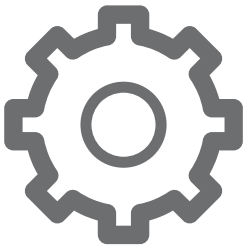
PROGNOST
INTELLIGENCE ON DUTY

Part of the Burckhardt Compression Group

PROGNOST®-Predictor

Gearbox and Bearing Diagnostic System

CONTENTS



PROGNOST® TECHNOLOGIES

proven by experience

"PROGNOST Systems was the only vendor who was able to prove the system capabilities and customer satisfaction through reference visits on site of existing customers."

Confidence. It is essential when choosing a highly complex system responsible for your most critical assets and processes. And it's what you get in abundance with PROGNOST Systems.

To be truly reliable, a full-featured monitoring system must continually evolve from a substantial number of installations over many years of field experience. No amount of laboratory testing can simulate the characteristics of many different operating environments over extended periods of time.

PROGNOST®-Predictor has an unmatched track record of real-world success. So you'll have the assurance that your monitoring system will perform as promised – and the confidence that every diagnosis it generates is accurate.

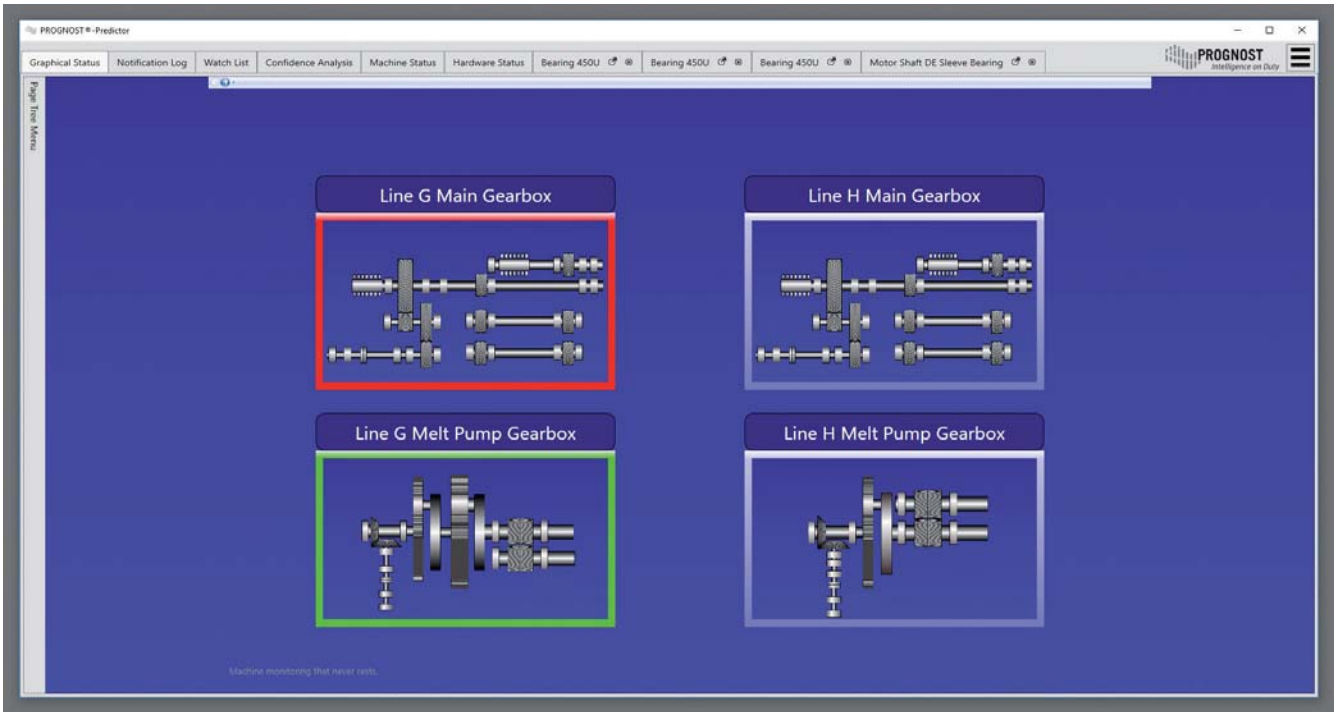
At PROGNOST Systems, we encourage you to put us – and others – to the test. Insist that your vendor documents the amount of time their system has been in actual use in operating locations. Determine how long the vendor has resolved problems and implemented user suggestions from the field in order to refine the performance of their system. Contact references. Better still, visit user sites whose environments most closely match your own. Input from vendor representatives is useful, but uncensored comments from genuine users are invaluable in deciding which system will meet your expectations.

Ready to boost your confidence? Ask your local PROGNOST Systems representative to put you in contact with the PROGNOST® user community.

PROGNOST®-PREDICTOR

in a nutshell

· Online diagnostics of gearboxes and bearings
· Component-centric analysis suite
· Patented Confidence Factor technology
· Intuitive graphical user interface



Monitor critical assets
PROGNOST®-Predictor is an automated condition monitoring system for rotating equipment that provides early fault detection for predictive maintenance by utilizing advanced diagnostics.

Complete component diagnostics
Analyses are configured specifically to the component monitored, including sleeve and rolling element bearings, gears, motors, and shafts. Results of these analyses provide health information for the individual component to support condition-based maintenance.

Patented Confidence Factor
The unique Confidence Factor parameter enables even untrained users to correctly analyze narrow band vibration signatures and identify the severity and development of component damage at a very early stage – all while minimizing false alarms.

Early warning
Early detection of machine faults allows scheduling of repairs well in advance, ensuring that all necessary parts and labor are available. You can reduce or eliminate unscheduled outages and realize the benefits of an effective predictive maintenance approach.

CONFIDENCE FACTOR

patented bearing diagnostics

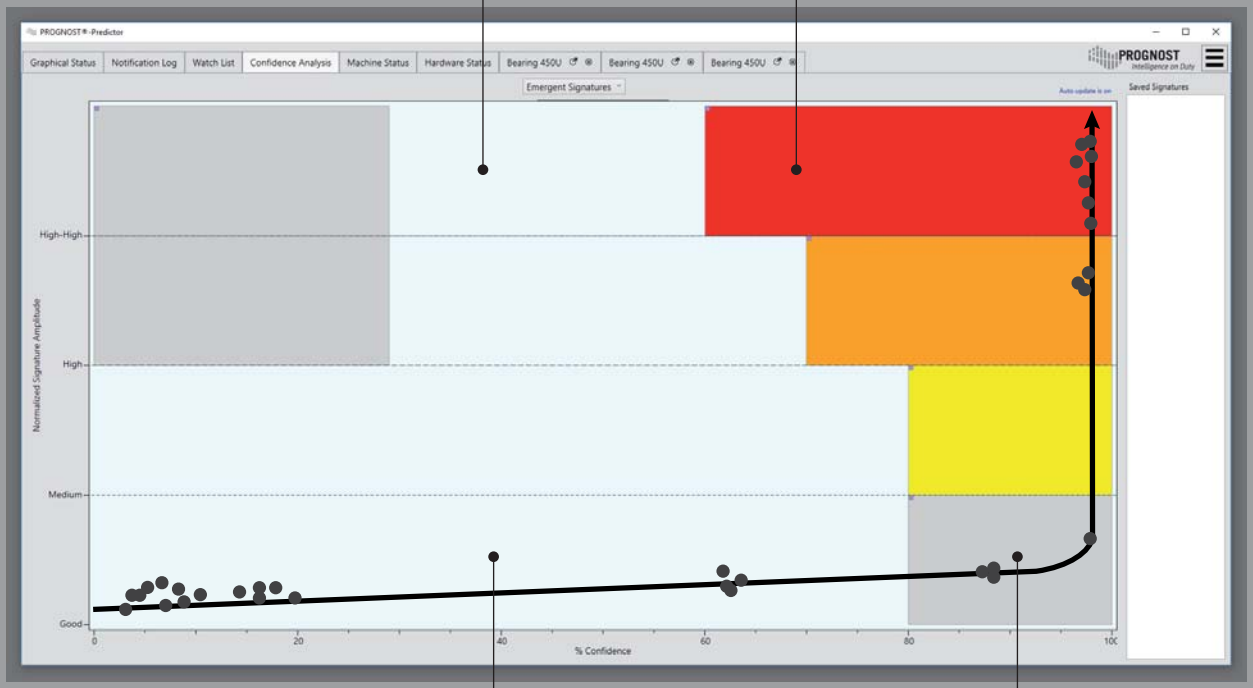
- Overview of developing bearing faults
- Two factor alarm logic
- Color code concept
- High reliability and precision

False alarms are suppressed

Analyses with high band amplitude, relative to alarm levels, but a low Confidence Factor. No alarm will be released.

True component faults

Points with high band amplitude, relative to alarm levels, and a high Confidence Factor.



Area of good condition

Low band amplitude, relative to alarm levels, and low Confidence Factor. This "good" status needs no consideration.

Thresholds need adjustment

Points with low band amplitude, relative to alarm levels, but a high Confidence Factor. These analyses, if unattended, would be missed alarms in a typical banded monitoring system since their alarm limits are too high even though a fault signature is present. Users should adjust limits to monitor upcoming failures earlier.

The Confidence Factor and built-in Two Factor Alarm logic have been developed to:

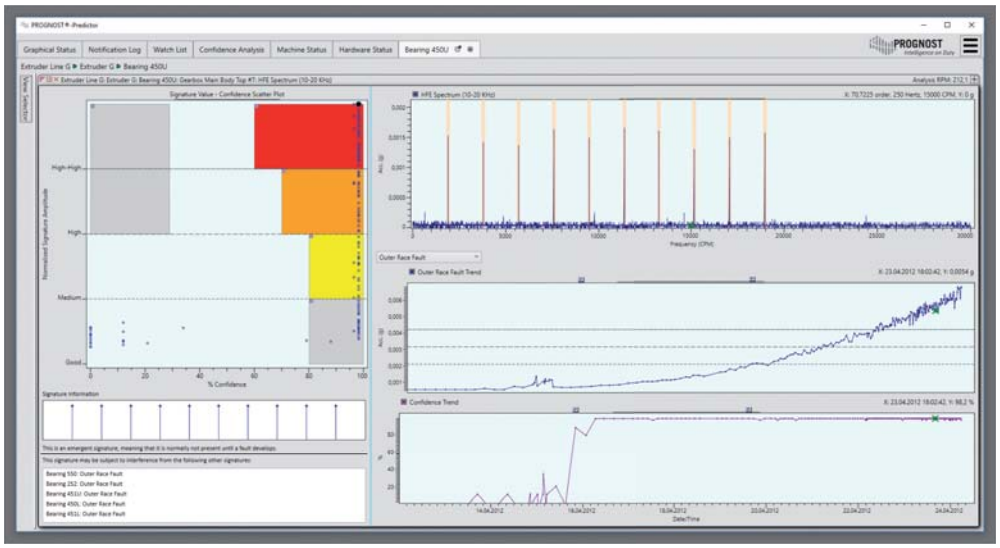
- manage hundreds of analyses results in one view
- identify critical developments as early as possible
- prevent false alarms

The normalized band amplitude is plotted vertically and the Confidence Factor horizontally. The plot is populated with a collection of amplitude/Confidence Factor pairs.

The plot quickly shows if a significant signature is present and if the amplitude is larger than normal, indicating that a component fault is developing.

A typical trajectory of a developing fault begins in the lower left quadrant in the "No defect region," moves right as the confidence and signature grows through the "Early fault region," and then moves up as the fault progresses in severity, as indicated by growing amplitude.

Low Confidence Factor despite of high band amplitude: These amplitudes do not belong to the failure represented by the bands in the upper spectrum since only a few peaks match with this failure pattern.

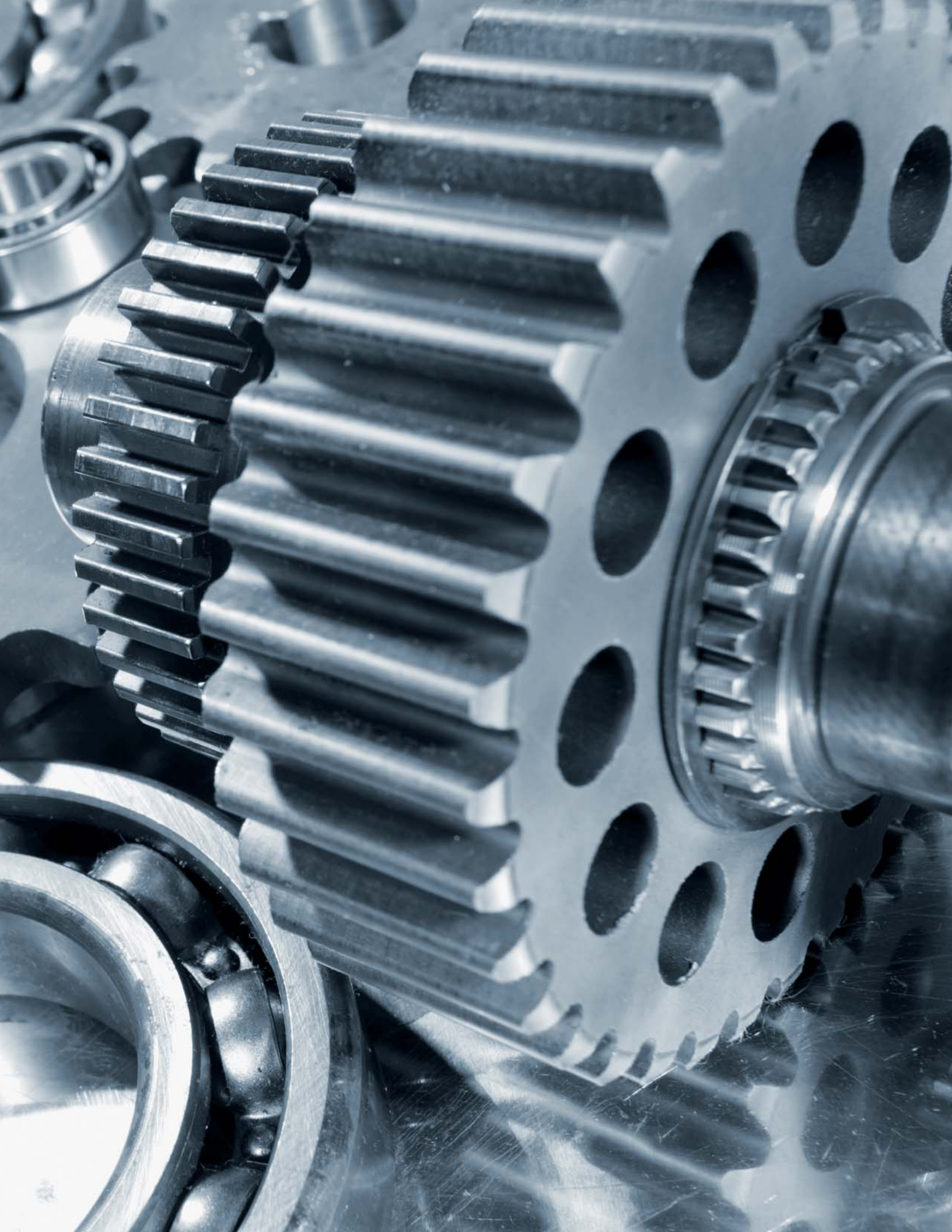


High Confidence Factor and high band amplitude: This condition results in an alarm and the component being identified in red color.

All bands of the pre-defined fault frequency show matching peaks inside the spectrum.

Users can select trend entries from the amplitude trend (center right), Confidence Factor (lower right) or even from the Confidence Scatter plot (left) – the corresponding spectrum will open automatically.

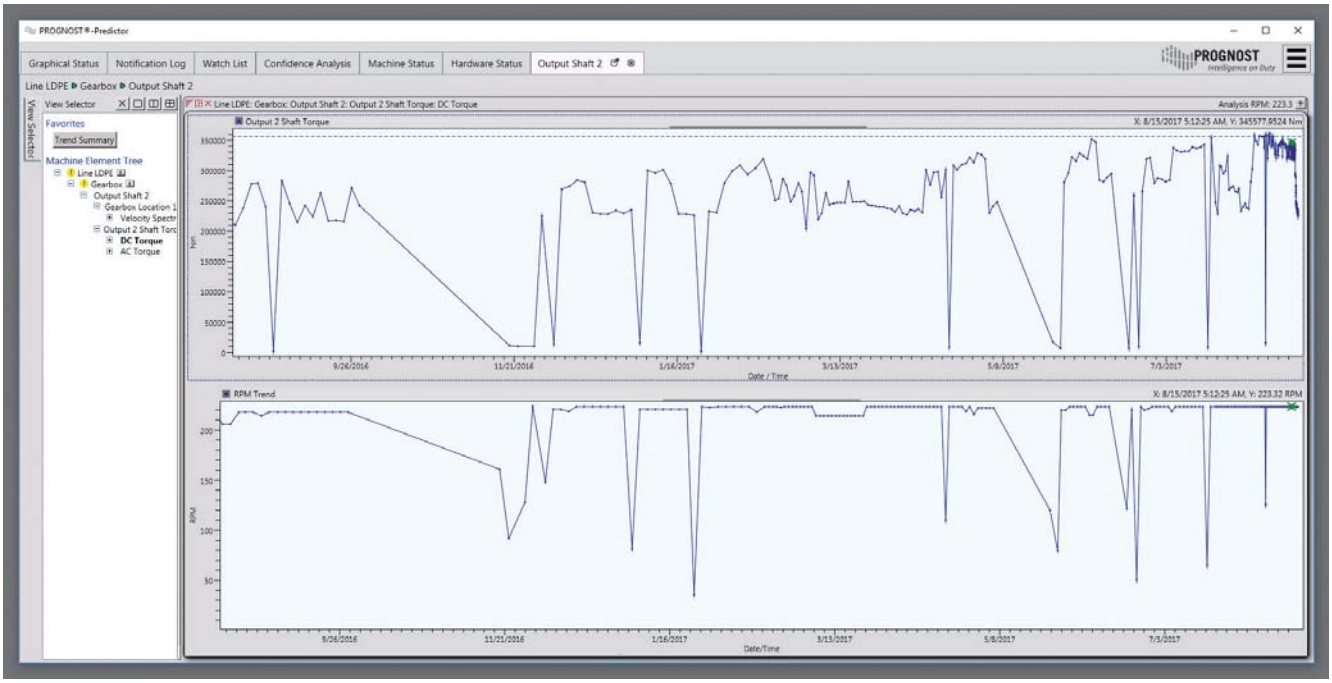
This sample presentation is specfic to the pre-defined failure mode "Outer race fault" and the selected component "Bearing 450U."



TORQUE MONITORING

diagnoses of gearboxes and shafts

· Detects changing viscosity
· Identifies feed impurities and mechanical failures
· Helps troubleshoot friction couplings



Trend plots of output shaft torque (above) and machine speed (below). Critical torque events are clearly visible.

Detect and diagnose critical torque events
Monitoring torque event signals allows you to detect impending issues on driven equipment, such as shaft cracks, extruder screw collisions, or process deviations.

Material impurities, discontinued feed, and extruder screw collisions are some of the causes of unexpected critical torsional forces. Experience shows that large gearboxes, such as those in extruder lines, call for gapless monitoring of these forces to detect impending failures and avoid costly secondary damage.

Transient torque events may excite shaft torsional modes that can lead to large torque fluctuations. Torque transients cause strain on the shaft that possibly leads to cracks. PROGNOST®-Predictor detects these transients, providing warning that shaft strain is occurring.

Transient torque monitoring also helps troubleshoot couplings with flexible shaft connections, such as friction clutches. These couplings are designed to protect the gearbox by releasing on overtorque transients. Sometimes the release setpoint is too low and the coupling releases during normal operation. Having a torque time waveform during a slippage helps calibrate the clutch setpoint and assists in performing root cause analyses for intimate process understanding.

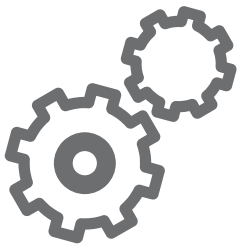
Torque analysis can also be applied to other critical gearboxes applications, such as vertical roller mills in the cement industry.

Data Acquisition and processing
The digitized torque signals are saved with a configurable sample rate.

PROGNOST®-Predictor computes:
- Absolute maximum torque
- Peak-to-Peak torque
- Average torque
- Maximum deviation and minimum deviation (difference between the maximum / minimum and average torque signal over a one-second period)

The event criteria are applied to these validation values. When any event criterion is met on any channel, the waveform data for all signals will be extracted from the buffer based on the pre and post trigger times and saved in the database for later review.

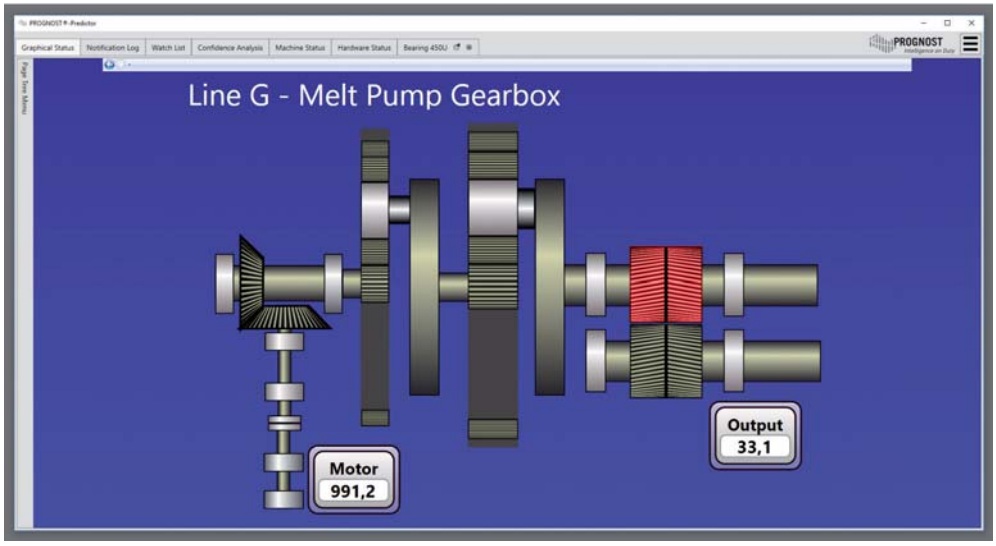
A user-initiated manual event can be triggered at any time and external hardwired triggers can also initiate an event.



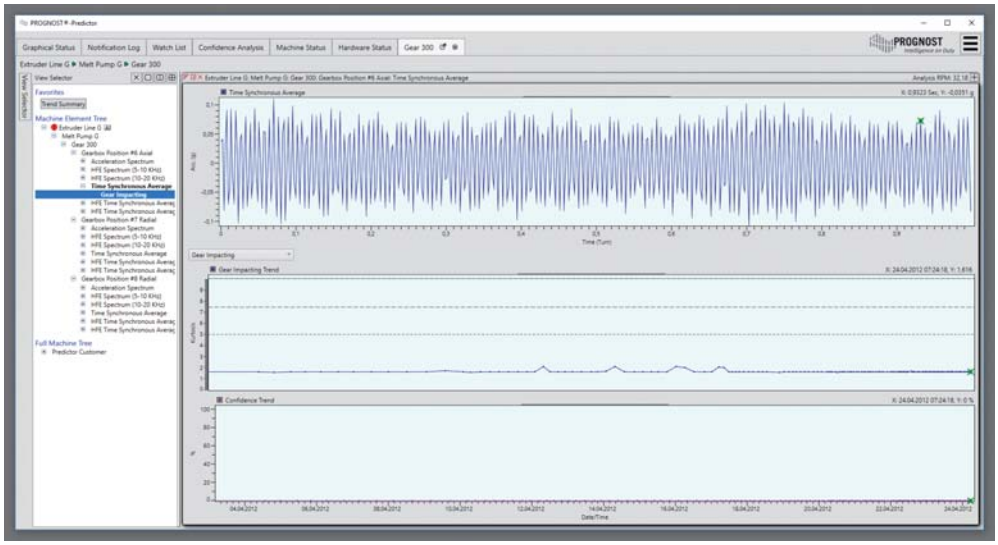
PROGNOST®-PREDICTOR

gear vibration imaging

· Ultimate method of detecting gear faults
· Pattern recognition



Users check the status of each component through a series of graphics. Components in an alarm state change color to indicate Warning, Alert, and Alarm.



Gear Imaging isolates the vibration generated by each gear in the gearbox while rejecting interfering vibration. Damage to an individual tooth will produce localized high-amplitude peaks.

Gear vibration imaging is the ultimate method for detecting gear faults. Time synchronous averaging of waveform data and further filtering methods isolate the vibration frequencies produced by each gear tooth as it passes through mesh, while eliminating noise and vibration generated by other mechanical components.

Statistical pattern recognition methods are used to identify and quantify these excessive vibrations and alarm when developing faults are detected.

This method is superior to standard spectral analysis techniques because the energy from the fault is localized to a particular region in the vibration image.

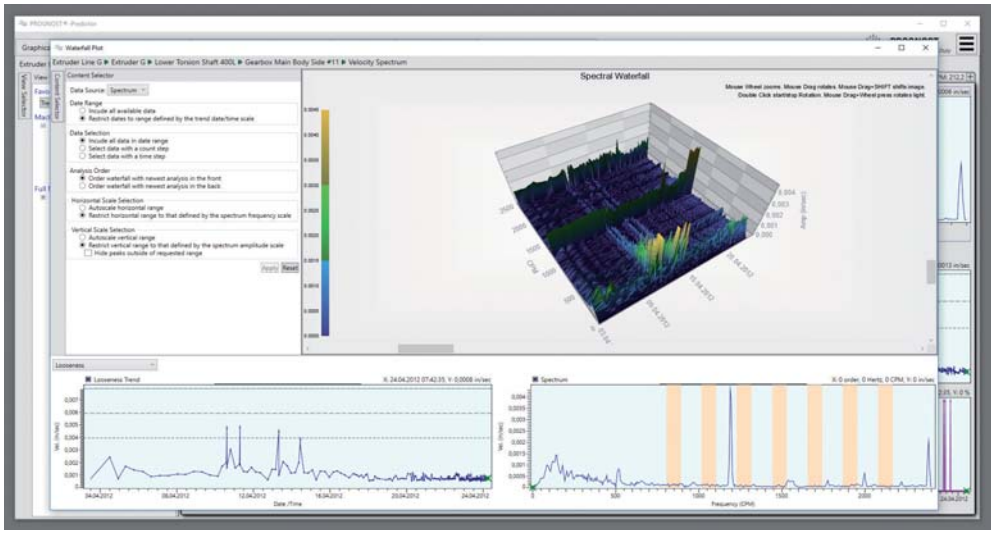
Gear vibration imaging even has the power to evaluate the condition of individual teeth, allowing a focused visual inspection without guesswork and detecting developing gear faults much earlier than with spectral methods.

MONITORING SLEEVE BEARINGS

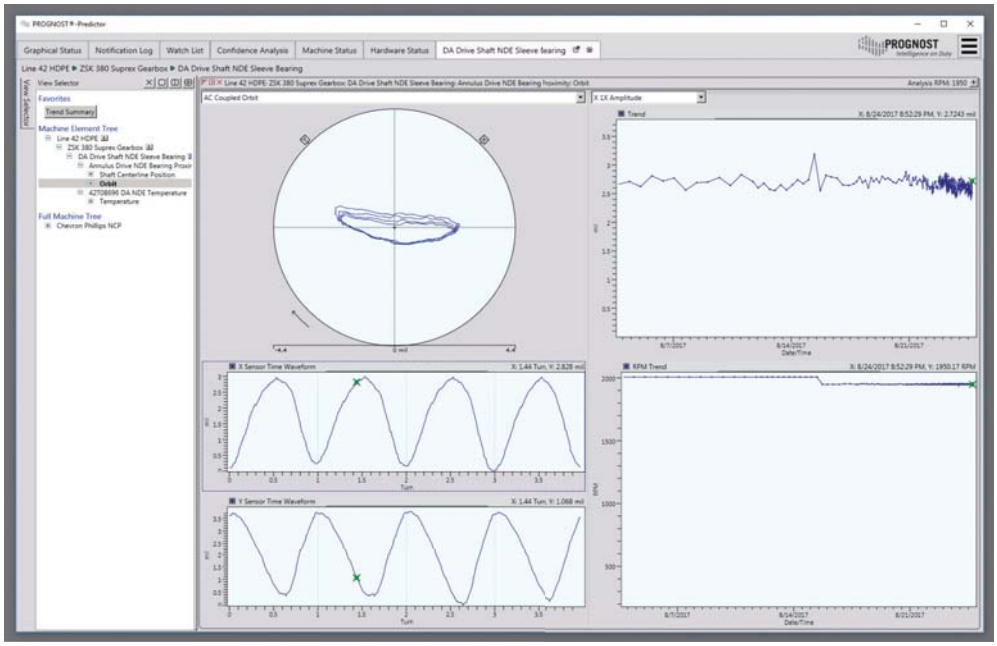
early detection of unacceptable wear

· Detection of sleeve bearing defects
· Assignment of failure patterns

Detection of imbalance failure pattern with trending of the Confidence



3D plot of velocity spectrum



Orbit analyses:
These analyses are used for sleeve bearings. It saves startup and coast down events and steady-state operational data.

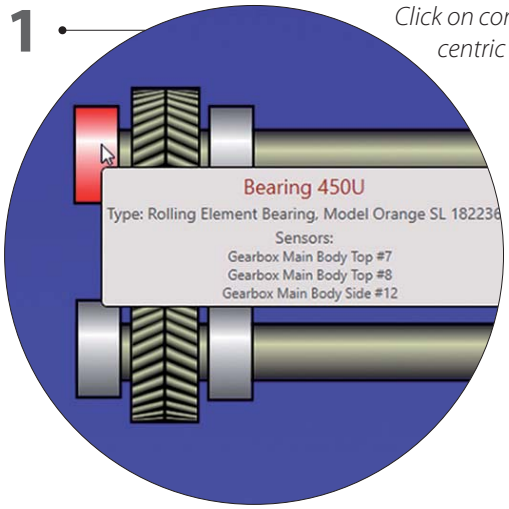
VISUAL ANALYSES SUITE

plotting and analyses tool

· Analyses of data and comparison to historical data
· Alarm logbook
· Individual component watchlist
· User notifications

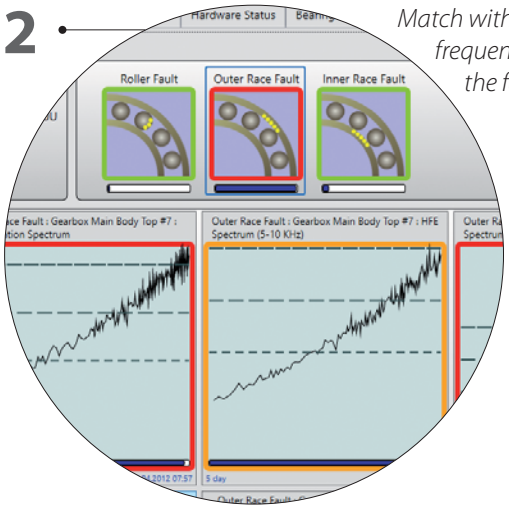
1

Click on component-centric machine status



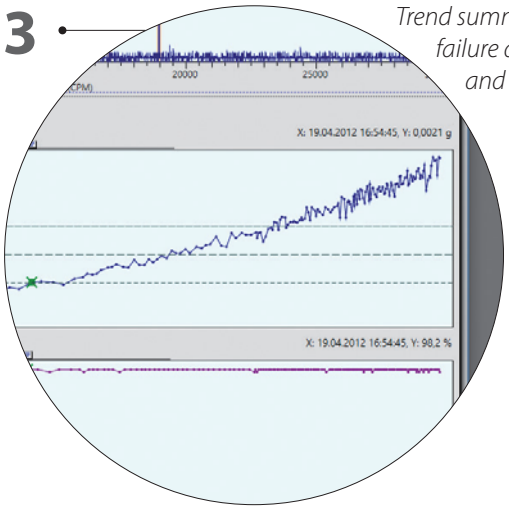
2

Match with fault frequencies indicates the failure mode



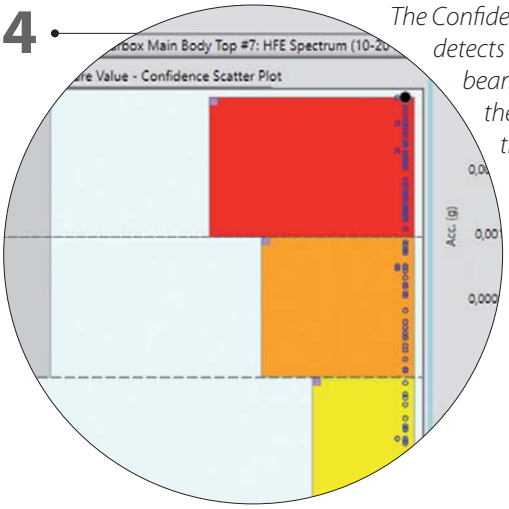
3

Trend summary displays failure development and Confidence



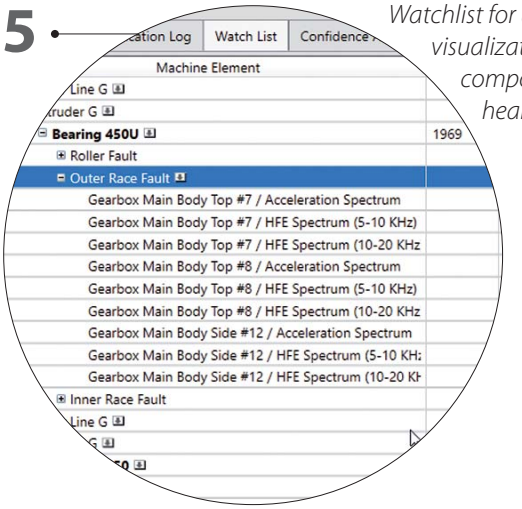
4

The Confidence Factor detects developing bearing faults before the amplitude trend increases significantly



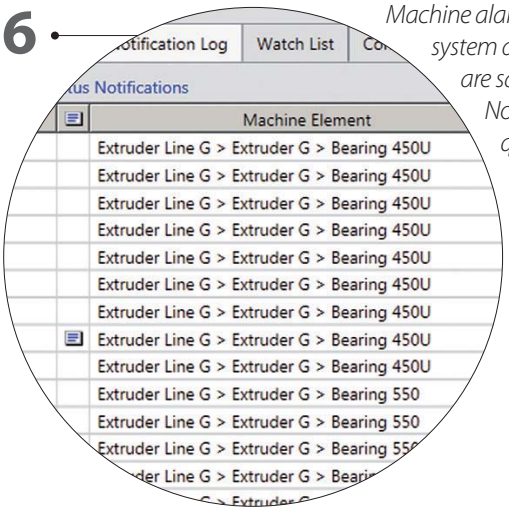
5

Watchlist for user-friendly visualization of component-oriented health status



6

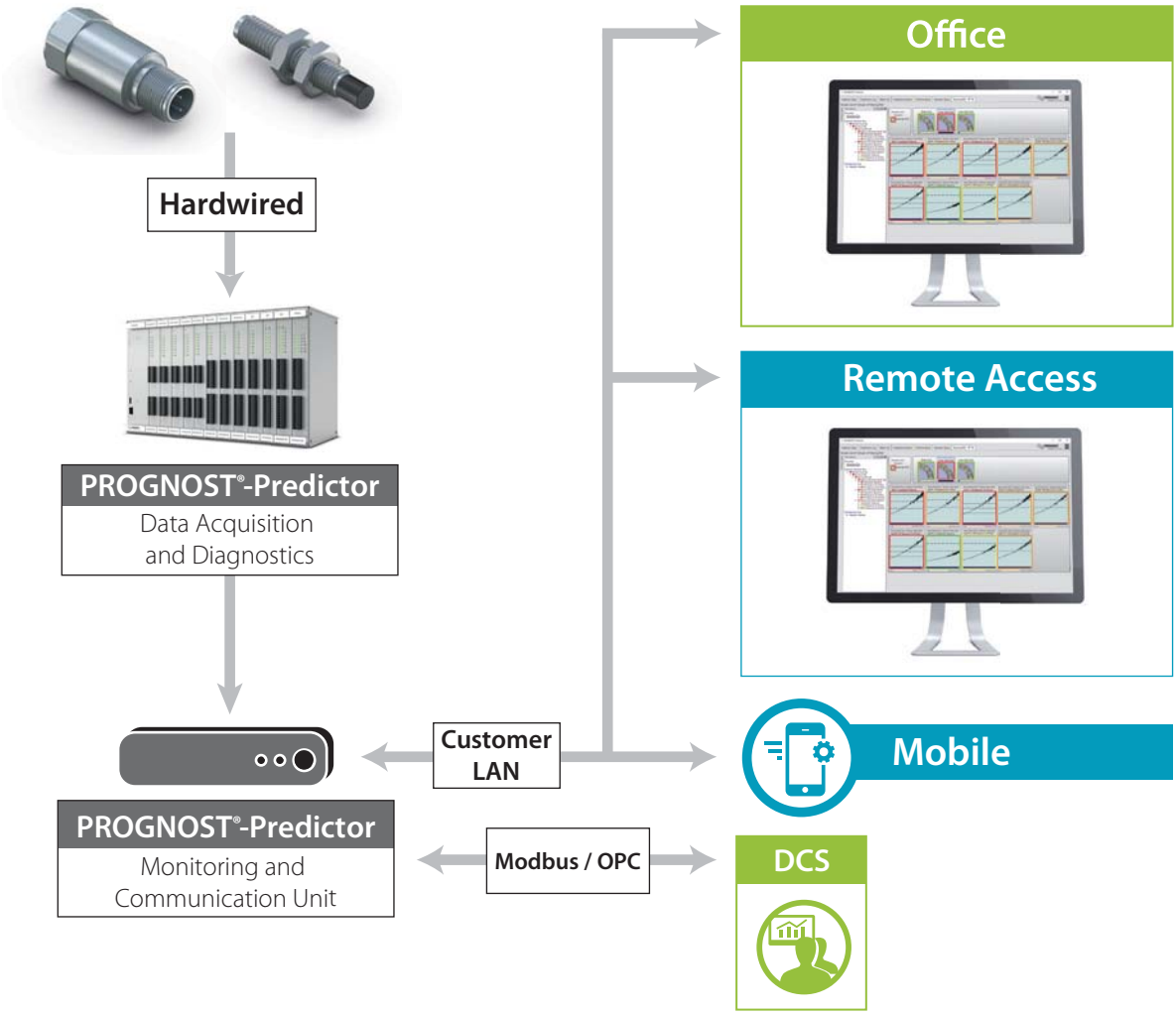
Machine alarm events and system diagnostic events are saved in the Notification Log for quick and easy review



PROGNOST®-PREDICTOR

system architecture

· Standard TCP/IP (LAN) communication
· Continuous self-diagnostics
· Alarming via relay output
· Remote access



Architecture
Communication between the data processing unit, server, customer DCS and workstations is accomplished via TCP/IP (LAN) connection. An available OPC server provides an alternative.

PROGNOST®-Predictor consists of a rack holding one controller card and up to 12 additional I/O cards which interface to all common sensor types (accelerometers, proximity probes, speed pickups, output relays, etc.).

Self-diagnostics are continuously performed on all cards and sensors:
- Open loop, short circuit or unstable bias (accelerometers)
- High/Low/Range limits

The integrated high-performance controller card uses a field-programmable gate array with 768 digital signal processing cores, allowing it to perform high-speed parallel processing.

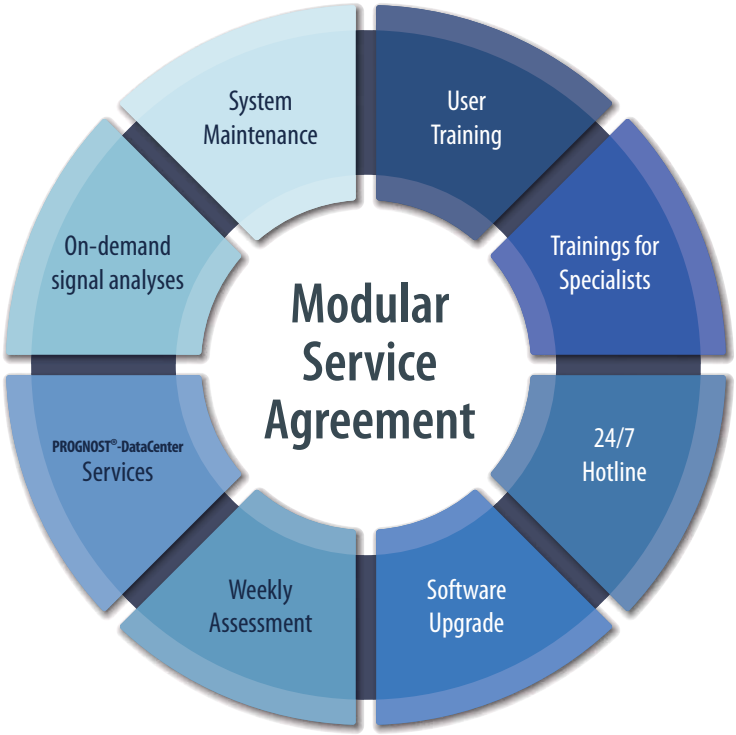
Simultaneous data collection and signal FFT analyses for all channels provide highly reliable failure indication and trend information.

Alarms and warnings can be transmitted via relay output or directly via OPC/MODBUS server link.

Remote access and support
Expert support is available from PROGNOST Systems either on-site or by remote connection. A highly skilled team of service engineers with long-term experience in remote data analysis is available to provide 5/10 or 24/7 online support.

CUSTOMER SUPPORT

24/7 Lifecycle support



User Seminars
- Initial Users Seminars
- Advanced Users Seminars
- Seminars for specialists

Assessment of machine condition
- Weekly service to ensure nothing is overlooked

Individual data analyses
- Evaluation of data, analyses and system messages to outline possible failure scenarios
- Recommendations for maintenance actions

Machine condition reports
- Documentation of machine condition trends
- Serves as a basis for long-term maintenance planning
- Includes incident evaluations by experts and recommendations for machine overhauls

Software Upgrades
- New signal analyses
- Innovative measuring methods (e.g., torque)
- Enhanced GUI user friendliness
- Extended failure pattern database

Phone hotline 10/5 or 24/7
- Remote access to your system
- Immediate support
- Data interpretation
- Verification of your own diagnoses
- Second opinion prior decision making

Imprint

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