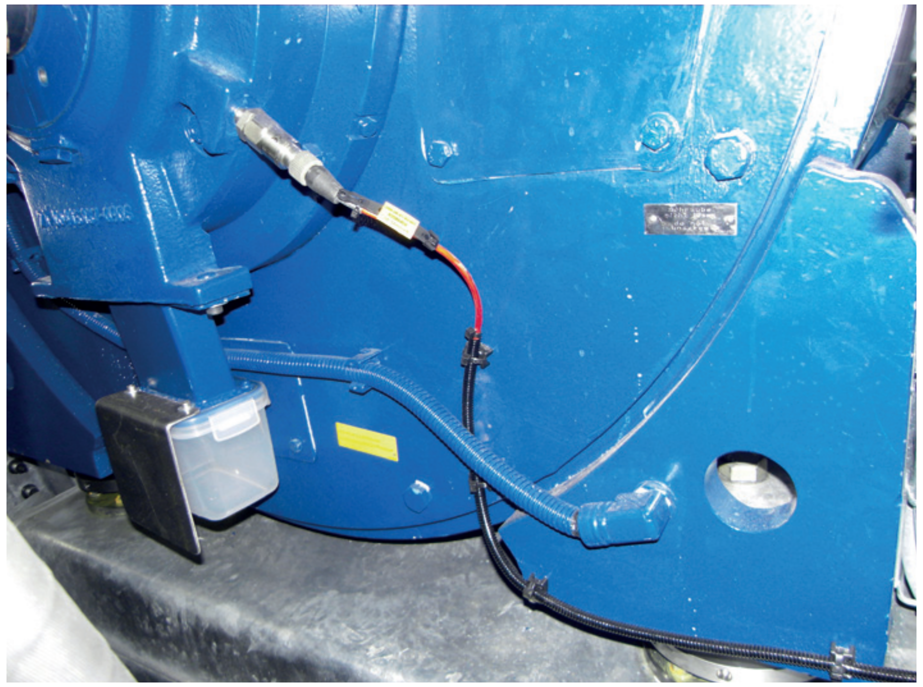


Figure 1. Accelerometer mounting on a wind turbine generator. The fault discussed in this article occurred on the driven end. Vibration information was also provided on the non-driven end end of the generator and other points on the drive train, but for simplicity, this is not presented in the article.

Estimating Bearing Fault Lead-time to Service

Monitoring and diagnosing wind turbines is hardly a trivial task, especially when it comes to estimating lead time to service for a bearing fault. This article demonstrates the successful process utilized by the world renowned Brüel & Kjær Vibro Wind Turbine Diagnostic Centre that combines automatic fault detection, simple diagnostic tools and solid expertise.

Bearing Fault Lead-time to Maintenance

Generally, rolling element bearing faults develop and progress in an almost predictable, linear fashion. With sufficient monitoring experience of different faults, it is possible to accurately predict when service is needed for a specific fault, right from when it was first detected and diagnosed. This is assuming of course the machine is operating at a constant load and speed, which is the case for example in many industrial process pumps.

For wind turbines, predicting the lead-time for maintenance is severely impacted and made complex by the variability in wind conditions. Yes, if you could accurately integrate the total cumulative load, speed and other influencing factors, you would theoretically be able to predict the calendar date for service with more precision, but this is hardly feasible. Fortunately there are more practical methods for providing this information.

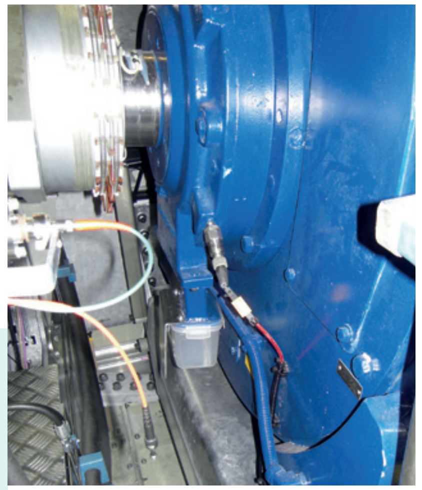
Automatic trending coupled with diagnostic expertise

With over a decade of experience, monitoring thousands of wind turbines at the Brüel & Kjær Vibro Wind Turbine Diagnostic Centre, a vast amount of experience has been gained in detecting bearing faults, diagnosing them and estimating lead-time to maintenance. Some of the findings from this experience can be summarized as follows:

- **Expertise** – There is no measurement technique or algorithm that can replace a vibration analyst. The specialists play a critical role in associating symptoms, local operating history of machines and knowledge of the local climatic conditions together, to estimate lead-time.
- **Early detection** – A number of measurement techniques have been developed for early fault detection, but sometimes the most simple solutions are the best. Read about the ECU measurement in the fact box.
- **Diagnosis tools** – Experience shows that standard diagnostic techniques such as FFT, FFT zoom and envelope measurements are sufficient for the task. An extensive number of process measurements are also used for correlation purposes. The envelope is explained in another fact box.
- **Close cooperation with the customer** – Brüel & Kjær Vibro has an agreement with their largest customers for mutual exchange of information and feedback on the service activities undertaken as a result of an action report. This includes photos, access to reports and metallurgical tests, and actually examining the failed/worn components after replacement.

It may be difficult to predict a precise calendar date for service when a wind turbine bearing fault is first detected, but it is possible to follow or “track” the different stages of the fault development and provide lead-time for action, based on the bearing condition at these stages. The primary milestones in tracking the developing faults are the severity classes, which start out as “4” and become smaller as the fault progressively becomes more severe and the lead time to service becomes shorter. In some cases the severity classes for rolling element faults are triggered by the scalar trend measurements, such as the ECU measurement.

Automatically detecting severity classes is a resource saver, since this avoids the need for specialists to repeatedly assess the same problem to determine status changes. The vibration specialist’s primary task is to determine the severity of the fault during a status change, and re-evaluate the lead-time for service action to be taken.



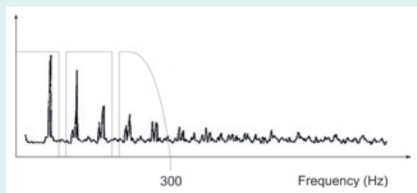
What is an ECU measurement?

ECU stands for envelope condition unit, and is an automatic bearing fault detection measurement based on the envelope measurement.

The envelope band pass frequency used is based on the wind turbine bearing natural frequencies, which are typically 6k-8kHz. The demodulated low pass frequency filter is set at approximately 300 Hz, which covers all the normal bearing fault frequencies.

A RMS value of the demodulated lowpass frequencies is calculated as a scalar value and monitored to alarm limits. As the changes that occur in this range are primarily due to bearing fault frequencies, there is much earlier detection of bearing faults in relation to, for example, the ISO 10816 overall vibration signal, which looks at all frequency components from 10Hz to 10kHz.

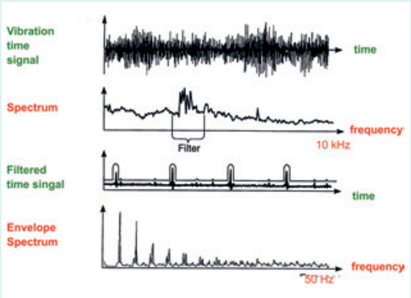
For wind turbines, the demodulated lowpass signal can be influenced by other factors not related to the bearing fault frequencies. This can of course reduce the effectiveness of the early fault detection. One such influence is the frequency inverter, which creates line frequency harmonic spikes that also modulate the higher frequencies together with the bearing fault frequencies. As seen below, these can be removed.



Envelope measurement – Finding the existence of a bearing fault frequency

During operation, bearing surface faults typically create a sharp impact and a vibration response that contains high frequency components. These excite the natural frequencies of the bearing components themselves. This high frequency increase is in itself an indication of a bearing fault, but without knowledge of what kind of fault it is, the lead time cannot be estimated.

The periodicity at which the impact occurs identifies where the surface fault is located, i.e. the outer race, inner race, cage or bearing element itself. Outer race faults have maintenance lead times of several months, while a bearing element fault could be just



days. Many times however, the bearing fault frequencies are buried under other low frequency components and are not visible.

If it is an inner race surface fault, the excited natural frequencies of the bearing components are modulated by the periodic impact of the bearing fault as it passes through the load zone at a specific frequency, which is often the shaft rotational speed. This modulation appears as sidebands around the excited natural frequencies (i.e. carrier frequencies) in an FFT plot, which are spaced apart by the cage rotational frequency.

The envelope measurement demodulates the periodic impact frequencies from the carrier frequency. The lower frequency components such as running speed, which can obscure the bearing fault frequencies, are consequently removed. A low pass frequency spectrum is then made from the demodulated carrier signal (which is filtered out), so only the low frequencies for the bearing faults can be seen.

This measurement is normally used as a manual diagnostic technique.

Case study

This case story follows a typical developing fault in a wind turbine generator bearing on the driven end. Plots are displayed for:

- **Diagnostic measurements** – Time waveform, FFT, FFT zoom and envelope measurement, at different stages of development.
- **Automatic detection and trending** – ECU measurement and ISO 10816 bandpass (for comparison only)

An analysis of the plots is given in the figure text.

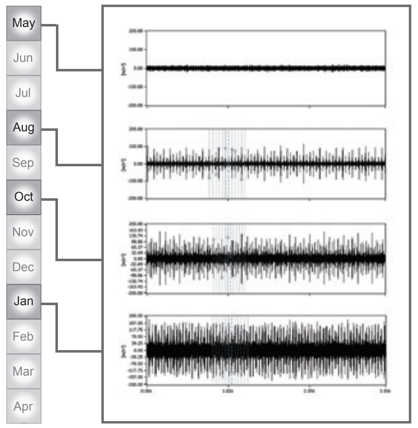


Figure 2. **Time waveform plots** – *Notice the appearance of the impacts and their increase in amplitude. The time between the impacts is inversely proportional to the impact frequency, i.e. the bearing fault frequency.*

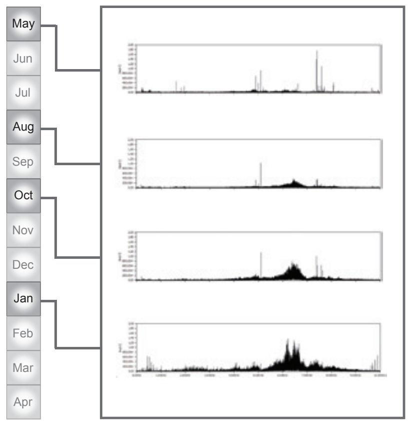


Figure 3. **Autospectrum broadband plots** – *Notice the increase of the high frequency components due to the excited natural frequencies of the bearing components. As the fault develops the vibration response covers a broader frequency band. The narrow peaks seen in the plots are line frequency orders caused by the frequency inverter.*

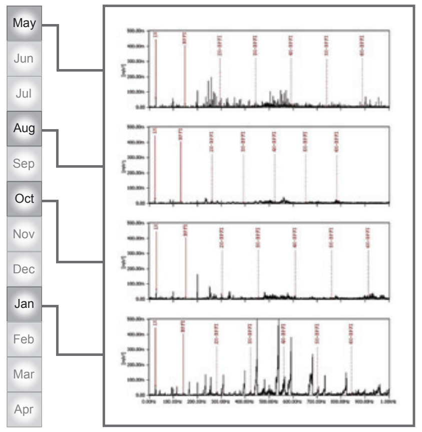


Figure 4. **Autospectrum zoom plots** *– Very little can be seen of the bearing fault frequencies in these plots.*

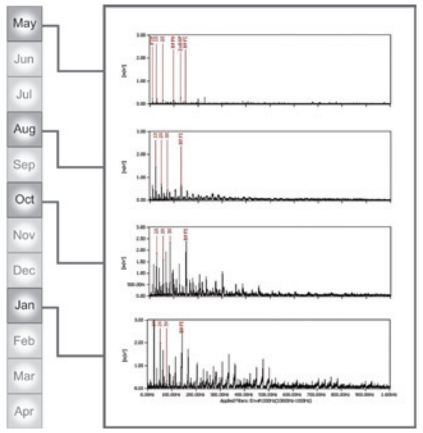


Figure 5. **Envelope plots** *– Notice the increasing fault frequencies. The inverter harmonics sometimes overlap a bearing fault frequency in the envelope. No problem, just look at the data for a different class (speed)*

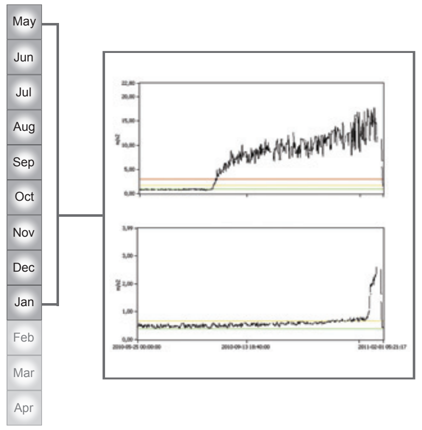


Figure 6. **ECU vs. overall vibration trend** *– Notice how sensitive the ECU is to severity changes in relation to the overall vibration trend (ISO 10816, 10-10kHz). Trend data is shown from May, prior to the fault development to January, just before the bearing was replaced. The severity levels (not shown in the figure) are NOT based on just the vibration levels shown in the plots. These are typically based on 10-12 other measurements at different frequencies (some shown above) plus experience.*

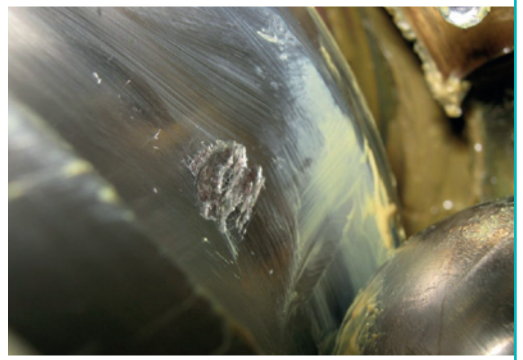


Figure 7. **Bearing spalling** *– This small defect is what created the substantial vibration response shown in some of the plots shown previously!*

Conclusion

The proceeding figures clearly indicate the presence of the bearing fault at an early stage of development. At this point the lead-time could be estimated "in months" but giving a specific calendar date was not possible. Nor was it necessary, since maintenance can be cost-effectively planned within a much shorter lead-time.

The severity classes provide important trigger points for manual diagnostics, in order to assess the overall condition of the bearing and to make a prognostic estimation of when service should be undertaken. As this cannot be automatically undertaken in an effective manner, diagnostic specialists play an important role in making the lead-time estimations when automatically alerted by the severity class. They take into account the trend, process parameters, results of the diagnostic plots, prevailing wind conditions, season as well as the operational history of the machine.

Even with advanced fault detection techniques that give advanced lead-time, this is of little value if specialists are not available to track the fault and undertake the necessary analysis of lead time to service/failure based on experience.

Acknowledgement

We would like to thank Reynir Hilmisson, vibration analyst at the Brüel & Kjær Vibro Wind Turbine Diagnostic Centre for his contribution in making this article. ■

product update

New Products

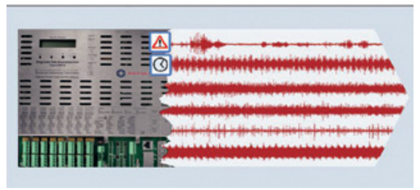
The following products have just been released! You can read more about these on our website.

VibroSuite – Stand-alone wind turbine monitoring

Brüel & Kjær Vibro is the largest independent supplier of condition monitoring systems and diagnostic services for wind turbines. Over the last decade, we have continuously improved and enhanced our diagnostic capabilities to increase productivity, through reliable and efficient fault detection. Now over a decade's experience and developments are available in the VibroSuite Wind Turbine Condition Monitoring System. The VibroSuite software system is highly scalable and supports monitoring of smaller parks with a limited number of turbines as well as large enterprise solutions with thousands of turbines under surveillance.

EventMaster – Time wave form recording

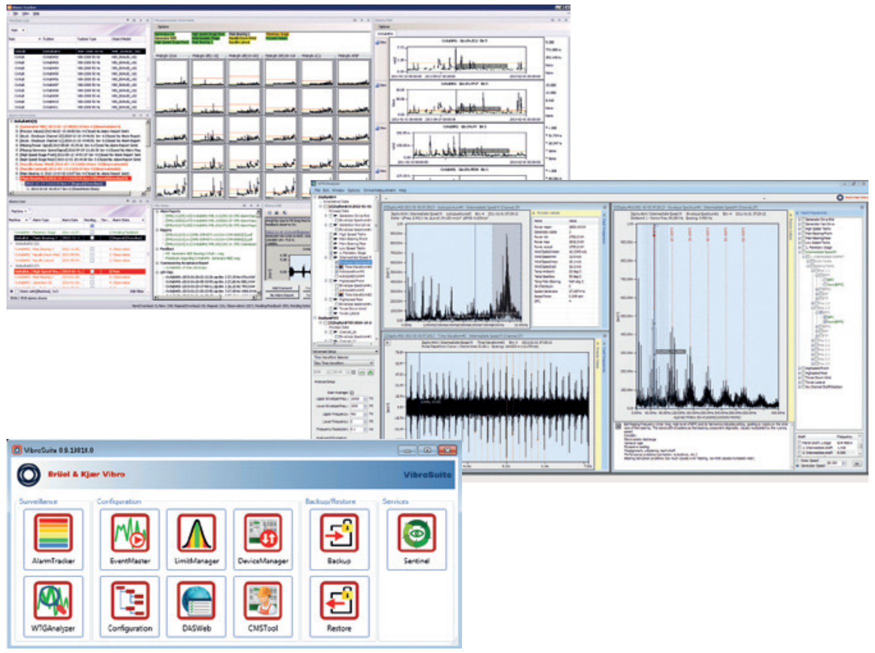
EventMaster is an add-on to your VDAU-6000 16-channel monitoring system or VibroSuite, our new stand-alone wind turbine monitoring system (mentioned before). Time signals from the data acquisition system are captured automatically on condition-based trigger events,



by hardwired signals or at fixed time intervals. Different analysis tasks and analysis methods require different frequency ranges and duration of time waveform recordings. EventMaster allows for time waveform recording with a duration from 40ms up to 87 minutes. These high resolution data, automatically downloaded just before and after a specific event such as a trip, can be analyzed in the post-processor system to find the cause of the event. Run-up and coast down time signals can also be downloaded to diagnose misalignment/unbalance, observe critical speeds etc. Other recordings can be optimized for gearbox and bearing analysis of signals in the medium and high frequency range. The data are stored on a standardized file format and can also be used by third party systems such as LabView®, Mathlab®, Pulse®, etc.

New bi-axial, high sensitivity accelerometer

This sensor is perfectly suited to monitoring wind turbine tower low-vibrations. Because of its high sensitivity, it can be used in many other similar applications. The sensor is based on a capacitive measurement principle, which allows for a response down to DC. Sensitivity is 1000 mV/g (±5%) with a maximum vibration amplitude of ±2 g over a frequency range of 0-1.8 kHz.



VibroSuite, part of the stand-alone wind turbine monitoring system, consists of management and analysis software such as the WTG analysis software, AlarmTracker, program LaunchPad and more.

This is the same software used at the Brüel & Kjær Vibro surveillance Centres. ■

business corner

New Regional Sales and Support Office for the Middle East & India

Brüel & Kjær Vibro has opened new headquarters for its Middle East and India operations in the UAE. This office will centralize sales and service functions for the region, delivering the highest quality support and fast response times to our Middle East and Indian customer base.

The dedicated local team will deliver expert technical sales advice for new projects in the region, while the service team will provide responsive, reliable technical support for Brüel & Kjær Vibro's extensive product range for new and existing installations. The new regional office will be headed by Mustafa Siddique. Mustafa, who has more than two decades of regional experience, brings both a strong technical background and extensive sales experience to oversee the growth and support of the customer base in the region.

For further enquires about the new office please contact the local team via email at Mustafa.siddique@bkvibro.com or direct call at +971 50 6467056 ■

field news

String test for **Prelude turbo-generators**

Compass 6000 was successfully used for testing two 40 MW turbo-generators and one 20 MW depletion compressor at Mitsubishi Heavy Industries in Japan in Dec, 2012. These two machines will be installed on the Shell Prelude floating LNG plant off the western coast of Australia; planned to be operational in 2016. Prelude will be largest floating structure ever built, producing 3.6 million tonnes of LNG per year. The extensive string testing included both steady state and transient speed monitoring of the machines. You can read more about our string test procedures in the next issue of Uptime! ■

events 2013-1

February 4-7 2013

EWEA 2013

Vienna, Austria

One of the major European wind energy events, the EWEA 2013 Annual Event brings together international companies, industry experts, policy makers and research communities, providing a platform to discuss the future of wind energy and its growth markets. Find our booth in the Danish Pavilion in Hall A-J20.

www.ewea.org

February 20-21 2013

EasyFairs Maintenance, Dortmund

Dortmund, Germany

Visitors will find an overview of all aspects of industrial maintenance. The show focuses on products, services and solutions that help the user to efficiently optimize his production process. Find our sales team at booth D:05.

www.easyfairs.com

April 8-12 2013

Hannover Messe 2013

Hannover, Germany

The upcoming HANNOVER MESSE 2013 will be staged under the banner of "Integrated Industry." The lead theme signals the fair's key focus on the growing integration of all areas of industry. You will find Brüel & Kjær Vibro in the Industrial Automation Section (15/F37) and in the Wind Power Section (Hall 27).

www.hannovermesse.de

April 24-25 2013

EasyFairs Maintenance, Stuttgart

Stuttgart, Germany

Visitors will find an overview of all aspects of industrial maintenance. The show focuses on products, services and solutions that help the user to efficiently optimize his production process. Find our sales team at booth B:11

www.easyfairs.com

May 5-8, 2013

Windpower 2013

Chicago, USA

WINDPOWER 2013 will provide exhibitors the opportunity to showcase their products and services to more than 10,000 individuals from the entire wind energy supply chain coming from across the U.S. and around the world. Exhibitors include manufacturers, developers, contractors, consultants, suppliers/service companies, electricity generators/utilities, financiers, insurance companies, research institutes, engineers, recruitment consultants and many more.

www.windpowerexpo.org