Bently Nevada
a Baker Hughes business

Plantwide condition monitoring

Choosing the right partner to get the right results

From the 5% to the other 95%

For more than sixty years, machinery-intensive industries have experienced the benefits that continuous vibration protection and condition monitoring deliver for their critical assets. Today, these disciplines are so well-entrenched that they have moved beyond merely "best practice" to standard operating practice. Indeed, many customers will not even consider operating their critical machinery without such systems in place.

But in most plants, only 5% of total assets are considered "critical". What about the other 95%? Are they worth worrying about? Consider for yourself whether the impact of these "non-critical" assets warrants your attention.

Steel plant
$235,000/hr in losses due to an unavailable overhead ladle crane

LNG tanker
$90,000 in losses to replace rather than repair a seawater pump

Coal-fired plant
$300,000 to restart a boiler due to failure of a non-critical asset

Mine
$192,000/hr due to failure of a non-critical asset impacting a single-stream mineral process

Cement plant
$75,000 for each restart of the kiln due to failure of a non-critical asset

Refinery
$140M due to a fire from failure of a non-critical asset

Nuclear plant
$13M for one week of lost generation due to ripple effects of failure of a non-critical pump

Cargo ship
$40,000 for each additional hour to sit dockside due to non-working support assets

Pulp and paper
$1.8M to interrupt pulp production and replace a digester cooling booster pump bearing

Every industry, every asset

With good reason, operators in every industry are turning their attention from only the "critical few" to the wider population of assets and the opportunities they present for improvement. This holistic, plantwide approach is fueled both by the benefits it yields and the market forces that are forcing operators to adopt proactive asset management strategies across their entire population of assets.

90%
of failures are not time-based

+25%
production

-70%
machinery breakdowns

50%
of workforce to retire in the next 5 to 10 years. Knowledge and experience is not being transferred

A move towards plantwide predictive maintenance

-40%
downtime

-50%
maintenance costs

60%
estimated increase in EHS spending among global E&P companies

6x
the cost for unplanned events vs. planned maintenance in process industries

Seven key considerations for plantwide success

Anybody can deliver enthusiasm and promises, but only Bently Nevada can deliver proven results in all seven key areas essential for success in a plantwide condition monitoring program

In your journey to plantwide condition monitoring success, who you choose to work with has never been more important. Will you end up with fragmented islands of technology or a uniform, integrated solution landscape that works cohesively and seamlessly? Will you be on your own when guidance and support are needed, or will you have a trusted, expert partner with decades of experience? When you have a machine problem, will you be dealing with someone that understands only the instrumentation and not the application, or someone that deeply understands both and can confidently augment your own knowledge?

1. The right hardware

You need a partner with a comprehensive hardware portfolio capable of addressing every asset—whether those needs are machinery protection, condition monitoring, or both.

2. The right software

You need a partner with a unifying software infrastructure that eliminates silos and point solutions without sacrificing power or functionality.

3. The right expertise

You need a partner that understands more than just instrumentation and software—you need one that understands machinery.

4. The right service and support

You need a partner that can deliver knowledgeable, 24/7 support no matter what time zone you are in, no matter what language you speak.

5. The right approvals and certifications

You need a partner capable of fully satisfying the certifications and approvals requirements of the locations in which you operate.

6. The right embedded intelligence

You need a partner that knows how to answer the challenges associated with embedded intelligence. At the edge? In the cloud? How much? How little?

7. The right cybersecurity

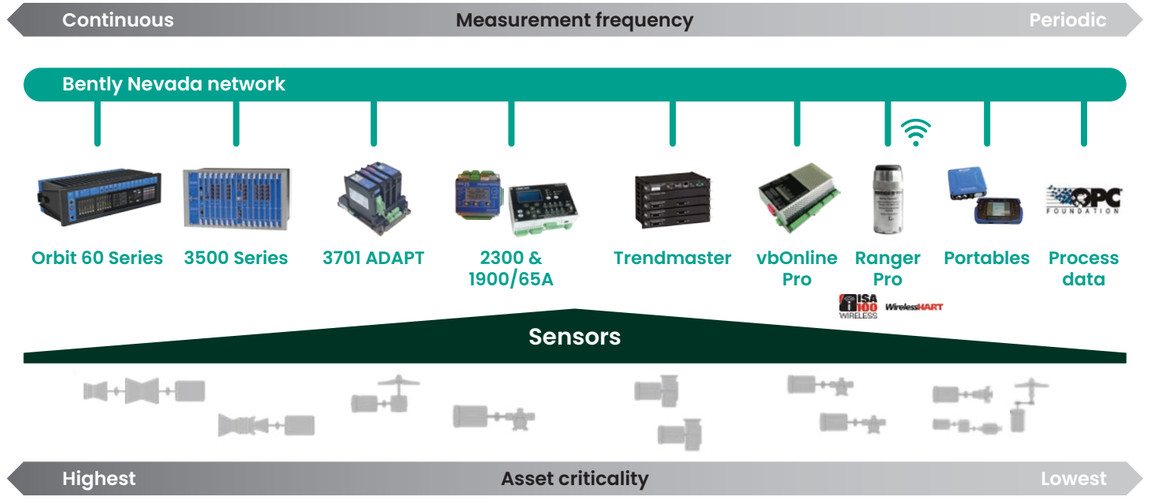
You need a partner with products that comply with modern security concerns and protocols if it’s going to be allowed through the door by your IT and OT gatekeepers.

1. The right hardware

Plantwide condition monitoring necessitates hardware that can properly address every asset, from the least critical to the most. Nobody offers the breadth of hardware that Bently Nevada brings to the table. Nobody. One-size-fits-all approaches sound good on paper, but they simply can't scale to fit the different needs of each machine, the different detection technologies warranted, the optimal channel granularity, and the unique place each must fill in the spectrum from continuous to intermittent measurements, protection to condition monitoring, online to offline, wired to wireless. Our hardware portfolio addresses every part of this spectrum with thoughtfully engineered solutions that are right-sized for the application, providing exactly the right feature set, measurement technologies, and functionality—at price points designed specifically for the economics of the assets in question.

Although we're perhaps best known for our protection and condition monitoring systems, such as Orbit 60 and 3500 Series, every part of our hardware portfolio is world-class. Our portable offerings build on the stellar legacy and renowned capabilities of Commtest, acquired in 2011. Our Ranger Pro™ wireless system was built from the ground up and supports not one, but both of the leading industrial standards—WirelessHART and ISA100—giving you unmatched flexibility and choice.

Our Trendmaster® scanning asset surveillance system revolutionized the industry in the 1980s by allowing thousands of sensors to share a common signal processing engine and sensor bus, providing cost-effective, permanent condition monitoring at a fraction of the price of single-point alternatives. Our vbOnline Pro platform provides highly tailored condition monitoring at user-configurable intervals in convenient hardware blocks of 12 channels. Our 2300 Series monitors offer affordable protection for high-consequence assets like pumps that may number in the hundreds but still warrant reliable monitoring. Our 3701 ADAPT™ platform delivers combined protection and condition monitoring in a high-performance package that can be skid-mounted on the machine for reduced cost.



8 million+
installed vibration sensors

Yes, you read that right. 8 million+.

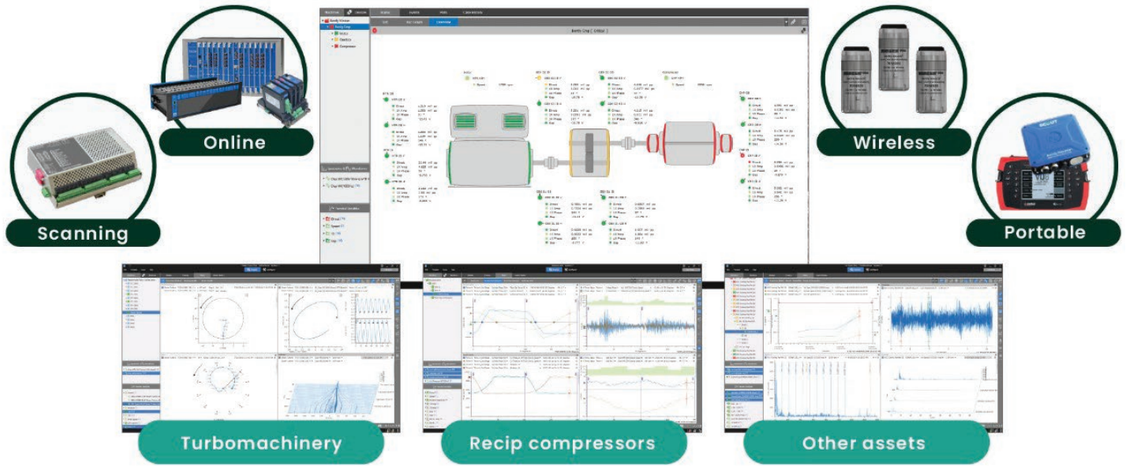
Some would argue that sensors are commodities. But operators know all too well that when it comes to making the right call, everything rests on the integrity the sensor. For six decades, Bently Nevada sensors have been trusted to deliver the highest quality and accuracy in the industry, across every part of the measurement portfolio: acceleration, velocity, displacement, pressure, speed, and position. The breadth of our sensor portfolio (over 20,000 catalog items) means you don't have to spend precious time looking elsewhere for what you need.

We have it. We designed it. We stand behind it.

2. The right software

When we developed System 1 software 20 years ago, we had a simple vision: one system for linking all of your asset monitoring field devices together, resulting in a unified asset management dashboard. System 1 delivers on that promise, bringing every asset in your plant together into a single, powerful ecosystem accessed from a single user interface. No other supplier can match the integration that System 1 delivers.

With others, plantwide means a patchwork of software that delivers little more than a collection of silos. That may not matter when you're only concerned with a subset of assets in your organization, but when a plantwide approach is the goal, integration matters. With System 1, you have only one system to configure. One system to learn. One system to maintain. And we deliver that unity without asking you to compromise analytic capabilities. Our powerful suite of diagnostic tools is best-in-class for not just fluid-film bearings but rolling element bearings as well, with powerful spectrum-based tools to complement all of the other tools we deliver, allowing you to analyze gear problems, belt problems, foundation and piping problems, electrical problems, and every other problem—not just bearing problems.

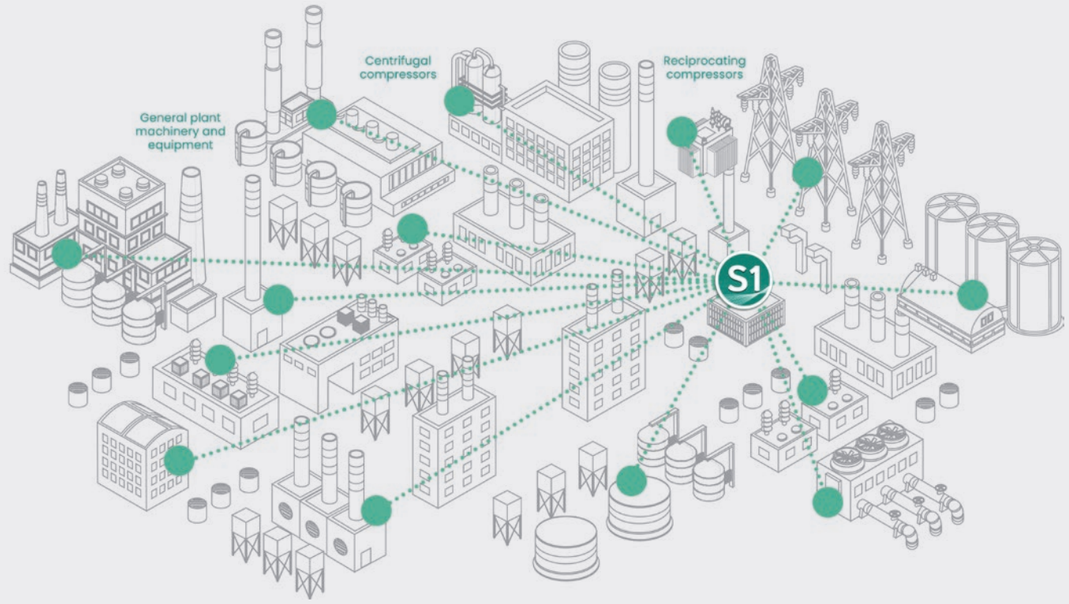


10,000+
System 1 installations globally

12
System 1 remote monitoring centers

100+
System 1 certified field engineers

3 million+
plantwide measurement points monitored by System 1



System 1 does more than just unify your assets under a single umbrella. It unifies your monitoring technologies by combining conventional diagnostic, visualization, and alarming tools, thermodynamic performance, and automated decision support. Alarms can be set on any incoming data stream—including process data.

Core alarming, analytics, and visualization

Decision support

Thermodynamic performance monitoring

3. The right expertise

It's nothing special to expect your provider to have expertise on their own software and instruments. But what about on the machinery those instruments monitor? We understood early in our history that it wasn't enough to possess merely instrument expertise. We also needed application knowledge, allowing us to be users of our own products and helping our customers interpret the data our systems provide. To that end, we launched our machinery diagnostics team in 1980 and have never looked back.

18,000+
completed machinery diagnostic projects

150+
machinery diagnostic engineers globally

30+
machine and component types where we possess deep expertise

1,200+
cumulative years of machinery diagnostic expertise

- **Fluid-film bearings**
- **Seals**
- **Foundations**
- **Rotor dynamics—lateral and torsional**
- **Gas turbines—industrial**
- **Compressors—integrally geared**
- **Compressors—screw**
- **Compressors—centrifugal**
- **Hydro turbines—Kaplan**
- **Pumps—centrifugal**
- **Gears—helical**
- **Gears—worm**
- **Motors—induction**
- **Motors—variable speed**
- **Pelletizers**
- **Conveyors**
- **Fans**
- **Turbo-expanders**
- **Separators**
- **Pulverizers**
- **Pulp refiners**
- **Rolling Element Bearings**
- **Couplings**
- **Piping**
- **Steam turbines**
- **Gas turbines—aeroderivative**
- **Compressors—axial**
- **Compressors—reciprocating**
- **Hydro turbines—Francis**
- **Hydro turbines—Pelton**
- **Pumps—positive displacement**
- **Gears—planetary**
- **Generators**
- **Motors—synchronous**
- **Wind turbines**
- **Crushers**
- **Extruders**
- **Blowers**
- **Centrifuges**
- **Ball mills**
- **Agitators**
- **Cooling tower/heat exchanger fans**

4. The right service and support

When you need help, you need somebody responsive. Somebody knowledgeable. Somebody experienced. Somebody that speaks your language. And you need more than one way to reach them—chat, phone, email, Zoom. We've built our service organization around a motto that dates back to the 1960s: "Take Excellent Care of the Customer."

- Need help installing your instruments? We can do that
- Need help modifying your machine to accept transducers? We can do that
- Need help troubleshooting a problem? We can do that
- Need help verifying/calibrating your instruments? We can do that
- Need help designing your condition monitoring and asset management program from scratch to reflect best practices? We can do that
- Need help filling the gaps and taking your efforts to the next level? We can do that
- Need to outsource your entire condition monitoring program—including hosting of all software on our own IT infrastructure? We can do that
- Need training? We can do that too. Whether traditional on-site, remote, or self-paced, on-demand eLearning, we have the course you need, in the format you need, in the language you need

50+
global training centers

15+
remote and eLearning course offerings

500+
services and support professionals globally

30+
course topics to choose from

18,000+
machinery and diagnostics projects

400+
training courses delivered each year

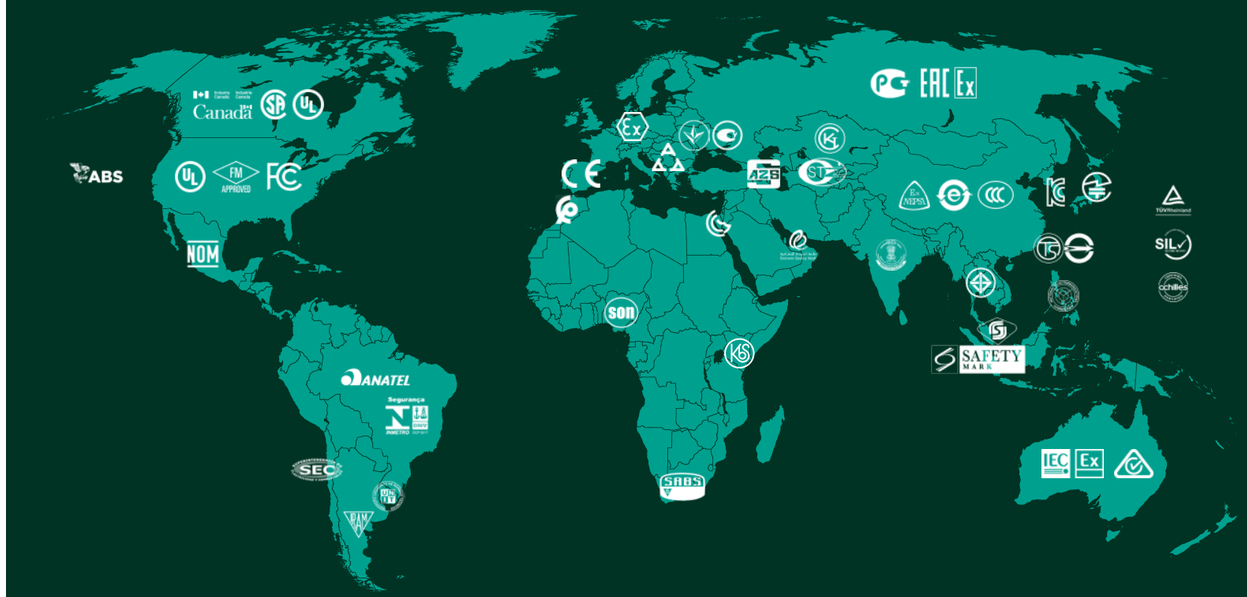
60,000+
field service projects completed

20,000+
customers trained globally

5. The right approvals and certifications

We take great care to make certain our products feature the global approvals and certifications needed by our customers. It's a never-ending journey involving a myriad of standards—each undergoing regular updates and revisions. Our dedicated team of approvals engineers makes certain we're always current, re-testing and re-certifying our offerings on an ongoing basis. It's one less thing for you to worry about and is just one more way that we sweat the details so you don't have to.

Can you afford to work with a partner who delivers anything less?



6. The right embedded intelligence

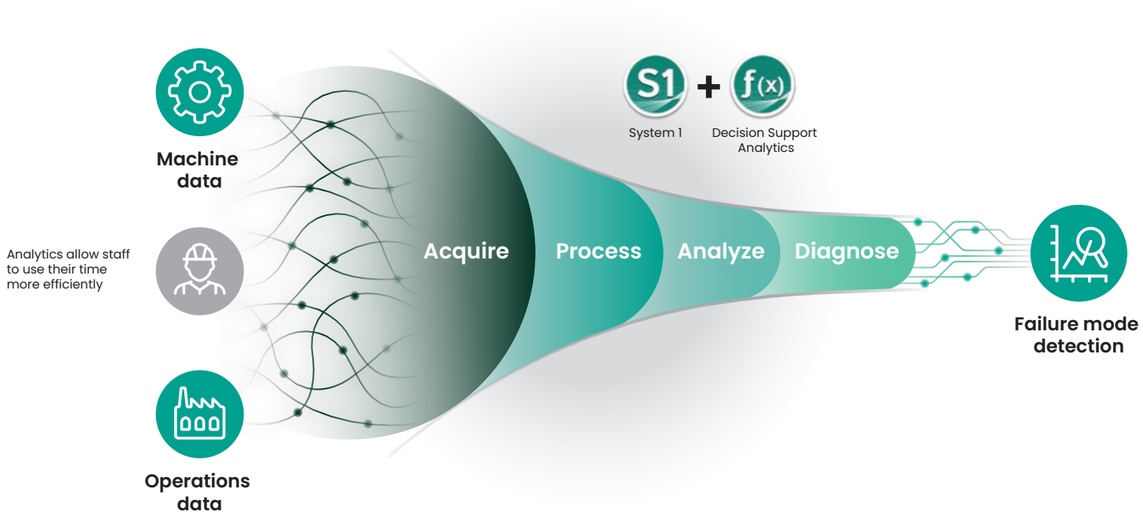
There's enormous hype when it comes to embedded intelligence and expert systems. Some put everything in the cloud and do all the analytics there—necessitating enormous bandwidth and corresponding processing power for terabytes of data. Others do it all at the edge, resulting in hefty IIoT appliances tasked with activities better done in a centralized location. Some insist that little to no domain expertise is required—just unguided artificial intelligence that can separate the gold from the gravel in any dataset, with a minimum complement of sensors and no first principles' guidance.

Who do you believe?

Here's a thought. Why not turn to the people that invented the term "Decision Support" and delivered the first AI system to the marketplace nearly 30 years ago? We've steadily refined our approach over those intervening three decades to find just the right balance of data science and rules-based embedded intelligence in ways that allow the technologies to complement one another—not compete with one another. Today, it's become the world's leading AI system for machinery condition monitoring: System 1 Decision Support.

Our innovative approach distills our intelligence about machinery assets into something called Decision Support Analytics—powerful software plug-ins for more than 15 specific asset types, capable of detecting and identifying more than 30 different malfunctions.

You can distill your own intelligence, too, by developing your own analytics using simple, powerful configuration tools as part of System 1 Decision Support's suite of tools and capabilities. These can then be deployed across your organization, just like any other Decision Support Analytic, ensuring that what you know about your own machines is shared across your entire organization and is continuously being used to automatically identify similar problems.



Decision Support Analytics perform real-time analysis and diagnostics to detect failure modes

7. The right cybersecurity

Remote access to data has never been more important. Travel restrictions, a shrinking pool of machinery experts that may not even be located at your own facility, and other factors mean that moving data, not people, is non-optional. But it's far more complex today than simply connecting your systems to a network and giving out a password. How do you make such connections securely, allowing access to data over business networks without creating vulnerabilities?

The stakes are incredibly high.

For more than a decade, we have been at the forefront of industrial cybersecurity:

- The first condition monitoring company to achieve Achilles's certification for our flagship protection system
- The first company to develop architectures that fully insulate the protection system from the condition monitoring system via inherently secure analog connections
- The first company to successfully employ data diode technology to replicate condition monitoring server data from the control domain to the business domain

We take cybersecurity extremely seriously so that it doesn't have to get in the way of your condition monitoring objectives. Our solutions were designed by consulting our customers' OT and IT professionals to understand the environments they operate in, the constraints they face, and the technology stacks they employ. System 1 as well as our edge appliances and monitoring hardware are designed from the ground up with cybersecurity as a primary design criteria.

77%

Of 150 IT professionals in the energy, utilities, and oil and gas segments interviewed, 77% reported at least one security breach in the last 12 months

290

In 2016, US Homeland Security responded to 290 incidents of cyber invasions or breaches with 63 in critical manufacturing and 59 in energy

$14.8M

Average cost of cyber crime in 2016 for the utilities and energy sector

$300M

Loss for Maersk after WannaCry attack, due to significant business interruption (no data loss or physical destruction)

1 in every 4

days the US power grid is struck by a cyber or physical attack

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