

uptime
magazine

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Brüel & Kjær Vibro

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 the VIBROPORT 80 release.

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Handhelds play an important role in the market

A positive result of the global financial crisis is that companies have realized the importance of optimizing machine assets to improve productivity. This has driven an increase in investment on condition monitoring products. This not only includes online systems but also handhelds.

Granted, handheld vibration instruments are often used in stand-alone applications, however, they also play a very important role in a comprehensive plant-wide condition monitoring strategy; alongside online systems. The three important functions of a handheld such as our new VIBROPORT 80 (VP-80), are condition monitoring (fault detection and diagnosis), balancing and analysis. From a condition monitoring point of view, a large plant can have online monitoring of several hundred machines, but what about the isolated machines, the stand-by machines, or the smaller non-critical machines in the plant? As these cannot always be cost-effectively monitored by online systems, an instrument such as the VP-80 comes in handy! Moreover, online systems are typically designed for automated, continuous monitoring functions. As balancing and analysis are only undertaken intermittently or as needed, this functionality is often not standard on an online system.

Again, in such applications the VP-80 shows its true colors!

In summary, online systems are not replacing handhelds, rather they complement each other in a comprehensive plant-wide condition monitoring strategy!

We never doubted the market place for handhelds, and we are very content with the success of our existing handheld products. It is only natural, however, that we capitalize on technological advances to further improve the functionality within this product line. A few years ago, we initiated a thorough market investigation to see how we can combine technical innovation with growing end-user demands. The result is the birth of our feature rich user friendly VP-80!

I am pleased to launch this issue of Uptime, dedicated to the VP-80, and hope you enjoy reading more about this product and the other exciting articles.

Dr. Peter Kytka
*Product Manager
for VP-80*





New product launch: VIBROPORT 80 handheld

The 4-channel VIBROPORT 80 is the newest generation of portable vibration measuring instruments by Brüel & Kjær Vibro. It provides early fault detection, rotor balancing and detailed vibration analysis in one instrument! It's a user friendly instrument with a modular design that enhances its versatile and cost effective scalability!

Introduction

The VIBROPORT 80's history goes back over 40 years to the development of Brüel & Kjær Vibro's first portable vibration meters, balancers and analyzers. By today's standards, the Type 2526 Data Collector can be considered our first handheld condition monitoring instrument. It could be used for data collection, fault detection, diagnosis and balancing as a stand-alone with its own condition monitoring software, or together with the Compass monitoring system. Introduced over 20 years ago, it is still being used in many industrial applications, especially for low frequency applications. This development was followed by our first generation handheld for fault detection, balancing and analysis; the VIBROTEST 60. Together with its xms monitoring software, it ushered into the condition monitoring com-

munity powerful fault detection and analysis capability in a very simple handheld. Like the 2526, VIBROTEST 60 is still being used today in a variety of industrial applications, and considered by many to still be the best portable balancer in the market.

These years of experience provided the necessary foundation and expertise to update the handheld product line with emerging technology –The result is the VIBROPORT 80! It combines many of the popular features available in our previous handhelds with some extended application functionality as well. Its versatility enables it to be used in a number of monitoring and analysis applications in a variety of industries. Despite the extended functionality, its user ▶

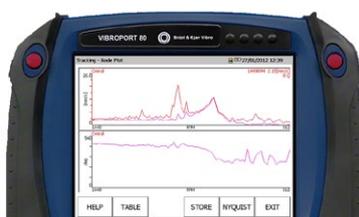


friendly design lends itself to both inexperienced operators and specialists. It has a large screen, numerous color plots (including 3D) and the setup and navigations functions have been greatly simplified. Its modular concept gives it the necessary flexibility and scalability to tackle the simplest as well as the most demanding customer requirements, in a cost effective way.

Application versatility

As a result of its extended monitoring, balancing and analysis versatility, the VIBROPORT 80 (VP-80) can be used on a wide range of machines in the petrochemical, power and process industries. Its extensive measurement and sensor input capability make it the perfect choice for early detection and diagnosis of incipient faults in bearings, shafts, gears, couplings, casing, etc. This includes everything from auxiliaries to critical machines, and even those in ATEX certified areas. The diagnostic functionality of the VP-80 rivals that of many on-line condition monitoring systems, and can in fact even complement the existing on-line system. The powerful balancing function is without equal, and the comprehensive analysis capability (time signal recording, post processing capability and transfer function analysis) meets all the sophisticated user requirements. This enhanced diagnostic and analysis capability enables operators to more accurately track faults on critical machines and thereby more effectively plan the necessary maintenance activities. This VP-80 not only provides early in-depth diagnosis of the faults, but also makes it easier to find the root cause, so corrective action can be taken to avoid the same fault ▶

Module name	Functionality	Functionality included
Overalls	Detection, diagnosis	ISO 10816 measurements vs. speed $f(n)$ or time $f(t)$
FFT Analyzer	Diagnosis	Diagnostic measurements with up to 80 kHz frequency range: <ul style="list-style-type: none"> ■ FFT spectra ■ Bearing Condition Signature (BCS – for rolling element bearing fault detection and some diagnostics) ■ Selective Envelope Detection/analysis (SED - for extended rolling element bearing fault diagnostics)
Balancer	On-site balancing	1-2 plane balancing, static and dynamic balancing, 2-plane polar plot. “Quick balancing procedure” offered via Fire key
Tracking	Diagnosis, analysis	Order/transient analysis. Recorded time signal can be post processed many times with user-defined parameter settings to obtain Bode, Nyquist, FFT-Waterfall and Spectrogram
Transfer function	Diagnosis, analysis	<ul style="list-style-type: none"> ■ Determination of the Transfer function - FRF (Frequency-Response-Function) ■ Ratio between impact hammer input-impulse and the related impulse response ■ Coherence analysis for evaluation of measurement quality ■ Multiple transfer function types such as compliance, mobility, etc.
Time signal	Analysis	Data recording in wav format (up to 16MB, 2GB per data set), wav format
Acceptance test	Detection	User-defined templates



re-occurring. Moreover, the instrument can be economically used from one machine to the next, as the need arises.

From an operator's point of view, this robust instrument's large screen with multiple display views, easy-to-use keyboard and simple setup make the VP-80 user friendly in the most demanding working conditions, whether it be cramped quarters, glaring sunlight, rain or wind. ▶

Hardware that offers modularity, scalability and flexibility

The VP-80 was designed with the user in mind, and one of the important considerations was that it be easily used in a variety of different applications.

Inputs, hardware

The VP-80 has four input sockets, which can be simultaneously used for vibration, speed/phase reference, process, digital input and time signal recording. For example an X-Y-Z accelerometer configuration utilizing three sensors plus a tacho can be used for order analysis.

Modules

One of the important distinguishing functions of the VP-80 in terms of flexibility, modularity and versatility are the scalable firmware modules. These can be mixed and matched to meet the monitoring requirements for your particular application:

The VP-80 offers powerful monitoring diagnosis and analysis capability but

it was not designed just for the specialist in mind! Brüel & Kjær Vibro offers combined starter packages for the less experienced operators.

(These packages also include some monitoring accessories; see the Product Specifications for details.):

Module name	Modules included
Analyzer select	Overalls, FFT analyzer
Balancer select	Overalls, wFFT analyzer, Balancer





Report & EXaminer Software – ReX

ReX is the modern PC software package that supports the VP-80 measurement modules. The software can be installed on all current Windows™ PCs. Reports can be generated quickly and easily from measurements stored in the instrument and uploaded into the ReX software. The optional premium version enables you to analyze previously stored time signal data sets (.wav files) so they can be digitally post-processed to obtain FFT and waterfall spectra. For the analysis of rolling-element bearing defects, ReX provides an OEM bearing database that lists the characteristic fault frequencies of all

common rolling-element bearing manufacturers. ReX is flexible, and it can also be used for creating user-defined templates for reports and acceptance tests.

Easy & Intuitive Handling

It is imperative that a powerful instrument such as the VP-80 is also easy to use, so this was one of the primary guiding principles during its development. Some of the special user-friendly features include:

- An ergonomic design that can be used by operators in real working conditions, even with one hand. This is where its physical shape, the large screen and easy-to-use

keyboard come to the fore

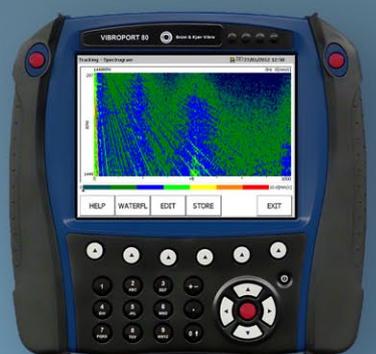
- The window displays for setup, plots and the navigation screen have been optimized for simplicity and functionality.
- Pre-defined measurements are provided to minimize setup time. (This feature is available in all modules.)
- User-selectable overview of multiple setup parameters. The Expand/reduce function keys are used to adjust the setup view to include either the most widely used parameters or additional ones for a more sophisticated measurement task.
- Easy sensor setup. This tedious task has been greatly simplified! Identical setups only have to be entered once. Pre-defined setups for Brüel & Kjær Vibro sensors can be complemented by customized setups of other sensor types. Once saved, these setups are automatically available in all modules!

Conclusion

The VP-80 is an entirely new handheld with respect to the technical components and user interface, but it incorporates the vibration detection, diagnosis and analysis principles proven over decades of industry experience. This instrument's modularity, application versatility and ease-of-use are unsurpassed and meet the requirements of the most demanding application! ■

Visit our website www.bkvibro.com or contact your nearest Brüel & Kjær Vibro Sales representative to find out more about the VP-80



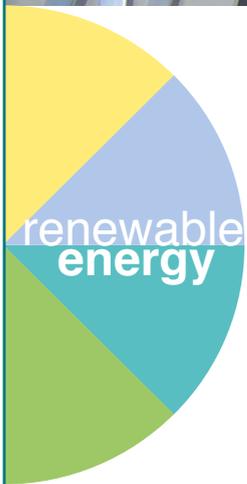


A Visit to the Service Department at Arise Windpower

Arise Windpower, founded in 2006, is traded on NASDAQ OMX Stockholm since March 2010.

Arise is one of the leading and fastest growing wind turbine operators in Sweden. Its wind parks are located on land primarily in the southern part of the country. The Arise business concept is to manage the entire value chain, from product development to selling green electricity produced by their own land-based wind turbines.

In production: 139 MW
Under construction: 102 MW
Permits: More than 500 MW
In prospecting: 250 MW



The Managing Editor of Uptime visited one of the leading wind turbine operators in Sweden to see how their one year old Brüel & Kjær Vibro condition monitoring system fit into their business strategy.

I was delighted for the invitation to visit Arise Windpower, but I have to admit I was a little apprehensive. This was the first time I visited a wind turbine operator/owner, and I didn't really know what to expect. Henrik Axelsson, the Arise Operation Manager who picked me up at the Halmstad train station, drove me to their modern office complex where we met Liane Persson, Managing Director of Arise Service AB. As we settled down in the light, airy Scandinavian design meeting room and started to chat, I could see our common business experiences and started to feel much more at ease. These two individuals, the ones who worked most closely with the Brüel & Kjær Vibro wind turbine condition monitoring system in Arise, were more than excited to tell me about their company and the role our monitoring system plays in enhancing their turbine uptime. I was very interested to find out more.

You are a relatively new company, what are the main challenges for you as an owner/operator of WTGs, and how prepared are you to meet these challenges?

Right now in Sweden there is a lot of support for wind energy; the Swedish Parliament has declared a goal for 2020 that an additional 25 TWh shall come from renewable energy sources. From the business point of view, however, there are a number of other activities that have a huge influence on the way we execute projects. This includes prospecting for sites, project planning, permit management, financing, construction, operation and maintenance of the turbines, transmission and distribution of the energy. Outside organizations can perform many of these activities for us, but these have significant impact on cost and timing of projects with little opportunity to control or influence the process. Therefore Arise adopted ►

an integrated wind power business concept that provides control over the entire value chain. We currently own our own grid company, crane, wind-measuring equipment and utilize our own resources for project management and setting up the wind farms.

What about out-sourced activities?

Clearly, to reach our business goals, we need to have 100% control over all our core activities. There are of course a number of other activities where it is more cost effective not to bring the expertise in-house. We work with external companies but we still have stringent requirements on technical quality and performance.

Did this business strategy pay off for you?

It significantly reduced our costs and lead-times, optimized production and lifetime costs, enabled faster project completion, provided a high return on investment and minimized risks. This increased profitability with improved cash flow.

So this business model works well for your project activities, but what about operation & maintenance, what kind of role does it play here in your success?

Operation & maintenance for us has a significant effect on our bottom line. O&M decisions are made on relevant wind turbine information, so we make a lot of effort to facilitate this process. The SCADA system that integrates all wind turbines to our control station has been significantly modified to our requirements. This applies also to our data historian and computerized maintenance management system. The machine condition monitoring and diagnostic system and services supplied by your company also play

a vital role in our O&M strategy by providing relevant information to optimize our O&M decisions.

This is interesting to hear! Tell me, what were the main drivers for you to consider implementing a condition monitoring system?

Our business goal is to maximize productivity and minimize life cycle costs. Service is important for ensuring the wind turbines keep running efficiently, but if it is not done properly it can cost a lot of money. Service should only be done where it is needed, and it shouldn't be done too early nor too late. An important tool to facilitate this is a condition monitoring system that can detect a developing fault in a particular component early and provide decision support diagnostic information for determining what kind of service is needed, and when. As the monitoring system would be employed on every wind turbine in all the wind farms with access to both old and new data, it could also reveal recurring problems, such as those that are component and operational related.

Yes, this is a good point, but what were the important criteria and decision making factors for specifically selecting a condition monitoring system partner?

Partner is a good choice of words! We of course needed a monitoring system but we also wanted the expertise that goes with it. We have specific demands for our monitoring requirements so we wanted a partner that could closely cooperate with us with an open attitude and share knowledge between our companies. This is an important point. They ultimately have to add value to our O&M! From a system point of view, we had some very specific requirements. It has to be designed for early detection and diagnosis of wind turbine component faults. It can't be a generic system that is used for monitoring all types of industrial machines. The system should also have sufficient previously logged monitoring hours ▶



on the same type of turbines we work with, and yet be adaptable to new turbines that will be installed in the future.

We also want a single monitoring system for all our wind turbine parks. In order to optimize production in specific areas and minimize risk, we have purposely installed different types of wind turbines at specific sites. Our existing fleet consists of GE and Vestas turbines in different models and hub heights, and it might be even more diversified in the future. However, we do not want different O&M information and management systems. Just like we have a single SCADA system for operating all our wind turbines, we wanted a single system for monitoring all our turbines.

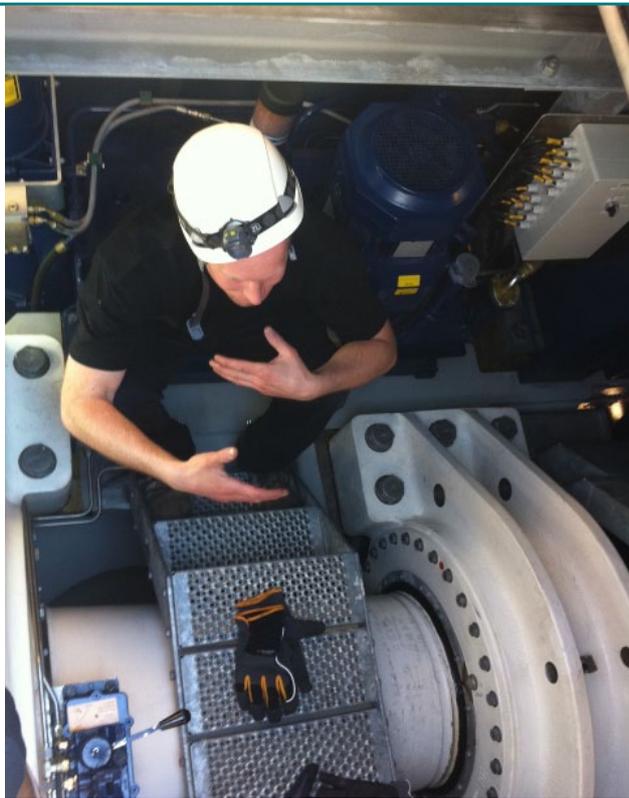
This makes it easier to correlate and compare data.

And how did you choose your partner?

We wanted a solution that would enable us to take the best operation and maintenance decisions on our existing turbines as well as those for future projects and from different turbine suppliers, so we carefully investigated the market. Different suppliers were looked at regarding price, cooperation, service and expertise. After a lot of deliberation, we selected the Brüel & Kjær Vibro system!

OK, you selected the Brüel & Kjær Vibro solution, but why with external diagnostics as a service?

We didn't expect to learn to use the system immediately, nor undertake



the diagnostics and analysis. Therefore we outsourced this expertise to Brüel & Kjær Vibro. Maybe one day we will be able to take it over but this is not planned yet for the near future!!

That certainly is a possibility. We have several customers, and not just in the wind energy sector, who staff up and take on a major part of the diagnostic work. Others, who are just as successful, want us to do only the more complicated diagnoses. And there are still other well running companies who let us do all the work so they can focus on other issues. This is definitely a business resource question.

My last question, can you tell me where do you see our system delivering value to your O&M processes?

Brüel & Kjær Vibro takes a professional approach to doing business, very much like we do. Your diagnostic specialists work to ISO standards in a systematic, effective manner. They are very good at informing us on events, and they are very quick to react. Your specialists come out to visit the installations if they have questions, and it is easy to get answers from them. Our insurance company is also convinced as we get premium reductions as a result of this

condition monitoring solution!

I'm happy to hear this. We take our customer commitments very seriously.

At the end of the interview, I had no doubt that this company was based on a well thought out business strategy and our system and service played an important role in it. I am often tied up in the technical details in my daily work, so it was a pleasant change to get a chance to see the benefits from a business perspective. I was also happy I had the chance to visit a wind turbine owner/operator and learn about this business sector. I hope I can return to Arise after they have gained more monitoring experience and write a case story with my new Arise service colleagues! ■

Acknowledgement

I would like to thank Liane Persson, Henrik Axelsson and Arise Windpower AB for taking the time to give us a glimpse into the asset management side of their work, and the important role our monitoring solution plays in it.



Early detection of a propane compressor gearbox fault using diagnostic measurements

The rapid deterioration of the incorrectly mounted spur gear could not be detected by the overall vibration measurements, however the condition monitoring measurements detected the developing fault with over two weeks lead time to service.

Observations and Analysis

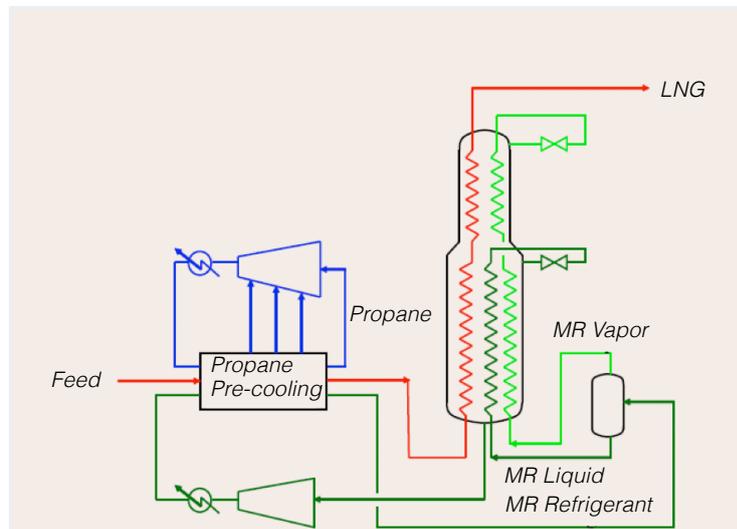
The critical propane compressor train at the LNG plant, shown in Fig. 1, is extensively instrumented by Compass for safety, condition and performance monitoring. As shown in Fig. 2, displacement sensor X-Y pairs were mounted on each of the bearings of the gearbox.

In February, the following condition monitoring measurements indicated a developing fault:

- Constant Percentage Bandwidth (CPB) filtered spectrum
- Vector measurement (magnitude and phase)

The Constant Percentage Bandwidth (CPB) indicated a pronounced trend as shown in Fig. 4. The running speed portion of the CPB gave approximately a 10 day lead time to shutdown.

The first order vector measurement data was also analyzed, and the magnitude portion gave a similar lead time before shutdown to that of the CPB measurement. The phase portion of the measurement, however, started changing even earlier as shown in Fig. 5, providing over two weeks advance warning. ►



LNG Liquefaction Process

Natural gas is liquefied (LNG) in order to facilitate transport and storage from the gas plant to the country destination. In its liquefied state, at -162 C, it occupies only 1/600 volume of its normal gaseous state at sea level pressure. This gives it an energy density that is 2.4 times greater than compressed natural gas (CNG), thus making it much more economical to transport by ship.

Approximately 160 million metric tons of LNG is produced each year.

The cryogenic process for making LNG is done at an LNG plant where there are one or more independent LNG trains. Approximately 86% of all LNG is produced using the 40 year old C3MR liquefaction process (propane pre-cooled mixed refrigerant), shown in the diagram above.

The liquefaction portion of each train, where most of the condition monitoring is done by our system, consists of these primary components:

- Main cryogenic heat exchanger (MCHE) - Liquefies natural gas with mixed refrigerant
- Propane compressor train - Pre-cools the natural gas and the mixed refrigerant
- Mixed refrigerant compressor train - Further cooling of the natural gas before entering the MCHE
- High pressure separator – MR is divided into vapor and liquid streams for further cooling
- Liquid expanders – LNG and MR is let down in pressure for further cooling. Also for turning a generator for supplying power to the grid

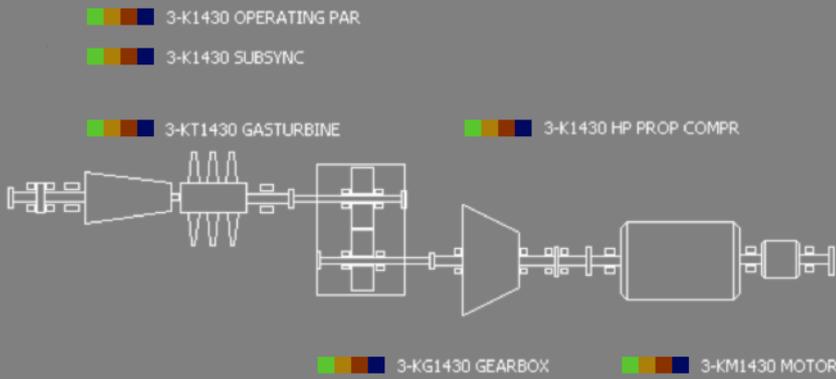


Figure 1. The propane compressor train at the LNG plant is monitored for safety, condition and performance. The gas turbine prime mover is shown on the far left, the gearbox second from the left, the compressor second from the right the helping motor/generator on the far right.

Figure 2. The propane compressor gearbox, showing X-Y displacement sensor pairs on each bearing.

By comparison, the overall vibration measurement shown in Fig. 3 indicated a weak trend that was well below the alert setpoint until the day the machine was shut down for service.

Results and Conclusion

When the gearbox was disassembled, the output shaft bull gear was found to be improperly mounted. It was this fault that caused a running speed vibration amplitude increase and phase change. When the gearbox was repaired and reinstalled, the vector amplitude vibration reduced and the phase stabilized.

Although all the condition measurements detected the developing fault with advance warning, the first order phase measurement provided the earliest detection and thereby the longest lead time to service.

In summary, diagnostic measurements can detect a developing fault long before the overall vibration measurements. If the diagnostic measurements are monitored to trend alarm limits, as shown in Fig. 6, a rapidly developing fault can be quickly detected long before any absolute alert alarm limits are exceeded. Either way, for faults that have a non-linear development, such as an improperly mounted gear, the CPB and vector measurements can detect these faults with sufficient lead time to plan the necessary maintenance and unplanned downtime and maintenance cost. ■

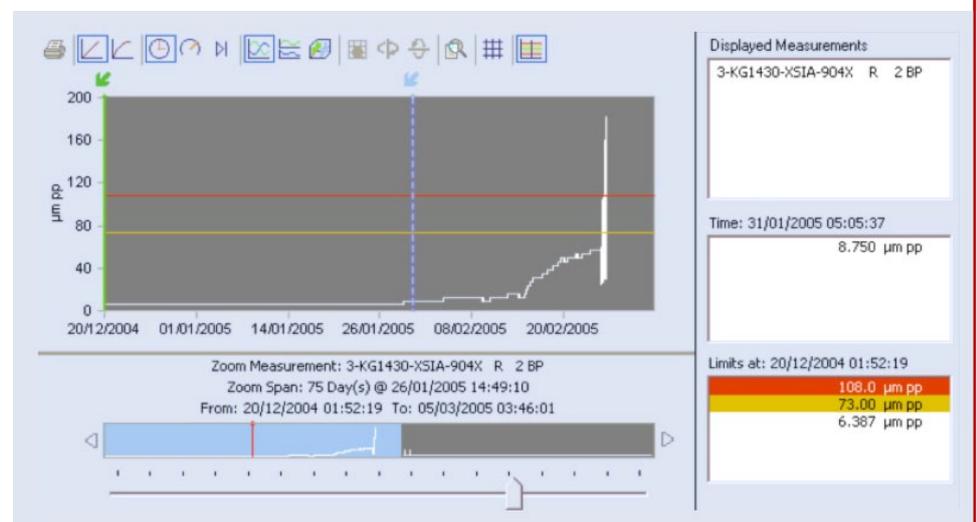
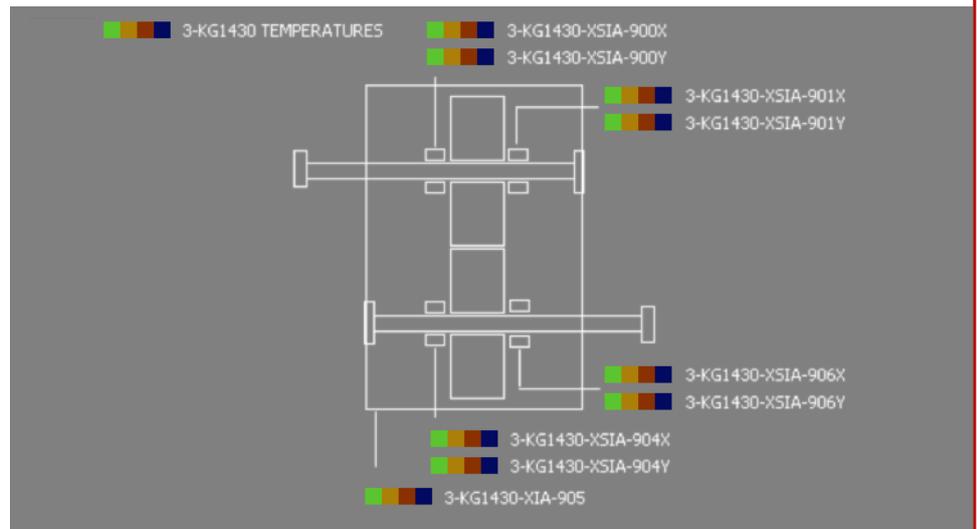


Figure 3. Very little warning from the overall vibration measurement of the inner bearings on the output shaft. The low vibration level trend would give around 8 days advance warning if it were trended to alarm limits.

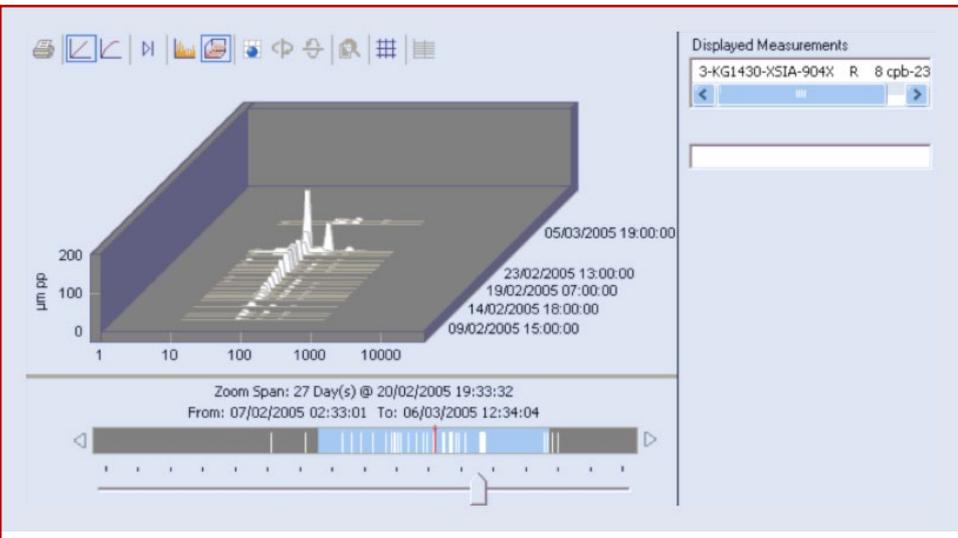


Figure 4. The constant percentage bandwidth measurement (CPB) showing the running speed vibration increasing. The 2x and 3x orders of the running speed are also shown.

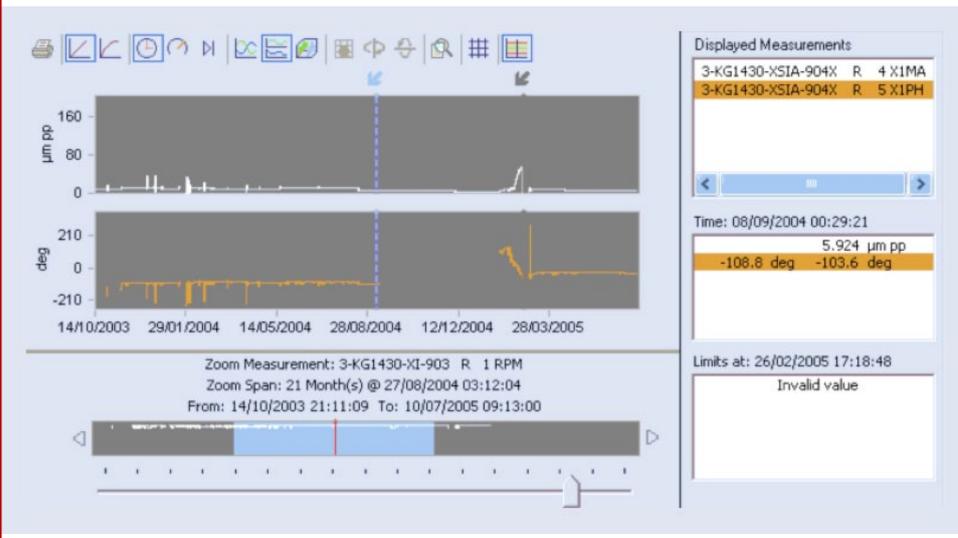


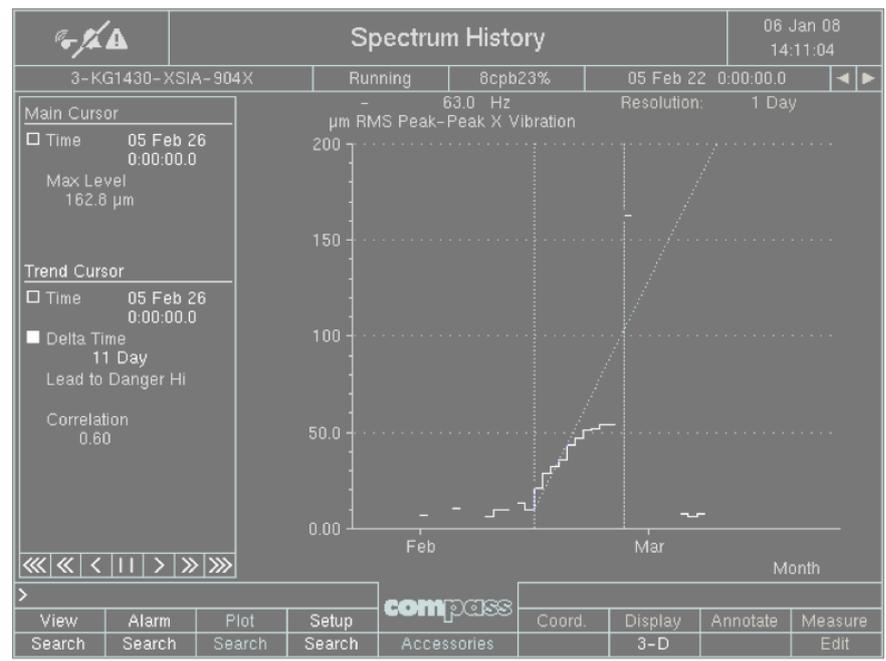
Figure 5. The 1st order phase is visible when the vibration amplitude is high enough. Around 10 Feb the phase begins to change significantly. The 1st order vibration magnitude upward trend didn't start until after 15 Feb.

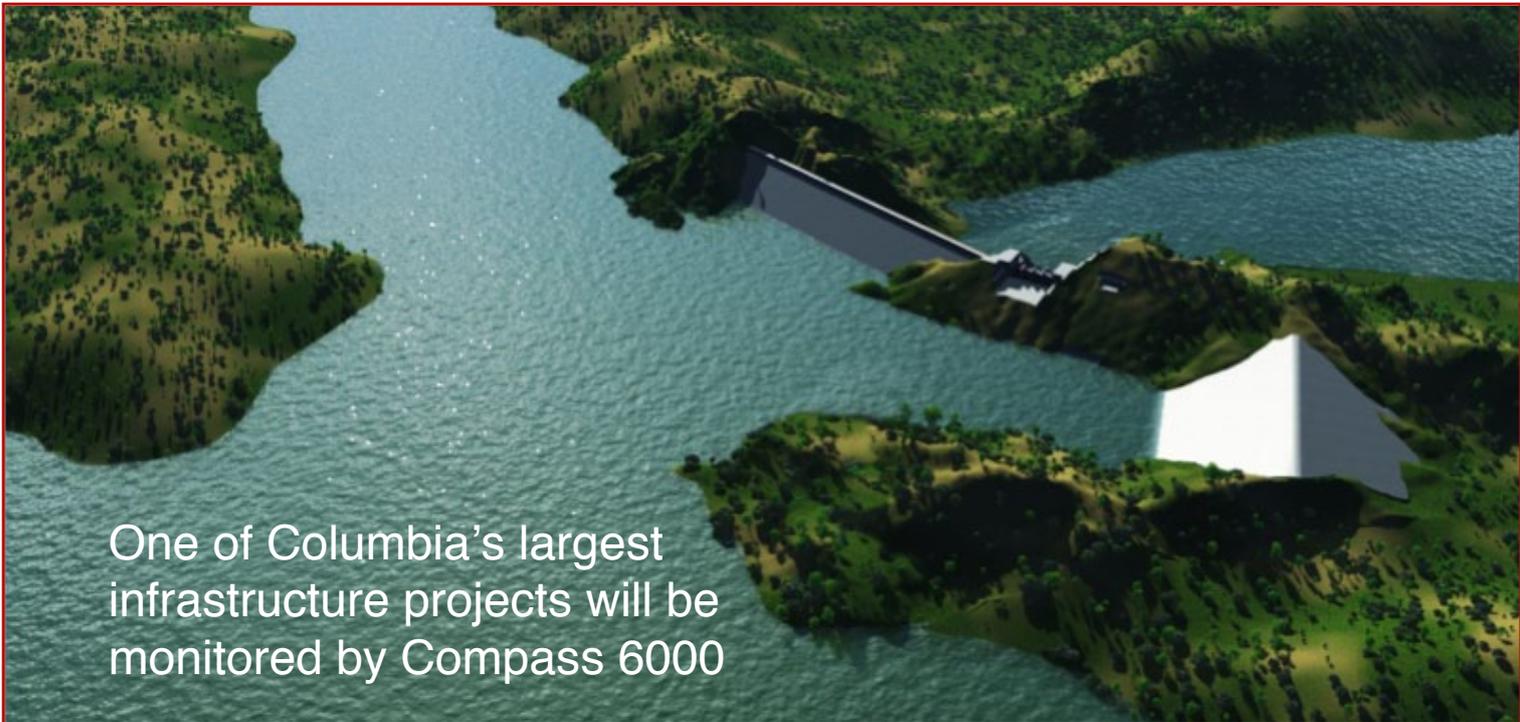
Propane Compressor Train

The compressor train in this case story consists of a 75 MW Frame 7 gas turbine driving an axial compressor via a gearbox. There is also a variable speed starter motor/generator at the other end that is used to help start the gas turbine, and afterwards the unused power of the gas turbine turns a generator for supplying power to the grid. The 4-stage single casing centrifugal compressor uses propane at four different pressure levels to supply refrigeration to the incoming natural gas and pre-cooling of the MR.

- Running speed - 3600 rpm
- Flow - 170000 m³/hour flow
- Output pressure - 30 bar
- Output temperature - -31 C

Figure 6. Automatic trend alarm of the first order vibration component of the CPB plot showing a 10 day lead time to the Danger alarm limit.





One of Columbia's largest infrastructure projects will be monitored by Compass 6000

The **EI Quimbo hydroelectric power plant project** is located on the Magdalena River in the central southwestern part of Columbia. This private sector project, one of the largest in

the country, will be completed in 2015. The powerhouse will have an installed capacity of 400 MW, consisting of two vertical-axis Francis turbine generating units. Brüel & Kjær Vibro have been awarded the contract to provide the integrated safety and

condition monitoring solution, which, in addition to extensive vibration measurements, will encompass air gap monitoring between the stator and rotor and partial discharge measurements to determine the stator insulation integrity. ■

field news

World's largest floating LNG platform will be monitored by Compass 6000 ▶



Compass 6000 selected for Siberian hydro project

The **Novosibirskaya hydroelectric power plant** was built on the Ob River in Siberia in the 1950's to supply the city of Novosibirsk, Russia. After many years in operation, it is currently being refurbished with new turbines and control systems. In addition to being modernized, the power output will also be increased to 504 MW. The Compass 6000 platform was selected to monitor **the Kaplan turbine generating units**. The comprehensive safety and integrated condition monitoring strategy includes vibration (shaft/bearing, casing, stator core), cavitation and air gap measurement techniques. ■



field
news

The strong demand for liquefied natural gas (LNG) has resulted in massive investments in the energy sector, and one such project is the **Shell Prelude floating LNG plant**. It will be permanently moored about 200km from the Western Australian Kimberly Coast and produce 3.6 million tonnes of LNG per annum, starting from 2016. It will be the largest floating structure ever built, more than six times heavier than the largest aircraft carrier! This colossal technological undertaking will be monitored by our own technologically enhanced Compass 6000 machine condition monitoring system. Similar to other LNG plants monitored by the plant-wide Compass platform, all the critical machines and many auxiliaries in the liquefaction process will be comprehensively monitored for safety and machine condition. ■



3 - 6 June 2012

AWEA Wind Power 2012

Atlanta, USA
*International Conference
and Exhibition*
www.awea.org/events/

The American Wind Energy Association's annual WINDPOWER Conference & Exhibition is recognized as one of the world's premier wind energy trade shows, bringing together attendees and exhibitors from every aspect of the industry. Exhibitors display the latest industry products and services from manufacturing leaders, component suppliers, and other wind energy organizations. In 2012, Brüel & Kjær Vibro will exhibit as part of the Danish Pavilion.



18 - 22 June 2012

ACHEMA 2012

Frankfurt, Germany, Hall 11.
*29. International Exhibition-Congress
on Chemical Engineering, Environ-
mental Protection and Biotechnology*
www.achema.de



18 - 22 September 2012

Husum Wind Energy 2012

Husum, Germany
Hall 7/booth D14
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Every two years Husum WindEnergy is the best shop window environment for making new business contacts and strengthening existing contacts.



16 - 18 October 2010

Maintain

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This is where people "live" maintenance. Besides a strong business orientation, the fair's key characteristics include commitment, solidarity and the spirit of partnership. MAINTAIN has become the leading industry gathering in the last five years.



29 - 31 October 2012

Hydro 2012

Bilbao, Spain
*International Conference
and Exhibition*
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Hydro is an annual conference in different parts of the world. The trade fair with symposia are dealing with all technical, environmental, social and economic aspects of hydro plants and future projects for developing multipurpose water resources in order to cover the increasing demand for energy in times of climate change. Our Austrian sales team will be on site to answer visitors' questions regarding monitoring techniques of hydro power machinery.