

Petroleum Refining



Introduction

For refineries, optimizing Operating and Maintenance expenses go a long way toward increasing profitability. A recent study¹ suggests that a 225,000 barrel per day (bpd) refinery that shifts from time-based to condition based maintenance can reduce maintenance expenses by 15%. That 15% translates to over USD \$8M per year in maintenance savings. That's the kind of return on investment condition-based maintenance programs have been providing for refineries for decades. And that doesn't even account for the increased revenues a condition-based maintenance program can deliver by reducing unscheduled downtime or improvements in energy efficiency.

With a condition-based program, maintenance is not performed based on a schedule, whether needed or not, nor is maintenance deferred until a machine breaks down. Most refineries have adopted this practice and are making smart choices based on measured mechanical conditions that indicate when maintenance is warranted. Condition monitoring provides early warning so that maintenance

can be planned and machines can be brought down without incident. That early warning also helps to avoid breakdowns with subsequent secondary damage and loss of production revenue.

Bently Nevada has been monitoring the condition of critical and general-purpose assets in refineries like yours for more than 60 years, using sophisticated technology that has been installed in more than 75% of all global locations. Our comprehensive portfolio of systems and services addresses the full spectrum of condition monitoring and machine protection applications in refineries today. We provide on-line continuous monitoring for highly-critical assets such as turbines and compressors (both rotating and reciprocating). For less essential assets, such as pumps, motors, fans and heat exchangers, we provide a cost-effective periodic on-line monitoring solution. And for non-essential assets located in remote or hazardous areas, our wireless solution – Ranger Pro* – enables on-line monitoring at far less cost than a hard-wired system.

¹ "Quantifying the ROI of an asset performance management program". Hydrocarbon Processing T. Ayral and M. Moran, Meridium, Inc. Roanoke, VA. May 2007. pp 63-68.



Your challenges

Market conditions are indeed challenging for refineries in the 21st century. Higher crude prices, lower demand and fluctuating energy costs cut into profit margins. And compliance with tighter environmental and safety regulations can be both difficult and expensive. At the same time, the opportunity to increase profit by refining poorer grade crudes requires machines to run at higher temperatures, putting greater stress on machines.

With so much at stake, your mechanical assets need to run at or even beyond original design condition or capacity, reliably and predictably. Our asset management solutions can help you overcome many of your most critical challenges such as:

- Reducing maintenance and production costs
- Complying with environmental and safety regulations
- Preventing environmental releases

- Minimizing unplanned outages and downtime
- Extending the time between and reducing the duration of planned outages
- Life Cycle Asset Management - optimizing maintenance and operating costs to maximize the useful life of your production an assets
- Protecting critical machinery against catastrophic mechanical failures
- Reducing workforce size - reducing unnecessary maintenance and optimizing planned maintenance based on condition monitoring

In the pages that follow, we'll show you exactly where our solutions can be applied and the benefits that they can deliver in a typical refinery, whether applied at a single plant or across an entire enterprise.





Bently Nevada Asset Condition Monitoring systems don't COST...



Payback through protection

Our solutions help protect your machinery from catastrophic failures and the costs of those failures.

For more than 60 years, the Bently Nevada name has been recognized for its industry leadership in machinery protection and condition monitoring. Today, with more than one million channels of machinery protection installed worldwide, customers have made us the proven choice for machine protection. We not only protect your machinery, but our legendary product quality, deep application expertise, and highly competent locally available service helps protect your condition monitoring investment as well.



Payback through mechanical validation

Our solutions let you capture baseline machinery conditions, pre- and post-maintenance, giving you a reference for optimal decision making.

One of the most crucial times in the life of a machine is immediately after maintenance has been performed. We can tell you if "all is well" with systems that capture relevant data both before and after maintenance. You can instantly see if problems are present and make decisions accordingly. For many customers, the ability to knowledgeably continue with or abort the startup of a large compression train can more than pay for their entire system in a single event.



Payback through predictive maintenance

Our solutions deliver information that allows you to perform maintenance when conditions – not calendars – dictate.

The results of a predictive maintenance program enabled by our condition monitoring solutions speak for themselves. Consider a recent study from Hydrocarbon Processing magazine. See footnote on back cover. At a typical 100,000-bpd refinery, when Predictive Maintenance is used as part of broader asset management program annual benefits are estimated to be over USD\$3.5M per year:

- Avoiding abnormal incidents...\$500,000
- Reducing lost profit opportunities...\$1,750,000
- Reducing maintenance budget...\$800,000
- Improving staff productivity...\$300,000
- Reducing liability insurance premiums...\$200,000

...they PAY.

Integrated monitoring applications in refining

FCC unit

- FCC feed pump
- Main air blower
- ★ Main air blower turbine
- Power recovery turbine/expander
- Overhead condensers
- ★ General purpose pumps
- Relief valves

Hydro-cracking unit

- H2 make-up compressor
- Recycle compressor
- ★
- Charge pump
- ★ Heat exchangers
- Valves

Alkylation Unit

- Refrigeration compressor
-
- Condensers
- ★
- Mixers

Distillation unit/pestill

- Feed pumps
-
- ★
- Overhead condenser/fin
- ★ Fan heat exchanger
- Feed exchangers
- General purpose pumps

Desalter

- Water pumps
- ★
- Transformers
- Mix valves

Vacuum distillation unit

- Vacuum ejector/pump
- ★ Bottoms pump
- VGO pumps

Catalytic reforming unit

- Hydrogen recycle compressor
- Net gas compressor
- ★
- Fin fan heat exchangers
- ★
- Motor operated valves

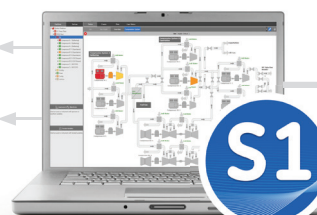
Delayed coker unit

- Coker wet
- gas compressor
- ★
- Jet water pumps
- ★ Overhead condensers
- Coke drum



CMMS/ERP system

Plant data network



System 1* software

● Protection

Online, continuous machinery protection

Sat. gas plant

- Wet gas compressor
-
- ★
- Fin fan heat exchanges
- ★ Condensate pumps

Cryogenic recovery unit

- Turbo expander
- Gas compressor
- ★

Hydro-treating unit

- H2 Make-up compressor
- Recycle compressor
- ★
- Charge pump
- ★ Heat exchangers
- Valves

Sulfur unit/tail gas unit

- Boiler feedwater pumps
- Reactor air blower
- ★
- Sulfur pumps
- ★

Flare gas recovery

- Compressor
- Sealed water
- ★ circulation pump
- Water sealing valves

Utilities

- Gas turbine/generator
- Steam turbine/generator
- ★ Boiler feedwater pumps
- Plant air compressors
- Instrument air compressors
- Cooling water pumps
- Cooling towers
- ★
- Transformers
- ★ Boilers

■ Condition Monitoring

Online continuous
Online periodic (wired or wireless)
Offline periodic (portable instrument)

★ Performance

Online, thermodynamic
performance monitoring
and optimization

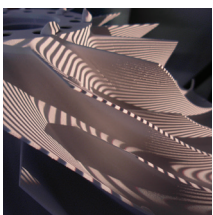
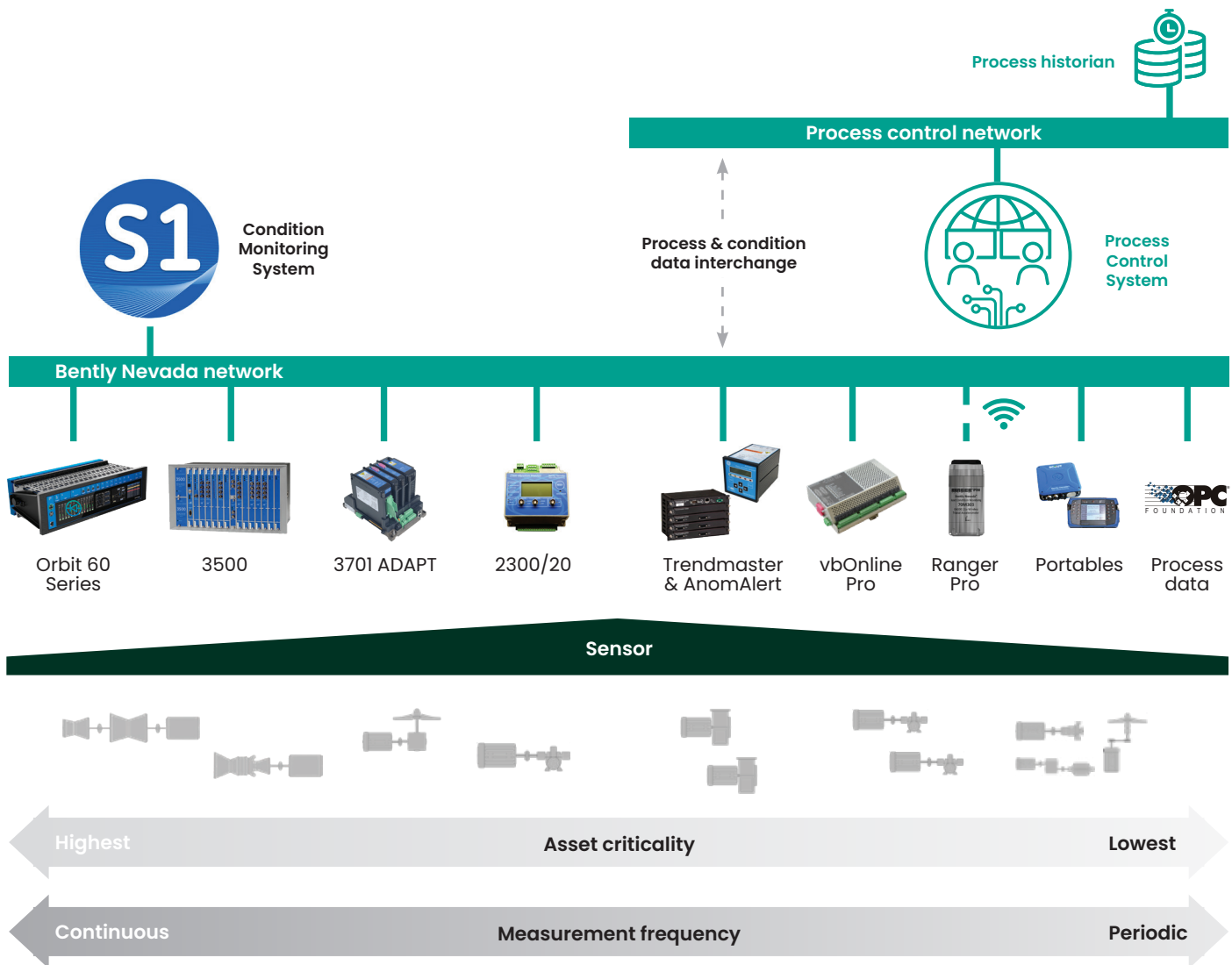
Tank farm

- General purpose pumps
- ★
- Tank mixers



Bently Nevada – one solution, endless possibilities

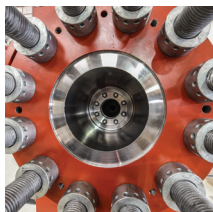
Bently Nevada machine condition monitoring solutions combine advanced hardware, intelligent software and trusted service and support – providing a broader, connected view of your operations. Together, they enable you to mitigate risk, boost safety and reduce maintenance costs. From highly critical to less critical equipment, our technology enables better data collection and improved insights across your operations.



Centrifugal compressors

With continuous on-line monitoring via Bently Nevada 3500 series monitors and System 1 software, transient data recorded at start-up and shutdown reveals problems that may go undetected when only steady state data is available. This was the case for a large Chilean refinery where an abrupt change in vibration was detected during startup of the Main Air Compressor/Booster Air Compressor.

"As a result of the data provided by the System 1 software, we were able to rapidly make the right decision regarding an inspection of the machine, knowing where to look and what to look for. We estimate that several days of additional downtime were avoided at a cost of USD \$300K per day."



Reciprocating compressors

Cylinder valves are high maintenance items on reciprocating compressors, and cylinder pressure is the most important measurement for assessing valve condition. The patented Bently Nevada 165855 Transducer enables continuous monitoring by withstanding harsh conditions inside the cylinder. Combined with the powerful visualization tools included in System 1 software, specialists can make informed decisions with confidence.

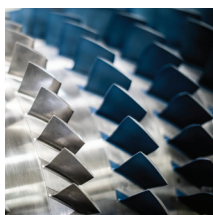
At a large refinery, losing any one of the three reciprocating compressors on the cracking unit would result in a 20% reduction in production. When a discharge valve showed evidence of impending failure, continuous monitoring of cylinder pressure and analysis with System 1 software enabled specialists to assess the damage without having to open the machine. By keeping the unit running through the important summer months, the plant reaped the benefit of not only continuous production but also averted a lengthy outage estimated at USD \$10K/Hr.



Pump installations

Pump failures often lead to more serious problems such as fires, which may cost millions of dollars in damage and lost production. Frequent data collection can detect faults before pump failures occur. Bently Nevada Trendmaster* systems can scan measurement points every few minutes, providing a cost-effective online vibration/temperature monitoring solution for pump alley installations.

"The Trendmaster system is like having an operator standing next to each pump 24 hours per day. Catastrophic pump failure prevention was the basis for justification of this system, and before we even had it commissioned, it paid off big time."



Expanders and recovery turbines

Energy represents one of the largest components of a refinery's operating costs. This makes expanders, which recover energy that would otherwise be wasted, essential to improving plant efficiency.

We help you protect your expanders by collecting high-speed transient data and giving you the analytical tools to properly diagnose conditions that develop within these assets over time. Armed with this information you can more successfully detect the path to catastrophic failures and proactively plan maintenance.



Turbine drivers

Centrifugal compressors, pumps, turbines and generators are used to keep refineries up and running. A major failure of one of these assets could result in an extended outage with substantial negative impact on overall profitability. When a problem is detected, timely and accurate diagnosis is critical to preventing serious damage, avoiding an unplanned outage, and optimizing O&M expenses.

"Using System 1 software to correlate vibration and field current data collected by our 3500 monitoring system, we identified a thermal sensitivity issue in a generator. Without this information, we would have resorted to balancing the generator. Instead, the plant ran the unit at reduced load until the next scheduled outage and made repairs at that time. By averting a major failure, we avoided an estimated 8-week outage, and saved nearly USD \$1 million."



Cooling Towers

Cooling towers are prone to sudden failures. For example, fan blades can disintegrate due to fatigue, causing serious damage to the tower and other potential loss. Pumps used in the cooling water systems are also frequently neglected. Oil and vibration analysis can be instrumental for early detection of fan blade fatigue, and Bently Nevada supports via its instrumentation.

Trending the different elements in the oil has proven to be effective for early detection of bearing and gear failures in oil lubricated drive systems. At the same time, without continuous spectra and waveforms, there is a good chance of missing faults, which could lead to unscheduled downtime or a catastrophic failure.

Comprehensive, globally available services



Implementation services

Get it right the first time.

- One source to design, plan, manage, and execute the installation
- Avoid costly delays and rework
- Avoid startup trips due to improper installation and configuration
- Ensure your assets are protected and monitored when you're ready to startup



Proactive support

Keep your system healthy and optimized.

- Access the expert support you need when you need it most
- Prevent instrumentation-related false trips
- Prevent and minimize potential data loss
- Keep up to date and compliant with the best technologies available



Asset health and consulting

Actionable insights you can trust.

- Plug into our global network of machinery experts with remote monitoring
- Professional OEM agnostic machinery diagnostics when and where you need it
- Understand your asset health to optimize outage and maintenance planning
- Custom analytic development and tuning to pinpoint specific conditions



Training and education

Critical skills that amplify your machinery management capabilities.

- Enable your personnel to operate and maintain your monitoring and protection system
- Maximize the value of your system by integrating expert knowledge into your operating procedures



Cybersecurity

Stay ahead of evolving cyber threats.

- Ensure your system is up to date and protected as threats continually evolve
- Identify and mitigate cybersecurity risks to your operation
- Keep your system secure and accessible with advanced security technologies and architectures leveraging data diodes and database replication

Why the Bently Nevada product line?

We have earned your trust. For over five decades the Bently Nevada product line has supported the most demanding applications in multiple industries. And even as we protect and monitor your machinery, we constantly strive to refine and improve our offerings – and help enable your success.

We design and deliver solutions for all your monitoring needs – including sensors, distributed and rack-based monitors, software, and supporting services – with the following goals in mind:

- Increased availability and production
- Lowered maintenance costs
- Reduced risk in terms of safety, environmental, and asset upsets.

And we have impressive statistics to back up our extensive experience:

- Over 60 years of condition monitoring leadership
- More than 600 international patents issued, including over 150 in the U.S.
- Over 2000 System 1 Condition Monitoring Software Users Globally.
- Over 85,000 3500 Series monitoring systems installed globally.
- Over 8 million sensor monitoring points.
- Over 20 years of offering overspeed detection systems.

Want to know more?

Detailed information, including product data sheets and application articles and guides, can be found at the Hydroelectric Power Generation page of our website, www.bently.com.

