



**Brüel & Kjær Vibro**



# **Uptime for Hydropower Plants**

**Compass 6000 Condition Monitoring System**

# Scalable monitoring for the hydropower market



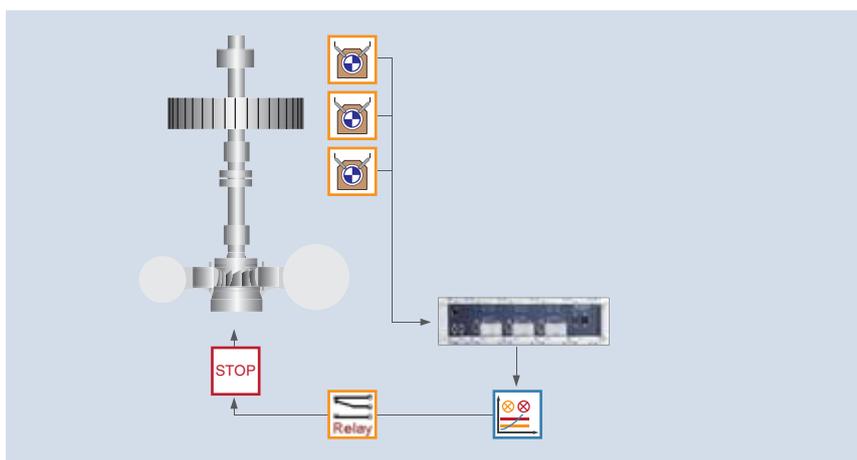
Hydroelectric power generation is playing an ever more vital role in global energy production; thereby rendering machine uptime, reliability and efficiency pivotal elements in its operational profitability. With increasing demands on operational and maintenance requirements, effectively monitoring these machines is of paramount importance. **Brüel & Kjær Vibro's Compass 6000 Monitoring System** provides a comprehensive monitoring solution for the hydropower industry that can be tailored to meet customer-specific needs.

## A monitoring solution that grows with your requirements: From protection to full diagnostics

Compass 6000 is a plant-wide system offering protection, condition and performance monitoring capability. The system was designed for scalability, thereby enabling use in both the simplest and most demanding applications. The machine protection hardware part of the system, VIBROCONTROL 6000®, can be upgraded to an advanced diagnostic system without additional monitoring hardware.

### PROTECTION

The VIBROCONTROL 6000® safety system provides reliable protection of your hydro machines with an alarm-relay reaction time of only 10 msec!

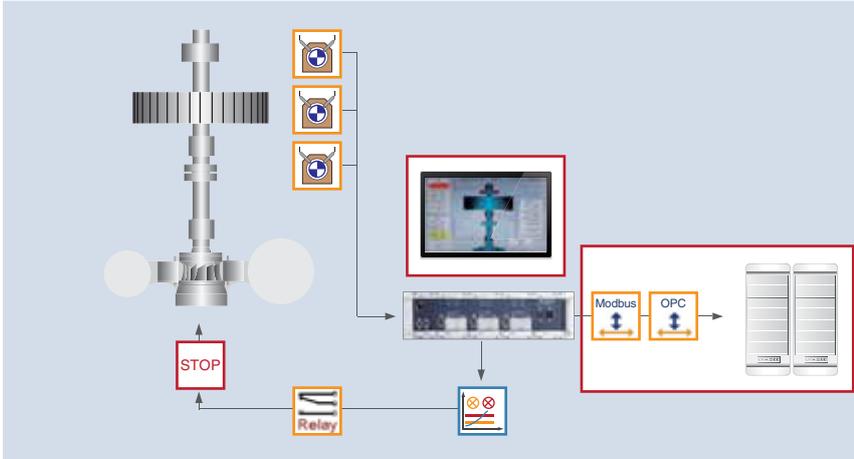


### ★ Highlights Protection

- Simultaneous monitoring of all channels
- Integrated power supply of sensors
- 4-20 mA and buffered signal outputs
- Relay outputs with voting logic
- Up to 8 sets of alarm limits for machine states
- Complies to ISO 7919, ISO 10816 and others

## PROTECTION ⊕

The protection system can be easily extended to display scalar values and alarm indication directly in the machine schematic image. This cost-effective solution gives you an informative overview on the status of your machine.

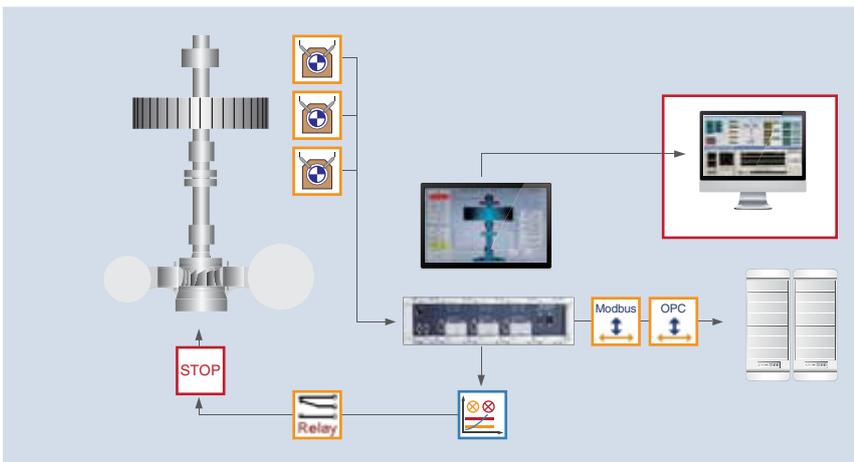


### ★ Highlights Protection ⊕

- Local and/or remote display of measurement values
- On-demand FFT, Bode and Orbit plot displays

## CONDITION MONITORING

Early fault detection and diagnosis maximizes lead time to maintenance, resulting in optimal uptime, production, efficiency and reliability. Advanced measurement techniques and a versatile database enable accurate and reliable prognosis. No additional monitoring hardware is required.

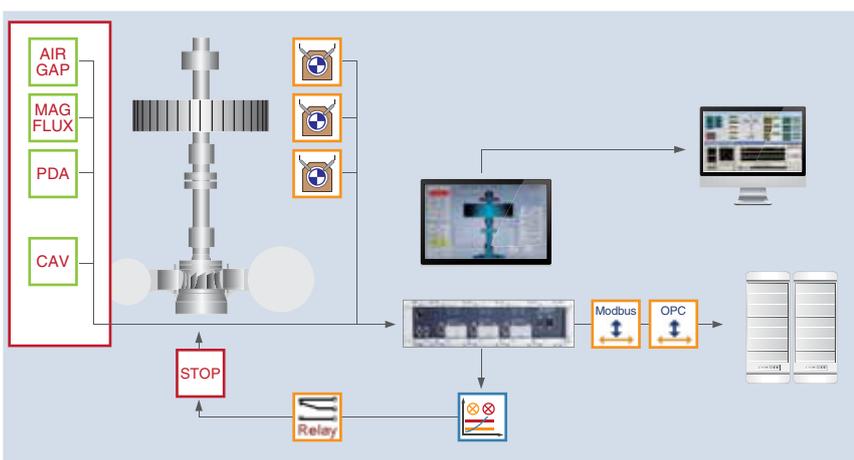


### ★ Highlights Condition Monitoring

- Database with up to 30 years trending capability
- Adaptive monitoring strategy that accounts for process conditions
- Monitoring spectra to alarm limits
- Advisor automatic diagnosis software

## INTEGRATED CONDITION / PERFORMANCE MONITORING

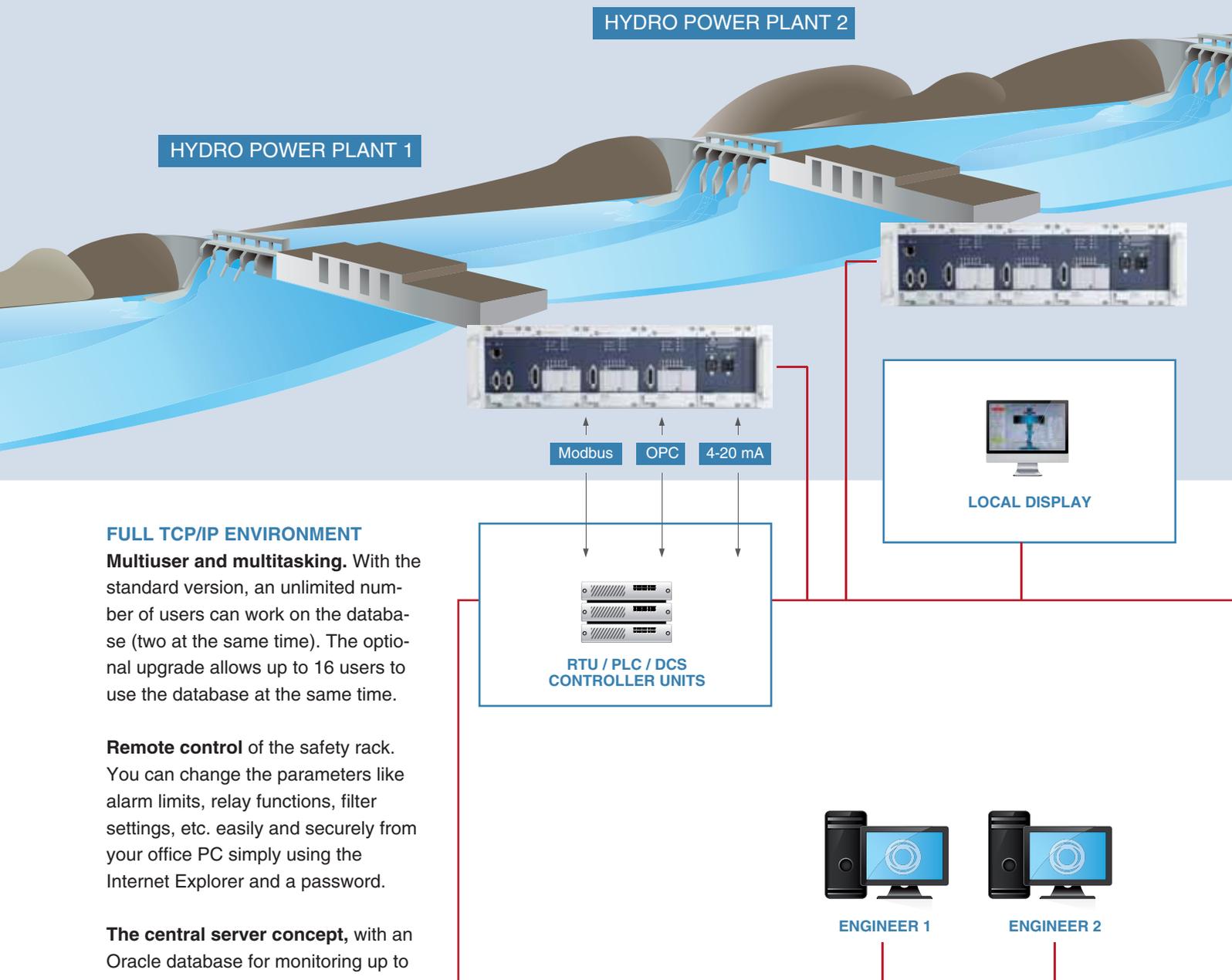
Vibration provides early indication of most developing machine faults, but when correlated with other monitoring strategies, it provides advanced actionable information. This enables effective decision support for operating your machines.



### ★ Highlights Integrated Condition / Performance Monitoring

- Monitoring and display of air gap, magnetic flux, partial discharge and efficiency in single database
- Ease of correlating vibration with other process and performance parameters
- Specialised plots for displaying process and performance parameters

# The Compass 6000 system offers outstanding networking



## FULL TCP/IP ENVIRONMENT

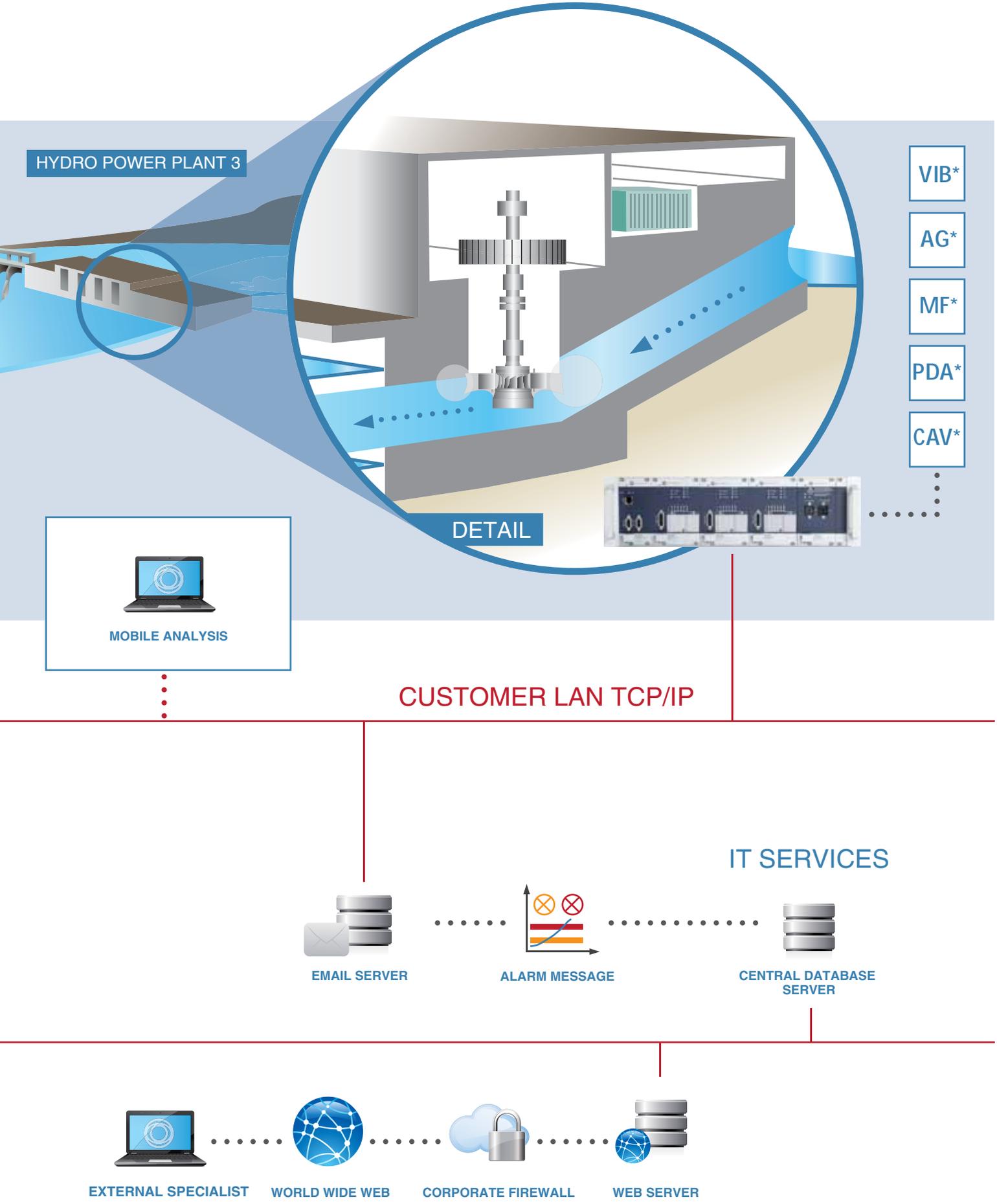
**Multuser and multitasking.** With the standard version, an unlimited number of users can work on the database (two at the same time). The optional upgrade allows up to 16 users to use the database at the same time.

**Remote control** of the safety rack. You can change the parameters like alarm limits, relay functions, filter settings, etc. easily and securely from your office PC simply using the Internet Explorer and a password.

**The central server concept**, with an Oracle database for monitoring up to 15 hydro power plants reduces capital investment and maintenance cost for your IT.

\* VIB = vibration, AG = air gap, MF = magnetic flux, PDA = partial discharge analysis, CAV = cavitation

# capability for cost-effective plant-wide monitoring



# Compass 6000: Dedicated modules for monitoring hydro power generating machines

State-of-the-art sensors and monitoring hardware complying to ISO 7919, ISO 10816 and other standards



## MONITORING MODULES

The VIBROCONTROL 6000® includes a number of monitoring modules that are designed specifically for hydroelectric generator unit monitoring. There are up to four modules and 48 measurement channels per rack. Outputs include buffered raw data and 4-20 mA signals that can be hardwired to other systems.

## COMMUNICATION MODULE

Onboard TCP/IP, Modbus and OPC communication ensure measurement and alarm information can be transferred to DCS, SCADA and other systems.

## SENSORS AND ACCESSORIES

Brüel & Kjær Vibro offers a full range of sensors which include displacement sensors, velocity sensors, accelerometers, air gap, magnetic flux and couplers for partial discharge analysis.

## MAIN HARDWARE COMPONENTS

- RC-600 Rack
- PS-610 Power supply
- CI-620 Communication module
- SM-610-A05 AG, MF and process module
- SM-610-A06 Vibration module



Acceleration sensors



Displacement sensors



Velocity sensors

## Compass software provides at-a-glance overview of machine condition

### TAG BROWSER

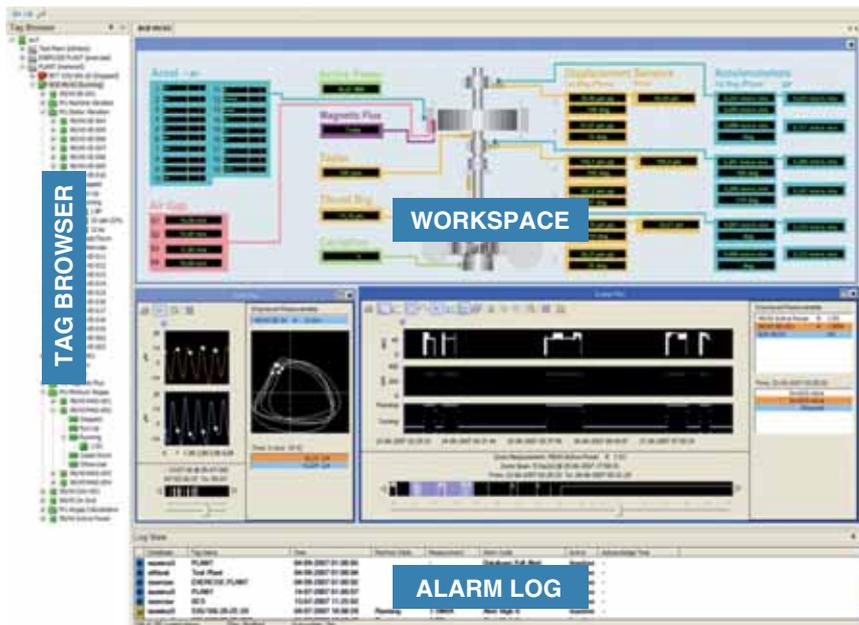
Full overview of the monitoring system status. You can navigate down to the measurement level to see alarm and setup information, and enable/disable measurements.

### ALARM LOG

Alarms are listed in real time and provide information about the location and cause. Clicking on the alarm item opens up the corresponding measurement plot.

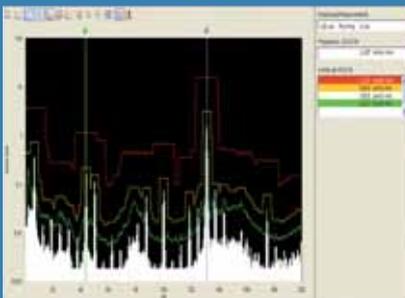
### WORKSPACE

Fully customizable with a display of measurement values on top of a machine image with several plots, which can include multiple trends, time signals, waterfall spectra and performance plots (scalar vs. scalar).

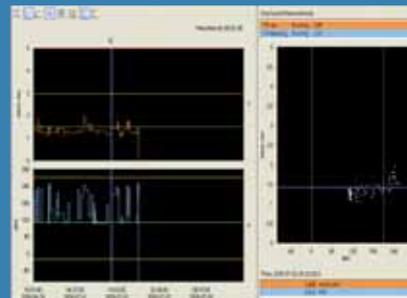


### MAIN SOFTWARE COMPONENTS

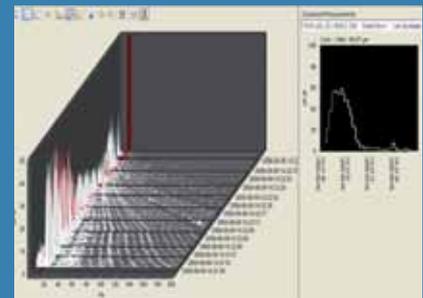
- Type 7126  
Hardware setup
- Type 7126 *plus*  
Setup, display, snapshot
- Type 7123  
Basic on-line monitoring
- Type 3160-01  
Detection and trending
- Type 3160-02  
Analysis
- Type 3160-03  
Performance
- Type 3160-04  
Advisor



Spectrum alarm profile

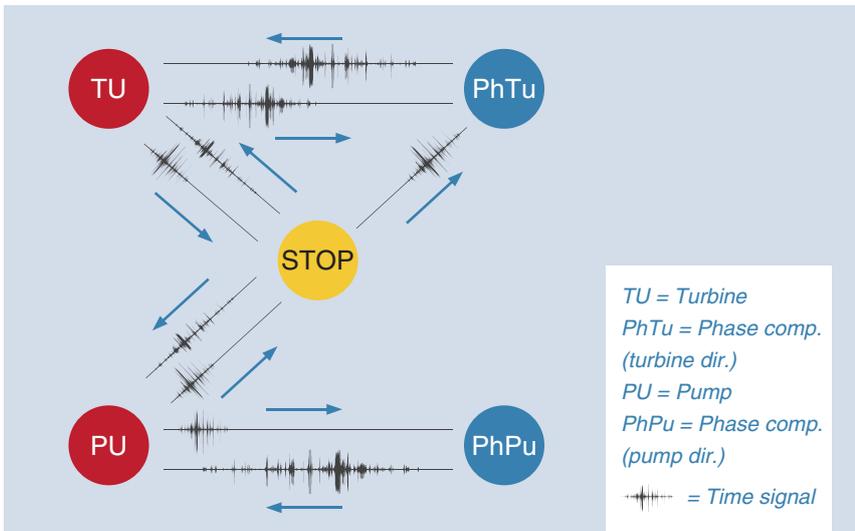


Performance plot



Coast-down 3-D spectrum plot

# Compass 6000 offers unique monitoring functionality



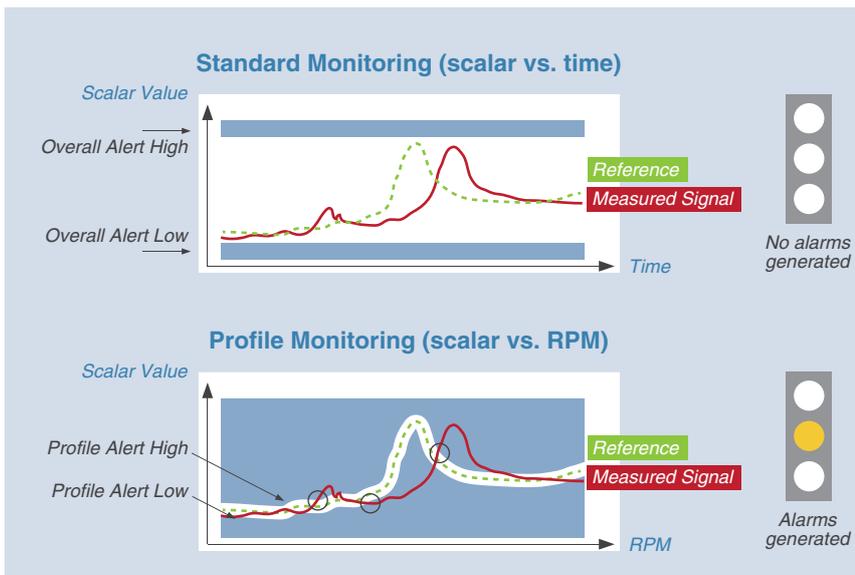
Machine state detection

## MACHINE STATE DETECTION

The vibration response of a hydro machine varies according to its speed, load and operating regime. Compass 6000 allows individual alarm limits to be set up for specific machine states, such as machine run-up, generating at partial loads, pumping and phase compensation, so potential faults can be detected earlier with less risk of false alarms.

## AUTOMATIC DIAGNOSTICS

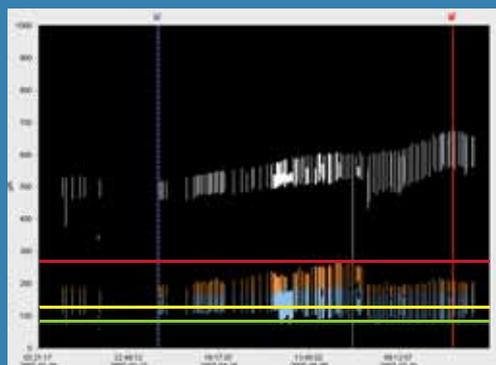
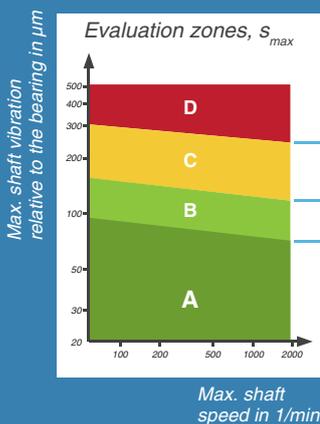
The diagnosis software Advisor scans the database to automatically detect symptoms of a developing machine fault. The neural-network algorithm assigns a probability ranking for several potential faults, which can be trended over time as the symptoms become more pronounced.



Transient machine state monitoring

## MAIN MONITORING STRATEGIES

- Machine state detection
- Measurements dedicated to process classes
- Profile monitoring
- Alarms on spectra
- Safety function with SM-610-A06



## AUTOMATIC ALARM LIMITS

VC-6000® can be set up to alarm limits according to ISO 7919 and ISO 10816. This is perfect for commissioning. The limits can be adjusted later to meet customer application requirements

# Brüel & Kjær Vibro's renowned service capabilities



## AFTER SALES

Brüel & Kjær Vibro has a global service organisation. A service partnership provides access to our responsive, highly skilled and experienced professional service engineers for system implementation, training, diagnostics, performance, system optimisation and extension. A number of individual services can be customized to your specific needs, and can be combined into a long-term service agreement that will ensure maximised production and minimised maintenance costs.

We offer a full range of services up to turnkey solutions, which includes installation and training. Our world-wide network of sales and service offices are ready to support you!

## PROJECT MANAGEMENT

We have extensive experience in working with large projects. The primary project activities include:

- **Coordination** - Ensure all aspects of the project are completed on schedule and coordinate all project activities with the appropriate members of the customer's project team.
- **Planning** - Establish and maintain a *Project Implementation Plan*. Any changes made are clearly reflected in

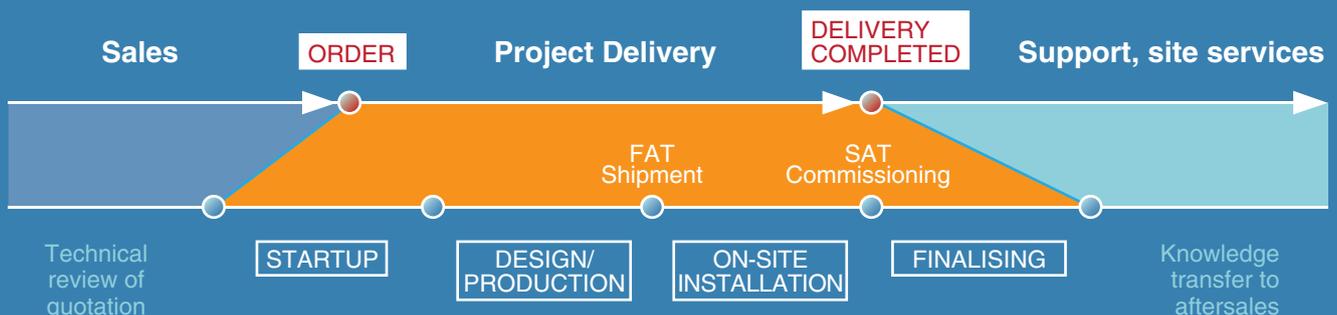
the plan and communicated to the customer. *Progress Reporting* ensures the customer is always informed.

- **Single Point of Contact** - The Project Manager is the single point of contact for all aspects of the project and coordinates with the appropriate specialists to resolve all issues.
- **Documentation** - Submit project specific information, drawings, etc.

## MAIN ENGINEERING COMPONENTS

- 3160-01-SM  
Safety database setup
- 3160-02-SM  
Diagnostic database setup
- 3160-03-FAT  
Factory acceptance test
- 6831-STD  
Standard documentation
- 6832 4 to 15  
Project documentation
- 6835-Rack  
Cabinet engineering

## THE PROJECT PHASES



# Compass 6000 application monitoring packages

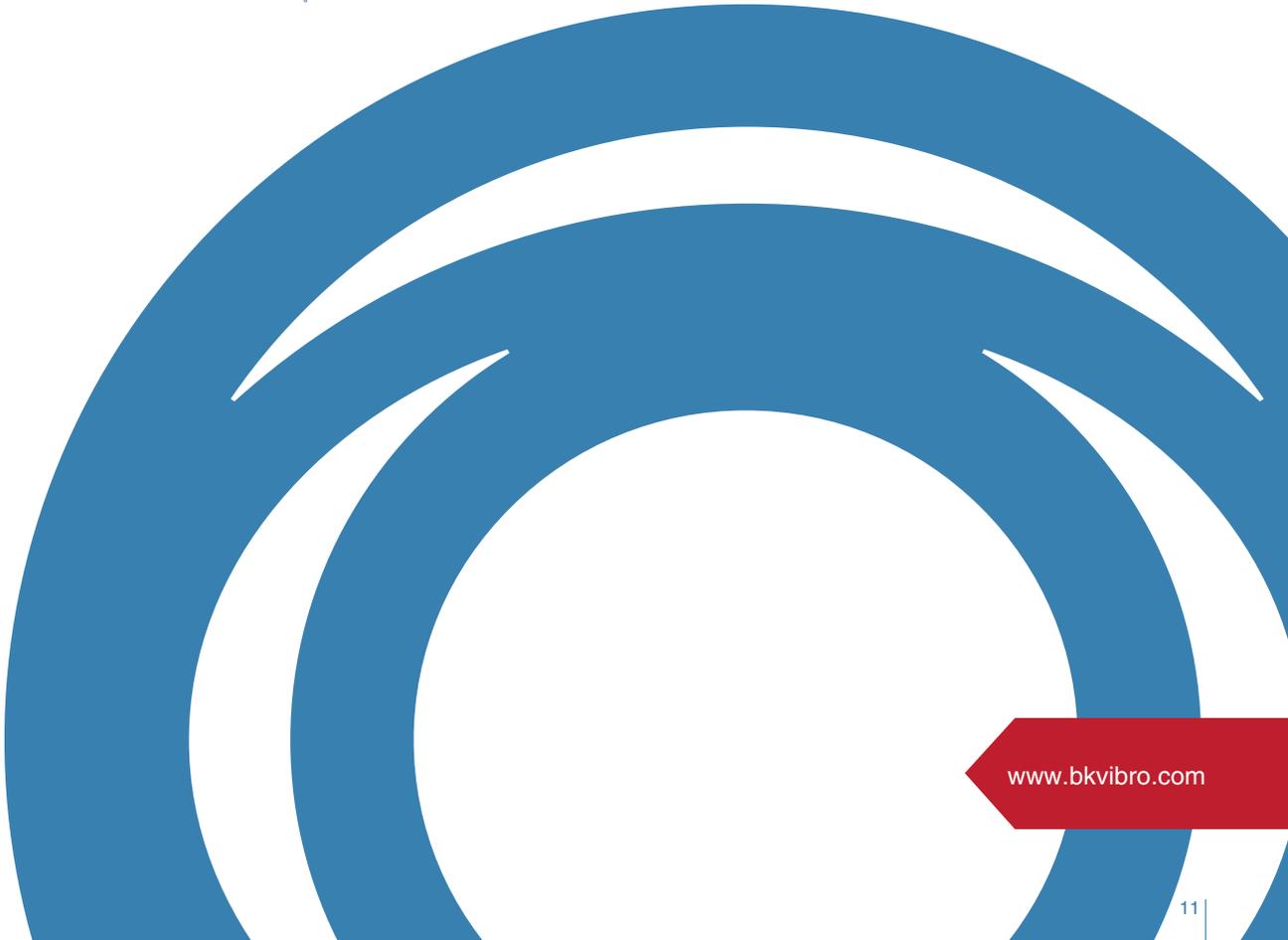
Hydroelectric generating units require specialized monitoring techniques for detecting and diagnosing potential failure modes in the generator, shaft, bearings, and the turbine. The actual techniques used for a given application depend on the size of the machine, its construction, maintenance history, operating regime and the experience of the operation and maintenance crew. Brüel & Kjær Vibro offers several standard application monitoring packages that can be customized to your specific requirements.

	Potential failure mode	VIB*	AG*	MF*	PDA*	CAV*
Mechanical	Unbalance (mech., elec., magn.)	● ● ●	●	● ●		
	Shaft bended and misaligned	● ● ●				
	Rotor rub	● ● ●	●			
	Bearing wear and oil whirl	● ● ●				
	Foundation, loose mech. parts	● ● ●				
Generator	Rotor-Stator (offset & shape)		● ● ●	● ●		
	Stator winding insulation				● ● ●	
	Generator Air Gap		● ● ●			
	Stator core/frame/winding	● ●		● ●	● ●	
Turbine	Runner clearance	● ●				
	Wicket gate and globe valve	● ●				
	Cavitation and erosion					● ●

\* VIB = vibration, AG = air gap, MF = magnetic flux, PDA = partial discharge analysis, CAV = cavitation



**Brüel & Kjær Vibro monitoring systems are installed on more than 750 hydro turbines around the world**



## Contact

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