# Reliability Solutions Customer Stories

## AMS Technologies

**EMERSON**

# The Race is On: A Timed Test of Route Collection Tools

## Refinery in the USA

### Will We Have What We Need?

A refinery in the USA obtained a AMS 2140 Machinery Health Analyzer to assist in their route data collection. They tested the accuracy and speed of the new triaxial device to assess how much time and effort they could save versus their old single-axis data collector. They also compared the amount of data they could collect.

### Setting Up and Performing the Test

Among the equipment trains (including turbine and pump trains) they chose for their test, some equipment had been performing reliably, while some equipment had been experiencing occasional trouble.

*"Those data show a huge time savings and good cost justification."*
- Lead Test Engineer

The technicians benefited from the AMS 2140's five inputs (four-channels and a tachometer) because they could measure horizontal, vertical, axial, and early bearing detection (PeakVue™ measurement) simultaneously while gathering tach data. A triaxial sensor assists in this situation because it creates the illusion of working with only one sensor, but provides the same data as three sensors.

During the tests, the technicians hit enter once and obtained four readings — simultaneously. Whereas traditionally with a single-axis accelerometer they were measuring only one channel at a time and had to move the sensor multiple times.

### Faster, More Comprehensive Data Collection

The testers were shocked at the ease of measurement and the difference in collection times. For their test, the technicians measured collection times from the moment they pressed "start" to the moment the data stabilized.

- On a single machine, the single-axis collection time was 6.3 seconds; the triax was 2.3 seconds.
- For an equipment train, the times were: single-axis collection (included 12 points) 1 minute, 49 seconds; triaxial (adding a PeakVue point to each bearing in the train for a total of 16 points) 29 seconds.

The testers were pleased with the AMS 2140 data accuracy as well as the ease of performing complicated tests. Because a tachometer is part of the data collection options, all data has the same time stamp. This simplifies tests such as seeing machinery movement relative to two sides of a machine train: the pump and the motor. No special activity is required to gather that type of information; it is part of the automatic data collection.

## *A Matter of Time in Route Data Collection*



### Power Plant in the USA

#### How Can Data Collection Time Be Reduced?

The predictive maintenance team at a large power plant in the USA had to monitor a complex variety of equipment–conveyors, gear boxes, pumps, turbines, blowers, compressors, pulverizers, fans, and mills. With all this machinery, they had a difficult time completing their route-based data collection. They wanted to complete the collection in less time and with greater accuracy.

#### Simultaneous Measurements, Plus a Tach

Typically, route-based data collection requires the user to place a sensor multiple times for each machine bearing; one sensor measurement for each of the three axes. It's a daunting task when faced with testing hundreds—or thousands—of machines.

The customer decided to test the capabilities of simultaneous four-channel data collection via the AMS 2140 Machinery Health Analyzer. Used in their route-based data collection, the AMS 2140 offered four-channel monitoring and a triaxial accelerometer measurements simultaneously so that one measurement action collected data for all three axes. They measured multiple bearings simultaneously—significantly streamlining advanced diagnostics, such as Operating Deflection Shape (ODS) analysis.

They found that not only was the testing itself more efficient with three simultaneous measurements, but the processing speed of the device was 30% faster than the CSI 2130 (one of the fastest data collectors in the industry) when collecting a measurement point.

#### They Found Time

The reliability team now completes their route data collection and analysis in 30 to 50 percent less time. They cover more machines during their shift, and they can spend time analyzing data to better focus on high-value tasks.

In addition, the team likes the convenience of the AMS 2140's long battery life and the ability to see the screen in low-light conditions without having to manually adjust the screen brightness.

## *Vibration Analysis Tools Provide Insight during Collection*

### Refinery in Germany

#### Where Can Helpful Data Be Found?

After data is collected, it must be analyzed. What if a technician knew which data would prove valuable for later deeper analysis? He could gather that data while still in the field rather than making another trip. A technician who had a rich set of analysis tools embedded in the portable collection device could give potential answers to issues and could provide direction for additional detailed data collection.

#### Field Analysis Helps Focus Data Collection

Recently at a customer site, an Emerson engineer used the analysis tools available in the AMS 2140 Machinery Health Analyzer to help prepare machines for start-up. After initially gathering data, the engineer viewed the vibration spectrum for a few moments of the test. He found (as expected) the running speed frequency of the machine. He also found (quite unexpectedly) a ghost frequency.

In the field without leaving the machine, the engineer—by simultaneously viewing dual-orbit plots available on the AMS 2140—looked for instabilities or other conditions that could lead to machinery damage. He then gathered additional data required for further analysis using AMS Suite tools in the control room. In fact, if required, the engineer could have chosen from 14 additional diagnostic tests to assist in deeper analysis in the field.

#### Data, Ease, and Insight

The AMS 2140 simplified and streamlined test configuration, field measurements, and plot analysis. In fact, if it were not for the ease of data gathering and analysis, some testing and analysis completed in this study might have been skipped due to the time they would have required.

- Ease of measurements—Without the ease of use and four-channel capability of the AMS 2140, time might have been spent measuring rather than designing additional tests and analysis to determine the source of the ghost frequency.

- Depth of data—Some of the analysis would not have been possible without the tach pulse input that was simultaneously gathered with data from the four sensor inputs.

- Rich analysis tools—The side-by-side plotting and the ability to select the points for further analysis made the AMS 2140 an invaluable tool in assessing the risk of the vibration.

# Predicting Gearbox Failures with PeakVue™ and Wireless Monitoring



> **"Wireless monitoring has shown itself to be a valuable tool in our condition monitoring armory. Predicting failures in gearboxes of this type can make considerable savings on any subsequent turnaround and help to keep equipment available."**
>
> - David Hambling, Instrument Electrical Technical Engineer

## SABIC Petrochemicals in the UK

### How Can You Be Sure You Won't Miss a Problem?

Not long ago at SABIC UK Petrochemicals, vibration data collection and analysis for their olefins cracker pumps were performed manually. Between the manual readings, however, potential problems sometimes arose that led to higher maintenance costs and reduced plant availability.

Simply put, SABIC "wanted to improve the monitoring of critical pumps at the Olefins plant in Teesside," according to David Hambling, SABIC instrument electrical technical engineer.

### Continuous Monitoring in an Easily Created Wireless Network

The SABIC olefins team chose to install a wireless condition monitoring and prediction system that included the AMS 9420 Wireless Vibration Transmitter and PeakVue technology.

Since the plant already had an Emerson Smart Wireless network, the installation of the wireless vibration transmitters was simple, and the devices started broadcasting machinery health alerts based on the vibration readings to the distributed control system almost immediately. In the future, the established mesh network will simplify adding or relocating wireless-enabled devices for additional process information from remote or difficult-to-access locations.

At the site, the AMS 9420 measured overall vibration and temperature, while PeakVue technology detected faults that could cause friction, impacting, and fatigue—particularly in gearbox and rolling element bearings. The monitoring system reported machinery health alerts every 30 minutes and conducted an in-depth, full-spectrum analysis once every day.

### Detection before Failure

Since installation, Emerson's online vibration monitoring system has detected a number of problems that could have resulted in equipment failure, including a chipped tooth on a gearbox gear and an impending bearing failure.

Identifying and rectifying potential problems earlier has helped minimize pump failures and maintenance costs and has improved maintenance scheduling. It also has helped reduce the risk of unexpected failures that can result in lost production as well as safety and environmental incidents.

# Improving Safety and Reliability with Wireless Vibration Monitoring

## Flint Hills Resources, Refinery in the USA

### How Can You Prevent the "Bad Day"?

A Flint Hills Resources (FHR) plant in the USA—processing 320,000 barrels per day of high-sulfur heavy crude—performed a process hazard analysis (PHA) that showed 110 high-risk pumps were potentially subject to vapor cloud release and explosion.

FHR was looking for a reliable, cost-effective way to prevent that "bad day." They needed an early detection method to determine when they were operating in a high-risk mode so that they could avoid pump failure. With this early detection, FHR hoped to manage the risk of pump failure, avoid injury, process shutdown, and additional maintenance expense.

One effective method to obtain early warning is about developing pump defects is vibration monitoring using Emerson's PeakVue technology.

*"With just one such situation, Flint Hills had achieved its objectives with the data."*

- Nick Jude, Rotating Equipment Reliability Engineer

### Vibration Data Collection and Analysis Brings Results

FHR chose the AMS 9420 Wireless Vibration Transmitter for early detection of hazardous vibration and impacting. The rugged AMS 9420 connected quickly to the pumps to deliver vibration information over a highly-reliable, self-organizing *Wireless*HART® network.

FHR identified Emerson's PeakVue measurement as the best indicator for high-risk operating states on their pumps in hazardous service. PeakVue detects the impacting caused by rolling element bearing faults, under lubrication, and pump cavitation—all major causes of pump failure if left unaddressed. The data is reported to the control room. When the PeakVue readings cross a pre-determined alert level, the facility has a procedure to address the issue within a certain timeframe. The on-site maintenance engineer can also tap into the vibration measurements provided by the AMS 9420 to perform advanced diagnostics and troubleshooting.

### Discovery and Resolution of Vibration Issues

Having the data provided by Emerson's AMS 9420 wireless vibration transmitters, Flint Hills now knows which pumps need to shut down and which pumps could safely remain in operation. In fact, in the first eight months of the new detection scheme, FHR found and addressed three or four potentially hazardous situations.

## *Ensuring Safe Operation of Remote Assets and Wireless Monitoring*

### Large Refinery in India

#### How Do You Monitor a Cooling Tower?

The maintenance team at a large refinery in India struggled with this exact question. Although breakdowns lead to serious process disruptions, it seemed there was no good solution. Monitoring the vibration with portable equipment was too hazardous, but online vibration monitoring was too expensive. Installing vibration switches looked like a promising solution, but ultimately proved ineffective because the switches failed without notice, leaving these key assets completely unprotected.

Around the world customers experience difficulty in monitoring their cooling systems because they are in remote, hazardous, and unpleasant locations.

Here's the catch: For many plants, losing cooling ability leads to a costly process slow down or even shut down.

#### Wireless Transmitters Reduce Cost

This refinery found their solution in the AMS 9240 Wireless Vibration Transmitter, and they discovered that—with Emerson's solution—vibration monitoring of the gears and gearbox bearings could be installed at a relatively low cost.

As part of an Emerson highly-reliable, self-organizing wireless Smart network, the AMS 9420 connected easily and economically to a wide variety of machines. It delivered vibration information for use by operations and maintenance personnel.

In addition, configuration, diagnostics, and alerts could be imported into AMS Suite: Intelligent Device Manager software for deeper analysis and greater improvements to the maintenance process.

#### Data Automatic and Complete

This refinery now has the reliable monitoring that it needs. Changes in gearbox vibration are visible to the operators in the control room and stored in the plant data historian. Furthermore, the maintenance and reliability team receive detailed diagnostic data automatically in AMS Machinery Manager software for full vibration analysis.

The AMS 9420 provides constant updates about the asset condition to the control room so that they can avoid surprises and schedule repair activity in advance of a failure.
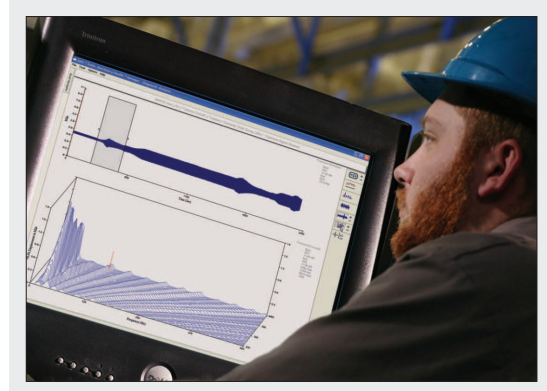
# SIL3-Certified Overspeed Protection for Hydro Turbines

## Hydropower Plants in Brazil

### Replacing Mixed, Inefficient Technologies

As a Brazilian company began to modernize the controls of multiple hydropower plants and a dispatch center, the power producer's goals included helping to boost unit reliability, flexibility, and efficiency. Because their facilities used outdated controls based on proprietary technology from many vendors, the company had a difficult time finding parts and integrating the controls with other equipment and devices.

### Move to Unity

The customer chose a unified solution that included Emerson's Ovation™ control, SCADA technology, and AMS 6300 SIS SIL3-certified digital overspeed protection system for their hydro turbines. In addition, they opted for AMS Suite to equip maintenance and operations staff with valuable insight into asset health — thus minimizing downtime and unplanned outages.

### Turbine Protection Leads to Improved Plant Performance

At these sites, Emerson's Ovation control system is the first distributed control system in Brazil to control the turbine and balance-of-plant equipment and processes, including wicket gates and the cooling system. Because it now controls plant processes and regulates turbine speed, the Ovation system helps ensure precise frequency control and smooth synchronization to the grid.

In addition, the overspeed protection system currently helps the customer in these ways:

- During transient operations like start up, shut down, and load change, the AMS 6300 SIS guards against overspeed conditions caused by sudden load losses and verifies the rotational direction to ensure your assets function correctly.

- During normal operation, the AMS 6300 SIS protects equipment from going into an overspeed condition caused by unexpected changes and sudden load losses.

- The customer's system has a SIL2-rated rotational direction detection so that the rotational direction of the machine is detected immediately when it starts.

- With Advanced Gap Drift Warning, the system constantly checks the position of its sensors. If the mechanical distance changes due to what reason ever, the system gives the customer early warning,

- The overspeed protection system always works with the optimal trigger level, independently from changes in the sensor-target position.

By replacing obsolete controls with a common automation platform and overspeed protection, these hydropower plants have gained methods to improve overall control, plant performance, and reliability.

## *Integrating the DCS and Machinery Protection*

## Power Generation Plant in the Middle East

### A Search for Integrated Turbine Protection System

One of the largest power generation companies in the Middle East recently embarked on a broad automation system upgrade at one of its main power plants. An integral part of the initiative included the upgrade of its existing turbine protection system to meet current safety and risk mitigation standards.

### Easy Integration

Emerson's overall solution included building on to an existing, installed Ovation distributed control system platform. The customer chose the AMS 6500 for its easy integration to Ovation and its protection capabilities.

The easy three-step integration between the AMS 6500 machinery protection system and the Ovation system promised to save the power generation site hundreds of work-hours and provide complete, error-free integration of machinery information with the Ovation system.

The customer also recognized the opportunity for real-time integration of machinery information into the Ovation system. The complete system would deliver actionable information to operations staff and protect the condition of critical machinery assets.

### One Company, Complete Solution

Emerson's monitoring expertise and world class Ovation turbine control system delivered a complete control/protection solution that was founded on one source for control, protection monitoring, and sensors.

The integration of protection data into the control system now pushes key protection parameter data faceplates onto Ovation operator displays within just minutes of system setup. It daily enables operators to have continuous real-time access to critical turbine and generator vibration and position status — it was made possible through out-of-the-box Ovation HMI macros.

## *Moving to Online Monitoring Improves the Bottom-Line*

### Anadarko in the USA

#### Expensive Failures Even with Monthly Route-Based Monitoring

Anadarko, a significant processer of gases from oil wells, contracted vibration reliability services to check equipment including critical reciprocating gas compressors each month. But many failures occurred so quickly that the once-per-month checks proved to be inadequate. Each reciprocating compressor failure resulted in more than $12,000 per hour in lost production.

Anadarko needed a comprehensive online monitoring solution that provided visibility to failures of roller element bearings and reciprocating compressor valves. Anadarko required remote monitoring of reciprocating compressors for real-time access to catch problems that develop quickly.

#### Continuous Monitoring Predicts Failures

Well equipped with two 48-channel AMS 6500 transient units including PeakVue and Modbus to monitor two critical reciprocating compressors, Anadarko's solution also used AMS Machinery Manager software and remote-monitoring AMS Asset Performance Manager software.

Anadarko recognized that by using the AMS 6500 to help them monitor machinery health, they would no longer run blind. In addition, they understood that the PeakVue technique would provide a simple, reliable indication of valve health viewable via a single trend.

#### Prediction Leads to Correction and Profits

Anadarko's choice proved to be a win for them. They now have detailed diagnostic data at their fingertips wherever they have an internet connection. Now they can monitor machines, predict issues, and correct issues before they lead to bottom-line losses.

## *Operators Obtain Visibility to Critical Machine Issues*

### Ethylene Oxide Facility in Mexico

#### Replacing an Outdated Maintenance Process

An ethylene oxide facility in Central Mexico had been working with online machinery protection systems, but they needed a more modern system to perform both online prediction and protection. In addition, they had been performing route-based collection maintenance by using hand-held portables. They realized an updated solution could include both protection and prediction, eliminate the walk-around measurements, and include prediction on additional machines.

#### Including Protection and Prediction

The company selected Emerson in part due to the transient capability of the AMS 6500. They realized that by using the AMS 6500 with the transient analysis option, no data would be missed. Any questions about machinery health could be answered with continuous data and playback capability.

Housed in a single chassis, the AMS 6500 provided the customer proven prediction and protection to provide a complete online machinery monitoring solution.

#### The Solution

The customer site is now monitoring three oxygen compressors and three air turbo compressors. They are monitoring radial, axial, temperature, speed, and phase for each machine. In addition, all data are integrated to the distributed control system so the operators can monitor the plant's most critical rotating machines. Overall, the facility gains real-time machinery health feedback integrated with process automation and can transform vibration monitoring into predictive alerts.

## Prediction-Based Maintenance Improves Offshore Maintenance

### Norske Shell Draugen, Oil and Gas Platform in the North Sea

#### Can Poor Spare-Parts Supply Produce Better Maintenance?

Yes ... if the situation leads to a change in supplier and an improved strategy to increase predictive maintenance. Shell had supply and support problems that, in part, drove them to rethink their machinery-health program.

Shell's goal: Use predictive maintenance in 40% of maintenance workload — helping improve maintenance efficiency and increasing production. Shell's plan: Migrate to a system that takes advantage of current prediction and protection technologies from Emerson's Reliability Solutions group.

#### Prevent Key Assets from Failing Unexpectedly

For years, Shell embraced both protection and machinery health management systems. It was not enough. By updating technology and adding prediction capabilities, they found enhanced power.

Now in place at Shell, Emerson's prediction-and-protection system records up to 100 hours from all channels and saves the data to a hard disk. By reviewing the information after an event, personnel gain a greater understanding of the cause and can devise the proper fix.

The prediction solution from Emerson is a powerful step beyond protection. For example, Shell installed new seals on a gas compressor during a planned shutdown. But after the change, they noticed compressor instability. The monitoring system provided a predictive parameter to Shell which enabled them to discover and address an imbalance near the center of the shaft.

In addition to using protection and prediction capabilities, Shell now integrates data from remote online machinery health monitoring systems. Shell personnel efficiently review data, compare data from other offshore platforms, and determine best-practice solutions for potential problems.

#### An Ambitious and Attainable Plan Delivers Results

Specific results are visible. For example, Shell personnel evaluated data from the gas compressor and determined how to address an imbalance: they scheduled an overhaul and balance check/correction during a short shutdown. This saved approximately one and a half days of compressor downtime — saving about 60,000 barrels of oil. Since then, the compressor has been stable and shows lower vibration levels, which reduces stresses on the equipment and extends time between maintenance.

Monitor equipment accurately. Identify potential problems early. Prevent assets from failing unexpectedly. Your result: Increased production and improved maintenance efficiency.

*Needed: Confidence in Production*

## Copper Production in Chile

### Equipment Reliability Affecting Production Goals

A large copper producer in Chile, producing over 350 million tons copper/year, was under intense pressure to increase their equipment's availability to ensure production goals. They recognized they had to invest in high-quality online prediction and diagnostic technology to assure they could address critical machinery issues before potential unforeseen shutdowns occurred.

### Data and Recommendations Easily Understood

The customer chose to include in the solution six AMS 6500s with prediction capabilities on multiple crushers, agglomerators, and refining pumps. The transient feature of the AMS 6500 was included in the solution to be able to replay the conditions as necessary for analysis.

PeakVue also was chosen as part of the solution so that the engineers at the mining facility could interpret easily machinery conditions and could determine both when a machine fault exists as well as the severity of the defect. PeakVue was also chosen because it could provide diagnostic information that assists in determining the exact nature of the defect and recommended targeted remediation.

### Business Results

This is the first of multiple investments already planned for additional critical equipment.

# *Cutting Through the Complexity of Machinery Analysis*

## New Technology

Traditionally, vibration data has not been routed to the control room because it required specialized training–and frequently specialized tools–to extract any information from the data.

Emerson's PeakVue technology cuts through the complexity of machinery analysis to provide a simple, reliable indication of equipment health via a single trend. PeakVue filters out traditional vibration signals to focus exclusively on impacting, a much better indicator of overall asset health on pumps, fans, motors or any other type of rolling element bearing machine.
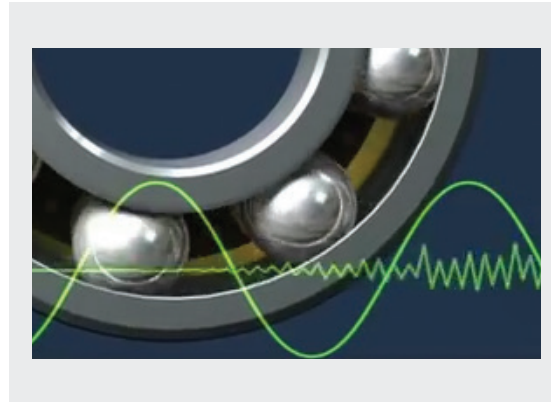
## Simple Interpretation

As a measure of impacting, PeakVue readings are much easier to interpret. A good machine, properly installed and well lubricated, should normally not have any impacting on it. This establishes the zero principle:

**The PeakVue measurement on a good machine should be at or close to zero.**

*The PeakVue trend provides operators with a simple yet conclusive way to verify when a machine is in good condition and provides early warning of developing problems with an indication of severity.*

As common machinery faults begin to appear on rotating equipment (e.g. rolling element bearing defects, gear defects, insufficient lubrication, or pump cavitation), the PeakVue reading typically can be evaluated using the Rule of 10's:

**PeakVue Reading (g's)**

*Rule of 10's*

- 40 — Critical abnormal situation *(Implement action plan)*
- 30
- 20 — Serious abnormal situation *(Develop action plan)*
- 10 — Abnormal situation developing *(Monitor more closely)*
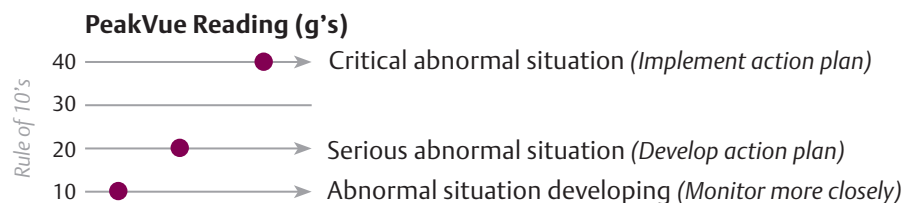
## Bringing Reliability to the Control Room

With these simple principles, PeakVue is a powerful tool to bring reliability to the control room. Operators with no special training in machinery diagnostics can use PeakVue measurements quickly and easily to determine both when a piece of rotating equipment is healthy and when an abnormal situation is present.

## Conclusive Analysis

Once an abnormal situation has been identified using the PeakVue overall, detailed diagnostic information can be extracted from the PeakVue waveform or spectrum to determine the exact nature of the defect. PeakVue can visualize distress signals on a machine that are simply not visible with other vibration measurements. Earlier indication of developing defects facilitates optimum maintenance planning and minimizes the impact on production.

# *Improving Dialogue between Operations and Maintenance*
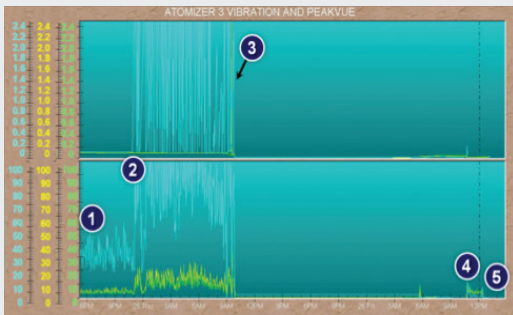


**The PeakVue trend makes it possible for operators to discern machine health without any specialized training.**

## Power Plant in the USA

### Frequent Failures

A power plant had been experiencing continued problems on an atomizer, with frequent bearing failures about every three months.

### Operations Makes the Call Based on PeakVue

The power plant installed an Emerson transmitter on the atomizer and included PeakVue technology. At the point of start-up indicated in the graph (area 1), the overall vibration readings (indicated by green line) were all below acceptable levels. In contrast, the PeakVue readings on one bearing (blue line) were already ranging from 30 to 40 g's—indicating that a critical bearing fault was likely already in play.

Six hours later, around midnight, the vibration at this bearing location (area 2 of graph) shifted dramatically. The PeakVue levels rose sharply to above 100 g's, while the overall vibration level jumped suddenly from baseline to nearly ten times the fail-alert level. Both of these changes indicated that the bearing was in the process of failing. The control room communicated with maintenance planning to schedule maintenance for the following morning and continued to monitor the machine closely.

By about 9 am, the overall vibration level (area 3 of graph) on an adjacent bearing suddenly increased sharply from baseline level to about ten times the fail-alert level. At this point, operations made an immediate call to shut down the process.

### Operations Makes another Call Based on PeakVue

The defective bearing was replaced, and the machine was scheduled for start-up the following morning (area 4). The operator, familiar with PeakVue's Zero Principle, noted that the machine was running at nearly 10 g's at start-up. He contacted maintenance and asked them to check out the machine. As result of the PeakVue warning and the operator's prompting, the maintenance team discovered the root cause of the repeated failures on this machine: the grease fitting was clogged. As a result, when they lubricated the bearing, only a fraction of the grease actually made it to the bearing.

The maintenance team cleaned the grease fitting, reapplied lubrication, and as expected, the PeakVue readings dropped below 1 g (area 5). The same asset that had previously failed every three months for more than a year has now been running for more than two years without incident.

This step change in reliability was made possible by the ability of the control room to view and interpret the machine condition and then function as an extra set of "eyes" for the maintenance group.

## AMS 2140
### Machinery Health Analyzer



- Enables portable vibration data collection and analysis with simultaneous four-channel plus phase-data collection and peak-detection capabilities for the earliest indication of bearing and gearbox degradation.

## AMS 9420
### Wireless Vibration Transmitter



- Connects quickly and easily to any machine. Wireless capabilities benefit equipment in hard-to-reach locations or equipment that needs more visibility to operations and maintenance personnel.

## AMS 6300
### SIS Digital Overspeed Protection System
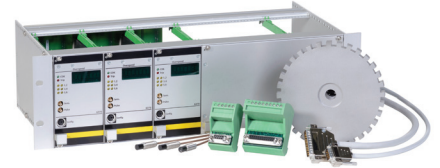


- Helps protect and prevent damage caused by overspeed conditions in critical rotating machinery and detects rotational direction to avoid problems during start-ups.

## AMS 6500 ATG
### Machinery Health™ Monitor



- Combines proven prediction and protection to provide a complete online machinery monitoring solution.

## PeakVue™
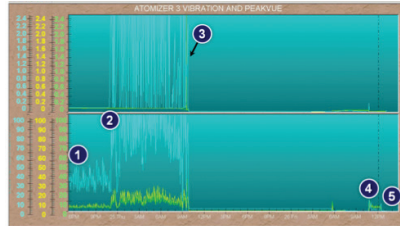


- Cuts through the complexity of machinery analysis to provide a simple, reliable indication of equipment health via a single trend.

## AMS Machinery Manager



- Diagnoses and communicates the health of mechanical and rotating machinery using data from predictive maintenance technologies.

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