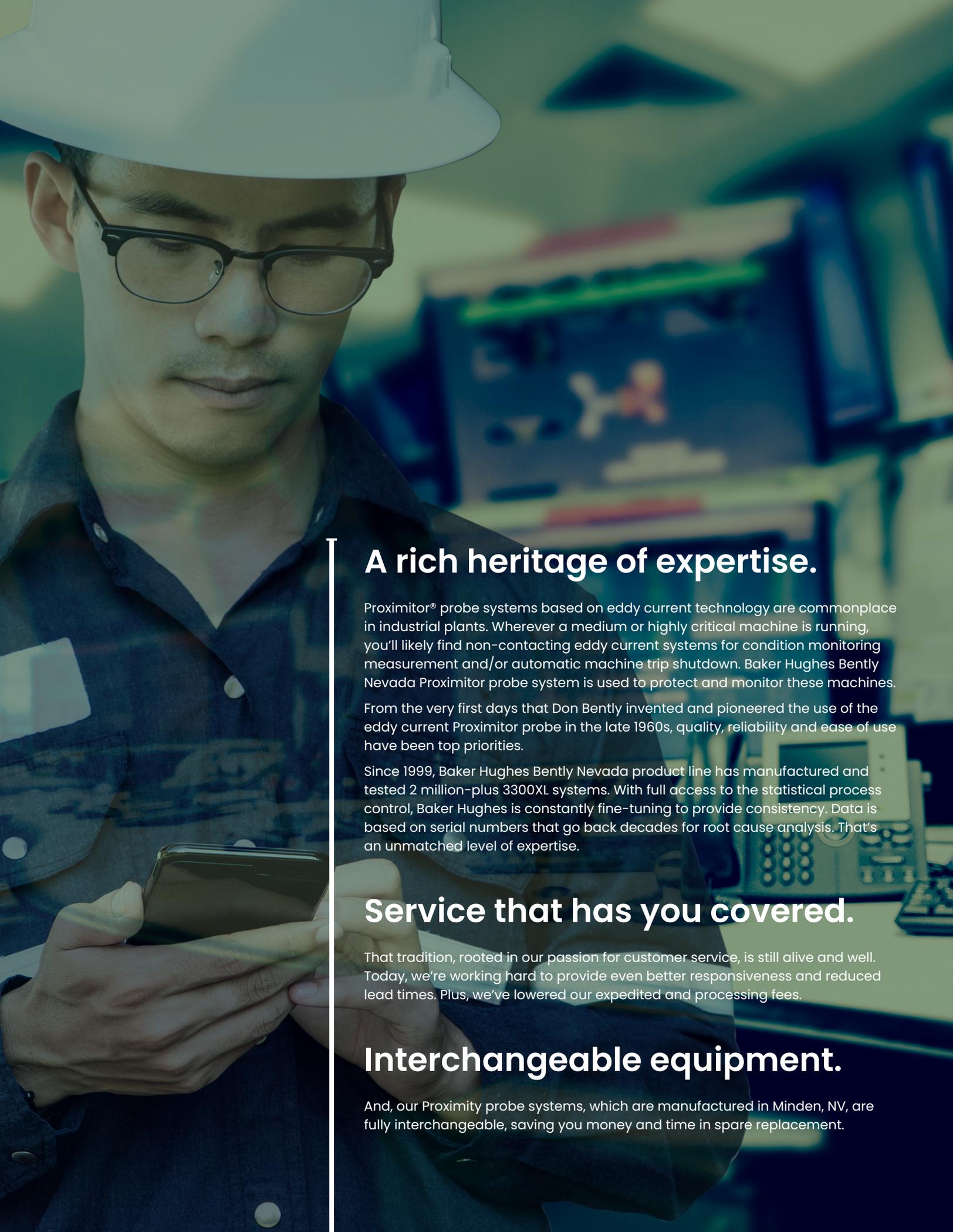


Proximity Probe System

Interchangeable equipment with
service that's got you covered.



A man wearing a white hard hat and glasses is looking down at a smartphone. He is wearing a dark blue button-down shirt. The background is a blurred industrial setting with various equipment and pipes.

A rich heritage of expertise.

Proximitor® probe systems based on eddy current technology are commonplace in industrial plants. Wherever a medium or highly critical machine is running, you'll likely find non-contacting eddy current systems for condition monitoring measurement and/or automatic machine trip shutdown. Baker Hughes Bently Nevada Proximitor probe system is used to protect and monitor these machines.

From the very first days that Don Bently invented and pioneered the use of the eddy current Proximitor probe in the late 1960s, quality, reliability and ease of use have been top priorities.

Since 1999, Baker Hughes Bently Nevada product line has manufactured and tested 2 million-plus 3300XL systems. With full access to the statistical process control, Baker Hughes is constantly fine-tuning to provide consistency. Data is based on serial numbers that go back decades for root cause analysis. That's an unmatched level of expertise.

Service that has you covered.

That tradition, rooted in our passion for customer service, is still alive and well. Today, we're working hard to provide even better responsiveness and reduced lead times. Plus, we've lowered our expedited and processing fees.

Interchangeable equipment.

And, our Proximity probe systems, which are manufactured in Minden, NV, are fully interchangeable, saving you money and time in spare replacement.

What does interchangeability mean?

With Proximity probe systems, the probes, cables, and Proximitor® sensors can be easily interchanged without the need for calibration or special tools.

For example, the most popular line of Bently Nevada proximity probe systems is the 3300XL 8 mm system. Interchangeability means that with this system a plant can easily exchange 3300XL 8mm probes, cables, and Proximitors® without any significant change in output such as gap voltage or direct vibration.

Interchangeability is an important advantage. In the early days of eddy current system development, each probe, cable, and Proximitor had to be tuned to match one another in a unique set. Anytime a piece of the system needed to be replaced, an actual calibrated match was required. This meant that each vibration point on a machine potentially needed to have its own spare. On a typical four-bearing machine, the plant might need to stock or calibrate many different spares—an expensive, complex and time-consuming endeavor.

System	Color
3300 XL 5 and 8 mm	Blue
3300 XL 11 mm	Purple
3300 XL 25 mm	Lime Green
3300 XL 50 mm	Brown
7200 XL 5 and 8 mm	Light Yellow
3300 XL NSv	Grey
16 mm HTPS	Orange

Baker Hughes Bently Nevada product line Proximitor families

The Bently Nevada product line answered the need for a better way, pioneering the development of our gold standard technology that provides complete interchangeability between the main Proximitor product families. As shown above, each Proximitor family has its own color-coding for easy identification.

Baker Hughes uses a metrology-tracked system, so a 3300XL probe purchased 18 years ago works correctly with a 3300XL Proximitor module you buy today and an extension cable you might buy 10 years from now. No one else in the industry can claim this level of rock-solid performance AND interchangeability.

Why does that matter?

A Proximitor is a precision instrument, and occasionally it—or a cable—will need to be replaced. Without interchangeability, unless the plant actually stocked the exact calibrated match for the Proximitor or probe cable in need of replacement, there is essentially no way to replace the part and ensure that the reading is correct. The plant would need to shut down the machine, remove the machine covers, and access the bearings to be able to replace all three at once—probe, Proximitor and cable—to ensure the correct reading. In some industries that may not be an issue. In the critical process industries where equipment is expected to run for years without stopping, it is unacceptable.

With a fully interchangeable system like the 3300XL, the plant simply replaces the damaged Proximitor or cable with an off-the-shelf spare part and continues to run. No calibration or special tools required and no need to disturb the probes installed deep within the machine. In fact, because of our gold standard and unmatched interchangeability, all machines at the plant can use exactly the same Proximitor drivers and cables and, with a few different probe options, the plant's entire needs can be covered by just a handful of spare parts shared among all the machines. That means lower maintenance costs and reduced chance of system mismatch.

Advantages of interchangeability

- No calibration or special tools required with replacement
- No need to disturb other probes
- Lower maintenance costs
- Reduced chance of system mismatch

3300XL 11mm Proximitor probes, both armored and unarmored cable versions



The 'Frankenstein System' mixing and matching parts from different manufacturers

A typical Bently Nevada Proximitors, probe, and cable set is engineered to work together as a system.

Companies that mix and match eddy current system parts from different manufacturers may encounter the so-called "Frankenstein System." This system mixes and matches parts from different manufacturers that were never designed to work together. At first, they may appear to work correctly. However, they soon may begin to have problems.

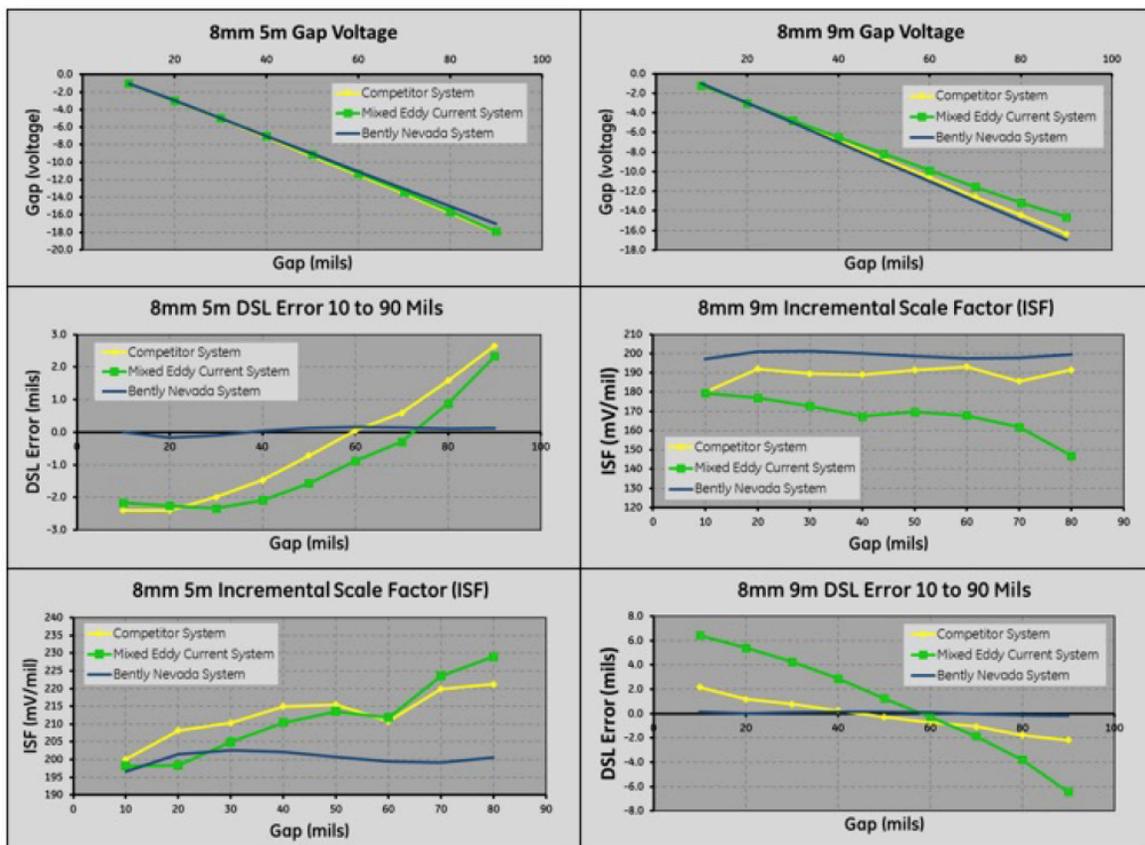
Case in point: Production was down at a refinery in the Middle East because critical turbomachinery was intermittently shutting down. The Bently Nevada system was suspected of causing false trips. Within hours a local Baker Hughes field engineer was on site to diagnose the problem.

Upon investigation it was discovered that all of the Bently Nevada Proximitors had been replaced. Although the Bently Nevada probes and cables were still in place, the compatible Proximitors had been replaced with an eddy current driver with unknown electrical characteristics.

Upon discovering this, the refinery management launched an internal root cause analysis (RCA) and determined that the mismatched eddy current driver was the source of the false trips. By changing from the Proximitors with its known characteristics and replacing it with a competitor's unknown product, the plant inadvertently "changed" critical machinery set points without the plant operators' knowledge.

Although eddy current systems are relatively easy to manufacture, they are very difficult to manufacture with repeatability and accuracy--something the Bently Nevada product line has done for more than 50 years.

No manufacturer will warranty the mixing and matching of transducers, which can lead to loss of plant production as well as unsafe conditions.



Performance plots of 8 mm 5- and 9-meter eddy current system comparison (gap voltage, DSL, ISF): The non-linear response and error of the mixed system can essentially "change" intended setpoints.

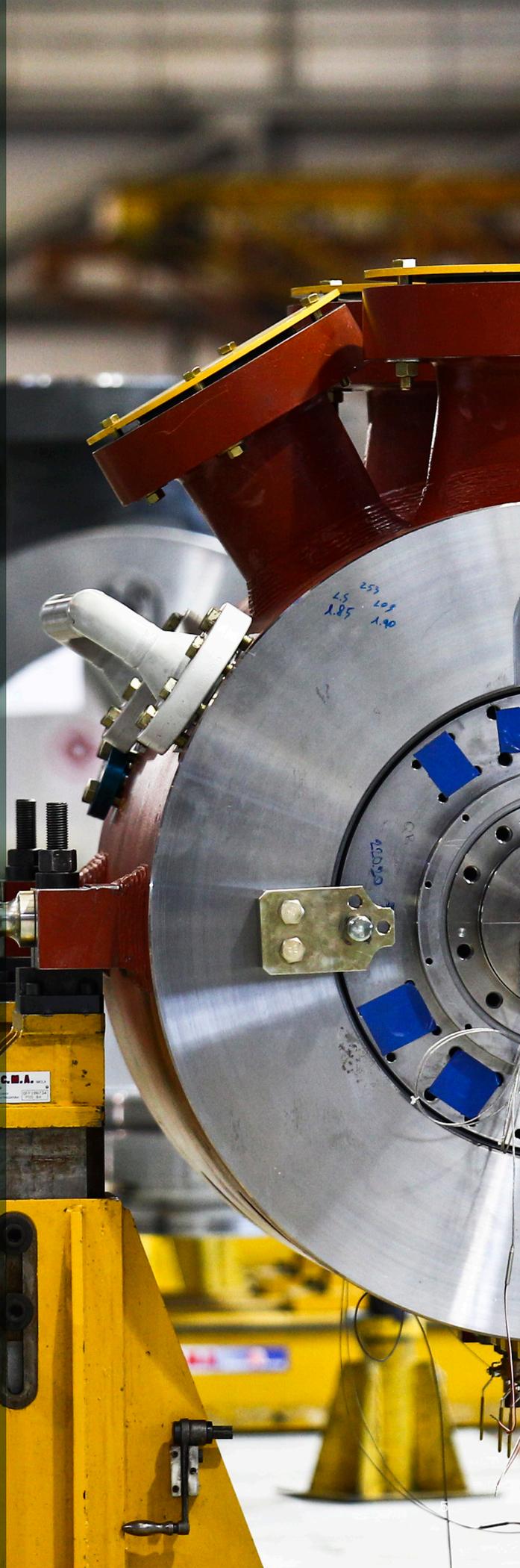
Setpoints changed outside the process

So how can setpoints be changed without the knowledge of the machinery team? Take this hypothetical example:

1. The plant orders a pair of motor-gearbox-compressors for a new expansion at the refinery.
2. The OEM delivers the compressors along with recommended alarm setpoints for vibration and thrust.
3. Three OEMs are involved: motor, gearbox, compressor.
4. All three OEMs have different recommended setpoints.
5. Plant reliability and consulting engineers have their own desired setpoints, which are different from the OEMs'.
6. Many meetings between the plant staff and OEM engineers ensue, and eventually agreement is reached on the initial alarm setpoints.
7. The installation project is completed.
8. Commissioning is completed.
9. The machine is successfully started, and production begins.
10. The operation of the machine has now been handed over to operations. **For any changes to be made to the system at this point, an extensive Management of Change Process (MCN) must now be followed, and for good reason: the amount of work that went into determining good setpoints and relay logic, as well as the risk of lost production or damage to the equipment if an error is made, cannot be over-stated.**
11. Fast forward one year. Plant reliability engineers wish to make a change to a thrust setpoint based on a catastrophic failure of the same machine at another plant.
12. The full MCN process then is followed, including many meetings outlining the reasons for the change. In the end in this case, the plant manager must sign the MCN to allow the change to take effect.

If, however, a Proximitor on these machines is replaced with a non-Bently Nevada driver and the Bently Nevada probes and cables are left in place, this becomes a mixed-system or so-called "Frankenstein System." The entire process outlined above—trusted by the reliability engineers, operations, the OEMs, the plant manager, and even the shareholders—and used to help ensure the safety, reliability, and financial viability of the operation—has been inadvertently bypassed. And it was all done because a vendor stated: "Our eddy current driver is compatible with Bently Nevada probes and cables."

Even more concerning is that it happened without a substantive process, evaluation, or the knowledge of many key stakeholders. Because the gap voltage of the mixed-system still reads essentially the same during installation (see gap voltage plots above), the plant in many cases has no realization that its setpoints have effectively been changed without process.



Sample testing shows 'Frankenstein System' results

Some parts manufacturers claim that their eddy current drivers are compatible with Bently Nevada probes and cables, even to the point of using our own part numbers. The system will appear to work at first, but often will give erroneous readings.

While the machine is not running during installation the gap voltage can show similar levels. However, it can be seen clearly in the plots below what happens to the vibration measurements with a mixed system when the machine is running. Across the range of gaps in the sample testing that was done, the vibration in the 9-meter system (shown above) is generally attenuated, especially above 50 mils of gap as can be seen in the center plot of incremental scale factor (ISF). At the extreme gaps the displayed vibration for the mixed system can be attenuated by 25% or more. The ISF actually disappears above 80 mils of gap dropping below 150 mV/mil on a system that is supposed to be 200 mV/mil! The 5-meter system that was tested actually shows the opposite, with greatly exaggerated vibration. Without the use of the Bently Nevada gold standard, the other manufacturer's transducer system has little chance of being within specification. Depending on each probe and eddy current driver, the levels could read high or low.

The consequences of the attenuation are more than inconvenient. If the current vibration reading with a 9-meter system at a given point on the machine is 6 mil P-P using another manufacturer's eddy current driver, the actual vibration could be in excess of 8 mil PP or more! This could mean the difference between continued smooth operation and a costly unplanned outage or even a machine crash.

More concerning than even this is the impact an erroneous reading has on a critical thrust protection measurement. Devastating thrust failures can happen within milliseconds, long before anyone can react. Because of this, many systems use dual voting or even a Triple Modular Redundant (TMR) thrust system. The implications of the incorrect scaling of a "Frankenstein System" in this scenario are even worse.

Baker Hughes Bently Nevada Proximitors and probe designed with gold standard methods

Baker Hughes: Keeping your operations reliable and safe

1. Avoid the "Frankenstein System"! Never mix eddy current systems using parts from different manufacturers.
2. Always use a genuine Bently Nevada Proximitors product from Baker Hughes. Our Proximitors systems are based on a proprietary gold standard available to no one else and have high reliability and performance over a wide temperature range. Our Bently Nevada product line also holds an unmatched suite of certifications including hazardous area, intrinsically safe systems, and country-specific approvals.
3. Evaluate the Performance. Regardless of what Proximitors or eddy current system is used, fully understand the reliability and accuracy of the system, especially over temperature. Refer to industry standards and specifications such as API 670. Even if you are not in the petroleum industry, this specification is quite often used as a general guideline for operating critical rotating turbomachinery and reciprocating machinery.
4. Keep the Whole System Reliable. Bently Nevada 3300XL Proximitors, probes and cables, when used together, form an engineered transducer system that is extremely reliable. In addition, the Bently Nevada 3500 Machinery Protection System incorporates all of the Bently Nevada product line's 50-plus years of machinery knowledge. That knowledge has made us exceptional at data acquisition and at detecting and preventing missed and false trips.



Why not an 'adjustable' system?

Some companies claim they can adjust the limits and outputs of the eddy current system, touting the ability to tune the output to "API standards." Originally an accepted method, this legacy approach is no longer needed. Some companies still rely on it, even advertising it as an advantage, because they do not have the ability to produce our world-class gold standard technology.

With more than 4 million Proximitors systems installed on the world's most critical equipment, our experience shows that customers do not benefit from an "adjustable" system.

Firstly, sensors that can be calibrated are often required to be recalibrated on a scheduled basis. The issue with this is that there are no calibratable degradation modes in any eddy current sensors, regardless of the manufacturer. If the sensor scale factor drops, the affected component needs to be replaced, not recalibrated. Under no circumstances should an eddy current sensor installed in a machine be recalibrated due to degradation as this can lead to significant measurement error over time, essentially "tuning out" the degradation and blinding the plant to high vibrations or extreme thrust position.

Another problem relates to troubleshooting and stems from the fact that once the system has been installed and adjusted, the question always arises about whether or not it was adjusted correctly. Did the technicians set the correct upper and lower limits? Was the system adjusted at some later date? This uncertainty becomes a real issue when a machine begins having a vibration problem. The first question that is asked is whether or not the instrumentation was "adjusted" correctly. Instead of

focusing on the vibration issue, the customer is focused on diagnosing and/or validating the transducer system! When a Bently Nevada Proximitors system is used, it requires no adjustment, therefore this uncertainty is removed, and the measurement can be trusted for shutdown or diagnostics.

Not only do we calibrate our 3300XL Proximity probe systems to our proprietary gold standard, but our calibration uses robotics on fully NIST traceable equipment. We have done this more than 2 million times with the 3300XL...and counting.

What about various shaft materials?

Real-world machines are provided with a wide range of shaft materials. Since the non-contacting eddy current system is sensitive to the particular alloy of the shaft, the eddy current sensor must be able to handle these various materials and provide a consistent, accurate output. Again, some companies claim the ability to "adjust" the output of the eddy current system to any shaft material as an advantage. Unfortunately, they end up in the same situation as outlined above with a system that is adjustable but may or may not have been adjusted correctly, leading again to uncertainty. Or, their system may have had the degradation "adjusted-into it." Baker Hughes offers a complete library of Proximitors for common (and uncommon) materials, each with their own genuine Bently Nevada gold standard so that you do not have to worry about "tuning" your system in the field.

Baker Hughes Bently Nevada product line takes the reliability and safety of your operations very seriously. Over the years we have labored to earn your trust with your most critical machines. These days, we're working even harder to cover your service needs with We've got you covered with better responsiveness and reduced lead times, lower expedited and processing fees, and longer product life.

In turn, you have come to trust in our solutions and our expertise, and the fact that we are committed to never compromise when it comes to safety, quality, and reliability.



3300XL 8 mm and 50 mm Proximitors probes

