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apr/may 09

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A New Approach

Elevate the Expectations for an Ultrasound Program

by James Hall

For many years and for many companies, Airborne Ultrasound was the beginning, or the Alpha, of their Predictive Maintenance (PdM) program. They used Airborne Ultrasound to find air leaks, diagnose steam traps, and listen to bearings. Unfortunately, some of these companies have since either reduced, or even dropped, their ultrasound program in favor of vibration, infrared and oil analysis only. These ultrasound programs of old have taken on a new role - simply a troubleshooting tool - used for air leaks, steam traps and occasionally used to listen for arcing tracking and corona activity in switchgear.

I would like Airborne Ultrasound to become both the Alpha and the Omega of your PdM program. I would like you to implement more airborne ultrasound programs, and, as a result, elevate the profile of ultrasound within your PdM program.

Why Airborne Ultrasound

There are a number of reasons Airborne Ultrasound should be a major contributor to PdM programs, and an excellent candidate to be the first technology employed in a new program.

Ultrasound is inexpensive and easy to operate. Lets face it, all motors make noise and all leaks make noise, but they are tough for us to hear because facilities are also very noisy. Since ultrasonic receivers weed out all of the sound in our hearing range, they are very useful in high noise environments. Ultrasound can pinpoint potential problems because subtle changes are heard in ultrasonic range first (before vibration & heat) and it is very directional. When you add all of these factors together, it means that Airborne Ultrasound can provide one of the biggest returns on investment (ROI) in the shortest amount of time.

Many of you think of 'real' Predictive Maintenance as vibration analysis, infrared and oil analysis. While those technologies should be included in any high quality PdM program, there is one important technology missing. If you don't have enough air to cut the paper or control the valves, production is effected. If your electrical switchgear panel fails due to corona activity, production may stop. So, why, do so many people place the ultrasound program at the bottom of the Predictive Maintenance Program, if in fact, they have an ultrasound PdM program at all?

There are many Ultrasound Programs you may want to implement, including: Trending of Bearings, Gearboxes, etc, Air Leak Audit Program, Electrical Inspection and Steam Trap Troubleshooting. These programs will not only increase your reliability, but will also add to the bottom line through energy savings. It takes a lot

of energy to produce compressed air and a lot of energy to run large motors or drives. All of these programs will save you money, some more than others, depending on your particular situation.

I would like you to think of Airborne Ultrasound with a new approach to predictive maintenance and how it fits into your overall maintenance program. Also, take time to consider how it can integrate with other predictive maintenance technologies such as vibration and infrared. Airborne ultrasound is a proven technology worthy of an expanded role in predicting and preventing failures.

Don't Just Listen, Trend Your Bearings

For years you have been told to listen and compare bearing sounds between one bearing and another. The problem I've always had with this is that you and I hear differently! I may not hear low or high frequencies as well you do. So, the newer, and better, approach is to trend your bearings. Do not just rely on listening to them'. Learn how to take & set "pre-determined" bearing decibel ranges. You will need to learn how to set:

A Baseline = An Average or Starting Reference
Warning Levels (Early Failure) = Lubricate & Retake
Alarm Levels (First Failure) = Schedule Removal & Replacement



Figure 1- Know how to use your airborne ultrasound instrument. Photo courtesy of Jim Hall, Ultra-Sound Technologies, Woodstock, GA.

Catastrophic Level* = Remove & Replace Now

* - Call for a vibration consult, review oil analysis and IR reports, if applicable

When you have a catastrophic reading but you do not have a vibration expert, or you do not practice infrared or oil analysis, you should then take the catastrophic level readings and schedule the removal of the bearing now, rather than scheduling at a later date.

After learning the correct steps to take to establish a trending program, you should write it all down. Creating a process with written procedures is critical to the program's success. The program will also be more successful if you teach everyone involved in maintenance and reliability the abilities of ultrasound and even how the ultrasound instrument actually works.

Trending your bearings over time (Figure 2) will lead to more reliable machinery, and will establish an ultrasound program that is trustworthy because it has documented data, which will also make it easier to justify the call for bearing replacement when necessary.

Acoustic Vibration

Years ago while working as a salesman, selling (of all things) airborne ultrasound equipment, I found it difficult to keep and hold an audience when I was talking to a mixture of vibration technicians, infrared technicians and mechanics. You see, unless the talk was about vibration, the vibration techs would leave the room. They were not interested in ultrasonic inspection of bearings.

So, I started using the term "Acoustic Vibration" during my presentations. It became much easier to keep the audience and also further the discussion of hooking-up a vibration box to an ultrasound receiver to diagnose bearing problems. I had become familiar with this technique in 1990 while working with the Performance Monitoring Team (PMT) at Naval Sub Base Pearl Harbor.

Acoustic Vibration (AV) is basically trending your bearings over a period of time, whether you are using low or high frequencies. At anytime during the trending process, when

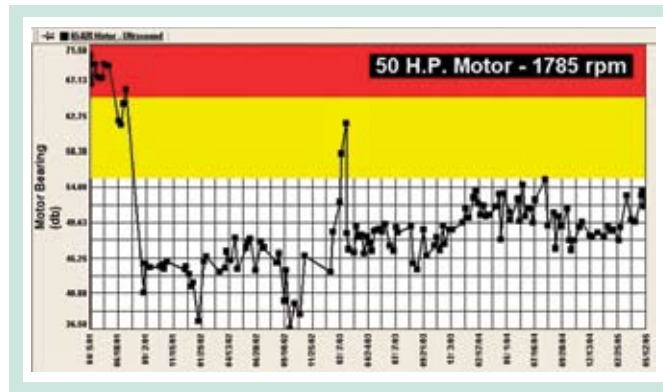


Figure 2 - Trending bearings over a period of time. Graph courtesy of Ralph Kopp, PCS Phosphates, Sussex, NB

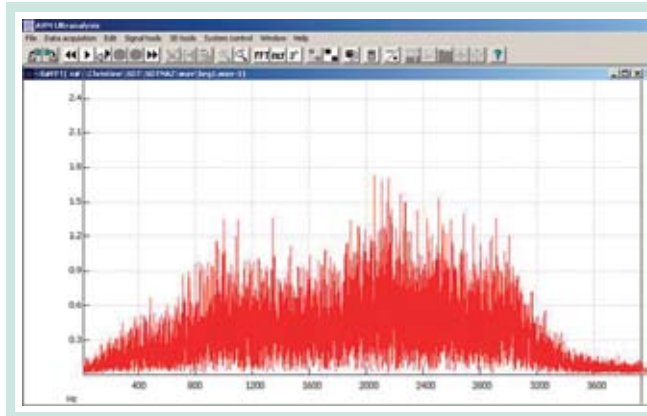


Figure 3- Acoustic Vibration Monitoring using SDT North America's AVM UltraAnalysis Software. Courtesy of SDT North America.

decibels tend to rise or cause concern, the ultrasound technician can ask for a vibration consult.

Imagine trending for several months or years and your readings are normally 65-75 decibels. This range may be your preset range that indicates moving from a "failure" to a "catastrophic failure". Of course, this would mean your bearing needs to be removed and replaced. But, you would like to hold-off shutting down production until you have had a chance to consult with a vibration technician. Vibration analysis on this bearing or motor, combined with oil analysis, and possibly infrared, may allow for another week or two of operation before removal.

Later another company, SDT North America, added the word "monitoring". SDT North America uses the term Acoustic Vibration Monitoring (AVM) within product line (Figure 3) and written material. In order to take advantage of this technique, you should be familiar with waveform analysis. Until you are familiar with waveform analysis, and how to diagnose problems using waveform, do not implement it into your program.

Even without waveform analysis, trending bearings over time aids you in predicting failures. However, keep these important facts in mind when gathering your data:

- If you have more than one ultrasonic instrument to use for bearings, choose only one of them.
- Do not use readings (dB's) from one manufacturer's instrument to compare against another manufacturer's instruments reading!
- Do not compare readings from the same manufacturer that are different models!
- There are only a couple of instruments in the marketplace today that are "Repeatable" among instruments of the same model!

Leak Detection

Almost all of you have a need for leak detection. Compressed air leaks can cost a fortune over the years. Whether your production line is using pneumatic controls or vacuum, cryogenic gases, or whatever else, you most likely need an air leak detection program, or an 'Air Leak Audit' Program. The new approach to an Air Leak Audit Program is a three part approach:

- **Acceptance** – Accept the technology, it works and is proven.
- **Dedication** – Everyone must be onboard, and convinced of the need and value of the program, or it will not succeed.
- **Enthusiasm** – Find an enthusiastic person to spearhead the program. Someone that accepts the technology, wants the program to succeed and is dedicated to the program.

Air leak audits are popular because they are easily understood as an effective way to save money on utilities. However, it may surprise you to know that even when the leaks are identified, the majority are not repaired. It sounds bizarre, but facility after facility that I visit will have leaks identified, but not fixed. This happens because it's easy for programs to lose momentum somewhere along the way, or to get pushed further down on the list of priorities.

Here are some tips for conducting a successful Air Leak Audit Program and for sustaining the program over the long haul:



Figure 4 - Tag your leaks and photograph for referencing location and identification.

- Use Safety as a First Priority
- Tag all of your leaks using a two or three part tag (Figure 4)
 - ~ 2-Piece – Locate & Repair Tag
 - ~ 3-Piece – Locate, Repair, Inspect/ Remove Tag
- Itemize your air leaks by taking Digital Pictures
- Datalog/Catalog your findings
- Determine true “Cost” of leaks
 - ~ Cost can be loss of production
 - ~ Cost of actual leak
- Estimate the cost of leaks and share

the amount of waste with other departments

- Air leaks need to be prioritized
- Highest cost is not always the highest priority (look for quick, easy fixes)

Note: A small \$125.00 leak on a natural gas line can easily receive a higher priority over a \$2,100.00 compressed air leak.

- Use data sheets from a previous leak audit if available
- Lay out a plan for tracking leaks
 - ~ Track leaks by Department
 - ~ Later track leaks by Divisions
 - ~ Track leak cost against repair costs
 - ~ Track gas leaks by type of gas

What Type of Leaks?

One customer found the leaks listed in Figure 5, but only about 25% of these leaks were actually repaired. Again, vigilance is required to keep the momentum of the program going by relentlessly vocalizing and documenting the value the program provides.

Electrical Inspections

Do you want to save a life? Sure you do... I ask that question to alarm you, and to alert

Type of Leak	# of Leaks	Estimated Cost
Argon	39	\$26,000
Oxygen	178	\$39,000
Natural Gas	234	\$50,000
Nitrogen	238	\$110,000
Steam	417	\$525,000
Compressed Air	1,444	\$678,000

Figure 5 - Leaks identified in one facility

you to the fact that in your plant, you may have a tool that could be used to save a life..

Ultrasound receivers can detect corona, tracking and arcing within closed switchgear. In the past, I have had electricians ask me, “You mean I can actually hear the corona, arcing or tracking before I open the doors?” Yes, just by scanning the door seam it is not just possible, but likely, that you will hear the anomaly.

One of your “New Approaches” for the electrical program is to think Safety First. By using an ultrasound instrument to scan your panels or doors before opening them, you could possibly save a life or save someone from serious injuries.

Arc Flash Survivor

On ReliabilityWeb.com’s website you can find an interview Bill Giffen, an Arc Flash Survivor. You can learn how he came in contact with a 13.8 kV cabinet and survived to tell others about this incident. Now, I am not suggesting that ultrasound would have prevented this particular tragedy, but I do want you to understand that ultrasound may, can and does save lives.

Ultrasound can detect corona starting at 1kv, whereas infrared can’t detect corona under 240kv. So why not use ultrasound to scan your cabinets before opening them?

The by-products of corona are nitric acid, ozone, ultraviolet light, and carbon. So, can you imagine a 4160v switchgear cabinet that has a fault inside? The technician can hear corona along the door seams of the cabinet. While listening, perhaps he will remember a picture from a corona camera that he had seen in a recent Uptime Magazine article, which asked him to really try to visualize what is going on inside the cabinet.

So, this is that article. Your new approach is to really visualize what is going on within the cabinet. Visualize a shower of sparks, the ionization occurring, the nitric acid and the ozone attacking the insulation of two cables.



Figure 6 - White powdery residue is evidence of corona activity. This was detected using the airborne ultrasound receiver. Photo courtesy of Jim Brady, Brady Infrared Inspections, Stuart, FL.

Eventually, a situation like this could ruin someone's day, like it did Mr. Giffen's. An ultrasound instrument could have heard this fault from outside the cabinet. But only if you have an ultrasound program in place.

Can you recognize the difference between nuisance corona and destructive corona? Typically nuisance corona is a steady frying sound that you might hear when driving your car down the road and listening to AM radio. Or, it may be the early morning dew sitting on the power lines that is creating the noise. Destructive corona is the sound of the steady frying sound accompanied by intermittent popping sounds.

Did you know that ozone generators are used to break down the rubber on tires when the manufacturer wants to simulate wear and tear on the tires? Ozone actually breaks down the rubber. So that white powdery residue you sometimes see between two cables (Figure 6) is visual evidence of corona activity.

So, the New Approach to Electrical Inspections contains four parts:



Figure 7 - A terminal end taken with a Corona Camera.

- (1) Safety First... the ability hear corona, arcing or tracking before opening panel.
- (2) Use ultrasound in conjunction with infrared to inspect. I think that using ultrasound and Infrared together is imperative. It can make the difference between a good, responsible thermographer and a fly-by night amateur.
- (3) Visualize what you are hearing (arcing, tracking & corona).
- (4) Ultrasound training is crucial to the success of this program.

Figure 7 is a photo of real time video over an ultraviolet light lens. Unless there is interference from background light or complete darkness, corona is not visible to the human eye. This shows you why it is so important to "Visualize" what you are hearing.

Steam Traps

The New Approach to your steam trap program is simply to implement a program to learn how to audit your traps and learn to troubleshoot your traps. It can be accomplished in two parts...

- 1) Build a route to inspect your traps
 - 2) Educate technicians on how to troubleshoot your traps.
- You need to audit your traps to find which traps are working or not working.
 - A pencil and a pad a paper works well.
 - Its very hard to use a datalogger to log the results.
 - Ultrasound is still one of the best methods to diagnose steam traps

You may only need to implement one of these ultrasound programs as it applies to your facility. Or perhaps, you may decide that none of the ultrasound programs listed are for you.

However, I do want you to think about just how big of a role airborne ultrasound does play for some companies. Especially, for instance, those companies that win the Uptime PdM Program of the Year Awards. The 2008 Best Overall Airborne Ultrasound Program winner, US Steel Gary Works of Gary, IN, has a very advanced program, and their airborne ultrasound plays a significant role in their overall maintenance effort. Your ultrasound program could do that too.

Think of the many different applications and how airborne ultrasound integrates with other technologies.

The New Approach

Think NEW, a New Approach to how airborne ultrasound fits into your overall PdM program.

In this article, I have identified five specific ways that you can increase the contributions of ultrasound to your overall predictive maintenance program, and, ultimately, to increase the reliability of your machinery.

Starting to trend your bearings, acoustic vibration, an air leak audit program, and using airborne ultrasound both in electrical inspections and to troubleshoot steam traps are all very effective ways to increase reliability and to make your facility more efficient.

All of the programs we talked about can produce a positive return on investment. You will need to decide, based on your particular industry, and particular facility, which one of these programs will benefit your company most. Implement the programs that will be most beneficial first. Once you have experienced success with one of the programs, trust in the capabilities of airborne ultrasound should start to increase in your organization, which will help justify starting additional airborne ultrasound programs into you predictive maintenance program.

Notes

1. The only exception to this 'rule of not listening' is when a bearing is so catastrophic that it literally sounds as if it is coming apart.

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 has provided airborne ultrasound training for several Fortune 500 Companies in electrical generation, pulp & paper, petro-chemical and transportation. 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). Jim is also president of All Leak Detection, LLC a leak detection company providing air leak audits above and below ground leaks. You can contact Jim at jim.hall@ultra-soundtech.com or (770) 517-8747.

All photos courtesy of Jim Hall, Ultra-Sound Technologies, Woodstock, GA, unless otherwise stated.

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