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the magazine for PdM & CBM professionals

mar 2006

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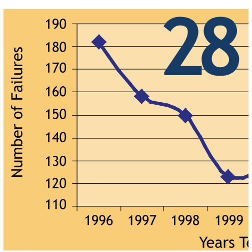

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Excitement's In The Air

I'm excited.

I'm excited because we just held our first web workshop in The Reliability Roadmap™ series. It was a great beginning. We had well over 200 people register for the first leg of the journey. We had two presentations, one focused on machinery healthcare, the other on failure fault findings, which shared real-world solutions with participants. Based on preliminary feedback, about 90% learned something that will improve their work. If you missed the live event, you can access audio and video online at www.reliabilityweb.com. Just look for the roadmap on the homepage. The event will also continue through discussion groups at www.maintenanceforums.com. Log on to join in. Our next workshop will be April 21st, and I encourage you to sign up early. Space is limited.

I'm excited because in January, I had the opportunity to go to ThermalSolutions 2006. That was a high-quality conference. I left there thinking that I'd like to be a thermographer when I grow up. If you are a thermographer, or are interested in learning more about infrared technology and its applications, you should put ThermalSolutions 2007 on your calendar now.

I'm excited because we are introducing the 1st Annual Uptime Predictive Maintenance Awards (details on page 24). If you have a program that you think is on the right track, I encourage you enter. There is no cost. The winners will be recognized at an awards banquet during the PdM-2006 conference in Chattanooga, Sept. 12th-15th.

I'm excited because in this issue we have our first article contributed by a reader. Bob Gelow, from Colorado Springs Utilities, submitted an article on balancing for our precision maintenance section (page 32). It is a powerful illustration of a PdM program that has the know how and ingenuity to solve their maintenance problems on-site, which lowers their costs and increases their uptime.

Bob writes, "I welcome the opportunity to share information and experiences (good and bad) that your readers or anyone in the industry would like to communicate. I believe that all of us that have been in this business for any amount of time have a wealth of experiences that need to be shared throughout the industry. Industry publications such as Uptime present an excellent forum to access and provide information to benefit shareholders in the PdM/RCM field."

I couldn't have said it better myself, Bob. Thanks again for your contribution.

We welcome your thoughts and comments. Please let us know how we're doing, and how we can be more useful to you.

All the best,

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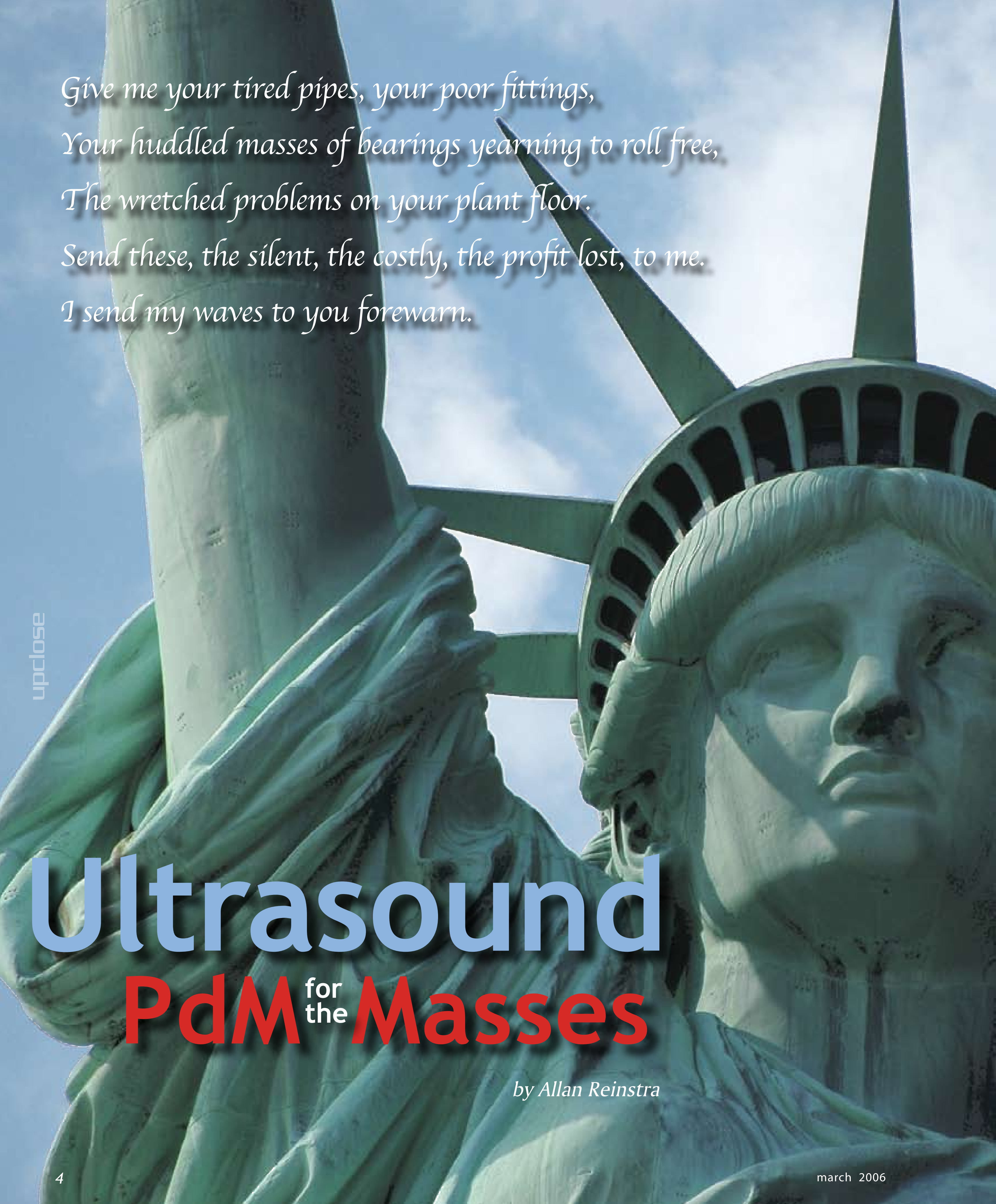

Give me your tired pipes, your poor fittings,
Your huddled masses of bearings yearning to roll free,
The wretched problems on your plant floor.
Send these, the silent, the costly, the profit lost, to me.
I send my waves to you forewarn.

Ultrasound PdM for the Masses

by Allan Reinstra

The phenomenal rise in popularity of Airborne Ultrasound for use in predictive maintenance programs is attributed to three factors; ease of use, versatility, and low implementation cost. Once considered a companion technology to core predictive tools such as vibration and infrared analysis, we now see the emergence of stand alone ultrasound inspection programs as standard practice for maintenance departments around the globe. Indeed ultrasound is now considered a front-line defense system in the everyday battle for manufacturing uptime. Airborne Ultrasound is Predictive Maintenance for the Masses.

Like any advanced inspection and monitoring technology, purchasing the hardware is only one of many steps involved in establishing a program that works. An effective ultrasound inspection program includes a planned pre-investment strategy to ensure results right out of the box. Your strategy should include identifying which applications are most important for your facility, how inspections will be carried out, and how your results will be benchmarked. It should address issues such as certification training and program leadership as well as goal setting and program evaluation. Without a sound strategy in place for your ultrasound program you may not achieve the long- term effect you desire.

Ultrasound is now considered a front-line defense system in the everyday battle for manufacturing uptime.

Program Implementation

Establishing this strategy can be problematic for maintenance departments that are already stretched thin by budget cuts or are managing to exist with a "putting out fires first" mentality. For example, assigning manpower to collect ultrasonic route data is a tremendous hurdle to overcome initially, but is more realistically achieved if implementation procedures are put in place first. An implementation strategist can assist in setting up your ultrasound inspection program, which should be custom designed to suit the needs and goals of your individual facility. On-site consultants help you justify the implementation of your program by:

- Educating your personnel on the basics of ultrasonic inspection and data collection
- Working with you to identify all the applications that apply to your plant
- Conducting plant tours to identify data collection points and logical route creation
- Writing procedures and manuals for inspectors
- Providing on-site certification training
- Establishing a corporate pilot program at a single facility
- Taking initial readings to establish baseline data and commitment to procedures

Many companies that recognize the value in maintaining an effective ultrasound inspection program based on the points outlined above have already invested in an on-site implementation strategist to help them meet and keep their goals.

Figure 1 - Airborne Ultrasound's versatility good for many types of inspections.

Mass Appeal

Predictive Maintenance Managers are attracted to airborne ultrasound inspection because it is a technology that is easy to use, has boundless versatility, and is low cost relative to other predictive technologies. The most common uses include leak detection, condition monitoring, and condition-based acoustic lubrication of bearings. Additionally, specific industries monitor thousands of steam traps and pinpoint in-leakage to boilers, condensers, and heat exchangers. Still others tie ultrasonic inspection and infrared scanning together for a more complete predictive maintenance of their electrical substations and switchgear.

Easy To Use

Ease of use does not necessarily equate with simplicity. The inner workings of an ultrasonic data collector are complex. However quality manufacturers dedicate additional resources to develop an ergonomic and logical user interface that promote an easy to use instrument.

The basic operating principle is to detect high frequency sound pressure waves, beyond the range of our human ears, and transform them into low frequency waves which can be heard through noise attenuating headphones. The sound quality is maintained during this transformation (Figure 2), so what we hear in the sonic range represents the original ultrasonic source. A bearing sounds like a bearing, a leak sound like a leak, and so forth.

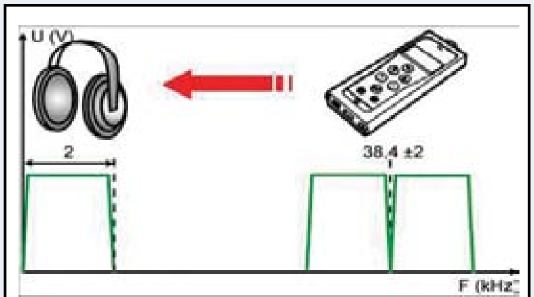

Figure 2 - Heterodyning effect

The development of more technically sophisticated ultrasonic data collectors is one driving force in the popularity of this technology. More than just translators of sound, today's technology provides repeatable measurements, processes data digitally from start to finish, can collect and trend readings, and records sound files for advanced analysis and sonic visualization.

Ultrasonic Analysis is a technology that benefits everyone, yes everyone, involved in maintaining the manufacturing process. As you have read, applications for airborne ultrasound are many, and far reaching. Perhaps one of the biggest hurdles faced by your ultrasonic program will be scheduling your turn to use the equipment. Ultrasonic applications will suit vibration analysts, infrared thermographers, lubrication techs, millwrights, pipe fitters, predictive maintenance planners, maintenance managers, facilities managers, production managers, quality control managers and more.

Most maintenance related problems encountered at your plant can be discovered at a very early stage through the implementation of an ultrasonic program. Traditionally excessive vibration and thermal increases were sure indicators of a mechanical failure on the not-to-distant horizon. But we also know that microscopic changes in friction forces, detectable with ultrasonic testing long before a machine enters critical failure, provide a bigger window of opportunity for scheduled maintenance. By hearing problems at an earlier stage, damage is minimal and the required maintenance is completed with less impact to the overall operation of the process.


Learn at your own pace
in your own place.

Take a look at some of the most common maintenance applications for airborne ultrasound that could be applied at your plant today.

Compressed Air Leak Detection

Compressed air is one of the three costliest utilities in use at your plant. Leaks are expensive, and often ignored. Most often they can be heard with the naked ear, but are difficult to pinpoint because of background noise. An ultrasonic detector can hear leak turbulence through the ambient noise of the factory floor. The high frequency component of a leak is directional making it easy to locate its source. A compressed air survey, performed with an ultrasonic detector once per quarter (Figure 3), can reveal savings potential in the millions and benefit facilities managers looking to improve efficiency and reduce costs.

Figure 3 - Conducting an Air Leak Survey.

Condition Monitoring

Ultrasonic data collection offers a significant and necessary application by condition monitoring production machines and trending normal operating levels to identify changes that affect healthy, continuous operation. All rotating equipment produces frictional forces with high frequency ultrasonic signatures which are often masked by ambient plant noise and low frequency vibrations. Changes in these signatures serve as early indicators of failure and provide comparative information for vibration data. An ultrasonic instrument equipped with digital decibel metering measures and logs the intensity of high frequency frictional forces. Understanding how this technology differs from traditional vibration analysis is the first step toward realizing the vital importance of ultrasonic condition monitoring at your facility.

Condition monitoring with ultrasound provides overall data that is indicative of friction levels, random impacting, rubbing, and energy produced by the machine at the sensor pickup point.

Figure 4 - Monitoring feed water pump

Unlike vibration analysis, readings are not "normalized" meaning that machine parameters are not inputted to the data collector prior to taking the measurement. Ultrasonic monitoring is useful as a first line defense instrument. Collecting information is quick and inexpensive. Much more data can be taken, extending condition monitoring to more machines which may have been overlooked by vibration due to time and costs. Ultrasonic monitoring (Figures 4 & 5) will detect a change earlier in the fault cycle than other technologies. For this reason ultrasound is generally used to alert changes in condition and provide a preliminary diagnosis.

Vibration Analysis is a great companion technology at this point because it does provide normalized readings. Information about the machine such as shaft size, shaft speed, and type of bearing is entered into the equation prior to collecting the data. Combining the vibration reading with machine parameters allows the analyst to make a thorough diagnosis by drawing educated, and usually correct, conclusions. Recent advancements in ultrasonic monitoring elevate the level of diagnostic possibilities for this technology. This opens the door for comparing low frequency vibration diagnostics with high frequency ultrasonic diagnostics for an even more thorough and conclusive analysis about the state of the machine. Ultrasonic signals are recorded as sound files and transferred to PC where the signal is analyzed using AVM Ultranalysis™ or other signal analysis software. This software is capable of viewing

Real World Report - Compressed Air Leak Detection

A medium sized southwestern Ontario factory that makes aluminum wheels for the automotive industry. The facilities manager was charged with the responsibility for utilities optimization, which means he looks at any technology that can save his company money, builds a project around the idea, and if the numbers add up the project goes ahead. Across from his desk scrawled in bold black marker on his whiteboard were the words:

Compressed Air Savings - $140K in 6 months

An Ontario factory calculates its annualized savings from reduced air leaks at $280,000/year. With their profit margin that is like adding $8,000,000 in Gross Revenue.

When asked to explain, he recounted that in the 6 months since purchasing his ultrasound leak detector (which happened to be an Ultrawave 170), he calculated ongoing savings of $140,000. That's $280,000 per year wasted to compressed air leaks. He went on to say that, based upon their company's current profit margins, they would have to make, and sell, an additional $8,000,000 of product to compensate the expense of compressed air leaks.

Since the position of Utilities Optimization was created, they have looked at many ways to reduce energy costs including energy efficient lighting and motors. No other ideas met the rewards posted by the compressed air audits and remediation. When asked what the future of their ultrasonic inspection program would be once their compressed air system was fixed, a candid reply followed a confident smile.

"We plan to continue our air leak surveys each quarter. The leaks we have today are the net result of years of neglect and ignorance about true costs. Now we are educated about the expense compressed air leaks represent, and we know that new leaks will manifest on their own. Leak detection is now part of our regular preventative maintenance and our post-strategy goal is to ensure that things never get back to where they were. Our strategy was born out of necessity, and it works. Goals were set, procedures were written, and significant savings were documented giving us approval all the way to the CEO level."

"Our next step is to analyze condition monitoring applications with ultrasound. If we can demonstrate similar benefits then a program will be implemented and launched based on our projected findings."

Figure 5 - dBµV levels on hydraulic pump motor

the sound file in time and spectrum domains. By comparing Ultrasonic time and spectrum analysis with Vibration time and spectrum analysis, analysts can rely upon two opinions instead of one.

Acoustic Condition Based Lubrication

There are cases when an inspector is very much in tune with the sound of his bearings and over time, can tell by the quality of sound heard from his ultrasonic data collector that the bearing needs lubrication or is entering an early failure stage. For most cases, the inspector uses the principles of acoustic vibration monitoring, which incorporates the science of ultrasound, true RMS signal averaging, and repeatable digital data to determine when the bearing needs lubrication and exactly how much. For decades, time-based lubrication programs were used, and during this same time period, bearing failures due to over-lubrication were constant. A new approach to lubrication is shifting away from time-based lubrication schedules to a predictive, condition-based schedule utilizing proper ultrasonic trending methods. This technique has become the norm for establishing lubrication requirements on most production machinery.

Figure 7 - Ultrasonic lubrication at Lafarge North America

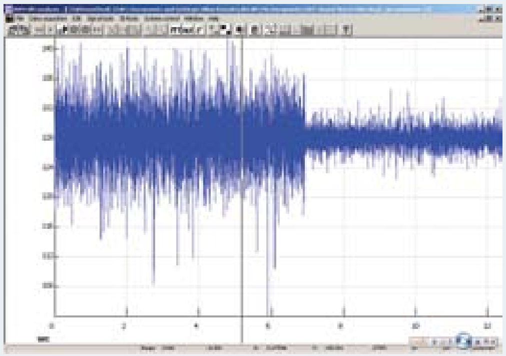

Figure 8 - Time waveform as bearing is being greased

Real World Report - General Mills, Chicago, IL

Chex brand cereal is among several foods produced at General Mills West Chicago facility. Since the introduction of AVM Acoustic Vibration Monitoring for their lubrication program there have been some significant finds. Figure 6 illustrates ultrasonic dBµV readings from five 75-HP cooker motors. Jerry Woolard, Maintenance Reliability Engineer, used a comparative method here to see normal baselines on all motors except number 4. A difference of 10-12 dBµV was noted on this motor's free end bearing. Woolard recounts how the high noise was picked up on a routine inspection. The bearing was changed out during a planned downtime without disconnecting the motor from the coupler (which saved re-alignment time) and placed back into service. It's normal for bearings to be autopsied after replacement to establish root cause. Upon examining the bearing they found thickener from the

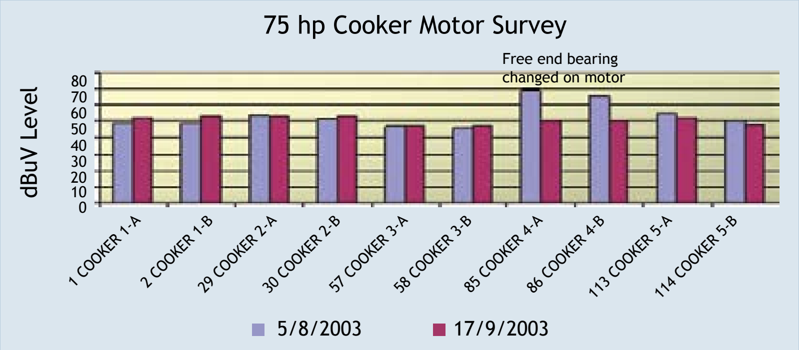

Figure 6 - Ultrasonic readings from 5 cookers at General Mills

grease was dried out and caked into the cage of the bearing. No oil was left in the bearing and no new oil could get past the caked-up thickener. The problem was detected early because ultrasound inspections are done on a regular basis due to the speed and low cost of collecting the data. The bearing cost was $32.00, labor cost was $100.00, and unscheduled downtime was averted.

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Real World Report
Potash Corp of Saskatchewan (PCS-New Brunswick)

Ultrasonic Data Collection, Vibration Analysis, Oil Analysis, and Infrared Thermography are four complimentary predictive technologies, and they are used extensively by Ralph Copp and the Predictive Maintenance and NDT team at Potash Corporation of Saskatchewan (PCS) New Brunswick. PCS is a Potash and Salt Mine near Sussex, New Brunswick, Canada. Both products are mined approximately 2000 ft. below the surface. After going through a concentrator (mill) on the surface, the potash is shipped around the world and used primarily in the fertilizer industry as one of the main ingredients. The mined salt is used mostly for road salt in the winter months.

For all mechanical applications, Copp uses the Ultrawave 170MD first to do bearing inspections. This is their "first line of defense" since it allows them to check as many bearings as needed quickly, then prioritize which equipment needs to be looked at further. Ultrasonic energy is generated by the frictional forces of rolling element bearings, regardless of their condition. Frictional energy from a well lubricated bearing is measured and logged to establish baselines. Changes in lubricant condition are heard and measured with ultrasound at a very early stage; normally before the bearing enters initial failure stage. The same technology can then be employed to properly lubricate and extend the useful life of the bearing.

Figure 9 graphs ultrasonic data from the drive-end bearing on a 150HP electric motor used to power a re-circulating pump. Between January 15 and February 22, 2003, a span of only 5 weeks, ultrasonic values taken increased 12 dBµV over normal baseline indicating the bearing needed re-lubrication. Using proper lubrication techniques, the bearings frictional forces returned to a normal level. This was confirmed by retaking dBµV readings after greasing. Ultrasonic data collection saved the bearing from running without proper lubrication, and afterwards, confirmed that the lubricator applied the correct amount of lubrication. This is equally important because too much grease would cause the dBµV and temperature levels to rise again.

Figure 9 - Ultrasonic dBµV readings on 65-028 #2 XLR Re-circulating Pump Motor

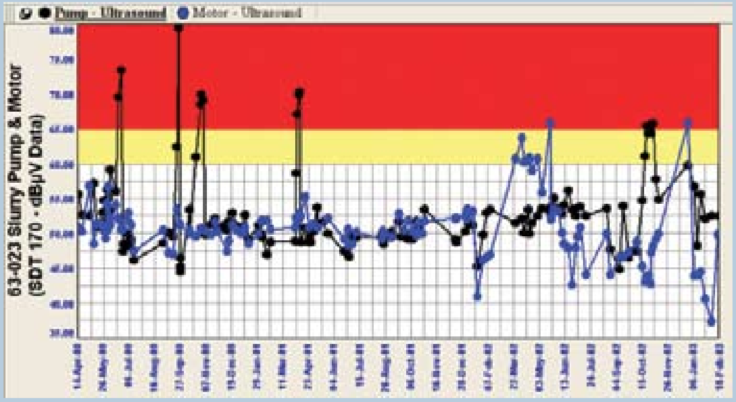


Figure 10 - Ultrasonic dBµV readings on 63-023 XLR Slurry Pump and Drive Motor

Only one point of contact on the bearing housing is required to display an acoustic reading on the screen. In addition to sensing lubricant failure, ultrasound detects very slight friction forces produced when two metals are in contact with each other. Deformations in the shape of the rolling elements, pitting and spalling of the raceway, and other deteriorations create sharp spikes of energy called bearing defect energy. This ultrasonic activity is measured as a dBµV (decibel/microvolt) reading for each bearing point, stored in the unit's internal data collector, downloaded to a PC database, and trended over time.

A CMMS software called Maintelligence, manufactured by DMSI (Design Maintenance Systems Inc) conveniently integrates Copp's ultrasound data with Infrared, Oil Analysis, and Vibration data. Recently DMSI wrote a dedicated driver for the SDT Ultrawave 170MD which streamlines route creation and maintenance, and data collection, alarming, and reporting. PCS has established alarm levels for their ultrasonic readings. Figure 10 is a trending graph of 63-023 XLR Slurry Pump.

Trending ultrasonic readings for this equipment started in April 2000. Every time a dBµV reading enters the red portion of the graph (Alarm Level) the equipment is scheduled for repair as soon as possible. In Potash Corp's case, the ultrasonic alarm level for most of their equipment is set at 65 dBµV. This level was set based on their previous historical experiences. One failure on this pump occurred at the end of September 2000 when, during their regular ultrasound inspection, they detected an 80 dBµV reading, up from 62 dBµV in the early part of September. The pump was replaced with a rebuilt assembly. Only a couple of weeks later the ultrasonic readings entered the alarm level again. Further investigation showed a defective rebuild of the pump assembly. After the pump was rebuilt again (properly this time), ultrasonic readings stayed low for several months. Potash Corp uses ultrasonic data collection to monitor the condition of most rotating equipment weekly. This technology provides the earliest possible indication of deterioration and potential failure. When the inspector wants to know the reason why ultrasonic readings increased, he uses his data collector and reviews the vibration readings.

Ultrasound answers several questions for the PdM inspector: Do I have a good or bad bearing? Does the bearing need lubrication? How much lubrication should be applied (being careful not to over-grease)? How fast is the bearing deteriorating?

When asked to summarize his experience with the equipment he uses as a predictive maintenance manager, and to offer some advice to colleagues in the industry, Copp offered the following: "I have been doing vibration analysis for approximately 20 years. About 5 years ago I started using DMSI Maintellegence Monitor. It is an excellent program for handling our oil analysis, temperature, and process data. 2 1/2 years ago (2000) I decided to add the SDT 170MD as another predictive maintenance tool. The DMSI team quickly built a SDT driver allowing me to import all SDT data into Maintellegence Monitor. Any type of data is very easily manipulated and graphed in Monitor. If I was a company with a limited budget I would definitely think about the DMSI - Maintellegence software in conjunction with their handheld inspection computer...for predictive maintenance tools temperature (*infrared*), oil analysis, and the SDT 170MD ultrasonic datalogger would be my choice. If used correctly, these technologies are very effective at monitoring the health of your equipment, and they don't cost thousands and thousands of dollars."

Lubricant absorbs friction energy between the rolling elements of a bearing. Acoustic vibration is low when the bearing is properly lubricated. However, as the lubrication film breaks down this energy increases, even though the bearing may not have any significant wear. An increase of 8 to 10 dBμV over historical baseline indicates a need for lubrication. This is confirmed by listening to the bearing's acoustic qualities in the headphones, or by viewing the waveform on a spectrum analyzer (Figure 8). Bearings lacking lubrication will sound louder, with a rough growl, compared to the relatively smooth whirring noises of a well-greased bearing. The waveform on an oscilloscope will show inconsistent peaks if the bearing is lacking grease.

Electrical Inspections

The versatility of ultrasonic inspections extends to the electrical maintenance department too, where routine scans of switchgear, substations, and high KV transmission and distribution lines are commonplace (Figure 11). With the growing concern about safety, and the danger of arc flash and transformer explosions, the importance of finding problems at an ultrasonic level can't be over-emphasized. Radio and TV interference are common complaints from local cable companies. Often the source can be traced to a faulty transformer or a failed lightning arrestor. Pinpointing the culprit is quick and simple with an ultrasonic scan. The directional nature of ultrasound focused on a parabola reveals problems from a safe distance.

Figure 11 - Electrical inspections with ultrasound not only identify problem components but also increase safety.

Steam System Inspections

A steam trap is an automatic valve that opens for condensate and non-condensable gases and closes for steam. It is designed to trap and remove water, air, and CO_2, which hinder the efficient transfer of steam, corrode system components, and cause damaging water hammer. Ultrasonic surveys of the entire steam system will reveal system leaks, blockages, stuck valves, and failed traps. On average a 30-40% increase in steam efficiency is attainable. That translates to huge dollar savings and increased product quality. Steam trap inspection is an ideal ultrasonic application for utilities managers and pipe fitters.

Pump Cavitation

Cavitation is the result of a pump being asked to do something beyond its specification. Small cavities of air develop behind the vanes, and these pockets have a destructive effect on the pump's internal components.

Figure 12 - Checking Cavitation

Air pockets form behind the vanes of recirculation pumps causing pitting and deterioration. Place the probe on the vanes first and register the dBμV reading. Move the probe to the bearing (as shown at left) and re-confirm the dBμV value. Listen to the signal. Is the cavitation sound louder or quieter at the bearing? Does the bearing require grease? After greasing, recheck the pump vanes. Is the cavitation sound still evident?

During normal data collection vibration analysts use ultrasonic inspection to isolate random cavitation, which can be masked by low frequency modulations. Using an ultrasonic detector in contact mode, isolate the pump vanes and listen for small air pocket explosions. Place the contact probe on the housing of the pump vane and adjust amplification to filter down shaft noise. Comparing similar pumps will help the uninitiated, but with experience, an operator will quickly be able to detect pump cavitation.

Reciprocating Compressors and Valves

Reciprocating valves allow compressors to "breath." Worn or dirty valves can't seat themselves properly. Worn springs also affect the sharp opening and closing necessary for efficient compression. Valve condition is monitored with ultrasound inspection and spectral analysis software. The demodulated signal from the detector is fed directly to an analyzer or stored as a wave file. Spectra graphs visualize the compressor valve as it opens and closes, and intakes and exhausts.

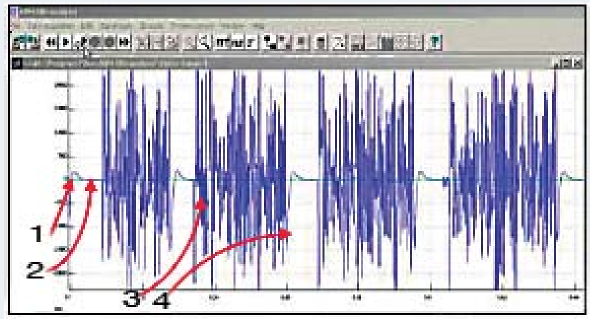


Figure 13 - Time Waveform of Typical Compressor Valve

1- Spike as valve closes
2 - Flat line as valve is closed
3 - Abrupt and continued spike as valve opens and air intakes or exhausts
4 - Abrupt and discontinued spike as valve closes.

By visualizing the recorded sound file of a compressor valve in the time domain a lot can be learned about the condition of the valves and their components Valves are opened and closed by a spring mechanism allowing reciprocating compressors to intake and exhaust. There are three distinct events (Open, Intake or Exhaust, and Closed) occurring all at split-second timing, much too quickly for our ears to process. By viewing the wave file in real time we can stretch it out to visualize each individual event. In Figure 13, the waveform shown is four cycles in less than 1/10th of a second. It clearly shows the valve closed (2 - flat line at zero), open and intake of air (3), then a small spike as the valve slams shut (1 & 4), and flat lined again to indicate a tightly sealed valve (2). There are a few things to look for in this picture. First, we can trend the small spike as the valve spring pulls closed (1 & 4). As the spring ages and wears this spike becomes smaller and smaller. As a result some noise may appear where the flat line (2) was as the valve is not held as tightly closed.

Weak springs and poorly seated valves will also change the shape of (2&3). As the valves open and close there will be in-leakage or out-leakage lessening the abruptness of the spike. Time wave images are saved and compared over time to see the evolution of wear.

Heat Exchanger and Condenser Leaks

Tube condensers and heat exchangers cool steam, which condenses back to purified water and is returned to a boiler where it's superheated back to steam. Leaks in the tube allow contaminants to enter, which opens the door for corrosion and reduced operating life. Keeping the water pure is the key to efficiency. The general method of inspection involves scanning with the instrument a couple feet from the tube sheet (Figure 14). If a noisy area is found it is noted. The inspector should then switch to an extended flexible sensor and scan tube to tube. If the sound signal on the digital dBμV meter or sound in the headset does not change from tube to tube, a leak is unlikely. This is particularly true of tubes located on the outer edges of the tube sheet as these tubes are more likely to have noisy steam flowing over their OD surfaces. If a significant signal change occurs, then a leak is suspected. If the leak is within the tube the difference will be heard at the tube opening. If the noise level is heard on the tube sheet, the inspector should block the area to eliminate reflected noise. Then place a rubber precision tip with an opening of one eighth inch on the flexible extended sensor and hold it almost on the tube sheet surface.

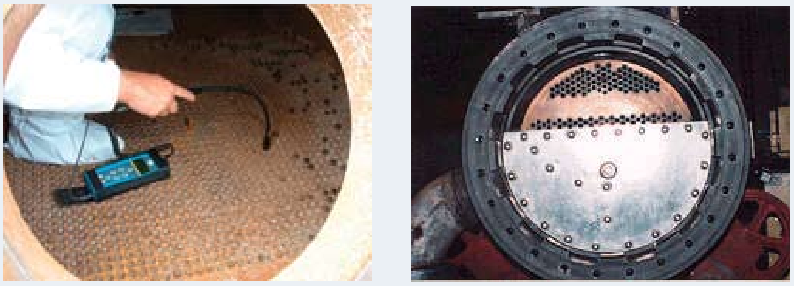


Figure 14 - Inspecting heat exchanger tube sheet and end plate for leaks

Valves and Hydraulic Leaks

Over time small leaks, blockages, and by-passing will manifest inside hydraulic systems. The sources of these faults are detectable with ultrasonic inspection. Hydraulic oil will form small bubbles which pop as they are forced across seals and wipers. With a magnetic or contact sensor placed against the housing, set the sensitivity to maximum to reveal the tiny explosions. The signatures from a passing hydraulic valve can be a steady rushing sound or an intermittent gurgle. Comparing similar areas in the system to trace down blockages and passing will save hours of visual inspection and tear down time.

Conclusions

Ultrasonic inspection, detection, and data collection has been around for over 30 years, but only recently gained acceptance as a standard for predictive maintenance departments. Branded as "Ultrasonic Leak Detection", this technology has shed its type-cast role to become a versatile, important, dynamic member of the predictive family. The case studies presented in this article reflect successful wins in the food, forest, and automotive industries, supporting claims of diversity for ultrasonic inspection technology. The three real world examples all have one thing in common; their investment was not restricted to the purchase of quality ultrasound equipment. They all pursued certification training from an accredited training program and they all developed an effective strategy which led to the implementation of a long-lasting meaningful airborne ultrasound program. Beware the traps of technology. Buying the latest and greatest gadgets, even the useful ones like ultrasound, will only take you so far. Your planning, strategy and implementation are the ultimate factors in determining the effectiveness of your ultrasound inspection program. For a successful and long-lasting program, be prepared to invest in a program implementation specialist to help you establish your goals, plan for the execution of those goals, and institute a means to measure the progress of your program as the benefits start rolling in.

Airborne Ultrasound is, indeed, Predictive Maintenance for the masses.

Allan Rienstra is the General Manager of SDT North America providing ultrasound solutions to maintenance professionals since 1991. Allan has written countless articles on practical applications for ultrasound inspections including "Strategies for an Effective Airborne Ultrasound Program". These published works are considered the standard by companies implementing inspections programs. As a co-author of SDT's Level 1 Ultrasound Certification Program, Allan is recognized as a leader in his field. He is a graduate of Simon Fraser University, Vancouver, British Columbia, Canada and resides in Cobourg, Ontario with his wife and two children.

Real World Report - Koch Cellulose, Brunswick, GA

Koch Cellulose in Brunswick, GA recently told us how they use ultrasound inspection to find internal leaks on a grappler hydraulic stop valve. The grappler is used to transport tons of timber through the mill yard and any malfunctions pose unwanted downtime.
Their goal was to determine location of fluid bypass or internal leakage of hydraulic components and reduce equipment downtime by limiting disassembly and repair to only defective components. This goal was set because they believed that properly holding hydraulic cylinder stop valves will produce no sound as heard by ultrasonic detection equipment. Defective valves will produce a continual "hissing noise" as the fluid leaks past the valve or valves.

Test Procedure

They position the grapple bucket in working platform so that all four stop valves can be reached by the inspector with his ultrasonic detection equipment. With the electric hydraulic pump pressurizing the system, they have the operator close the grapple. With the ultrasonic detector set to the internal leak setting, the inspector positions the contact probe on the stop valve body. The inspector then instructs the operator to pressurize system once again by continuously forcing the grapple into the closed position. Then the inspector simply observe the amplitude bar scale and value on the detector.

Note - An amplitude fluctuation of approximately twenty decibels indicates a properly seating, non- leaking stop valve. With headphones, listen for either a continual or fluctuating hissing sound. A continual hissing sound combined with a constant amplitude value means that the stop valve is leaking pressure.

Test Validation

All four stop valves were manually tested by removing the return oil lines and pressurizing the hydraulic cylinder and stop valves. With the system operating at approximately eighteen hundred PSI, a substantial amount of oil could be seen leaking from the suspected valve. No leaks were observed from the other three valves. Inspection of the leaking valve revealed broken (clipped) "O" rings around the valve body. The stop valve was replaced with a newly rebuilt valve that when tested also leaked. The valve was removed and found to have suffered from clipping of the "O" ring seal. Inspection of the valve block revealed a sharp entrance edge that may possibly clip the "O" ring during valve installation. Using ultrasound, they identified the root cause of the valve failure.

Convective Cooling

ΔT Changes With The Wind

by John Snell

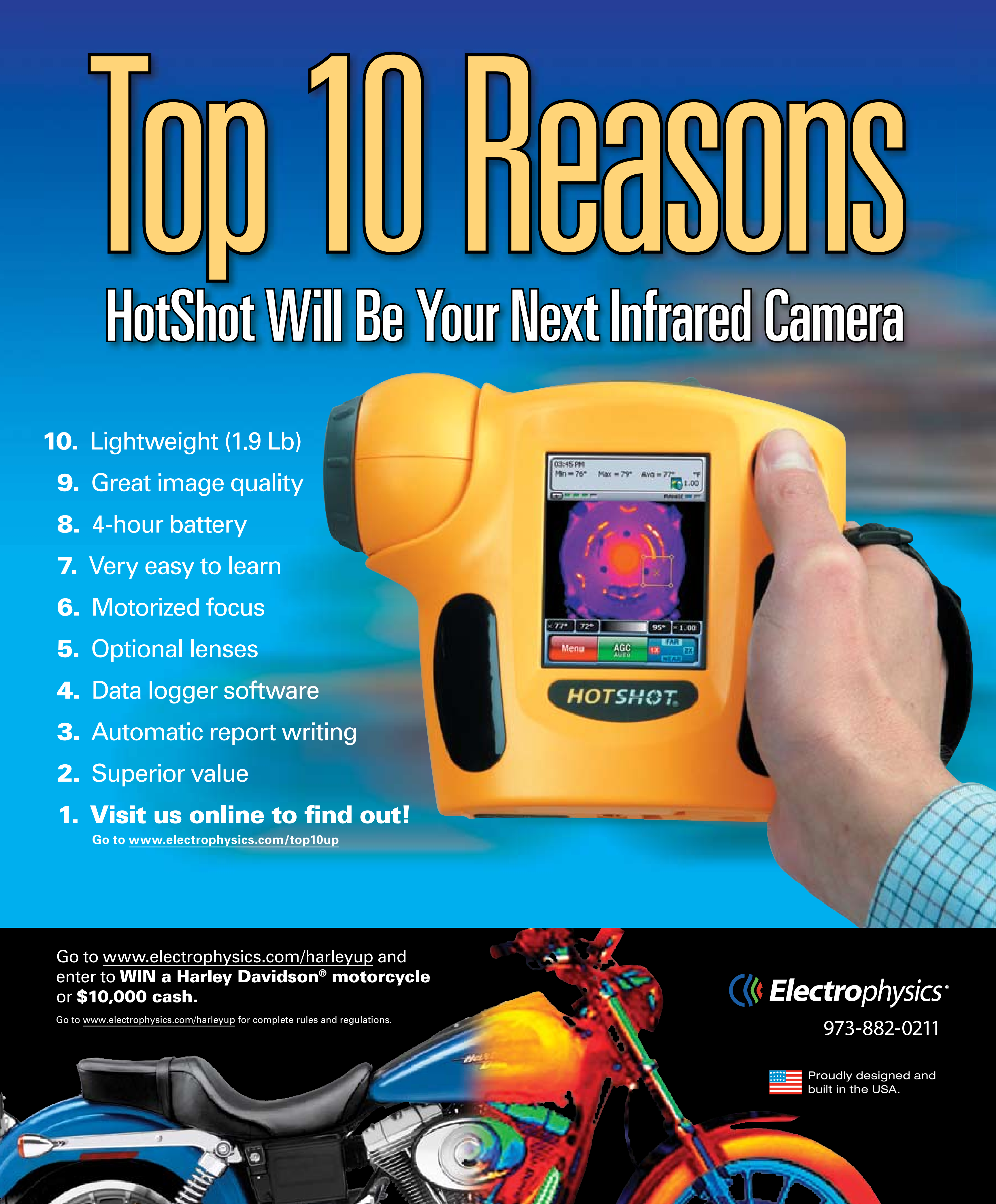
Many factors influence the temperatures of surfaces we are inspecting with infrared thermography. One of the most significant is convective cooling by wind or air currents. Not fully understanding the complex relationship between surface temperature and convection can result in serious errors of interpretation. While the impact of wind is typically the most significant, air currents inside many plants are also common and, if not understood, confusing to interpretation. A simple, but convincing, example is offered here and provides a valuable learning opportunity for all thermographers.

The Lesson

How often do we "learn" information but fail to incorporate it as knowledge? Having been involved in the business of training thermographers for nearly twenty years, we anticipate this by building plenty of "hands-on" activities into our work to drive home key points in an undeniable fashion. Once students are back on the job we know their continued learning will again be reinforced at the gut level by reality.

An excellent example recently came to us from one of our instructors who was doing a Level I on-site course at a large power plant on the coast of the Gulf of Mexico. During the class, the students conducted a hands-on field exercise and inspection of their large distribution substation. As is often the case along the coast, there was a steady 12 MPH breeze off the Gulf. While inspecting a set of oil-filled circuit breakers (OCBs) in the switchyard for the power plant (see Figure 1), several students found a "hot spot" on the load side of the B-phase bushing; it clearly showed a temperature difference (ΔT) of 13°F over the normal phase. With loads running at maximum, as they were, this temperature rise was deemed a concern but not a high enough priority to warrant immediate concern. The students also noted an almost imperceptible anomaly on the line side B-phase which was indicated by a ΔT of only 4°F. Both anomalies can be seen in Figure 2. Both appeared to be

Figure 1 - A set of 3-phase oil-filled circuit breakers (OCBs) seen from the outside (left) and another set (right) from the inside, with the oil drained, showing part of the bushing structure and contacts.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8. 4-hour battery
7. Very easy to learn
6. Motorized focus
5. Optional lenses
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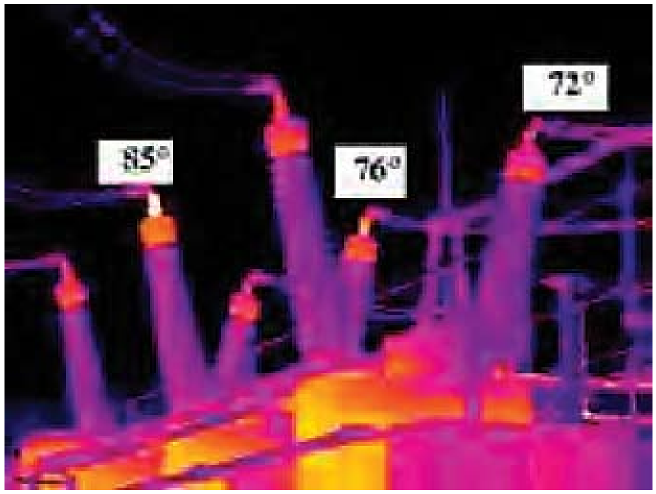

Figure 2 - In this image, taken during a 12MPH wind, two problems can be seen; one is obvious, while the other is not. The thermographer gave both low priority.

related to a threaded connection in the top of the bushing assembly.

The students had nagging concerns about the accuracy of the temperatures they had measured.

"What if we're wrong?" they asked themselves in class that afternoon. They all felt assigning such a low repair priority for a piece of equipment that was this important might be a mistake. As part of the Level I course, they had just had an in-depth discussion on the impact of conducting a survey in the wind. They had learned about how Newton's Law of Cooling defines the relationships impacting convection (see Figure 3). They knew that the relationships determining "h" (velocity, orientation, surface, geometry, and viscosity) were interactive and complex. It was clear they were also difficult to quantify in a field situation like they had encountered without sophisticated software and the experience to use it. While they had heard of programs that could make simple corrections for wind, they heeded the instructor's warning that things were not necessarily that simple.

Their intellectual understanding had been reinforced as they had watched a simple classroom demonstration with amazed disbelief. In the demonstration, a 15MPH air current caused the temperature of a resistance heater to drop from 320°F to less than 140°F in a matter of minutes. Could the same thing be happening in the switchyard due to a 15MPH wind?

The Snell Infrared instructor discussed the situation and challenged the class to dig in deeper and really find out what was true about the OCB hotspots. Early the next morning they met again before class, grabbed the infrared cameras and headed back to the switchyard. The surface of the nearby Gulf was as close to a mirror as it ever gets. The electrical loads on the plant were at normal. Conditions for a follow-up inspection were perfect.

Although the students half expected it, they were all, quite frankly, rather shocked at what they saw (see Figure 4). The ΔT on the load side bushing had increased from 13°F to 36°F. The line side bushing connection, which had been barely imperceptible the day before, now showed a ΔT of 14°.

What had changed? Only the wind speed. It was a simple convective heat transfer problem - reduced wind meant reduced cooling! Also now undeniably obvious was the fact that both problems stemmed from internal threaded bushing head connections, and were much more serious problems than they had initially appeared to be. There was little doubt that the heating at the source of the high resistance was hotter than it appeared on the bushing surface being observed. Later that morning, sobered by their learning experience, our trusty group of young thermographers made a recommendation to schedule further testing (ultrasonics and dissolved gas analysis) and, based on those results, make repair at the next available opportunity.

This is an experience from which we can all learn, whether we are new in this game or

$$q = h \cdot A \cdot \Delta T$$

In which:
q = heat energy transferred by convection
h = convective heat transfer co-efficient
A = area over which transfer takes place
ΔT = the temperature difference between the surface and the convective medium

Figure 3 - Newton's Law of Cooling

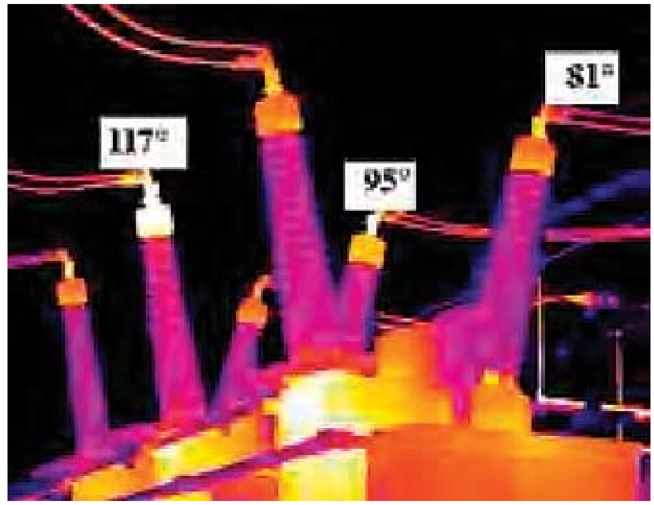

Figure 4 - The same set of OCBs was re-inspected the next morning, this time with no wind. The results were alarming, resulting in an order for repair during the next available opportunity.

seasoned veterans. Thermographers may recognize that convective cooling has an impact, but how can we estimate what it will be? Unfortunately, it's not as simple as some would have us believe. The reality of heat transfer in and around a particular component is that it is usually quite complex. For that reason, thermographers should avoid using any of the simplistic software programs available that employ a single correction factor for all convective situations. These programs will produce results that will, in all probability, be inaccurate and should be considered highly suspect by an educated thermographer.

To make accurate temperature corrections of real-life situations requires a detailed analysis, skilled modeling, and confirmation of results for each situation encountered. Variables such as the shape of the components, their orientation, and precise local conditions involved are all necessary for an accurate correction calculation. Is it worth all this effort? That depends on the consequences of having inaccurate data versus accurate data. Situations like this set of OCBs probably warrant a careful analysis given the variability of the local conditions, and the cost and criticality of the equipment.

Thermographers must always be mindful that the components we are inspecting in these situations are being cooled by

1st Annual Uptime
PdM Program of the Year Awards

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Best Infrared Thermal Imaging

Best Lubrication/Oil Analysis

Best Motor Testing

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Uptime Magazine is devoted to Predictive Maintenance and Machinery Condition Monitoring. Part of our mission is to promote and acknowledge best practices. We have created the Uptime PdM Awards to provide positive exposure and acknowledgement for predictive maintenance professionals from around the world.

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Beaufort's Wind Scale

4-7 MPH	8-12 MPH	13-18 MPH
wind felt on face leaves rustle weather vane moves	leaves in constant motion small flage are extended	dust & paper raised small branches move

Figue 5 - The Beaufort Wind Scale

convection, either wind or air currents. It is likely that the cooling, even for air currents as low as 5MPH, will be significant enough that either one or both of the following two things will be true:

- Any hot connections you find during convection will be hotter when convection is reduced.
- You may entirely miss some problems because they are simply being cooled below the threshold of detection.

Inspections conducted at times when convection is in excess of approximately 10MPH should be undertaken only with great caution. The exact nature of findings should be verified on a calm day or by other test methods. Wind speed should be measured or estimated at the site of the inspection; listening to the weather report in not sufficient. In fact, in one instance, the authors found winds of 18MPH at the upwind end of a large substation and only 5MPH winds in the downwind side! The structure of the substation itself had a huge moderating influence.

Snell's Recommendation

We have used, and can recommend, the Kestrel Model 3000 as being rugged and reliable; cost is approximately $160. A new model, the Kestrel 4000, costs about $300 and can be left unattended to automatically make, store and display graphically a series of measurements over time. If you are unable to find these products locally, the are available on our website at www.snellinfrared.com

Two simple methods can yield an accurate understanding of local convective conditions

- Use Beaufort's Wind Scale, a simplified version appears in Figure 5, to estimate wind speed based on its effect on the surroundings.
- Use any of the newly marketed hand-held, electronic "weather stations" now available.

These remarkable devices very accurately measure instantaneous, maximum, or average wind speeds, as well as air temperature, relative humidity, dew point, heat index, and other parameters. (for more info see Snell's Recommendation).

By the way, the story of our friends at the Gulf Coast utility ended safely and happily. Shortly after the class, they took an unscheduled outage for other reasons, and followed the students' recommendation to make repairs.

Damage to the threaded connections on both bushings was obvious and extensive, confirming their worst suspicions. After the repairs were made, the students shot one last thermal image to verify they had been effective (see Figure 6). You can be certain the wind was not blowing when this last image was made! They'd learned their lesson well and would not make the same mistake again.

John Snell, president and founder of Snell Infrared, has been teaching people to use this remarkable technology since 1983. He was the first person in the world to receive an ASNT Level III certificate in the thermal/infrared method and continues to be very active professionally on numerous standards committees and at conferences. To learn more about thermography and Snell Infrared visit http://www.snellinfared.com or call 800-636-9820.

This article was originally delivered as a presentation at ThermalSolutions, one of the premier learning events in the world for infrared thermographers. For more info on the conference go to www.thermalsolutions.org

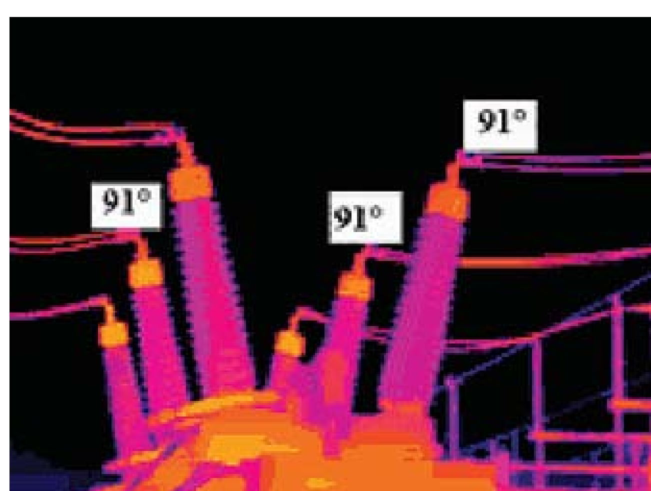


Figure 6 - A follow-up inspection after repairs are made is highly recommended. The thermal image, taken during ideal load and no-wind conditions, clearly shows repairs were effective.

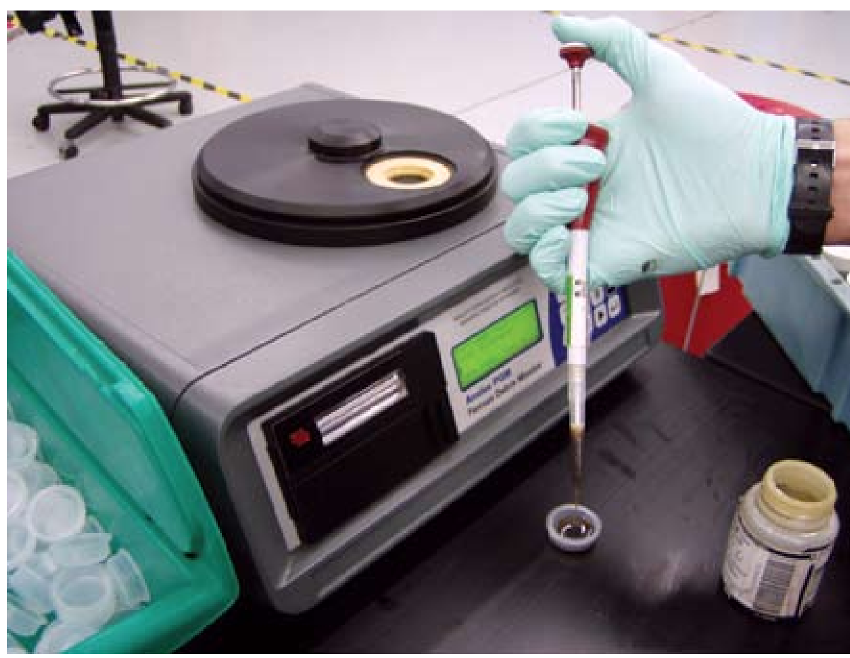
Indexing Big Metal

Particle Quantifying Provides Low Cost Alternative

by Jacque Powers

Particle quantifying, or PQ, is becoming an increasingly popular method for measuring concentrations of large ferrous wear particles in used oil samples. When supplemented by spectrographic oil analysis, such as Inductively Coupled Plasma (ICP) Spectrometry (metals analysis), PQ provides a low-cost alternative to Direct Read Ferrography for many reasons.

Unlike direct read ferrography, particle quantifying does not require multi-phase dilution for accurate results. The expense of using chemicals and the hazards of handling them are eliminated. Since there is less material interference in particle quantifying, both sample preparation time and the probability of human error are reduced. Therefore, PQ not only has better repeatability - it makes trend analysis more reliable and costs less.



PQ requires little sample preparation. Samples may be introduced in plastic pots (pictured), glass bottles, membrane filters or glass slides.

How Particle Quantifying Works

PQ exposes samples to a magnetic field. Those containing ferrous metals cause a distortion in the field, which is represented as the PQ Index, an arbitrary unit of measurement that correlates well with Direct Read Ferrography - large. The PQ is designed to monitor trends. It does not provide a ratio or Ferrous Wear Particle Concentration (FWPC) code of small to large particles as does Direct Read. However, if the PQ Index is smaller than the iron parts per million (ppm) as measured by ICP, it's unlikely that particles larger than 5 microns are present. If the PQ Index increases dramatically while the ICP's iron ppm remains consistent or goes down, larger ferrous particles are being generated and further testing or diagnostics would likely be recommended.

Why Include PQ In Your Testing Regime?

The benefits of PQ are substantial. There is no single laboratory test that gives a result to quantify or qualify wear. Metals analysis from Atomic Emission Spectroscopy (AES) is typically limited to <10 micron metallic particles. Most wear trends start with the smaller size particles and will eventually lead to larger (>10 microns) wear particle generation. If your testing regime only includes metals analysis from

Example of Information Generated by Particle Quantifying

Helical Gear		<5 Micron Ferrous Wear	>5 Micron Ferrous Wear
Iron	PQ Index		
129 ppm	21	Normal	Very Little
129 ppm	126	Normal	Minor Level
129 ppm	208	Normal	Moderate Level
129 ppm	355	Normal	*Significant Level
129 ppm	552	Normal	*Severe Level
Trend			
152 ppm	68	Normal	Normal
229 ppm	92	Upward Trend	Some Increase
447 ppm	211	Occurring	*Increasing
459 ppm	408	Stabilizing	*Significant
22 ppm	817	Decreasing	*Severe (failure event)

*An increasing PQ Index with little or no change in Iron ppm <5 microns is a strong indicator that Iron particles >5 microns are being generated and an Analytical Ferrograph should be performed to qualify the type of wear, alloy and source.

spectroscopy, you are not getting all the information you need. Including PQ gets you much closer to the full picture.

Additional Testing

Carefully monitoring iron concentrations with metals analysis and particle quantifying will identify the development of wear trends and provide the trigger for ordering an Analytical Ferrograph to qualify the type and severity of the wear. Analytical Ferrography is a powerful tool, and, when used in conjunction with metals analysis, PQ, viscosity, acid number and water content, helps a data analyst provide users with a well-defined course of action to correct the condition of the unit and/or the lubricant.

The Particle Quantifier automatically recalibrates between each sample measurement.

What Unit Types Should Utilize PQ

PQ works very well for units where ferrous metals are the primary wear concern. These unit types include, gear systems, transmissions, PTO's, wheel motor bearings, rolling element bearings, rotary screw compressors, reciprocating compressors, engines and hydraulic gear pumps.

What PQ Can Do For You

PQ is a very inexpensive way to regularly screen samples for ferrous metals. It provides enough information to recommend further testing only on those samples determined to be problems. It is, without a doubt, considerably more thorough and cost effective to do PQ on a regular basis and run Analytical Ferrographs on samples with potential problems than it is to run a Direct Read on EVERY sample.

Jacque Powers has a Master of Arts Degree in Journalism from Ball State University and a Bachelor of Arts Degree in Communications from Pittsburg State University in Kansas. She is currently the Marketing and Communications Manager, as well as a technical writer, for POLARIS Laboratories in Indianapolis. She can be reached at jpowers@polarislabs.com

Opportunity is Knocking

Are you going to answer the door?

by Howard W. Penrose, Ph. D. & Richard Borge

The application of motor systems maintenance and management programs have the potential impact of saving industry an initial $26.5 Billion in electrical energy costs while reducing greenhouse gas emissions by over 3,000 Mega-Tons per year. The individual impact on production availability is also significant, by reducing troubleshooting and evaluation time by over 50%, motor repair by over 30% and general motor-system related labor by up to 50%, following the application and sustainment of the program. In this article, we are going to cover three opportunities obtained through the application of the Electrical Motor Diagnostic component of an overall program.

Opportunity 1 - Application of Motor Diagnostics for Periodic Testing

In a recent study, 1,054 motors were evaluated with motor current analysis (MCA) in a marine environment. The motor system owner's previous program involved the use of insulation to ground testing with a pass/fail limit of 1 MegOhm. The selected technology used in the study was an ALL-TEST IV PRO 2000 motor circuit analyzer which obtains data on resistance, impedance, inductance, phase angle, current/frequency response and insulation to ground testing.

During the period of testing, 35 machines were found to have insulation resistance values of '0' MegOhms. A total of 398 machines had a variety of potential faults identified as developing winding shorts, winding contamination, poor connections and/or a combination of faults (Figure 1).

Of the 35 machines with low insulation resistance values, only one failed during the following eight months. This machine was also identified with developing winding faults. Of the remaining 363 machines, over 20% were identified as having failed over the next eight months. Note that additional machines may have also failed, however the data was limited based upon the accuracy of failure data entered into the associated CMMS software system.

A majority of the 1,054 machines were considered critical, with a number of them including fire pumps. Most of the identified motors were allowed to operate to failure. One of the significant issues identified in this study was that the application followed along with the expected 1 in 4 to 1 in 6 motors being identified with potential faults as identified in the 2003 "Motor Diagnostics and Motor Health Study."

Opportunity 2 - Application of Motor Diagnostics for Predictive Maintenance

In 1996, a field service company initiated a motor diagnostics program utilizing a Baker Surge

Figure 1- Faults and Types Detected

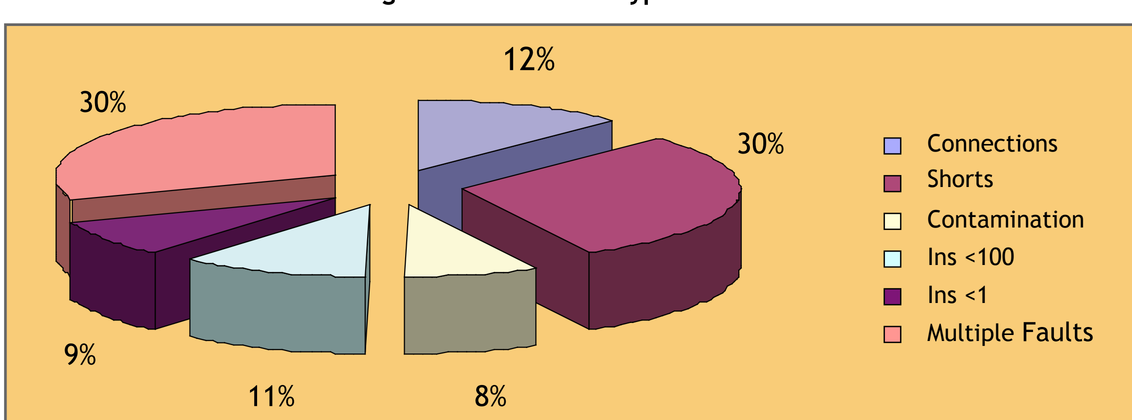
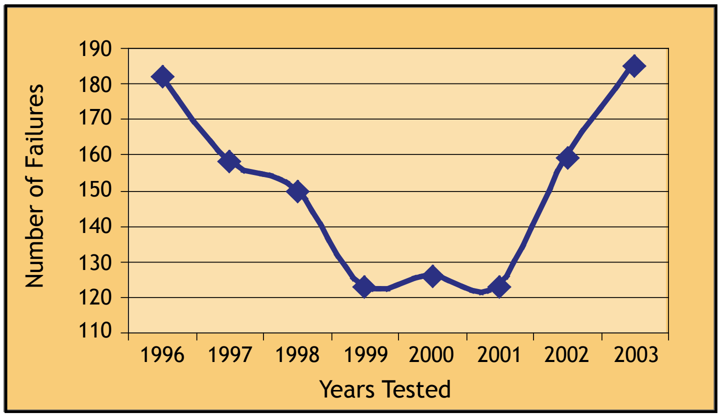


Figure 2- Motor Failures 1996 to 2003
(Program started in 1996 and eliminated at end of 2001.)



Comparison Tester. The results were dramatic in that the number of annual motor repairs dropped by over 33% while production remained constant (Figure 2). The impact was an improvement in equipment availability and planned outage overhauls (the correct machines were removed for attention). There was also a direct reduction in emergency work orders by over 66%, which directly translated into a reduction in maintenance overtime costs and allowing a higher rate of completed PM's.

Notable in this study, was the fact that electric motor repairs were not eliminated. However, the severity of the remaining repairs was significantly reduced.

Following several years of success (1996 to 2001), new management made the decision to eliminate the motor diagnostic program. In less than 18 months, the conditions that existed prior to the application of the program returned. The result was a dramatic increase in maintenance costs associated with the electric motors, increased unplanned downtime, additional overtime man-hours and emergency work orders (Figure 3).

Opportunity 3 - The Application of Motor Diagnostics for Condition Monitoring

A Midwestern transmission manufacturing facility with an existing, and successful, infrared, ultrasonics and vibration program implemented Motor Circuit Analysis to support the program. The results were fairly dramatic within the first quarter of implementation in 2002:

- Over 50 % reduction in troubleshooting time
- Over 80% reduction of 'no problem found' reports, for rotating machines sent to repair shops
- Reduction of repair costs for rotating machines by over 50%, when repairs were proactive. For example: Winding contamination resulting in clean-dip-and-bake versus allowing servo motors to run to failure, resulting in rewind.
- About a 35% reduction in motor system life-cycle cost

Average maintenance man-hour savings for the first three quarters of 2002 were $30,000 per quarter. Immediately following the implementation of the motor diagnostics program in the middle of the third quarter of 2002, the amount increased to $300,000 per month, not including any production or other cost avoidance.

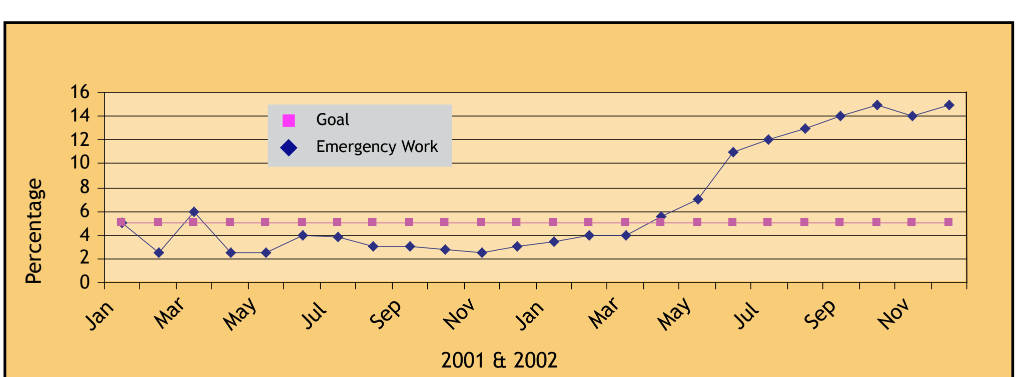
Conclusion

Today the technology and know-how are readily available. Any company relying extensively on electric motors without an electric motors diagnostic program in place, is ultimately compromising their reliability and competitiveness in the marketplace. The implementation of an electrical motor diagnostics program, and attention to the health of your motor system, will have immediate and significant impact on your maintenance program and the profitability of your company.

Richard Borge is president of Performance Evaluation, Inc., which has been testing electrical equipment for the past 22 years with an assortment of test equipment. Performance has used both static and dynamic tests to help prevent unscheduled downtime. The testing includes AC/ DC motors of all sizes and transformers. Richard can be reached at perfeval@aol.com and at 888-484-7564. The company's website is www.performancetdr.com

Howard W. Penrose Ph.D., CMRP, is the President of SUCCESS by DESIGN, a reliability and maintenance services consultant and publisher. He has over 20 years in the reliability and maintenance industry with experience from the shop floor to academia and manufacturing to military. Dr. Penrose is a past Chair of the Chicago Section of the Institute of Electrical and Electronic Engineers, Inc. and is presently the Founding Executive Director of the Institute of Electrical Motor Diagnostics. For more information, or questions, related to this article or SUCCESS by DESIGN services, please contact Dr. Penrose via phone: 860 575-3087 or email: howard@motordoc.net.

Figure 3- Emergency Calls Related to Motors



Balancing Act

In-Place Balancing Reduces Costs & Downtime

by Bob Gelow

Colorado Springs is located at the base of Pikes Peak, on the high desert plains of Colorado at an elevation of 6008 feet above sea level. This setting at the edge of the Rocky Mountains is ideal for its scenery, crisp mountain air, and snow fed streams and reservoirs. Colorado Springs Utilities serves this community of over 500,000 with electric power, water and gas services. One of the greatest challenges the utility faces is providing water from western slope reservoirs and local distribution of treated water in a diversified elevation setting.

While 30% of our water is from local watersheds, the rest is from water stored in Western Slope lakes and transported in tunnels bored through the Continental Divide where gravity brings the water to the eastern side, where it is stored in reservoirs that are part of the Arkansas River chain. From there it is pumped through a 70 mile long pipeline via the 118 MGD Otero Pump Station to Rampart Reservoir, located above Colorado Springs. There the water is treated and then distributed to tanks perched on hilltops around the city. Obviously, moving this much water uphill requires motors and pumps - including vertical pumps.

Although pump manufacturers spend considerable time and effort to eliminate balance problems in their equipment, it seems that more often than not, when all components are assembled and in service, unbalance seems to dominate the vibration spectrum on vertical turbine pumps. These symptoms are present in the larger, 1000HP vertical pumps at our Otero Pump Station facility, as well as the smaller 25HP-500HP vertical pumps in our distribution system. It is often very difficult, and expensive, to remove the complete units and transport them to a balancing shop for repairs. Our predictive maintenance personnel discovered that in many cases of unbalance, we could correct the problem in place without removing the equipment.

Anyone who has ever pulled the top cover or the end bell off of a vertical motor knows there is usually an anti-reverse mechanism or a bearing housing collar that is large enough in diameter for balancing purposes and contains four or more drilled and tapped holes for attaching weights. Although the holes are small in number, if they are uniform in distance around the circumference, modern vibration analyzers have built-in vibration programs that allow for balancing by the number of references instead of degrees. This feature, along with vector splitting, can facilitate in place balancing of the equipment with a small amount of weight in the form of screws and washers.

On equipment where this was not possible, we have fabricated balancing rings (Figures 1 & 2) that can be bolted to the top of the motor (Figure 3), thereby creating 36 holes spaced at 10 degrees to enable significantly more accurate balancing of the unit. The machine shop prefabricates balance ring blanks (Figure 1). Within hours they can then produce the finished rings (Figure 2), which are custom mountable to specific

Figure 1 - Prefabricated Blank Balancing Ring

Figure 2 - Rings After Custom Modification

Figure 3 - Balancing Rings Mounted

vertical motors. These rings are quickly and easily produced in our machine shop and can be custom designed to virtually any vertical motor.

The advantages to balancing equipment in place are obvious:

- Costs are low due to the ease of fabrication of the rings, when necessary, and balancing can be done by in-house personnel.
- Unbalance is one of the most destructive forces in rotating equipment.
- Balancing your equipment greatly enhances bearing and component life, reducing and/or eliminating equipment failure as a result of imbalance forces.
- In most cases, the equipment you use for vibration analysis is all you need for balancing.
- Turn around is quick - less downtime.

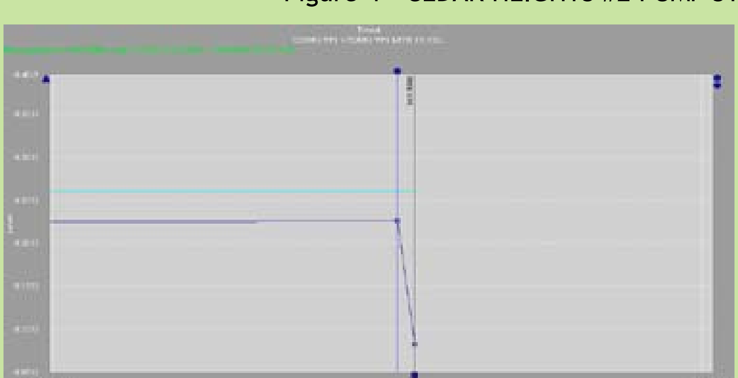
The PdM group at Colorado Springs Utilities has experienced great success with in-place balancing of vertical motors from 25HP to 1000HP using from 10g to 50g of weight, depending on the size and weight of the rotor. Of course, the amount of weight necessary to be effective is proportionate to the distance of the weight placement to the shaft center - the more diameter you can achieve with your balance surface, the less weight you will need to place on the balance ring.

As seen in Figure 4, when we installed the rings in these photos, vibration went from .309in/sec before the balance shot to .076in/sec after, at the outboard radial ("horizontal" in this case is really "perpendicular to pump discharge") motor bearing, and from .231in/sec to .087in/sec in the motor outboard radial ("vertical" - or "in the same direction as pump discharge").

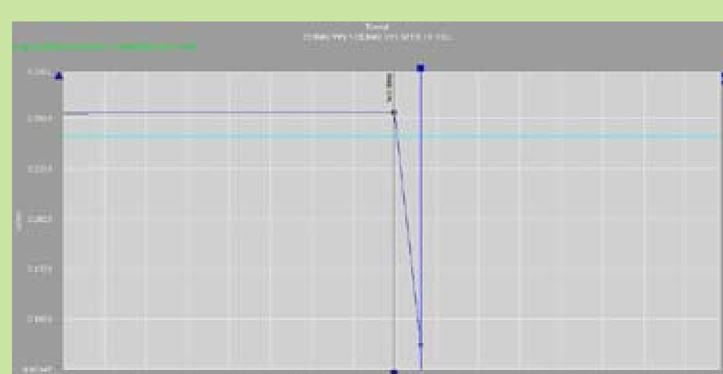
NOTE: On this application, the three mounting bolts are not part of the 36 balance weight mounting holes that were drilled and tapped for 1/4 - 20 bolts and washers. The 36 hole count at 10 degree increments make it a lot easier to make the phase references accurate.

Bob Gelow has works for Colorado Springs Utilities for 26 years - the first 10 as an electrician using vibration analysis occasionally on rotating equipment. Bob then took a full time position to implement a PdM program for Colorado Springs Utilities. The Technical Services group utilizes vibration analysis, infrared thermography, motor analysis and oil analysis to prevent failures in 310 machines & 6222 vibration measurement points. Bob has a BS in Public Admin, is a Level II Vibration Analyst, and is Level I Infrared and Level I Oil Analysis certified. Bob lives with his wife, Ruth, in Colorado Springs, and enjoys fishing, hiking, mountain biking and traveling...to Mexico or anywhere else warm and sunny. Bob can be contacted at bgelow@csu.org

Figure 4 - CEDAR HEIGHTS #2 PUMP STATION, VERTICAL PUMP #1, BALANCE SHOT



CDR#2 VP1 MTR Outboard radial velocity .087in/sec. from .231in/sec. (horizontal direction)



CDR#2 VP1 MTR Outboard radial velocity .076in/sec. from .309in/sec. (vertical direction)

Ultrasound & Leak Detection

Know the Basics - Find the Leaks

by Jim Hall

Today's maintenance technicians can sometimes be thought of as "Jacks of All Trades" and "Masters of None." Perhaps this is because in many companies a lack of man-power and assets forces today's technicians to become experts in several different skill sets, such as vibration analysis, infrared imaging, oil analysis and airborne ultrasound. Some of these skills sets can take months or years to become an expert in the field.

However, airborne ultrasound is one of those technologies that with just a little training and some hands-on experience you will contribute greatly to the success of your company's predictive maintenance program and to its bottom line.

In this issue, I want to start with the basics of leak detection - Leak Detection 101 - and give you the enough of an introduction that will allow you to pick-up your instrument and start finding leaks.

Leak Detection 101

By understanding just a few rules of airborne ultrasound you can start finding compressed air, vacuum and steam leaks today. Here are three simple rules to follow:

- Know your individual or personal limitations.
- Know your equipment.
- Understand basic airborne ultrasound theory.

You must be able to hear with a minimum of > 20 dBHL at 500 Hz to 4 kHz (aided or unaided hearing). Know that the airborne ultrasound equipment you have, has leak detection capabilities. Many manufacturers sell kits that only perform one or two tasks. Such as, leak detection, bearing analysis or steam trap inspections.

Basic ultrasound theory:

- Above the human hearing range (20 kHz & above).
- Very directional, sound wave 1/8" to 5/8" long.
- Does not travel through solids.
- Pressure & Vacuum are heard at 38-40 kHz.

Getting Started:

- Prepare yourself for the environment you will be working in by following all safety precautions, safety equipment and procedures applicable within your workspace.
- Assure the equipment is in good working condition.
- Check the battery for proper charge before starting a survey.
- Prepare the instrument for scanning air leaks. No matter if you are looking for vacuum, steam or pressure leaks. Set the instrument accordingly before leaving the shop or office.

"Sniff Test" For High Noise Environment

Before leaving the office or shop, hold the instrument below your nose with the airborne scanning module pointed upwards toward your nose. Breathe through your nose and set the frequency so that you have a "peak response" or sharp sound quality of air (38-40 kHz range).

- Does your instrument have data-logging capabilities? Prepare a route for data entry.
- Does your instrument have "frequency tuning"? Be able to change frequency to tune out what you do not want to hear or tune in to what you are trying to hear.

Airborne ultrasound is more than just a leak detector. However, leak detection is the primary reason airborne ultrasound instruments are purchased. One of the largest utility costs many plants incur is due to compressed air leaks.

Equipment

In their product brochures, airborne ultrasound manufacturers list specifications that their instrument is capable of detecting a leak of 5 psi from .005 inch-diameter at 50 feet or a leak rate (threshold) of $1x10^{-2}$ to $1x10^{-3}$ std/cc/sec of Freon. Keep in mind that this specification is under prime conditions, such as laboratory conditions. To put this in perspective, at the leak rate of 1×10^{-3} standard cc's per second it would take 277 minutes to fill one cubic inch of space.

Most instruments have accessories such as a long range horns, parabolic dishes, flexible wands and close focusing modules. The long range horns or modules enable the user to scan from greater distances (see Figure 1). Parabolic reflectors, some with laser sighting to pinpoint a leak location, allow the user to scan from an even greater distance than a long range horn or module (see Figure 2).

Flexible wands or extensions allow the end user to reach behind, low, high or hard to reach areas. Another popular module is the close-up or close focusing module. The "close-up module" and the "flexible wands" can be advantageous in locating in-leakage or vacuum leaks. All manufacturers have a "rubber cone" in the kit that can be used to focus in on a suspected leak in an area (see Figure 3). Do not place the rubber cone on your instrument until you have located a leak. These cones are also used to differentiate between multiple leaks in a small area.

Figure 1 - A long range horn or cone is excellent for use from 5 ft. - 40 ft. (coutesy of SDT)

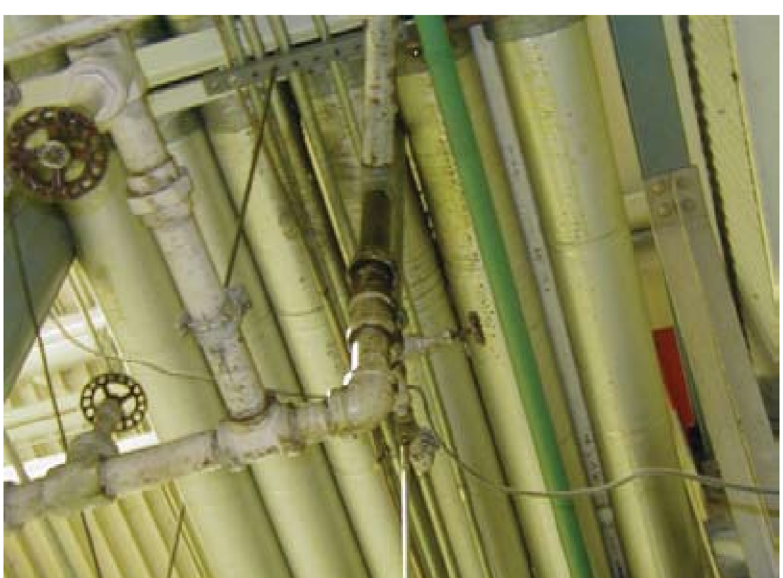


Figure 2 - Using a long range horn or parabolic will aid you greatly in finding overhead leaks. Note the residue of oil and smut around this leak.

Check the manufacturer of your equipment for what accessories they have for leak detection applicable to your industry.

Procedure

If you are entering a high noise environment you may want to perform the "Sniff Test" as mentioned above. When entering the plant or survey area place headphones on your head and turn the instrument on.

Rub your fingers in front of the receiver or piezoelectric sensor.

Adjust the volume or sensitivity to a high, but comfortable level. Not too low or too high. (CAUTION: Too "LOW" of a volume setting or sensitivity may result in not finding leaks. Too "HIGH" of a volume setting or sensitivity may result in leaks being missed because of high ambient noise or as a non-discernible noise or leak.)

Note: there is a difference between sensitivity and volume. Stay tuned for a future article devoted to this subject.

Scan from side to side, high and low. Start by scanning the suspect area from a distance. In other words, as you walk towards the area scan the instrument from side to side, high and low. Listen for sounds that are similar to what a leak sounds like, such as a rushing or hissing sound.

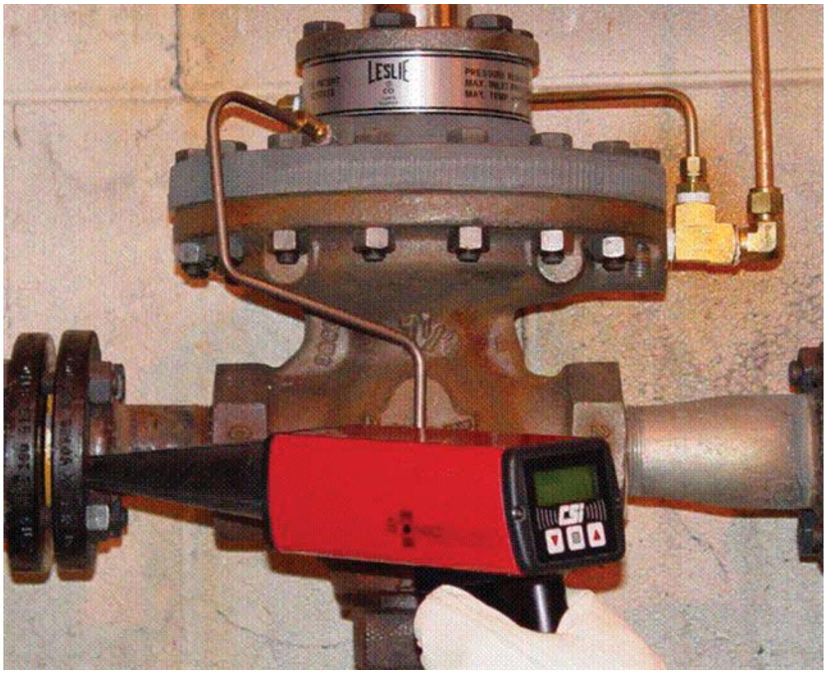


Figure 3 - Place rubber cone on instrument as you focus in on the suspected leak.

Background Noise

Can't hear the leak because of background noise? That's alright! Most instruments today have "tuneable frequency". Think of it as tuning out what you don't want to hear, tuning in what you do want to hear. (Remember - What is noisy to you and me, Is not noisy to the ultrasonic receiver! - see Figure 4)

Reflection

Play the "bounce" when surveying for leaks using airborne ultrasound. Ultrasound tends to travel in a straight line. Ultrasound is low energy that can be absorbed by some materials. A gypsum flat wall for instance may reflect more than a brick or masonry wall. A good practice is to put yourself with your back to the wall and scan side to side, high and low to locate the leak.

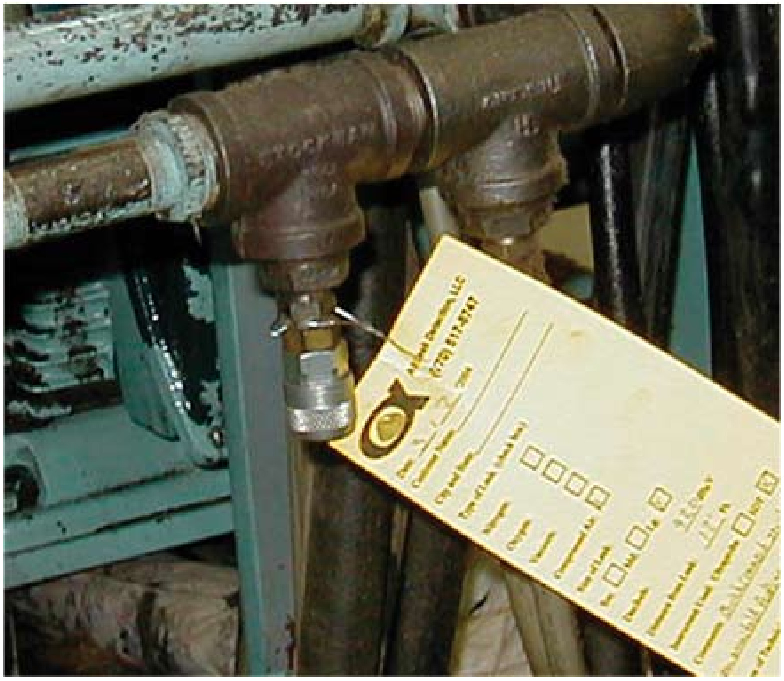


Figure 4 - Previously, unnoticed. A faulty quick disconnect fitting, with poppet valve and spring missing, blowing 85 psig. That's 24 hrs, a day, 7 days a week, 365 days a year. In a high noise environment, ultrasound found it immediately.

Competing Sound

When other sounds seem to compete with the sound you are looking for, try a glove or a rag placed on the hand you are not holding the instrument in. Place the gloved hand between the instrument and the competing sounds. If you are using a rag, place it over the free hand and shield the scanning module or sensor from competing sounds. You can also hold a piece of cardboard, clipboard or some other reflective solid material to block the competing sound. These are called shielding techniques. Another shielding technique is to hold the instrument directly in front of you, letting your body shield you from competing sounds (see Figure 5). Remember, ultrasound does not pass through a solid.

Liquid Leak Method

Looking for low level leaks? There are liquids available that can help you locate very small leaks. Most ultrasound receivers can detect a $1x10^{-2}$ to $1x10^{-3}$ std/cc/sec leak rate. When used with these liquids, an ultrasonic receiver can detect as low as $1x10^{-4}$ to $1x10^{-6}$ std/cc/sec. This is a low surface tension, pressure activated liquid. The sound that the liquid produces is like a bowl of Rice Krispies a thousand times over! The bubbles are tiny, like spider eggs. No leak, no bubbles. Besides using the liquid for small leaks, you may want to use this liquid for quality assurance during product manufacturing and best of all its also reusable. Collect it and reapply it.

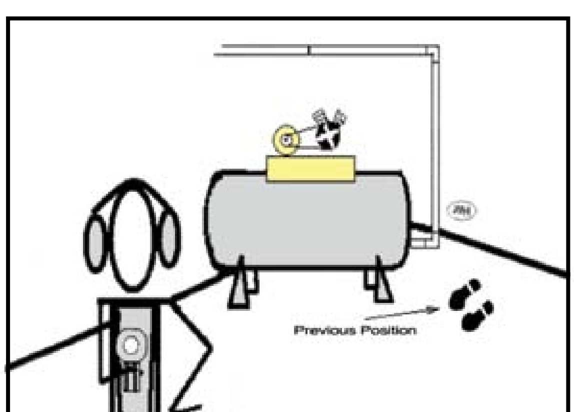


Figure 5 - Walk through or passed barriers, hold instrument in front of body to shield from competing sounds or ultrasound.

Cost Savings

Besides the immediate Return-On-Investment (ROI) on the ultrasound instrument you purchased, tremendous cost savings can be had by locating and repairing leaks. Locating and repairing typical compressed air leaks can generate large amount of savings through reducing the cost of utilities. You may notice that after repairing the leaks, you have gone from having 3 compressors on-line to two or possibly one. Just how much you will save depends on how large your plant is. It's not uncommon for large facilities such as automotive plants, steel mills or paper mills to save hundreds of thousands of dollars from a leak detection audit. So what are you waiting for? Pick-up your airborne ultrasound instrument, learn how to use it and start saving now.

Jim Hall is the president of Ultra-Sound Technologies, a "Vendor-Neutral" company providing on-site predictive maintenance consultation and training. UST provides an Associate Level, Level I & II Airborne Ultrasound Certification. Jim is a regular provider of on-line presentations at ReliabilityWeb.com and is a contributing editor for Uptime Magazine. Jim has provided airborne ultrasound training for several Fortune 500 Companies in electrical generation, pulp & paper, petro-chemical and transportation (marine, automotive, aerospace). A 17 year civil service veteran, Jim served as an aerospace engineering technician for Naval Aviation Engineering Service Unit (NAESU) and with the Naval Aviation Depot Jacksonville Florida (NADEP). He can be reached at jim.hall@ultra-soundtech.com or at 770-517-8747.

If Only I'd Known...

10 Things I had To Learn The Hard Way

By Joe Strader

I have been fighting machinery problems by using vibration analysis and predictive maintenance for over eighteen years. Often when I speak or write, I feel compelled to preface my remarks with a disclaimer. Since this article is not a technical paper at all, but more of an essay, it is full of the wild, unsubstantiated opinions typical of the author. Therefore, I must say that the opinions in this article are those of the author, and are not necessarily those of this magazine, its publisher or any of its readers, except for one—me. I also reserve the right to change my mind. As my high school math teacher so often stated when she made a mistake and corrected it, "Wise men change their minds; fools never do."

That is not to say that the opinions are not valid. Quite the contrary, the opinions expressed here have been developed over years of experience with vibration analysis. Many of the ideas to be expressed may be unprovable, but that does not reduce their validity. In fact, the empirical evidence indicates that the opinions may have even broader application than even I have thought.

...I got started in vibration analysis and didn't know anything. My boss immediately recognized this as a problem...

First Things First

Like many of you, I got started in vibration analysis and didn't know anything. My boss immediately recognized this as a problem in need of correction and sent me to some training seminars. Since this initiation, I have remained on a continuous quest for knowledge about this craft. Even now, when it comes out of my own pocket, I continue to send myself to school and read about my craft. I found out early on that it's easy to become complacent in knowledge gained. The result of this complacency was finding out, often embarrassingly, that I did not know everything I needed to know, and probably never will.

But throughout all this training and learning, there are several important items that you most likely will not hear, at least in the introductions to vibration analysis that seem to be the most popular. Maybe they were mentioned in the classes I attended, but they were not emphasized enough that I remember them. Since these bits and pieces are all this article is about, there is no room to fudge. For convenience, there are ten basic principles. I have a few more, but these are ones that I think are the most important.

1. 1 times RPM is not always imbalance.

I'm sure that this isn't news to most of you reading this. You have found out that this simplified rule doesn't fit every situation. So why mention it? It is to emphasize all the simplistic little rules that are often quoted as absolute truths when, in fact, most simplified rules, at least in this profession, have more qualifiers than a surgery release form.

Now, I understand that mathematics can't be taught by first teaching calculus. A foundation must be established, and this foundation must be built upon little by little. These simplified rules accomplish this task. However, no one warned me that they were virtually useless for most analysis situations. That, regrettably, was left to the cruel lessons of experience.

Sure, in advanced classes, these simplified rules were put to rest for what they were. But, if you are like me, you were sent to advanced classes only after finding out that you did not know everything you needed to know. Experience taught me the lessons of the invalidity of simplified rules in a complex world, and the advanced classes were my effort to seek the truth.

The sad truth is that many vibration technicians are

Valid answers to the question of "Why?" invariably lead to two important things: greater knowledge and more questions. This is the essence of life-long learning.

never given the training to advance beyond the stage where the simple rules dominate the analysis. The responsibility for this situation falls squarely on the backs of equipment suppliers and maintenance management—on the suppliers for telling management that the systems require little training to use and management for believing them. Oh, I guess we technicians deserve some blame too, for not adequately communicating to our superiors that we need help.

If you are new to this profession, you have now been warned. Take the knowledge any way you can get it, but be wary of simple rules that don't apply in every situation. Which leads directly to. . .

2. The most important question you can ever answer is "Why?"

You will learn more by answering this question than by any other method. You won't learn a thing by asking it; but by answering it you'll learn a lot. Using our previous example, "Why is it that one times RPM is not always imbalance?" The answers to this question lead to some amazing revelations about dynamics and the vibration response. By learning the exceptions to the rules, your knowledge is enhanced.

Young children understand and base their actions on simple rules. Critical thinking develops as they learn more and start asking "Why" about the rules. You know the "Why? Why? Why? stage that hits when children turn about 3 or 4. The same principle applies to us on our journey to critical thinking in vibration. When we learn enough about the basics we hit the Why? Why? Why? stage.

The question "Why?" applies to more than the simplified rules of analysis. Why do severity charts have the values they do? Why do sum and difference frequencies exist? Why does the vibration amplitude often go down, as the bearing gets worse? Why do bearing defects of the races occur as the fundamental plus several harmonics? Why does my boss keep asking me how long it will last? Valid answers to the question of "Why?" invariably lead to two important things: greater knowledge and more questions. This is the

You cannot trust your FFT analyzer to display accurate magnitudes of mechanical movement. Period.

essence of life-long learning. As an example, one of the most vexing problems I encountered was why one gear set was in good shape and one identical gear set was a wreck when the amplitudes in frequency domain were essentially the same. This leads to the next leg of our journey. . .

3. Absolute amplitude in the frequency domain is relatively useless.

It may seem out-of-place to apply this as a general rule since it is technically specific, but I have run into more innocent ignorance about the application of the Fourier Transform than any other subject. With modern instruments, the FFT, or Fast Fourier Transform, is the basis for nearly all trending and analysis. We should at least make the effort to be less ignorant about what it is and what it represents. Do not mistake the term "ignorance" as insulting. It is definitely not. I was really ignorant of the technology when I first started using it. I am still ignorant about many of the quirks of this wonderful technology.

Let's examine some basics of the FFT. First, the Fourier Transform is a mathematical tool that reduces a periodic function to an infinite series of sines and cosines in which the coefficient of each term is the value of one spectral component of the function. So far, so good. No modern digital instrument does exact mathematical computations. Depending on the instrument, the approximations may be very close, but they are never exact. The reason is the limitations of digital electronics.

An FFT device begins by making the assumption that what you are shoving into it is a periodic signal. If it isn't, the FFT device doesn't care. It will pretend like it is. Regrettably, few vibration signals are precisely periodic. The FFT device then digitizes the signal, and the accuracy depends on the resolution of the analog to digital converter in the device. To guarantee that the signal simulates a periodic function and does not cause problems with calculations, it must first pass through a filter to eliminate aliasing.

Now is where we begin to run into problems. I mentioned that the Fourier Transform is an infinite series. How long does it take to calculate an infinite series even on the fastest computer? Infinite time. Therefore the FFT device limits the series to a set number of lines of resolution so that it knows when to stop.

The FFT also assumes that all of the signals you put in are actually sine and cosine waves. Mechanical stuff is usually not nice enough to confine its reactions to pure mathematical functions such as sine waves, but, again, the FFT device doesn't really care. What the FFT device displays is a restricted set of the coefficients that would have been accurate if the machine had been nice and moved in pure sine-shaped motion....which, of course, it did not.

Harmonics of rotation are often the result of non-sine shaped motions that the FFT device forces into its relatively narrow view of how things move. (In reality, the FFT does not look at motion. It looks at an electrical signal that represents the motion.) An oddly shaped motion at one event for each rotation will confuse the FFT device into telling you that you have events occurring at twice, thrice or any number of times the rotation. Often it is simply one event that is not nice enough to be sine-shaped.

Modulation of a decently sine-shaped signal must be the sum of some series of sine waves, at least to the FFT device. This is the source of sum and difference frequencies. However, it may simply be a single motion that is varying in amplitude, not the multiple frequencies you see on the FFT display.

Back to the importance of Item 3. The harmonics, and sum and difference frequencies, that are displayed in the spectrum, may be the result of a large event that is forced into different smaller frequencies, each of which represents a part of the total magnitude of the non-sinusoidal event.

Here it is in raw form: you cannot trust your FFT analyzer to display accurate magnitudes of mechanical movement. Period. Look at frequency content. The FFT device will display extremely accurate frequency content, assuming that you understand where all those sine waves the FFT device says you have (but really don't have) come from. And, since it is mechanical movement we are interested in. . .

4. Physics is really important.

Well not necessarily physics, but the subset of physics dealing with mechanics and mechanical motion. Machines vibrate. Some vibrate more than others. Some vibrate in nice, smooth patterns, and some vibrate in ugly patterns.

We must make an effort to learn about the physics of machines and structures. We must understand the patterns of motion that result from normal operation and how our devices interpret those patterns. We must then learn how to think backward from the display on our FFT devices to the probable motion in the machine.

While we learn to accomplish this with some degree of accuracy, we must be able to define the forces that are produced by failing components. These forces also produce motions. The FFT devices also interpret these motions in sometimes strange ways. Finally, we must be able to think backward to the probable mechanical forces that produced the motion that was converted to an electrical signal by a transducer that was transmitted to the device that converted it from an analog signal to a digital representation of the analog signal that performed digital math on it while assuming it was periodic and the sum of sine-shaped patterns to give us the display we are looking at. Whoa. Whenever I dwell on this Rube Goldberg type system, I am reminded of a song from my childhood: "There's a hole in the bottom of the sea. . ."

You may have noticed that I have been very careful to name certain electronic assemblies as FFT devices. There is a reason for that. . .

5. I have yet to find a company that sells a vibration analyzer.

I often call my box a vibration analyzer. You probably call yours one too. But, let's be honest. It is a blatant lie to call an FFT device a vibration analyzer. My "analyzer" does not analyze anything. Artificial intelligence and expert systems notwithstanding, yours does not either. These devices simply rearrange information to make it easier for you to analyze the information. Although my dictionary does define "analysis" as the breaking up of something into its parts - it's a cheap dictionary, it's old, and it's the third definition listed. These devices do split the electrical signal that represents vibration into parts. (Although, we have already seen how this analysis is flawed since the parts we are looking at are not the same parts that were originally put together.) To be fair, analysis is a mental activity that takes diverse information, examines the information for consistency, and develops conclusions based on that information. This is not done in the box. It happens in your head. If it were not for this fact, the vibration section in this magazine, annual user group meetings, and all the seminars for vibration analysis, would simply not be needed.

Well, you ask appropriately, what about expert systems? The analysis is still simply a matter of mental activity translated to a computer program. The rule writer takes diverse information, examines it for consistency, and develops a conclusion. Were it not for the person behind the rules, expert systems would not exist. As far as I know, no expert system has been developed for vibration analysis that learns from experience. (However, we are probably close.) The vibration "analyzer" is simply a tool to provide information for you to analyze. If we are doing our jobs, we will not depend on one source of information for critical maintenance decisions. Which brings up. . .

6. Don't throw away your stethoscope.

I use every source of information I can get my

...let's be honest. It is a blatant lie to call an FFT device a vibration analyzer. My "analyzer" does not analyze anything.

hands on for my analysis. I collect enormous amounts of information (much of it useless and thrown out during the analysis process) that I use to make recommendations for people to use to make maintenance decisions. If you are not listening to your machines, looking at them, feeling them, asking questions of people, examining company records, and using any source of information you can find, you may miss the one important detail that can make the difference in your analysis. As for vibration specific information, do not underestimate the value of secondary indicators such as temperature, pressure, the time signal, or any other trick that may help find information you did not know. As a footnote, do not throw away your oscilloscope either.

7. Five years of experience is not the same as one year of experience five times.

I have found that, in most cases, it takes a year of full-time commitment to become competent at vibration analysis and five years to become proficient. The rapid gains of the first year level off and the program moves into the growth phase. After five years, the program is mature, and the real savings begin.

Generally, it is after about five years that the original animosity of mechanics, electricians and machine operators becomes cooperation and support. It is after five years that management begins to showcase the program in sales presentations. It is after five years that failure analysis matures and specific failures are prevented forever and not just predicted. If we rest on our first year successes, which will come rapidly and with great fanfare, we fail to struggle to the stage of proficiency. That is why it is critical to make certain that the right person is in the job.

8. The most important part of any vibration analysis program is the person doing the analysis.

Stubborn, curious, a thirst for knowledge and willing to crawl around on greasy, filthy machines. The perfect vibration analyst.

Since we cannot depend on the FFT device to analyze the information, this central responsibility falls on the person doing the analysis. What are the qualifications for a good vibration analyst? Many characteristics seem to be shared by most of the successful vibration people I know. Some of the characteristics are built-in and others are learned. In any case, these are the most important, based on the empirical evidence:

- The person must be stubborn. This person must be able to stand behind the recommendations with conviction and not back down to pressures based on information that is inconsistent with the results of the analysis.
- The person must have a thirst for knowledge. Look around at those that are successful practitioners. People that have been doing vibration analysis for many years are still sitting in seminars and meetings taking notes.
- The person must be curious. After all, this is the prerequisite for asking "Why?".
- The person has to be willing to crawl around on greasy, filthy, noisy machines to get that one piece of information that will solidify the analysis. The person that only wants to sit in an office and have information brought in is not a particularly good candidate.
- The person must be big enough to admit mistakes without emotional trauma. We learn most from our mistakes.
- The person should be able to communicate, both verbally and written, with all people from the janitor to the company president.
- A college degree is not required, but the person should have the mental capacity to understand some rather odd mathematical and physical concepts. They do not have to do the math, but they should understand the relationships.
- The person should be able to recognize and use company politics to their advantage.

- The person should be willing to give away credit anytime it is due to someone else.

No one person will fit all of these requirements. However, most of these requirements can be learned as long as an effort is made. Therefore. . .

9. The second most important part of your program is the training given to the person selected.

A well-trained person can have amazing accomplishments with a poor set of tools. The most expensive software and analyzer do not guarantee success. The right person with the right training does, even with less than ideal tools. Better tools only improve the quality of the success, not whether it occurs.

I have seen all too many programs fail due to lack of training. But what is "ideal" training? Initial training is a must, but as we mentioned before, it is often limited to the simplest analysis. Therefore, advanced training should be seen as a necessity. Training should also be continuous. This knowledge can be from seminars, books, journals, conferences or any number of sources. If your management will not give you time at work to read or study, do it at home. Yes, on your own time. Go back to school. Not necessarily for a degree, but at least to learn specific topics in more detail.

10. If the job is done right, it's possible to work yourself out of a job.

Predictive maintenance done correctly leads to better machine designs through supplier compliance requirements. It leads to better in-plant engineering. It leads to higher skilled repair people. It leads to fewer failures due to corrections to the causes of failures, not just a focus on failures.
In a plant with only one technician required, the number of problems to be predicted may reduce themselves to a level that the predictive costs may not be justifiable through normal accounting methods. Always justify continuation with real numbers, do it continuously, and do it honestly. If you reach the point that you may no longer be needed, it may be the indication that you have done you job superbly. Of course, it could also mean just the opposite.

A well-trained person can have amazing accomplishments with a poor set of tools. The most expensive software and analyzer do not guarantee success.

Conclusion

Can all of this be put into one cohesive statement? Probably. Of course then it would be one of those simplistic rules that don't hold up (see item 1). I'll do it anyway - confident you'll remember that simple statements of partial fact are foundations to build upon, not the finished structure.

I wish I had known that Vibration Analysis is a profession of personal commitment - commitment to training, understanding, and knowledge. It is hard work. It is highly rewarding work. It is a job that often isolates a person, setting one apart from the masses. It is a job of tremendous value, if done correctly.

Would I recommend that seminars include the information in this paper? Probably not. Most people are not ready for it until they need it, and by then it is too late—they are already beginning to learn it. It would have been nice to know, but I probably wouldn't have appreciated the value of the knowledge.

Joe Strader is the President of Dynamic Solutions, Inc. His company offers on-the-fly vibration-based press inspections and dynamic problem solving exclusively in the printing industry. Joe was a maintenance specialist at R. R. Donnelley for fourteen years before leaving to start Dynamic Solutions, Inc. He enjoys golf but generally stinks at it, plays piano at church better than he plays golf, and is currently an eBay Power Seller of industrial parts and supplies. Joe can be reached at joe@pressinspector.com or at 270-646-2374.

Simplicity. Portability. Affordability.

Datastick

We recently encountered an interesting take on basic vibration analysis offered by Datastick Systems, Inc. Datastick is a newcomer to the condition based monitoring market, but fresh ideas and new players are nearly always a good thing, especially for the consumers. We sat down with Datastick's Michael Scandling to get some answers to the questions we had about this ultra portable data collection system. Here's what he had to say:

What led Datastick to develop this particular product?

Quite simply, we saw a need. Obviously, vibration analysis as part of an overall predictive maintenance program is extremely valuable in reducing maintenance costs and increasing efficiency in plants and other facilities of all sizes. However, often the perception is that monitoring and analysis equipment is too expensive, and that vibration analysis is too specialized a skill with too steep a learning curve.

We saw an opportunity to leverage our experience in PDA-based data acquisition equipment to create a vibration analysis system that is neither too expensive nor too difficult to learn. We wanted to create a product that is affordable and that people could actually use effectively.

What makes the VSA-1212 different from other vibration spectrum analyzers?

The system is based on Palm OS handheld computers, which makes it very compact and extremely reliable from the start. The complete system consists of the Palm OS handheld computer, the Datastick VSA-1212 hardware module which snaps onto the back of the handheld, Datastick Spectrum software, which runs on the handheld, and Datastick Reporting System software, which runs on the desktop (or laptop) PC. The last component is the accelerometer. You can use any 100 mV/g or 500 mV/g ICP-type accelerometer. The handheld system is used as a data collector and for simple on-the-spot analysis, and the desktop software is for more detailed analysis. This modular approach keeps the system uncomplicated and helps us to keep the price affordable. That's one major difference.

There are two more differences that are perhaps even more important than purchase price. The first is that the Datastick Spectrum software is designed to be very easy to learn and use. Our beta testers were up and running without a manual. All it took to get them going was a brief e-mailed instruction and two or three quick questions over the phone. The software puts all the pertinent vibration information on one screen. Peak detection and cursor-point readout tools make it very easy to see the value of any data point. And you can attach text notes to any measurement and save it for export to the desktop PC.

The second important point is that the Datastick Reporting System (DRS) PC software is based on a completely open platform: Microsoft Excel. DRS makes it extremely easy to create machine histories and display waveforms and spectra in waterfalls and stacked and aligned graphs. But the best thing is that you can save any report and e-mail it to anyone who has Excel and it will open right up. Everyone has Excel. This means that if a user needs further analysis he can send any file to any consultant. The consultant doesn't even have to have our software.

Finally, if you want to use more specialized software, you can, as long as it will accept an Excel file or a CSV text file. So that's a huge difference: anyone can read our files, and most high-end vibration software programs can read them too.

What applications is this Datastick system best suited for?

We developed it for vibration analysis in machine health monitoring. That takes in a lot of territory: predictive maintenance, troubleshooting, and field service, to name a few.

This last one — field service — is quite interesting in itself. Imagine a company being able to afford to outfit scores or even hundreds of reps with vibration analyzers. The reps don't have to be vibration experts — they can just e-mail the file to the home office where a small group of specialists can do the field analysis for the whole company without having to buy more desktop analysis software. One sensor manufacturer is considering deploying our system to all of its reps for field verification of their accelerometers. It would save them many thousands of dollars.

It seems like a nice system for companies just starting a vibration program. Can this system benefit companies that already have mature vibration programs, too?

Absolutely. Apply the same concept I just mentioned. In a large facility — or in a company with a number of far-flung facilities — the people collecting the data don't have to be vibration experts. They just need to know how to collect data. Equipment cost is low. Software cost is minimal. Training is minimal. And the analysis expertise can be centralized or outsourced very easily.

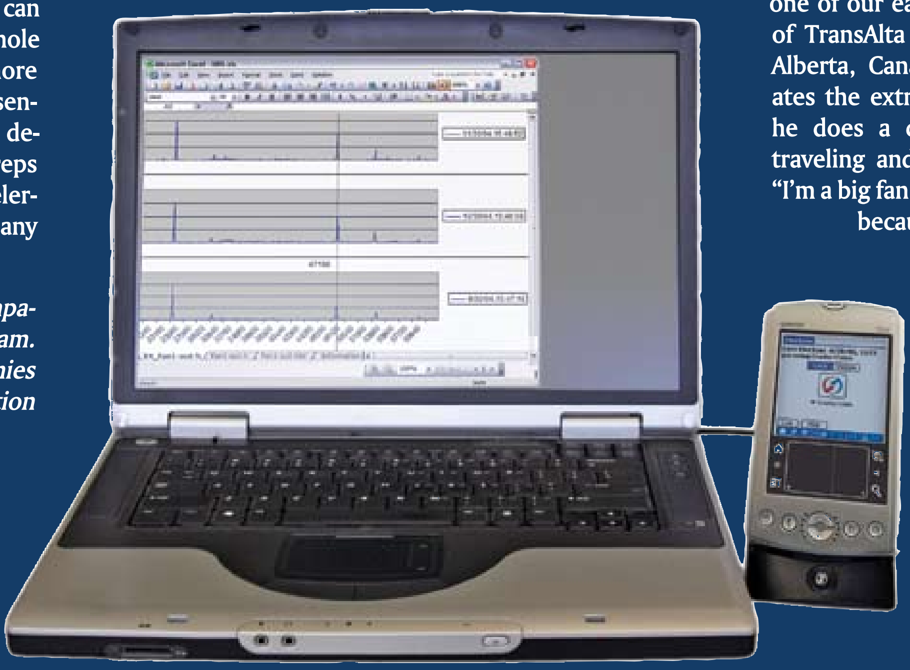
At the same time I want to stress that the VSA-1212 isn't going to replace high-end vibration analyzers. The VSA-1212 is intended to be an inexpensive, efficient tool for routine data collection and analysis. Why use high-end analyzers for routine work that doesn't demand high-end power. You don't need a Ferrari to go to the supermarket.

Is it cost effective to outfit many technicians in a facility with their own Datastick VSA-1212 system?

Well, in light of what I just said, the real question is: is it cost effective NOT to?

Can a handheld computer hold up in the harsh operating environments that many plants have?

Realistically, in many cases probably not, unless the user is more careful than he probably wants to be. That's why we recommend and sell a rugged enclosure, which we offer at a reasonable price. It will survive a drop onto a concrete floor and is waterproof, but you can still operate all the controls through a waterproof membrane under a hinged view window.



What are some of the key features of your Datastick Spectrum software?

First and foremost, it's easy to use. All the important data is shown on one screen, so you don't have to drill down to see your peak values, for instance. The 15 highest peaks are automatically detected and displayed with their values and you can see the value of any peak just by putting the handheld's stylus on it. You can set yellow, orange, and red alarm-level thresholds of your choice for each test point. You can use ISO guidelines or your own standards. It's easy to set up inspection routes and it's easy to run them. And at the end of the day, all the data exports to the PC with one push of a button and a couple of mouse clicks.

How long does it take for a technician to learn how to use the Datastick Spectrum software well?

It should take about half an hour to learn the basics of the Palm OS handheld and another hour to learn the basics of Datastick Spectrum software. After two or three hours of actual use, it becomes second nature.

Can you share a success story from a company implementing this Datastick system?

The product is so new we haven't had time to gather a lot of success stories, but one of our early testers, Mark Shoup, of TransAlta Corporation in Calgary, Alberta, Canada very much appreciates the extreme portability because he does a considerable amount of traveling and field-testing. He says, "I'm a big fan of PDA-based equipment because in addition to quick vibration tests, I can do twenty other things with the same equipment — so I can travel light. I also really appreciate that I can easily dump all the collected data into Excel and do reports easily and send them anywhere in the company."

Check back with us in two or three months. We should have a quite a list of success stories.

What are some of Datastick's plans for the future?

This is our first venture into this market. We intend a lot more vibration products in the future. We think we're off to a very good start, but we know there's room for more, and we intend to deliver. There are a few extra things we know will be needed and we're hard at work on them. We are, in fact, very customer-driven. I invite people to get in touch with us and tell us what they need.

You can contact Datastick at 888-277-5153 in the US, 408-871-3300, findout@datastick.com or visit their website at www.datastick.com

SKF® cylindrical roller bearings feature unique logarithmically "crowned" rollers providing improved contact geometry between roller and raceway. This roller profile reduces stresses under high loads, enables excellent performance even under misaligned conditions, and promotes cooler running to allow for high-speed operation and longer bearing life. Other performance-related features include precision-honed inner and outer ring; raceways; and rollers for improved lubricant effectiveness and quieter, cooler, and reliable service.

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The Vibration Division of PCB Piezotronics, Inc. (PCB®) introduces Model 377A20 prepolarized, 1/2" Random Incidence (Diffuse Field) microphone, which operates from ICP® sensor power. The distinguishing feature of this model is its extended frequency range to 16 kHz (+/- 2dB). It has a sensitivity of 50 mV/Pa and a wide dynamic range (14.6 to 146 dB (A) re 20µPa). This microphone has a +150 °C (+302 °F) operating temperature range and coefficient for temperature of -0.001 dB/°C.

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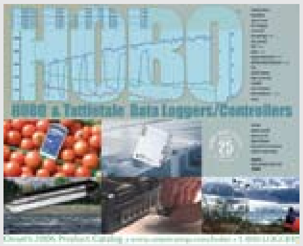
Sentinel® Current Data Loggers are a new line of loggers that record True RMS measurements of current parameters. The current loggers include integral flexible current probes for three-phase measurements up to 3000A.

The loggers are small, portable and battery-operated (Alkaline and rechargeable NiMH models available). The loggers are able to store up to 480,000 points (1MB) and 64 samples per cycle.

Jenny Pellerin
(508) 698-2115
jpellerin@aemc.com

Onset Computer Corporation, a supplier of battery-powered data loggers and weather stations, has released its 2006 product catalog. The catalog offers detailed product descriptions, specifications, and prices for its full line of PC and Mac-based HOBO® data loggers, weather stations, and Tattletale® logger-controller products. New hardware and software products are highlighted, including Onset's new HOBO FlexSmart Logger for energy monitoring, and new alarm software that provides real-time notification of environmental conditions via e-mail, pager, and text messaging.



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Des-Case's new FlowGuard™ hand carts offer end users greater flexibility over traditional hand carts, which provide little customization. Des-Case's unique approach offers end users a chance to create their carts entirely on Des-Case's website at a very affordable price. The design of the hand cart incorporates the cleaning capability of dual filter media and the sealing capability of the quick disconnects. Pairing it with FlowGuard™ quick connect adaptors makes oil handling even easier and cleaner.

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The Vibration Division of PCB Piezotronics, Inc. introduces Model 377A60 externally polarized, 1/2" Random Incidence (Diffuse Field) type microphone. The distinguishing feature of this model is its enhanced sensitivity of 50 mV/Pa. It has wide dynamic range (15 to 146 dB (A) re 20mPa) and a frequency range from 3.15 Hz to 10,000 Hz (+/- 2 dB). This traditional type condenser microphone has a +150 °C (+302 °F) operating temperature range, and –when combined with the PCB Model 426A30 preamplifier –can operate from a 200 V power supply for externally polarized microphones.

Andrea Mohn
mktg@pcb.com
(800) 828-8840 ext. 2216
www.pcb.com

Patented, industry-first infrared "spectral tuning" allows the MikroScan7400 to be used in mid-wave mode for high-temp, through-the-flame boiler monitoring, or in long-wave mode for general predictive maintenance thermal imaging. The unique dual-range camera can save up to $50,000 over complex, cryogenically-cooled cameras traditionally used for high-temp, through-the-flame IR monitoring. Compact, portable design allows comfortable one-handed point-and-shoot operation.

Along with the specialized infrared filtering capabilities, the camera is also available with a radiation shield and protective window assembly to allow temperature measurement inside a furnace without interference from combustion flames.

The MikroScan 7400 is battery-operated and self-contained in a rugged, IP54-rated metal case for simple, point-and-shoot versatility. It includes on-board digital voice recording and can simultaneously record high-definition 14-bit thermal images with digital visual images. It comes standard with extensive onboard image processing software and stores images and data to PCMCIA cards. Images can also be viewed in real time via video output or optional built-in IEEE 1394 (Firewire®) interface.

Jon Chynoweth
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TORKDISC® Rotary Torque Sensor System from the Force/Torque Division of PCB Piezotronics, Inc. (PCB®) is a compact in-line rotary torque sensor, ideally suited for spindle qualification testing of machining center and other torque measurement applications that require a robust torque transducer where axial space is at a premium. The torque sensor can aid in selecting proper spindle sizes by comparing rated power to actual torque delivered to cutting tools. The compact, low weight TORKDISC® features high torsional stiffness and low sensitivity to axial and thrust bending moments.

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mktg@pcb.com

AE Light introduces the Power Light 14™ a powerful, lightweight flashlight, they like to describe as a personal searchlight. It produces 800+ lumens of true white light in a compact beam. Protective rubber lens & end caps, strap rings and a strap are included. The end cap houses the charger receptacle for convenient access when charging. It comes with a 100/240VAC charger with automatic over charge protection and for maximum versatility; a 12/24VDC charger is available.

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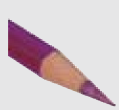
The 260A Series Triaxial Force Sensors from the Force/Torque Division of PCB Piezotronics, Inc. simultaneously measure dynamic and quasi-static forces in three orthogonal directions (X, Y, and Z-axes). The sensors are used to study vehicle chassis dynamics at interfaces between shock absorbers, struts or other chassis components.



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(800) 828-8840 ext. 2216
mktg@pcb.com

The 260A series features full-scale measuring ranges from 500 lb to 4,000 lb (2.2 kN to 18 kN) in the X and Y directions and from 1,000 lb to 10,000 lb (4.5 kN to 45 kN) in the Z direction. Single axis models are also available.

The Vibration Division of PCB Piezotronics, Inc. has released a 1/2" in-line A-Weight filter, which operates from ICP sensor power and is designed to work with prepolarized microphones. This filter simulates how a sound pressure level, at different frequencies, would appear to a normal human ear. It's commonly used in automotive, aerospace, and appliance testing applications, or anywhere manufacturers are concerned about how the human ear perceives sound pressure levels at the frequencies generated by their products.

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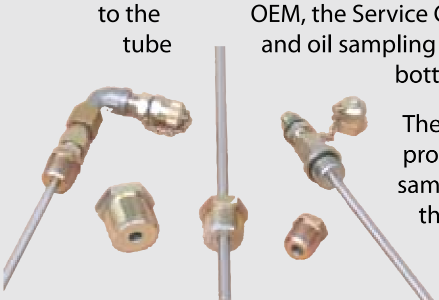
24-hour SensorLine 716-684-0001 **mktg@pcb.com**

OILMISER™ Sampling Tubes are designed as a three piece assembly. The three separate components include the gland-seal bushing, a stainless steel sampling tube and the gland-seal tube retainer. This configuration gives unparalleled flexibility to the OEM, the Service Contractor and the End User. Now in a matter of minutes, a sampling tube and oil sampling can be added to most gearboxes and reservoirs using an existing top, bottom or side access port.



The overriding design criteria for OILMISER™ Sampling Tubes was to provide for easy installation in the field. In one simple installation, oil sampling valves and test points can now be located and positioned where they can be most effectively used.

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