Brüel & Kjær Vibro

Uptime for Wind Turbines

Dedicated Remote Condition Monitoring System for the Wind Power Industry

Maximize wind turbine production

Examples of typical drive train faults

Wind power is a renewable energy source that makes life greener while at the same time playing an increasingly important economic role in the total energy market. The profitability of this business, however, depends largely on how effectively the wind turbines are operated and maintained.

The wind turbine drive train is a major area of focus for maintenance.

Components such as bearings and gears fail because of wear, overloading, environmental conditions or assembly/manufacturing errors. These incipient defects – if undetected and uncorrected – can lead to major catastrophic machine failures such as a generator rotor/stator rub, gearbox seizing and main rotor collapse.

The potential failure modes of a wind turbine drive train are unique and therefore require a dedicated monitoring system concept. This is due to the widely variable operating conditions coupled with non-rigid foundations, complex gearbox and low rotating speeds. Special monitoring and diagnostic techniques are therefore required for early fault detection, which gives lead-time to maintenance and avoids down-tower repairs.

Brüel & Kjær Vibro provides a solution that takes into account all of these factors!

IS CONDITION MONITORING AT ALL NECESSARY?

Experience shows that when properly implemented, condition monitoring systems and services can significantly increase uptime, improve reliability and reduce the overall lifetime operating costs of the wind turbines. Catastrophic failures are averted, inspections are prioritized and properly focused, and maintenance scheduling and costs are optimized.

We deliver lead-time to maintenance!

Condition monitoring brings benefits!

It is important for manufacturers, operators and owners of wind parks, to understand the benefits of a dedicated condition monitoring solution and the impact of implementing such a system.

The life-cycle operating cost savings, as shown in the plot below, give an example of the overall benefits over a period of time. These are typically:

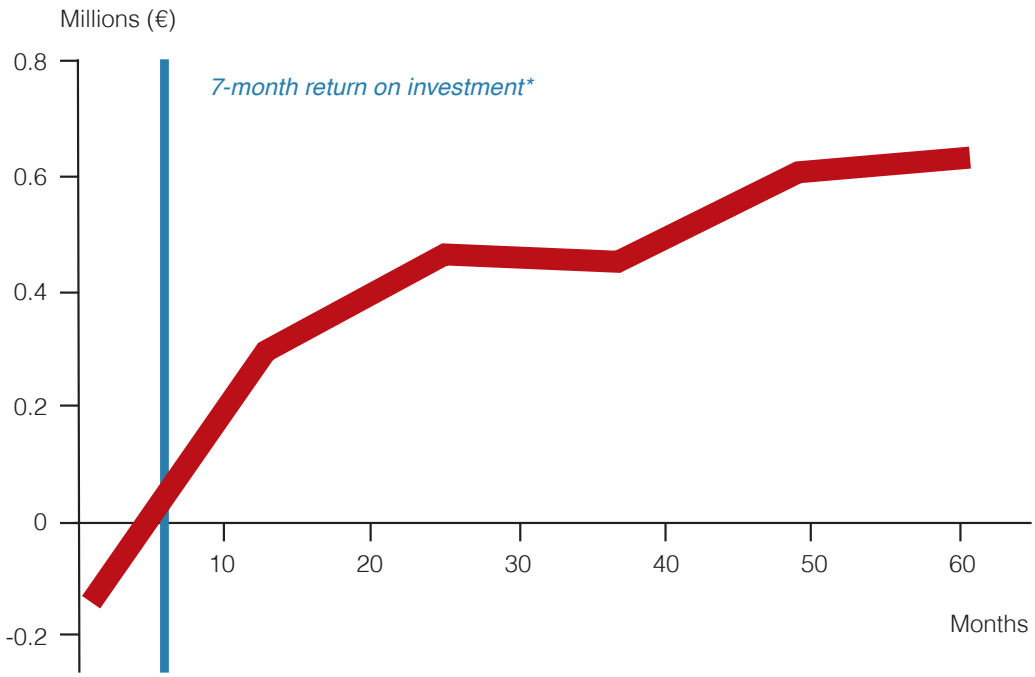
- Increased uptime, power and revenue
- Focused, short duration maintenance that is scheduled ahead of time
- Right people, right tools, right parts at the right time
- Maximized component life
- Maintenance is typically up-tower with minimal need for expensive cranes
- Lowered risk of secondary damage to nearby components
- Fewer or no catastrophic failures, that can cause personal injury, environmental oil cleanup, expensive component replacement and crane service
- Reduced insurance premiums

OUR TRACK RECORD

After 150 million hours of wind turbine monitoring (i.e. 120,000 GWh of energy):

- 375 high-severity reports were issued, avoiding catastrophic failures
- 2,000 lower severity reports were issued, allowing maintenance to be planned ahead

ECONOMIC BENEFITS OF CONDITION MONITORING



**The plot shows the total net cost savings achieved by using an effective condition monitoring solution in relation to a park without such a system. The savings are based on avoiding catastrophic failures for the typical bearing/gear faults that occur in a wind park of 20 wind turbines (2 MW wind turbines) over a 5-year period. NPV (net present value) calculations are based on a 10% discount rate. Calculations originate from a joint study between Brüel & Kjær Vibro and a major wind turbine manufacturer.*

Unique monitoring concept

Brüel & Kjær Vibro has been closely involved with the wind turbine monitoring industry since its infancy in 1999. Conventional condition monitoring systems and practices prior to that time were simply not applicable. Much research has since been done together with turbine and component OEMs, Germanischer Lloyd, Allianz Insurance and selected operators for improving the way wind turbines are monitored. Significant experience has been gained and a number of innovative, unique concepts and measurement techniques have been developed and refined to facilitate and optimize monitoring of wind turbines.

Surveillance and Diagnostic Service Centres

Brüel & Kjær Vibro's dedicated diagnostic teams monitor thousands of wind turbines every day in the Shanghai, Beijing, Copenhagen and Houston monitoring centres. This provides **24/7 worldwide coverage**.
The **ISO 18436-certified diagnostic engineers** provide a wide range of services, including complete turnkey monitoring programs, training and hotline support. Secure database servers with sophisticated monitoring analysis software ensure faults are detected reliably and with maximized lead-time to maintenance.

"The ISO 18436-certified diagnostic engineers provide a wide range of services, including complete turnkey monitoring programs, training and hotline support."

Effective fault detection-to-service action

This unique procedure is based on years of experience in monitoring thousands of wind turbines. The automated part of the system detects faults at an early stage of development based on unique measurement techniques. **Automatic alarm management** reduces alarm flooding and intelligently assesses the severity of the alarms from the time they are detected and as they develop. A team of certified diagnostic engineers then evaluate the alarms, perform post-processing of stored time signals for root cause analysis, evaluate long-term trends and issue service recommendations. The diagnostic engineers also customize the measurement techniques as experience is gained, and as new turbines and components come into use.

"Automatic alarm management reduces alarm flooding and intelligently assesses the severity of the alarms from the time they are detected and as they develop."

Fully flexible solutions...

The Brüel & Kjær Vibro condition monitoring solution is an all-inclusive program of deliverables that not only includes a dedicated monitoring system, but also local or host-based alarm management and diagnostic software and database, and a unique service program. These components can be customized to the client's monitoring strategy and interfaced with the existing controllers. This gives actionable information for ensuring lead-time to maintenance of the wind turbines and for optimizing uptime.

Three basic monitoring solutions, all of which can be modified according to the customer's needs, are described in the following:

1. **Hosted Brüel & Kjær Vibro Turnkey Solution**
2. **Customer-Owned Solution**
3. **Customer-Owned Solution with Brüel & Kjær Vibro Services**

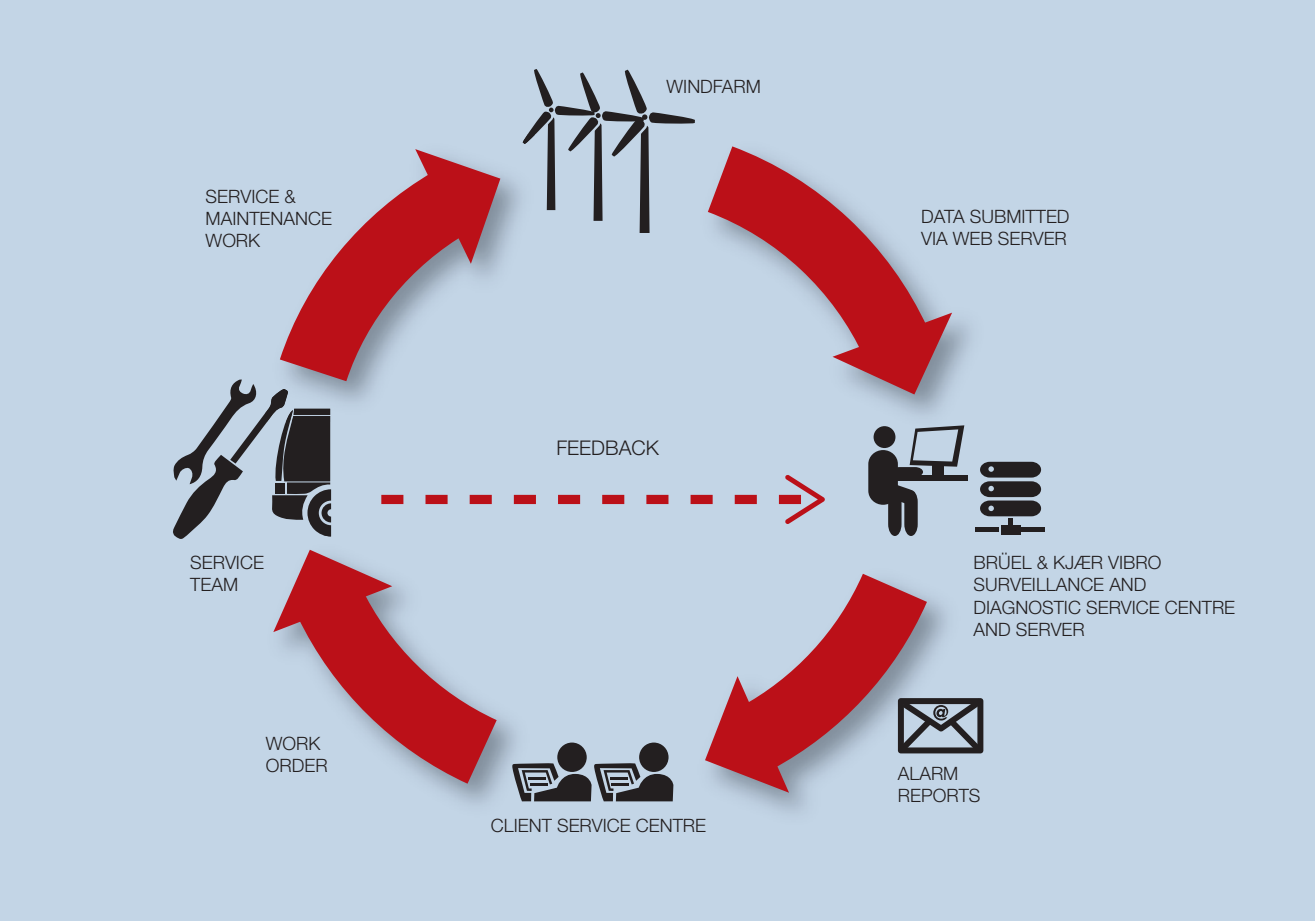
1. Hosted Brüel & Kjær Vibro Turnkey Solution

If machine monitoring is not one of your core business functions, you can still benefit from complete monitoring coverage as an external turnkey solution. Our comprehensive service includes all monitoring and diagnostic functions as well as the operation and maintenance of the monitoring hardware, software and servers. We simply deliver maintenance recommendations to your service group with ample lead-time.

★ Highlights

We take care of everything:

- Supply and commissioning of all hardware
- Fault detection and diagnostics by ISO 18436-certified diagnostic specialists
- Monitoring server and database
- Reports and recommended actions
- Firmware updates



...for cost-effective fleet-wide monitoring

2. Customer-Owned Solution

With a well functioning condition monitoring and IT group, it will be possible for you to operate and maintain your entire monitoring system and database server on your own, completely independently of Brüel & Kjær Vibro. Our **VibroSuite** system allows your vibration specialists to take care of all monitoring and diagnostic functions without outside assistance. No services are needed from Brüel & Kjær Vibro in this situation.

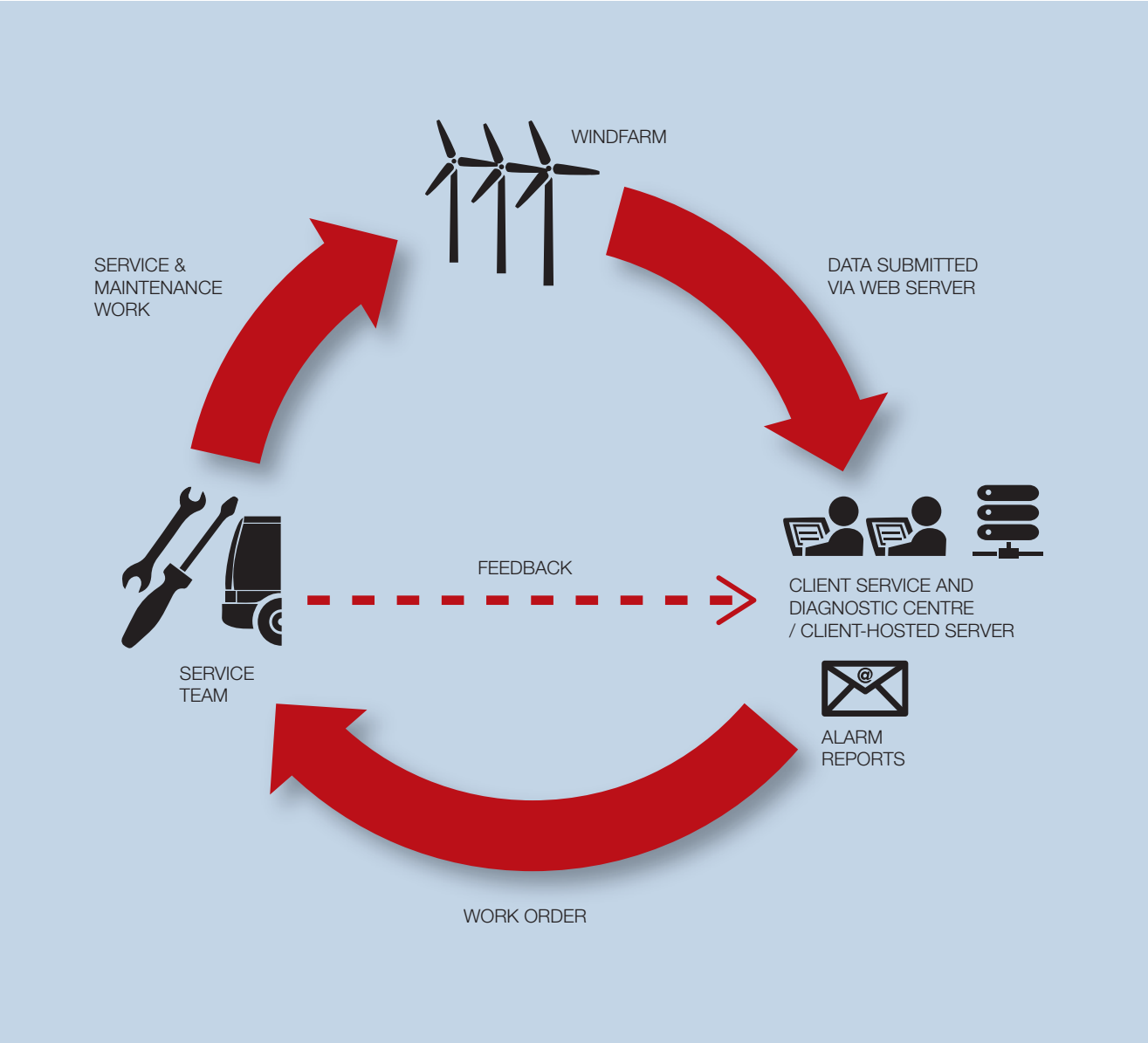
★ Highlights

You take care of:

- Installation and commissioning of all hardware
- Fault detection and diagnostics
- Monitoring server and database
- Reports and recommended actions

We take care of:

- Supply of all hardware and software



3. Customer-Owned Solution with Brüel & Kjær Vibro Services

Maybe you have the means to operate and maintain the monitoring system and database server, but are lacking the diagnostic expertise to make accurate service calls. We can provide services to help you here!

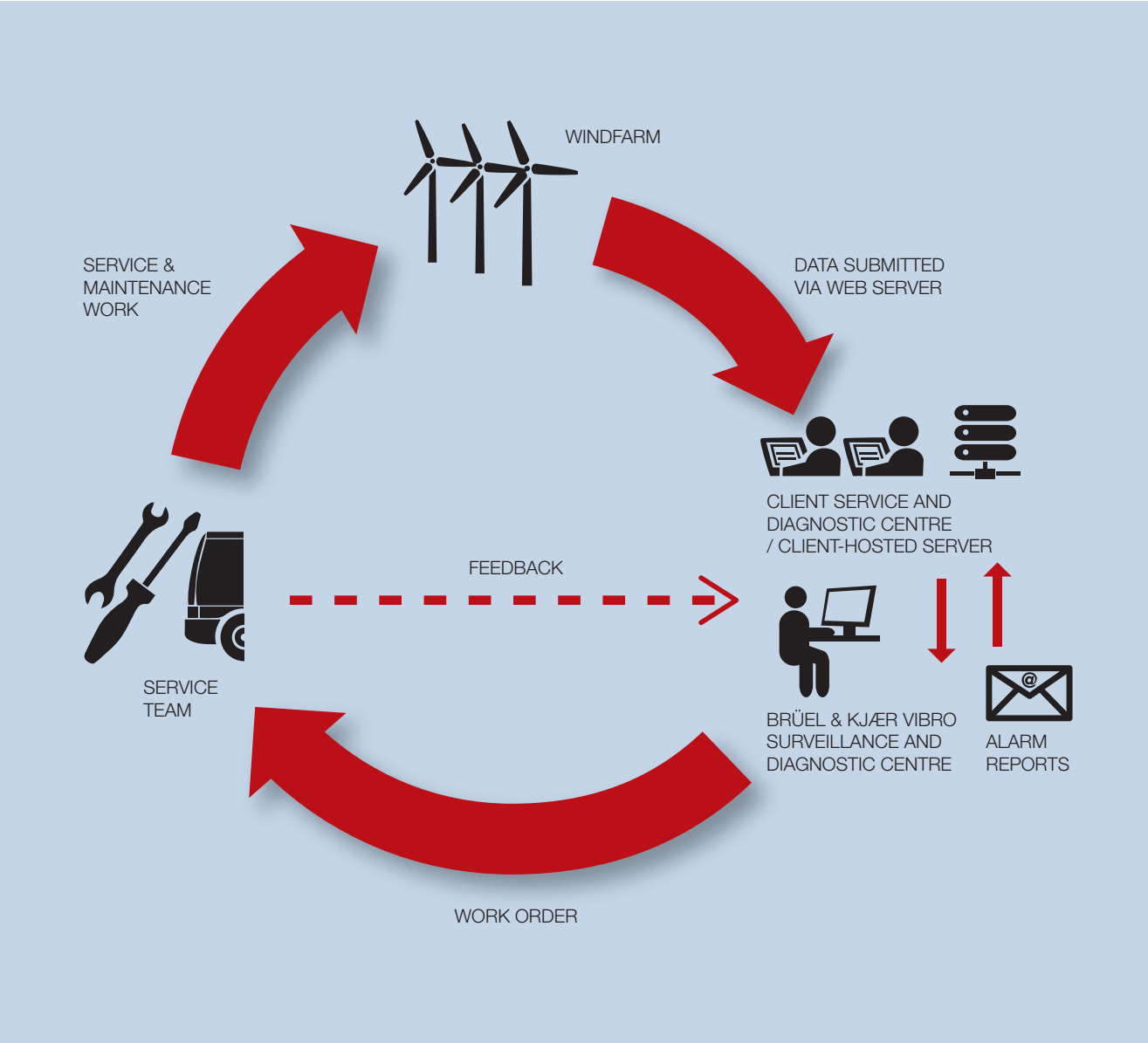
★ Highlights

You take care of:

- Installation of all hardware
- Monitoring server and hosting of database

We take care of:

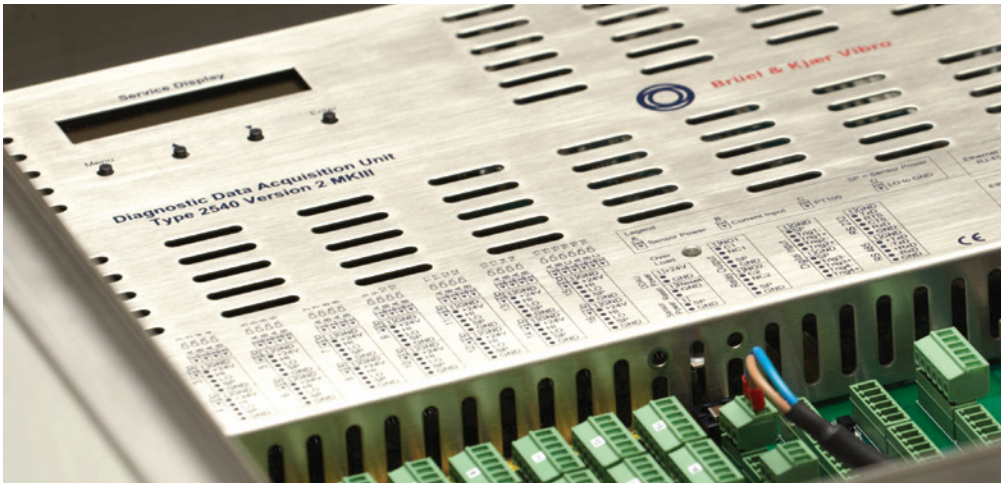
- Supply and commissioning of all hardware and software
- Fault detection and diagnostics by ISO 18436-certified diagnostic specialists
- Reports and recommended actions



Dedicated hardware for monitoring wind turbines

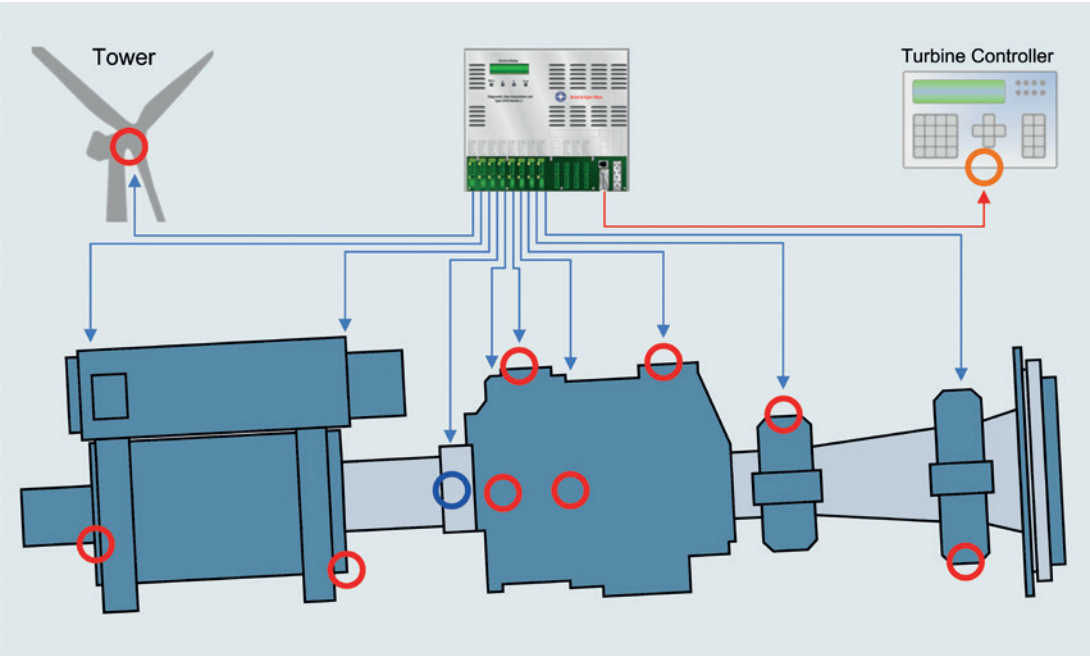
FACT BOX DDAU

- 16 channels (accelerometer, 4-20 mA, DC, speed, temperature) with synchronous capture of raw data
- LAN connection via fibre optic or RJ45 connector. Wireless via external modem (2G, 3G, 4G)
- Controller interface: LAN, MODBUS, 4-20 mA, DC
- Customized monitoring strategy by turbine type
- No park server required
- Proven reliability; more than 6,000 systems installed
- No on-site maintenance
- OPC UA and OPC DA compatible interface



The data acquisition unit (DDAU), installed in the wind turbine nacelle, is connected to a number of sensors on the drive train for detecting faults with the bearings, coupling, rotor, generator and gearbox. The tower sensors detect problems related to blades, rotor or yaw system and can be used to monitor changes in tower resonance frequency. High-resolution time waveforms from these sensors, triggered by an event, time interval or user request, are sent to the data centre for detailed analysis. Costly park IT maintenance is avoided as DDAU communicates directly with a remote data server. If required, local park servers can also be installed.

Brüel & Kjær Vibro acceleration sensors AS-062, AS-070 and AS-247 (from top)



DDAU data sources: Vibration - Speed - Controller

Dedicated software for monitoring wind turbines

Interfacing directly to the DDAU monitoring hardware, the unique **VibroSuite** software package provides market-leading alarm management and diagnostic capabilities. Furthermore, **VibroSuite** is completely client-owned, enabling all customers to host, process and analyse the data in-house.

VibroSuite is built on over a decade of wind turbine monitoring experience, and utilises the same software used by the Brüel & Kjær Vibro global Surveillance and Diagnostic Service Centres. The system efficiently avoids alarm flooding and has been designed with a high focus on the alarm handling and reporting process. This, together with a complete overview of the alarm history of the turbine greatly reduces the workload of analysis specialists.

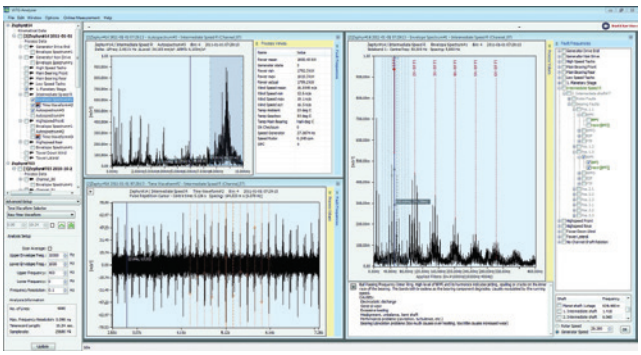
VibroSuite can be customized to the end-user's needs and capabilities, thus providing a high degree of flexibility and scalability to a number of different users. This comprehensive user-friendly solution lends itself to operators with all levels of experience, and is designed for monitoring all types of wind turbines and park sizes under varying operating conditions.

VibroSuite
Wind Turbine Condition Monitoring

VibroSuite launchpad

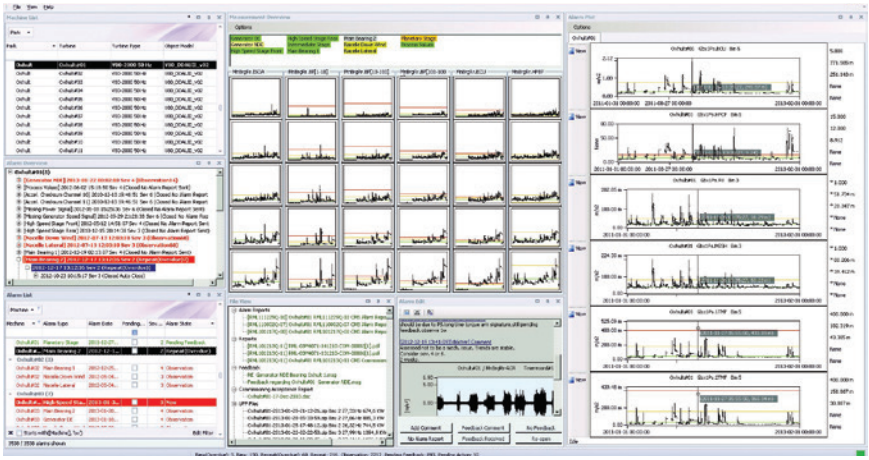
FACT BOX VIBROSUITE

- Scalable, from a few to several thousand turbines
- Early fault detection
- Alarm limits based on statistical calculations
- Data reduction by Automatic Alarm Management
- Effective health assessment and root cause analysis
- Quick reporting
- Fast commissioning by off-the-shelf monitoring packages
- One server for multiple parks
- Lifetime history of measurements, alarms and alarm handling



VibroSuite detailed diagnosis

VibroSuite alarm handling functionality



Brüel & Kjær Vibro‘s renowned services and training

Services

There is a large difference in the amount of resources and experience individual customers have for operating and maintaining their monitoring systems. Therefore it is up to service to fill the gaps and ultimately add extra value to their investment. This is what we call customer focus. Some services are monitoring system specific; others provide monitoring and analysis expertise such as diagnosis, root cause analysis and prognostics. We also provide Project Management for the implementation phase. These services are provided by a worldwide network of service engineers.

Training

We offer a broad spectrum of courses, from installation, commissioning and configuration to in-depth courses on monitoring techniques, monitoring strategy, and vibration diagnosis. In addition to our standard training courses, we also offer training packages that can be customized to our clients’ requirements. All training courses can be held locally at our customers’ premises or in one of our regional training centres.

FACT BOX PROJECT MANAGEMENT

Implementation Phases

- Sales
- Order
- Design/production
- System delivery
- On-site installation
- System commissioning
- Support and after-sales services

Our systems are installed on more than 6,000 turbines worldwide

● *Brüel & Kjær Vibro Surveillance and Diagnostic Service Centre*

What our clients say:

"We believe that using one common condition monitoring system on wind turbines [we have chosen the Brüel & Kjær Vibro DDAU system], of all of our suppliers, regardless if it is a Vestas or GE turbine will help us to standardize the system installation, data acquisition and diagnostic procedures, and will ultimately deliver significant benefits to Arise Windpower"

Liane Persson, Executive Vice President Operation, Arise Windpower, Sweden.

With over 60 years of experience in machine condition monitoring, Brüel & Kjær Vibro know the customer needs and technology well. This is our core business. We are the largest independent supplier of condition monitoring systems and diagnostic services for wind turbines.

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