

3500 series

Machinery protection system

Bently Nevada Asset Condition Monitoring



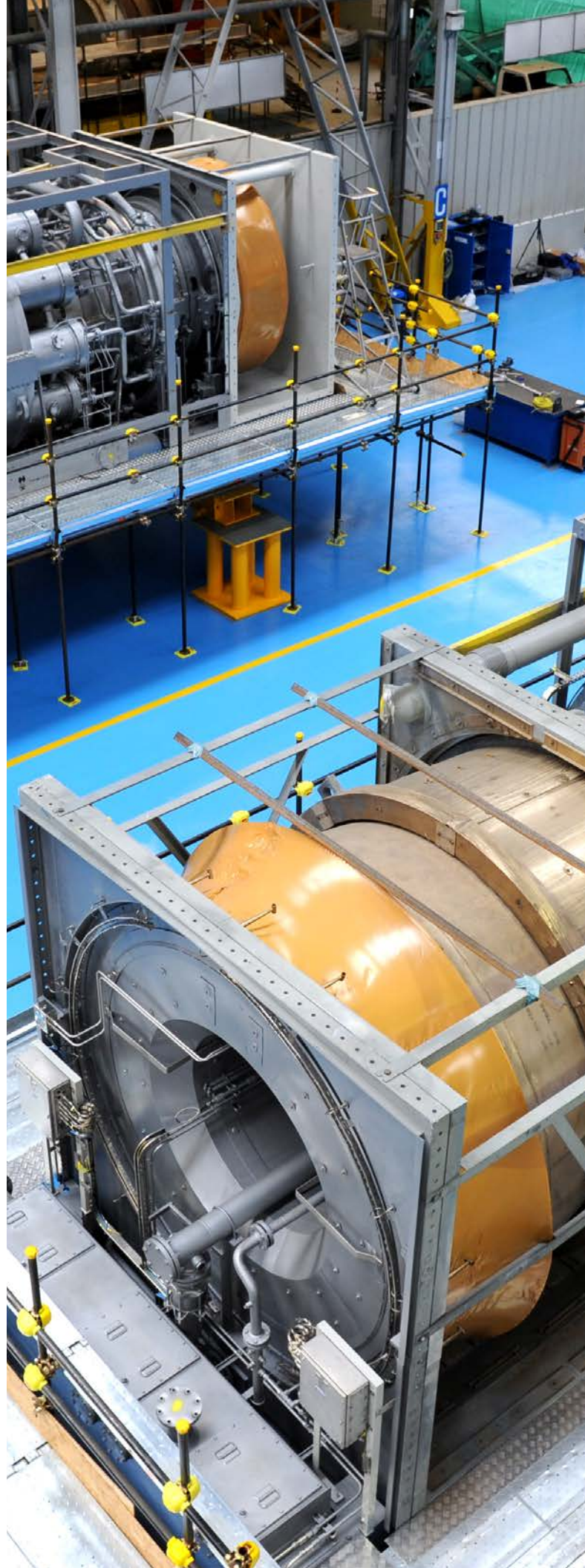
Why protect and monitor?

Whether generating power, compressing and pumping fluids, or driving process equipment, industries rely on critical machinery every hour of every day. In these settings, machinery failure isn't just inconvenient, it can be catastrophic. While repair costs alone can be staggering, the partial or even total loss of production resulting from critical machinery failure – sometimes worth millions per day – can mean the difference between profit and loss for the entire year. With so much at stake, mechanical condition monitoring is more than just a good idea, it's a necessity.

Continuously monitoring critical asset parameters such as vibration, temperature, speed, and numerous other condition indicators is a proven method for anticipating and preventing mechanical failures – proven in tens of thousands of industrial facilities around the world by delivering tangible benefits such as:

- ✓ Improved protection from catastrophic failures
- ✓ Better machinery reliability/availability
- ✓ Fewer process interruptions
- ✓ Enhanced maintenance/outage planning
- ✓ Lower maintenance and repair costs
- ✓ Longer intervals between outages
- ✓ Reduced insurance premiums

And when it comes to protecting and monitoring critical machinery, one name has proven itself above all others: Bently Nevada[†].



Why Bently Nevada Condition Monitoring?

Bently Nevada machinery protection and monitoring systems span more than a dozen different models deployed during the last 60 years. Combined, they comprise the largest installed base of permanently installed transducers and monitoring channels in the world. It's a position of trust that has been earned over more than six decades of learning, refining, and improving our solutions to meet the industry's most demanding applications. Applications that require the highest integrity. Applications where false trips or missed trips simply cannot be tolerated.

It's not just our products, it's our people. Our reputation for the highest quality, best value in the industry is born of a culture that "takes excellent care of our customers." When you choose our condition monitoring solutions, you get it all: the best people, the best products; the best service; the best solutions – together generating the best value.

For more than half a century, Bently Nevada products have been world-renowned as the standard by which all others are measured. Because after all, with so much riding on your machinery, why trust anyone else?

Experience

With more than six million transducers and monitoring channels installed worldwide, more end users trust their machinery to Bently Nevada's continuous monitoring systems than anyone else. We are also the supplier of choice to nearly every major machinery manufacturer in the world.

Technology

Today, although our products number in the thousands, we never rest. Each year, tens of millions of dollars are invested in expanding and improving our technology with the purpose of better serving our customers. Better technology that creates better value is our passion.

Technical support

Behind everything we deliver, you'll find our unwavering commitment to provide the best technical support to our customers. No matter where in the world you are, or what time of the day, a knowledgeable professional with technical experience is standing by 24/7 to assist you with answers to your technical questions. We also have the ability to supply many emergency parts and services after traditional working hours. Additionally, our state-of-the-art knowledge database tracks every support call, every question, and every answer, allowing our global team to deliver faster, more complete support than ever before.

3500 – Simply the best

Beginning with the 5000 Series in the 1960s, we've introduced seven successive generations of highly successful monitoring platforms. Today, that experience is embodied in the most advanced, powerful, and reliable system we have ever offered: The Bently Nevada 3500 Series Machinery Protection System.

Certified

The 3500 is designed to fully comply with the American Petroleum Institute's Standard API 670, the world's most widely used specification for machinery protection systems. For reciprocating compressor applications, the 3500 meets API 618 requirements as well. It can also be ordered with DNV and Class NK certifications for maritime applications such as offshore platforms and ship propulsion. And, when used as part of a safety instrumented system, third party Functional Safety Certification can be supplied for applications requiring up to Safety Integrity Level (SIL) 2. In addition, the 3500 is approved to meet relevant Canadian Standards Association (CSA), Factory Mutual (FM), GOST, ATEX, and CE requirements.

Bently Nevada follows closely the development and changes in these standards and continually demonstrates our capacity and commitment to be in sync with them as they change and evolve. This continued focus and investment in regulatory excellence ensures our customers don't have to worry about deploying a non-compliant solution that may later require significant update or replacement. A compliance miss has the potential for exposure to not only catastrophic consequences, but also can lead to fines from governments and inspection agencies as well as impact on insurance rates and reputation. Baker Hughes Bently Nevada is committed to continued compliance leadership and full regulatory excellence.

Reliable

We understand that our systems are routinely used not just for indication, but to provide auto-shutdown protection. That's why – even in simplex mode – the 3500 is the most reliable monitoring system we have ever offered with extensive self-checking and fault tolerant design features.

Connected

Connecting to condition monitoring and diagnostic software has never been easier. With the 3500 there are no bulky external modules, no additional wiring, and no extra rack slots required. Simply use the Ethernet port in the 3500/22M Transient Data Interface Module and a single network cable to communicate with our System 1[†] software. Connecting to plant control and automation systems is straightforward as well. Simply add a communication gateway module. You can even add multiple gateways when communication redundancy is required or when multiple systems must be supported with differing protocols.

Flexible

The 3500 Series features the industry's most extensive selection of machinery measurement parameters combined with software configuration for virtually all monitor options. Local or remote mounted displays are available, or you can operate the 3500 without a display. The result is unparalleled flexibility to address almost any application.

Field-proven

The 3500 Series system has proven its value and dependability with customers everywhere, year after year, with more than 100,000 racks installed globally.



| | Monitor modules | | | | | | | | | | | | | |
|---|-----------------|------------|----------|----------|---------|----------|---------|---------------|---------|----------|----------|----------|----------|------------|
| | 3500/25 | 3500/32/33 | 3500/42M | 3500/44M | 3500/45 | 3500/46M | 3500/50 | 3500/60/61/65 | 3500/62 | 3500/64M | 3500/70M | 3500/72M | 3500/77M | 3500/91/92 |
| Measurements | | | | | | | | | | | | | | |
| Phase reference | ● | | | | | | | | | | | | | |
| Radial vibration (proximity probes) | | | ● | | | | | | | | | | | |
| Radial position (proximity probes) | | | ● | | | | | | | | | | | |
| Axial position (proximity probes) | | | ● | | ● | | | | | | | | | |
| Eccentricity (proximity probes) | | | ● | | | | | | | | | | | |
| Seismic vibration (velocity transducers/accelerometers) | | | ● | | | | | | | | | | | |
| Shaft absolute (proximity and seismic) | | | ● | | | | | | | | | | | |
| Aeroderivative gas turbine casing vibration | | | | ● | | | | | | | | | | |
| Differential expansion | | | ● | | ● | | | | | | | | | |
| Ramp differential expansion | | | | | ● | | | | | | | | | |
| Complementary differential expansion | | | | | ● | | | | | | | | | |
| Case expansion | | | | | ● | | | | | | | | | |
| Valve position | | | | | ● | | | | | | | | | |
| Hydro turbine/generator vibration | | | | | | ● | | | | | | | | |
| Hydro generator air gap | | | | | | ● | | | | | | | | |
| Machine operating state (discrete input) | | | | | | ● | | | | | | | | |
| Rotor speed | ● | | | | | | ● | | | | | | | |
| Rotor speed rate-of-change (acceleration) | | | | | | | ● | | | | | | | |
| Rotor zero speed (turning gear engagement) | | | | | | | ● | | | | | | | |
| Reverse rotation | | | | | | | ● | | | | | | | |
| Relays | | ● | | | | | | | | | | | | |
| Temperature (direct/average/differential) ¹ | | | | | | | | ● | | | | | | |
| Process variable signals (4-20 mA, 1-5 Vdc, etc.) | | | | | | | | | ● | | | | | |
| Gas turbine combustor instabilities | | | | | | | | | | ● | | | | |
| Reciprocating compressor impulse/velocity | | | | | | | | | | | ● | | | |
| Reciprocating compressor rod position | | | | | | | | | | | | ● | | |
| Reciprocating compressor cylinder pressure | | | | | | | | | | | | | ● | |
| Communication gateway | | | | | | | | | | | | | | ● |

1. The 3500/60 and /61 are 6-channel monitors. The 3500/65 is a 16-channel monitor.

Buffered outputs – every dynamic input signal is conveniently available at the front panel via buffered output connectors for easy connection to portable and test instrumentation.

Digital communications – the 3500/92 Communications Gateway supports Modbus[®] and Modbus/TCP protocols via serial (RS232/422/485) or Ethernet links for digital communications with PLCs, DCSs, and other instrument and automation platforms. Multiple gateways can be installed in a single rack for link redundancy or when multiple protocols are needed.

Keyphasor* module – accepts single- and multi-event-per-turn signals from proximity probes and magnetic pickups. A standard rack can accommodate up to four Keyphasor* signals (two 3500/25 modules), and special modifications are available when more than four Keyphasor* signals are required.

Built-in Intrinsic Safety (I.S.) barriers – I/O modules can be ordered with or without internally mounted I.S. barriers to decrease wiring, increase accuracy, and reduce installation costs when hazardous environments require intrinsically safe installation practices.

3500/15 Power supply – accepts worldwide AC/DC voltages and frequencies and can be supplied fully redundant to assure uninterrupted performance.

Keylock security – all monitor modules are software configurable via the 3500's Transient Data Interface Module – key lockable to prevent unauthorized tampering.

Industry-standard 19" rack size – provides more than twice the channel density of previous systems. Available in both EIA rack and bulkhead mounting versions, along with integral (standard) or external field wiring termination blocks (optional) for maximum installation flexibility.

Analog communications – monitor module channels are available with analog 4-20 mA proportional outputs for process control systems and other instrumentation.



VGA display module – The 3500/94M VGA module displays all 3500 machinery protection system information, including:

- System event list
- Alarm event list
- All module and channel data
- Alarm and OK status
- Nine Custom display options

Supports either the 10" or 15" Advantech VGA touch screen displays. These compact, durable displays are designed for excellent viewing quality in industrial applications. The 10" Advantech display is certified for hazardous environments



Transient Data Interface (TDI) – provides configuration interface as well as single-cable connection to System 1* software via conventional wired or wireless Ethernet networks. The 3500's advanced design ensures that simultaneous data acquisition occurs for all channels in the rack.

Multiple parameters from each channel – radial vibration channels can provide eight individual parameters (overall, gap, 1X amplitude/phase, 2X amplitude/phase, Not 1X, Smax), meaning a 4-channel monitor actually provides up to 32 channels of measurements. Alarms can be set on any or all 8 parameters from each channel.

Hot-swappable modules – for ease of maintenance and maximum uptime, modules can be removed and reinserted without removing rack power.

Relay modules – software-programmable voting logic provides unmatched flexibility. 4- and 16-channel versions available.

Applications and industries

The table on page 5 summarizes the enormous selection of measurement types available in the 3500. This allows it to be applied to an extremely wide-range of rotating and reciprocating machinery in many industries. Below are just a few of the more common applications that can be easily addressed by the 3500 System.

If your specific machine doesn't appear on the list, just ask us. Chances are, our applications engineers have already developed a solution that's right for you. And, with our extensive custom applications capabilities, we can easily modify off-the-shelf 3500 solutions to handle your nonstandard applications and signal processing requirements.

- Steam turbines
- Hydraulic turbines
- Industrial gas turbines
- Aeroderivative gas turbines
- Reciprocating compressors
- Centrifugal compressors
- Axial compressors
- Screw compressors
- Gears
- Turbo-expanders
- Horizontal and vertical centrifugal pumps
- Reciprocating pumps
- Electric motors
- Generators
- Fans
- Blowers
- Agitators
- Mixers
- Centrifuges
- Pulp refiners
- Ball mills
- Crushers/pulverizers
- Extruders
- Pelletizers
- Cooling tower/heat exchanger fans



Service and support

We design and manufacture the 3500 system so there's nobody better equipped than Bently Nevada to professionally install and support these products.

Bently Nevada Services offer complete lifecycle support coverage from initial design, commissioning and integration with your operating processes, and continue throughout the operational life of your facility with available upgrades, replacements, and retrofits. This enables you to get the most out of your investment. Our service offerings are carefully developed to ensure you realize the maximum benefits our

solutions have on your operation. Bently Nevada service professionals undergo rigorous training and certification processes developed through our 60+ years of machinery protection and conditioning monitoring experience. This ensures we provide the highest quality and most expert services in the industry. With more than 500 service and support professionals in over 50 countries we have the global reach and local presence to be there with expert support when and where you need us.

Bently Nevada service menu

| | |
|------------------------------------|---|
| Implementation services | <p>Get it right the 1st time</p> <ul style="list-style-type: none"> • Ensure your assets are protected and monitored when you're ready to startup • Avoid costly delays and rework • One source to design, plan, manage, and execute the installation • Avoid startup trips due to improper installation and configuration |
| Proactive support | <p>Keep your System healthy and optimized</p> <ul style="list-style-type: none"> • Prevent instrumentation related false trips • Prevent and minimize potential data loss events • Keep up to date and compliant with the best technologies available • Access the expert support you need when you need it most |
| Asset Health and consulting | <p>Actionable insights you can trust</p> <ul style="list-style-type: none"> • Understand your asset health to optimize outage and maintenance planning • Plug in to our global network of machinery experts with remote monitoring • Professional OEM agnostic machinery diagnostics when and where you need it • Custom analytic development and tuning to pinpoint specific conditions |
| Cybersecurity¹ | <p>Stay ahead of evolving cyber threats</p> <ul style="list-style-type: none"> • Ensure your system is up to date and protected as threats continually evolve • Identify and mitigate cybersecurity risks to your operation • Keep your system both secure and accessible with advanced security technologies and architectures leveraging data diodes and database replication |
| Training and education | <p>Critical skills that amplify your machinery management capabilities</p> <ul style="list-style-type: none"> • Enable your personnel to operate and maintain your monitoring and protection system • Enable your operation to maximize the value of your system leveraging expert product and application training and knowledge |

1. https://www.us-cert.gov/sites/default/files/documents/Seven%20Steps%20to%20Effectively%20Defend%20Industrial%20Control%20Systems_S508C.pdf

System 1

System 1, connected to your 3500 Monitoring System, delivers the comprehensive machinery wide diagnostic HMI capability users need to make informed decisions on how to proactively manage their machinery.

Connectivity

Seamless connectivity to Bently Nevada's 3500 machinery protection system with full access to available trend, waveform, and event data. Standard integration to control system PLCs through OPC DA protocol with full access to applicable process data, first-outs, permissives, surge control, and set points.

Visualization and management

Complete Diagnostic HMI desktop-based application, designed to enable rich HMI overviews, extensive trend diagnostics, vibration analysis, and proactive condition monitoring.

Plant-wide scalability

Ability to scale connectivity beyond 3500 and the control system to monitor more machinery leveraging other Bently Nevada online, scanning, or portable devices in the same System 1 platform.

Comprehensive diagnostic HMI implementation

Standardized & holistic machinery configurations based on Bently Nevada best practices for vibration and process data. Standard data connectivity (OPC, 3500, etc.) for overall machine and key sub-systems (vibration, lube, seal, surge, etc.).

Optional hosted and/or remote monitoring

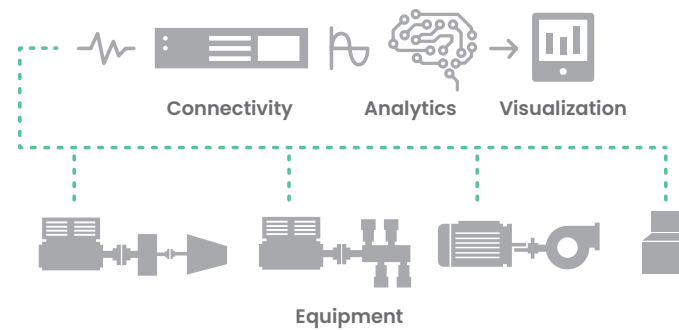
Access to Bently Nevada machinery experts through standardized remote monitoring.



Customer solution



Plant-wide data with context and clarity



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