uptime

the magazine for PdM & CBM professionals

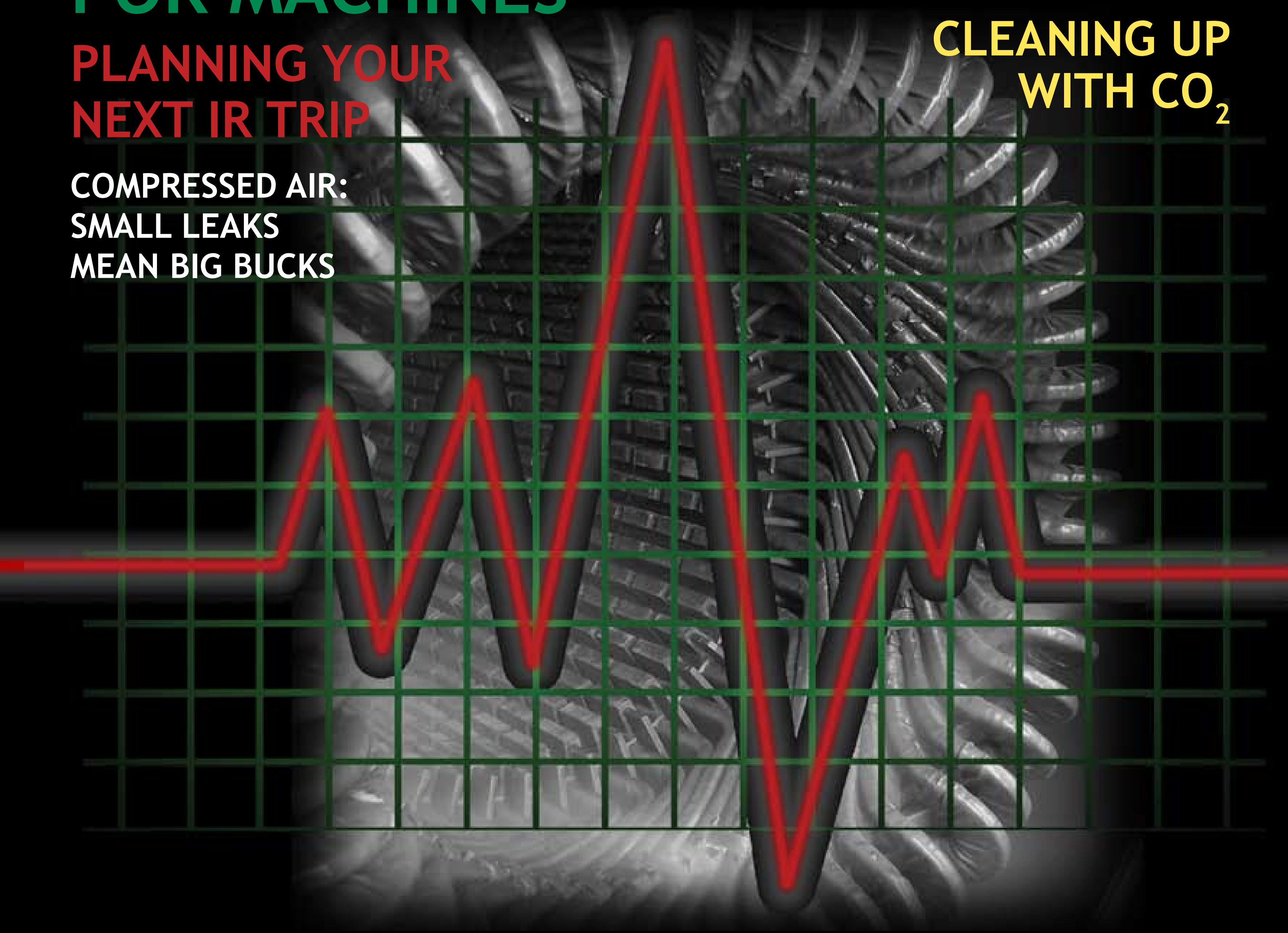
dec 2005

A HEALTHCARE PLAN FOR MACHINES

PLANNING YOUR NEXT IR TRIP

COMPRESSED AIR: SMALL LEAKS MEAN BIG BUCKS

CLEANING UP WITH CO_2



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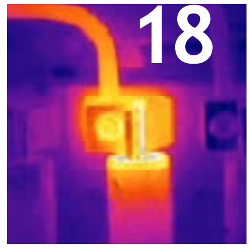

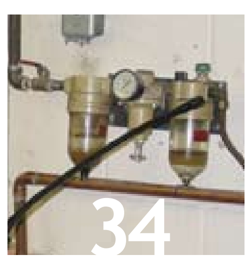

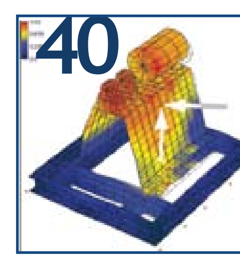

The Human Factor

Predictive Maintenance is really cool. The advances in predictive technology over the last several years have been nothing short of incredible. I am going to go out on a limb here and say that the innovations will not stop. They will keep on coming, and, if the past few years are any indication, at a faster and faster pace.

This is wonderful news for all the professionals in maintenance and reliability. It means that we will be able to increase production, decrease equipment failures, extend the life of our equipment and lower maintenance costs in the process. Predictive technologies give us the opportunity to accomplish great things.

Today's technology is so powerful it's easy to think of it as the silver bullet. It's easy to think if you buy that hot, new infrared camera your maintenance program will become world class.

That's a big mistake. Technology is certainly critical for an excellent maintenance program, but it's not the most important element.

People are the most important ingredient. Establishing a culture where the entire organization understands the merits of a long term commitment to maintenance is the key. This culture begins with education. If people throughout the organization - executives, production, accounting, etc. - understand the benefits of maintenance, they will support your program.

Education is a process, not an event. Maintenance professionals should think of each conversation as an opportunity to establish or maintain the culture of world class maintenance.

Predictive technology is really cool. I hope you will keep up with the latest and greatest products, techniques, ideas and processes in predictive maintenance by reading **uptime**. Just remember, without people, technology won't take you where you want to go.

I hope you enjoy issue number 2. You may not receive issue 3 if you haven't subscribed. To assure you get more **uptime**, hit our website to subscribe. I welcome any comments or suggestions on how we can enhance the dialogue within the maintenance & reliability community.

All the best,

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uptime
volume 1, issue 2

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POSTMASTER: Send address changes to: Uptime Magazine PO Box 07070, Ft. Myers, FL 33919.

upclose

Machine Centered Healthcare

A Holistic Approach To tracking your Machinery's Total Health?

by James W. Taylor

Condition assessment programs are often structured to optimize the application of the technology. This spreads the cost of equipment and training over as many pieces of equipment as possible, minimizes cost per measurement, provides a full work load, and keeps the equipment in use. But it means that we may be spending time and resources taking data that is not particularly valuable in improving reliability and reducing costs. And the information derived does not get integrated into overall machine healthcare decisions.

What we want to do is to maximize the effectiveness of technology in improving machinery reliability. We should only do those tests and tasks that are cost effective from the point of view of the machine. Machine centered condition assessment is a problem looking for a solution.

Background

Many plants have one or more condition assessment programs... (but) the payback is never fully realized.

Many plants have one or more condition assessment programs. They might have a vibration monitoring program, an oil analysis program and a thermography program. And they may also have preventive maintenance tasks calling for routine overhaul of some machines based on running time or calendar time. This has the potential to make major contributions to the reliability of the machinery. But usually, these various sets of data never meet. And the routine overhaul — it's not effected by collected data. So the payback is never fully realized.

Let's consider the typical vibration program. After some research, a cost justification is made and approved to purchase vibration equipment and software. Then one or two technicians are trained and designated to manage the program. They are told to make the vibration program run. In the absence of any measure of cost-benefit, they make the decision to apply the vibration to as many pieces of equipment as possible. From their perspective, it's a smart move: it spreads the cost of equipment and training over as many pieces of equipment as possible, minimizes cost per measurement, provides a full work load, and keeps the equipment in use. In short, it optimizes the individual technology program.

Is this the best strategy to improve machine reliability? Would you be happy with your doctor if on your annual physical he only tested your blood pressure? And, perhaps, then makes a decision on whether to do surgery based on that? (That pump overhaul is surgery!) Probably not. You'd like to see him make a number of tests — blood work, EKG, chest x-ray, etc. Then he'll get a complete picture of your health --and have a lot better basis to make a decision on surgery.

Would you be happy if your doctor only tested your blood pressure and made a decision to do surgery based on that?

The same principle applies to machinery. To get a complete picture of machine health, you need to run a number of tests. And when that PM for overhaul (surgery) comes up, you can make an informed decision on whether to perform or defer it.

Condition assessment involves a lot more parameters than just vibration, oil condition and IR. Process parameters such as temperatures, pressures, flow rates and operating speed all have things to tell us about the health of our machinery. For example, suction and discharge pressure of a pump, along with motor amps, RPM and flow rate will give a good indicator of impeller condition. Based on those, you may decide to defer that pump overhaul for another year or two. That's a big savings.

If you have a technician going to a machine to collect data for one technology, why not collect all the data you need? Instead of just vibration, how about bearing temperatures, fluid pressures, RPM and other parameters that contribute to a complete picture of the machine's health. It means that more time will be spent at each machine. Fewer machines will be assessed in a day, but you have much more valuable information. You will also save transit time, prep time, and administrative time associated with multiple trips to the machine. And you'll save time by just applying a technology to those machines where it's cost effective. You haven't optimized the technology, but you have optimized the machine's healthcare. And isn't that what we really want?

A Different Way

There is a more effective way to approach this problem. It's not new or unique because many maintenance managers have been doing it for years. I call it Machine Centered Healthcare. The process has its roots in Reliability Centered Maintenance.

A machine-centered approach looks at the machine first, and through a series of steps, helps you decide how to maintain the reliability of the machine. In other words, it is the machine's healthcare program. I believe that Reliability Centered Maintenance is the best approach for critical machines, but not every plant can afford, get approval, or has the manpower for a full-fledged Reliability Centered Maintenance program. It's expensive in the short run. I'm proposing a process that will help you decide how to maintain your machines in a less formal manner with less paperwork than reliability centered maintenance.

In this process we'll look at what a failure is and which ones can occur. Since we can't do everything at once, we'll decide which ones to work on first. Then we'll decide what the symptoms of each of those failures are and select tests to measure the symptom? Finally, we'll combine that information to make the overhaul/no-overhaul decision?

Step One

Make a List of the Possible Failures

Functional Failure

To ask what failure is, first we need to know what the machine is supposed to do. What is its primary function? At first glance, you might say that a chilled water pump's primary function is to pump chilled water. In reality, the primary function of a chilled water pump is to pump chilled water at a specific temperature at a minimum flow rate. If the pump can't pump at a sufficient rate, the computers will overheat. That minimum rate may vary from season to season.

As you're deciding what the function is, look beyond the obvious to find the real function of the machine. Machines often will have both a primary function and a secondary function. A piping system's primary function might be to convey product from one point to another. Its secondary function may be to prevent loss of product. Another secondary function may be to maintain product temperature.

Once you've decided what the machine's function is ask what can happen to prevent it from meeting that function. In the case of the pump, the answer might be the impeller wearing out reducing available head, bearing failure causing low RPM, a crack in the casing or worn-out seal causing liquid to be lost reducing flow, or a number of other possible failures. At this point, you're just brainstorming. Don't consider whether the failure is likely or has much impact. We'll do that in the next step. For now, just get a complete list.

Failure

When making a list of possible failures, there are several situations that should be considered. Failures to consider include failure to meet steady state demand, failure to meet transient demand, hidden failure, secondary failures and failure to operate economically.

Failure to meet steady state demand is probably the most obvious. This is when the machine cannot meet the normal demands of production. For example, a heat exchanger that is so fouled that it can't cool the process liquid sufficiently. When that happens, you'll know it because the system won't be able to do its job under normal circumstances.

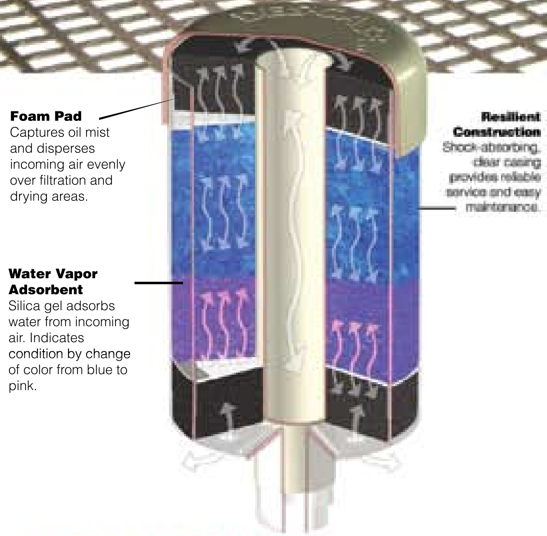
Failure to meet transient demand is more subtle. It may be a type of hidden failure. For example, the motor may have enough power to run a pump under steady state conditions but not have enough power to accelerate the pump from a stopped condition to running speed. Clogged piping may allow sufficient flow for normal conditions but when a surge in the system requires extra supply, the back pressure due to clogging is too high to achieve it.

Another example of a hidden failure might be the emergency diesel generator in a hospital. Because it doesn't run all the time, it can fail in a way that would prevent an emergency start. Often periodic tests are conducted to make sure it will start when needed.

With the rising costs of energy, failure to operate economically becomes important. Common failures of this type include excessive compressed air or steam usage due to many minor leaks. Or it could be a machine that uses more power than it should, or must run faster to make up for deterioration. A diesel engine may use too much fuel per hour.

Is the failure a secondary failure or can it cause secondary failures? A belt over tightened or a fan out of balance may cause a bearing to fail. The failed bearing allows the shaft to drop, allowing contact between the fan and shroud. This causes destruction of the fan, the shroud, and the shaft. It's very unlikely that two independent failures will occur at the same time, but secondary failures are common.

The choice is clearer than ever.



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Step Two

Decide Which of These Failures Are Significant

Now that you have a list of possible failures, you want to decide which ones you should worry about first. Limited resources mean we can't manage them all. Some failures are so unlikely that you won't think to worry about them; others have such a low consequence that their impact and cost is minor. But both of these might be significant over time.

The significance of a failure is the combination of two factors: frequency and impact. A small failure that occurs often can have the same impact as a large failure that occurs infrequently. For example, a bearing may fail once a month (a chronic problem) because the drive belts are too tight. The cost to replace is $2000. Over a period of five years, that's $120,000. But because each individual failure is not major, it doesn't receive the visibility as a single failure costing $120,000 that only occurs once in five years (an acute problem). But they both cost the same.

The best way to determine how often a failure occurs and its impact is from the machinery history. Search for both chronic and acute problems. Try to determine their costs including labor, parts and downtime. Figure out how often they occur. Multiply cost times frequency and rank by the result.

However, we can do it without the history. I've had success in the past using a subjective evaluation. Make a list of the failures and ask two questions about each of them: how often does this occur and what's the impact on production when it does. Make it up as a questionnaire. Possible answers are in Table I below. This may sound simplistic but it works.

Score	Frequency	Effect
1	1 per 10 years	None
2	1 per year	A Little
3	1 per month	Some
4	1 per week	A Lot
5	1 per day	Complete

TABLE 1

You should also ask if the failure is a safety issue. Does it have the potential to cause injury to personnel or machinery? If so, it's automatically the highest priority.

Now send the questionnaires to a cross section of maintenance, production and management personnel. When you get them back, average the scores for each item.

By taking the score for frequency (1 to 5) and multiplying it by the score for effect (1 to 5) you'll get a composite score for each failure in the range of 1 to 25. Rank the list by the composite score. The higher the composite score, the greater the significance of the failure.

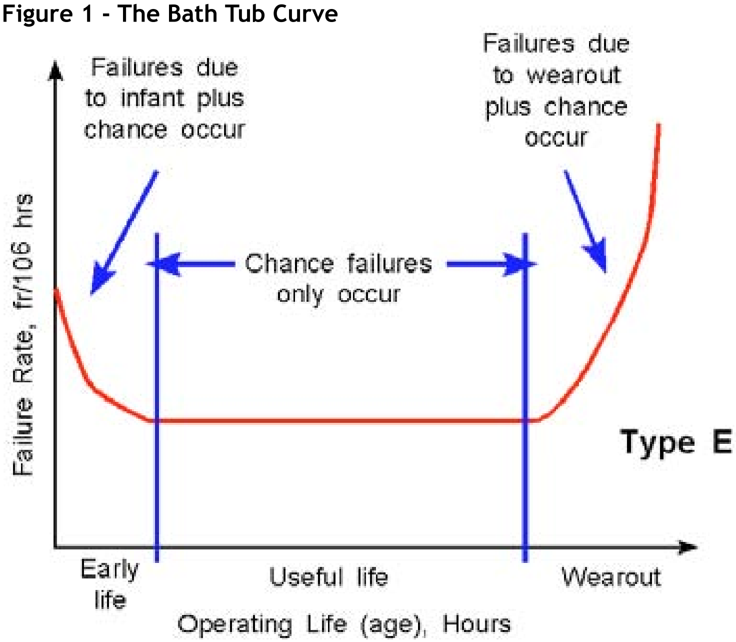
Now you have to make a judgment call — which failures should you worry about? Any failure that presents a safety hazard automatically goes to the top of the list. Often, only a few will have a high rank and you can concentrate on them. Other times most will have a high rank. This is where your knowledge of the machine and professional judgment come into play.

Step Three

See if these failures can be avoided

Starting at the top of the list, ask "how can we avoid this failure?" Is there some action we can take that will keep the failure from ever occurring? Can we change the design? Can we replace a part that has a predictable wear-out period with one that doesn't?

Figure 1 - The Bath Tub Curve



When you think about how a part fails, think about the bathtub curve. The classic bathtub curve has a region of infant mortality, in which new parts fail more frequently than average. This is often called the break-in or burn-in period. Then there is a period of constant failure rate during which failures are random in time. Finally, there is the wear-out period, where failure rate increases. Figure 1 shows the bathtub curve.

But the fact is that studies by United Airlines and the US Navy have shown that only 3 to 4 percent of simple components follow this pattern. And usually, complex machines don't follow it at all.

According to the same studies, between ten and twenty percent of failures are due to wear out and the remaining seventy to eighty percent are due to random failure. What this tells us is that time based replacement is not very effective. In particular, complex machines (the only kind we have) fail in a random manner. So what to do?

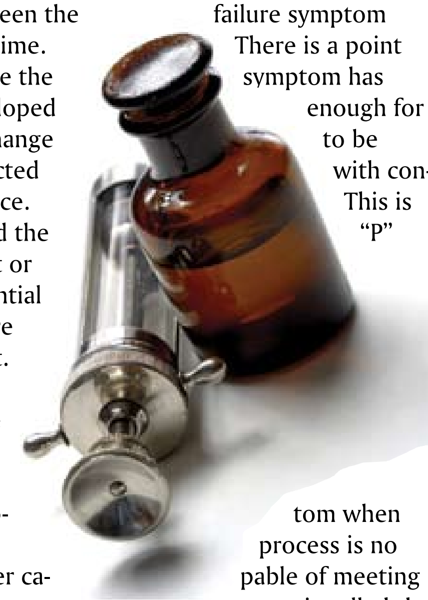
We may be able to design the failure mode out of the machine but that's usually beyond our resources. Taking a cue from our doctor, we could test to see if the machine is starting to deteriorate.

Step Four

For those failures that can't be avoided, see if there is a symptom that will give an early warning

For those failures that we can't avoid, we ask "How can we detect the failure before it occurs?" Most failures show symptoms before they happen.

Find the symptoms of failure for each failure mode. A pump may have to be run faster because of a worn impellor. A motor may draw more amps because of misalignment or a seal that is too tight. A coupling may be hot because of misalignment or lack of lubrication. The delta-T across a heat exchange may decrease as it becomes fouled. The wall thickness of a pipe may decrease because of flow induced corrosion. Make a list of symptoms for each failure.



It is useful to think about the process of failing as what's called a PF Curve (Figure 2). This curve illustrates the relationship between the failure symptom and time. There is a point where the symptom has developed enough for its change to be detected with confidence. This is called the "P" point or potential failure point. The value of the symptom when the process is no longer capable of meeting requirements is called the "F" point or functional failure point. Note that the "F" point is not necessarily the point of mechanical break up.

We want to find a parameter to measure that will meet several criteria. First it should be a reliable indicator of machine health: i.e.: it should be a reliable measure of the symptom. It should be economic to measure. And it should give sufficient warning so that there is time to react.

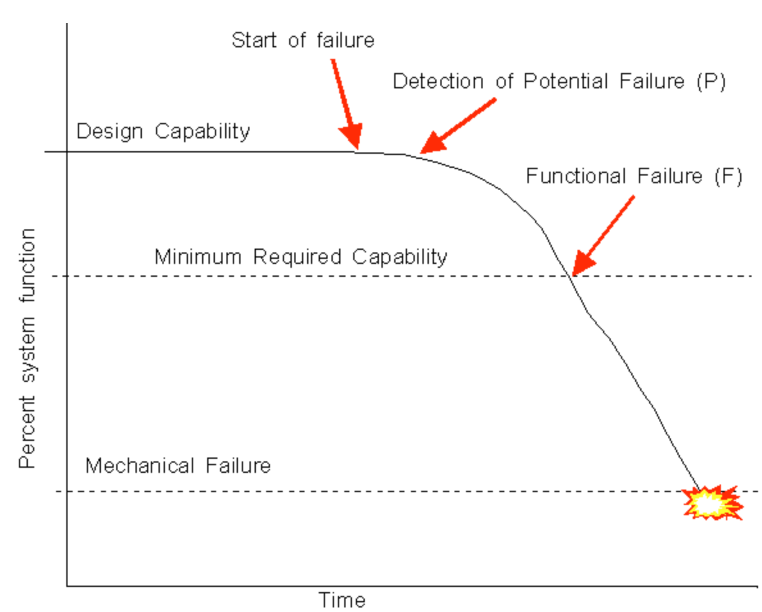


Figure 2 - The PF Curve

Step Five

For Each Machine, Select A Suite Of Tests To Detect Those Early Warning Signs

With a list of symptoms and measures, you're now in the position to select tests that measure or detect that symptom. For each symptom, try to get as many independent tests as possible. The more information you have, the more confident you'll be in your call. You should have at least two tests for each failure that can confirm each other and avoid false positives (or negatives).

As you're considering tests, don't limit yourself to high tech methods. Process parameters are also valuable. It may be a process parameter that is already available in the PLC or DCS. You may need to add a gauge or thermometer. It could be a visual inspection such as a bore scope. You may need a high tech instrument such as vibration analysis, ultrasonic thickness measurement, or probes to measure a magnetic field strength in a generator. Some tests such as oil analysis or Transformer Oil & Gas Analysis (TOGA) are best done by an outside laboratory. And one of the most valuable tests is the operator and maintainer. An experienced person, familiar with the machine, making a conscious effort to sense a particular effect, can be very effective at assessing the health of a machine. Table 2 is a partial list of machines and the tests that may be effective in monitoring them. But don't limit yourself to this list. Anything you can measure has potential. Just make sure it meets the three criteria for a good measure: it should be a reliable indicator of machine health, it should be economic to measure and it should give sufficient warning so that there is time to react.

Step Six

Collect all available information At One Decision Point

Many plants have some form of condition assessment program in place. But as a rule,

Table 2 - Applications and Appropriate Technologies

Application / Technologies	Pumps	Electric Motors	Deisel Generators	Condensers	Heavy Equipment /Cranes	Circuit Breakers	Valves	Heat Exchangers	Electrical Systems	Transformers	Piping Systems	Tanks
Vibration Monitoring And Analysis	X	X	X		X							
Lubricant / Fuel Analysis	X	X	X		X							
Wear Particle	X	X	X		X					X		
Bearing Temperature	X	X	X		X							
Performance Monitoring	X	X	X	X			X		X			
Ultrasonic Noise Detection	X	X	X	X			X	X	X	X		
Ultrasonic Flow	X			X			X	X			X	
Infrared Thermography	X	X	X	X	X	X	X	X	X	X	X	X
Thickness Testing				X				X			X	X
Visual Inspection	X	X	X	X	X	X	X	X	X	X	X	X
Insulation Resistance			X			X			X			
Motor Current Signature Analysis		X										
Motor Circuit Analysis		X				X			X			
Polarization Index		X	X						X			
Transformer Oil & Gas Analysis (TOGA)										X		
Electrical Monitoring									X	X		
Power Quality Monitoring									X	X		

those programs operate in relative isolation. The people responsible for them work to maximize the efficiency of application of the technology. They optimize the technology. Doing the tests without putting all the information together is not effective. I recommend that each machine have one or two individuals assigned to monitor its health (The machine's personal trainer?). They should be trained in assessing all the information provided by the tests. Notice I didn't say, "Trained to evaluate the data". They don't have to analyze the data (vibration spectra); they just have to understand the results (information) of that analysis.

They should receive the results of the tests along with any other pertinent information on a regular basis. Then they can use that information to manage the machine. They can use it to adjust lubrication intervals, decide when adjustments are needed or part replacement is indicated. And that overhaul? They may decide it's not needed after all.

A large power generating station provides an actual example of the effectiveness of this step. They had been overhauling their main feed pumps every five years, whether they needed it or not. It was calendar based. Then they instituted a condition monitoring program and designated an individual to be responsible for those pumps (a planner who knew and understood them). Now at the five year point the planner collects all the available information about that pump and assesses its condition based on complete information. He usually makes one of three determinations. Overhaul it now (not a normal call), defer the overhaul for one year (most common) or defer it for two years. Then when that overhaul task comes up again, he repeats the process. They have gone as long as nine years between overhauls. A major savings in money and manpower.

Summary

Most condition assessment programs in industry concentrate on one or two technologies. The people, procedures and practices are tailored to those technologies. Application of the technology is optimized, rather than the results. I advocate a machine centered, as opposed to a technology centered, approach to the assessment of the condition of machinery. Just as your physician uses a variety of tests and evaluations to assess your state of health, we should do the same for our machinery. To do less means we make decisions based on incomplete information. What we want to do is to maximize the effectiveness of the technology in improving machinery reliability. We need to assess machine health based on several measures. And we should only do those tests and tasks that are cost effective from the point of view of the machine. The question is how do we decide what to do? I propose we follow the systematic process outlined above to help us evaluate the overall health of our machinery. It's just what the doctor ordered.

Jim Taylor has more than 40 years experience developing, managing, training and performing preventive and predictive maintenance in both military and manufacturing environments. During 28 years of naval service, he was GM/officer in charge of the U.S. Navy's Performance Monitoring Team which performed predictive maintenance for the ships in the U.S. Atlantic Fleet, and managed a $500,000,000 overhaul of the aircraft carrier USS America. Jim has multiple graduate degrees from MIT and a BS degree in physics from Purdue University. Machinery Management Solutions, Inc. provides machinery condition monitoring services and mentoring, and project management, technical quality and industrial maintenance related training. Jim can be contacted on the web at www.machineryhealthcare.com or via e-mail at jim.taylor@machineryhealthcare.com.

Reliability Centered Maintenance Managers Don't Gamble on Results

by Terrence O'Hanlon, CMRP

RCM-2006 brings the intelligence, innovation and leadership of the maintenance and reliability industry together in one place at one time.

RCM Lessons Learned

Last March, over 250 maintenance and reliability professionals met in Clearwater Florida for the first Reliability Centered Maintenance (RCM) Managers' Forum to share RCM knowledge and experiences. This was the first event dedicated to RCM since the seminal F. Stanley Nowlan and Howard F. Heap Department of Defense report published in 1978.

The general lessons learned over the course of 12 RCM case studies last March were:

- A little RCM is better than no RCM
- The RCM Process you select is not as important as ensuring your site is ready for RCM
- RCM often fails to get implemented even after a successful analysis
- It is OK to blend different RCM derivations based on your own decision criteria
- Leadership and strong management commitment are required
- The payback from successful RCM is 10:1 to 15:1
- Implementing RCM requires a different talent and skill set than running a maintenance program based on RCM

Now it is time to bring a new group of people who are interested in Reliability Centered Maintenance together again for RCM-2006, a focused 3-day "community of practice" event held March 8-10, 2006 in Las Vegas, Nevada. Participants will include some of the world's leading RCM experts along with people who are just beginning to explore the subject.

RCM pioneer Anthony "Mac" Smith, co-author of *RCM - Gateway to World Class Maintenance* states, "Instead of a traditional maintenance focus of preserving equipment operation, the primary objective of Reliability Centered Maintenance is to preserve system function."

The 4 primary features of RCM include:

1) Preserve system functions
2) Identify the failure modes that can defeat the functions
3) Prioritize function need
4) Select only effective PM/PdM tasks

To create a logical starting point and shape the context of the sessions to follow, RCM-2006 invited Jack Nicholas Jr., who managed the original RCM project for the US Naval Submarine program, to lead a brand new full day RCM workshop titled Reliability-Centered Maintenance (RCM) Methodologies, Metrics, Readiness Factors and Relationships to Other Elements of Asset Management. His intent is to educate prospective users and service providers to take a new look at RCM principles, various approaches available in the marketplace and potential benefits. His presentation describes pitfalls to avoid in order to improve the chances for a successful outcome.

For the first time, readiness factors to consider before entering into an RCM project are described and discussed. For presentation in this workshop he has developed a logical description, partially based on actual applications, of how RCM fits with other major maintenance and reliability initiatives such as Total Productive Maintenance (TPM), 6 Sigma and Procedure Based Maintenance (PBM). In addition he will present for the first time a Preventive Maintenance Optimization logic, developed in 2005, that provides a screening tool for assessing current tasks, task periodicity and assignment criteria prior to preparation of procedures for their execution.

For attendees who need to keep up with the latest Reliability Engineering principles, the event also offers Reliability Engineering for Maintenance Managers by Vee Narayan, author of Effective Maintenance Management. This full day workshop will address aspects of equipment failure: both physical degradation mechanisms as well as their statistical treatment. You will learn when and how to apply a variety of reliability tools for their most cost-effective use. The emphasis is on practical application of the concepts, so that you can use them in your work situations.

This workshop examines the role of maintenance in minimizing the risk of safety or environmental incidents, adverse publicity, and loss of profitability. In addition to discussing risk reduction tools, it explains their applicability to specific situations, thereby enabling you to select the tool that best fits your requirements. Intended to bridge the gap between designers/maintainers and reliability engineers, this guide is sure to help businesses utilize their assets more effectively, safely, and profitably.

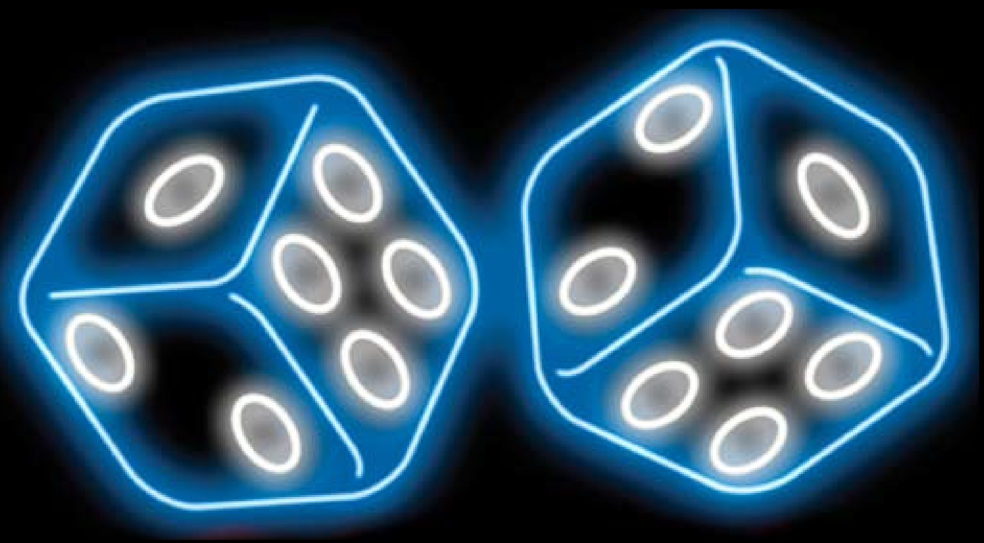
To enhance your learning experience, RCM-2006 includes a deep selection of short courses including:

- Introduction to Reliability Centered Maintenance by Alan Katchmar, certified RCM2 facilitator
- Reliability Incident Management by Steve Turner
- Successful RCM Application - Lessons Learned by Anthony M. (Mac) Smith and Glenn R. Hinchcliffe, Co-Authors of *RCM-Gateway To World Class Maintenance*
- RCM - A New Beginning by Neil Bloom Author of *Reliability Centered Maintenance - Implementation Made Simple*
- When to template an RCM Analysis by Doug Plucknette
- Using the RCM Scorecard by Jack Nicholas Jr.
- Using Failure Mode databases to speed RCM Analysis by Glenn Hinchcliffe and David Worledge
- Detective Maintenance by Vee Narayan

Short courses are designed to provide a more in depth learning experience and are scheduled at the beginning and end of each learning day. A series of RCM case studies is also included as part of the learning zone sessions including:

- An Introduction to the US Naval Air System Command RCM Process and Integrated Reliability Centered Maintenance Software by JC Leverette
- Human error in maintenance by Derek Burley & Rick Baldridge, Cargill
- RCM Supports USPS Automation Strategy by Ray Darragh, US Postal Service and Anthony Mac Smith, Co-Author, *RCM-Gateway To World Class Maintenance*
- Chemical Lime RCM Case Study Using RCM tools to improve PM Frequency by Steve Lindborg
- U.S. Navy Analysis of Submarine Maintenance Data and the Development of Age and Relia-bility Profiles by Timothy M. Allen
- RCM For Facilities by Alan Pride, Smithsonian Institute
- Quantified RCM Analysis by Rich Overman
- RCM at the Y-12 National Sec-urity Complex by Nancy Regan

Don't Roll The Dice with Your Maintenance Program



The Society of Maintenance and Reliability Professionals (SMRP) will also offer the CMRP Certification Exam at RCM-2006 to enhance your professional development. RCM-2006 provides a certificate for credit toward re-certification for those who are already Certified Maintenance and Reliability Professionals.

As a bonus, RCM-2006 attendees can also participate in the Enterprise Asset Management Summit – EAM-2006 taking place at the same time. With a focus on the strategies, techniques and technologies available for managing physical assets across the enterprise, there is a close relationship between the two focus areas. A Solutions Expo will also feature over 40 Reliability and Enterprise Asset Management vendors.

Both events are produced by Reliabilityweb.com and supported by Uptime Magazine, Reliability Magazine, MRO-zone.com and The International Proactive Maintenance User Group (IPMUG) and the Council of Certifying Organizations.

As with many Reliabilityweb.com learning events, attendance is limited to maintain a community setting that fosters dialogue and information exchange among all participants.

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Routes and Frequencies

The Foundation for a High Quality Infrared Inspection Program

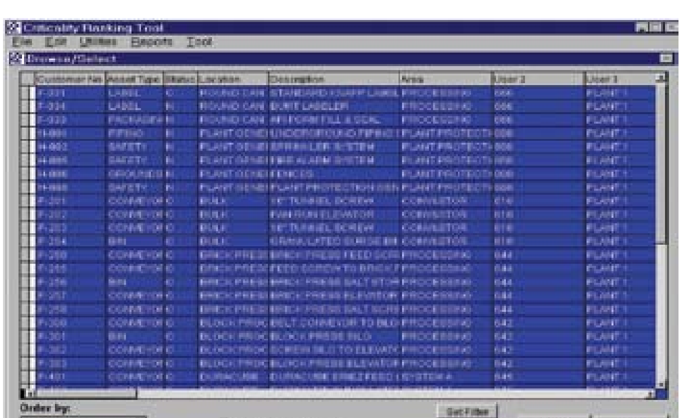
by John Snell

One thing I've learned in the more than twenty years I've been teaching people to use infrared thermography, is that it is very easy to get really excited about what you can do with it, especially for condition monitoring of machinery and electrical equipment. That enthusiasm sometimes goes astray as some new thermographers end up running all around their plant finding problems here and there.

The results, while they can be impressive—especially in a plant that has not had an active thermography program—never add up to the full potential. In the long run it is essential to establish routes so that all equipment is inspected in an appropriate frequency.

How does one get started? Begin with any existing equipment lists, even if they may not be current. These probably reside in a CMMS or in an equipment inventory for another condition monitoring technology. Eliminate any equipment for which thermography holds little promise or where other technologies are far superior. Focus on equipment that creates a production bottleneck or a safety concern or any that has had costly failures in the past. Don't try to finalize the list on your own; get input from the floor, operators, management and anyone else with knowledge and interest.

If at all possible create records in an electronic database format, grouping the selected equipment together in preliminary routes—by area and function—that can be inspected in time blocks of two or three hours each.

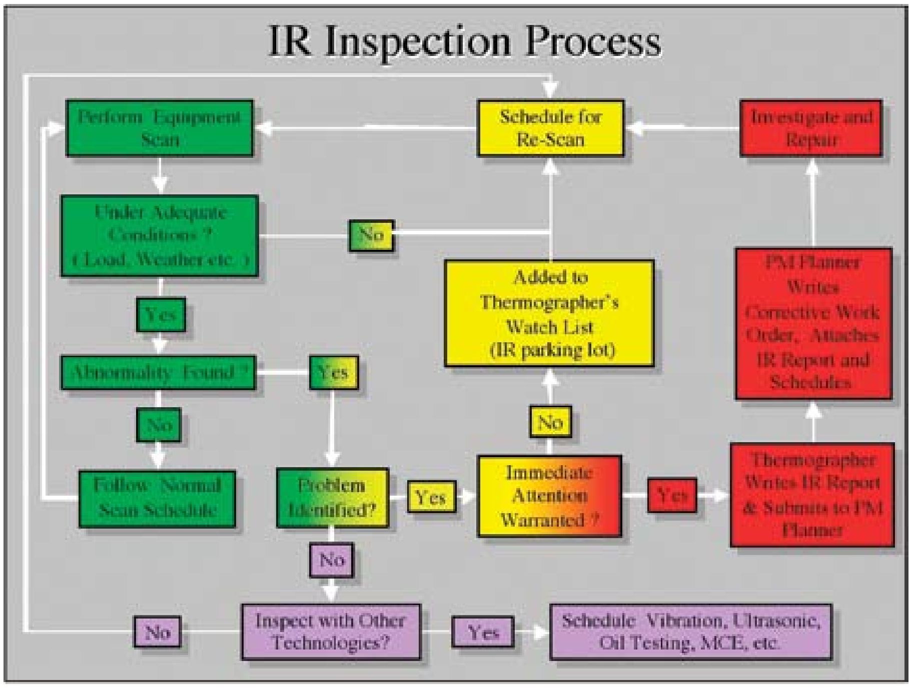


For a successful program, it's essential to list and prioritize all equipment to be inspected. An electronic database can be sorted according to various parameters to create, and modify, the infrared inspection routes and frequencies. (Courtesy Management Resources Group)

The first inspection cycle may go slowly as you take time to locate equipment, update lists, deal with access issues, etc. Consider documenting all the equipment with high-quality digital visual images at the same time. This will prove an invaluable reference later. All this takes time but will prove to be a wise investment and a solid foundation for later work. Remember, you will get results from your efforts, typically by finding a fair bit of "low-hanging fruit!"

If thermography is new in your plant, the first few inspection cycles will probably yield a large number of finds. This will definitely be true if you report all abnormalities regardless of their temperature—an approach that is strongly recommended, even if you will not fix everything found. To do otherwise fails to document the actual condition of the system and results in a poor allocation of future resources to the program. Don't, however, let your organization be overwhelmed by these findings! Prioritize them and—given available resources—first repair those that are quick and lucrative to deal with. Others can wait, but should be scheduled for more frequent inspections.

Subsequent inspections should go more smoothly and effectively. After approximately three cycles it may be appropriate to re-organize the routes so they are more efficient. Trends should begin to reveal themselves and the use of multiple technologies will greatly enhance your results. Continue to add new routes and equipment into the program as time and resources allow. Allow time to accumulate and analyze data to create reports for manage-

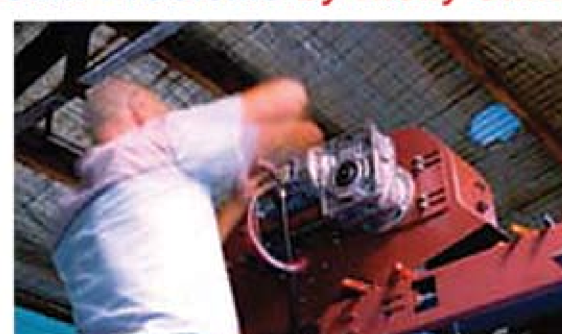


This flow chart is an example of how thermography can logically fit into an overall maintenance program that includes other PdM technologies. *(Courtesy Greg McIntosh, Snell Infrared Canada)*

ment. You must never forget that if maintenance is working right, you will find fewer and fewer problems. At that point, when many will question why you are still doing what you are doing and getting "no results," you need to be able to document your accomplishments.

Many thermographers fall prey to inspecting once a year. This is a mistake! Optimum frequencies for inspection should be determined by the needs of the equipment assets. Some circumstances—age, heavy loading or poor maintenance, may suggest an accelerated inspection frequency. It is vital, however, to begin the planning process accounting for these optimum needs, even if reality does not support implementing the program fully at this time. If you begin with a lesser goal, you may never be able to justify and, thus, achieve full implementation.

The reality of how often inspections will actually occur is typically driven by outside forces—staffing budgets being the big item. By having a program firmly in



Creating formal routes and frequencies is the most efficient and effective way to use thermography for condition-based monitoring of electrical equipment.

place, however, one should eventually be able to weather these anticipated, periodic economic storms. Why? Because you will have a good idea of the actual condition of equipment assets and, thus can, if needed, stretch frequencies without undue damage to the plant or program as a whole.

Typical thermographic inspection frequencies are based on a number of factors. The key drivers are safety, the criticality of the equipment, the expense of a failure, and the frequency with which problems have been impacting production and/or maintenance in the past. This later is important enough that you should devote time to researching past failures, either informally through discussions with co-workers or more formally by reviewing plant records.

In the long run, however, it is the results of your inspections that will drive changes in the frequencies. As fewer problems are found, the natural outcome of a planned maintenance program based on condition monitoring, inspection frequencies for many of the assets can be extended. It is essential, therefore, to document all your findings and to accumulate and analyze this data periodically.

The following frequencies, even if unrealistically generic, are good targets to aim for over the long run.

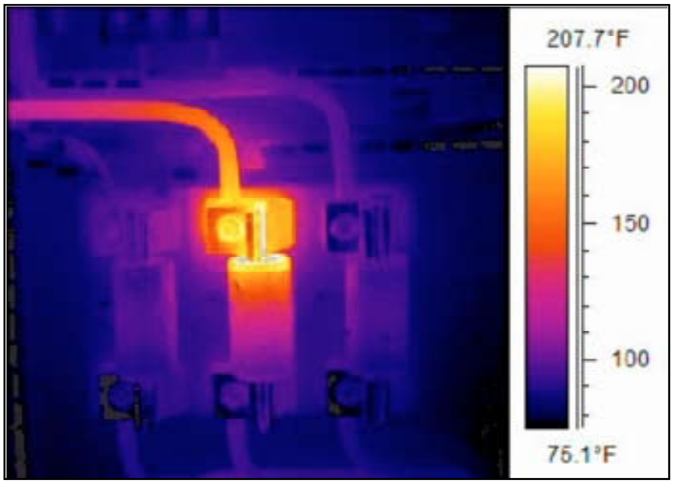
EQUIPMENT TYPE	FREQUENCY OF INSPECTIONS
High Voltage Substations	1-3 Years
Transformers	Annually
440V Motor Control Centers	
Air Conditioned	6-12 Months
Non-Air conditioned or older	4-6 Months
Electrical Distribution Equipment	4-6 Months
Large Motors*	Annually
Small Motors	4-6 Months

*** Assumes vibration analysis, MCA, and lube analysis are also being used**

In addition it is important that all new equipment be inspected both as part of the acceptance process as well as, especially for larger equipment, to establish baseline thermal data. Many plants are now routinely sending their thermographers off site to inspect new equipment before it is delivered to the plant by the vendor. These “buy-off” inspections have proven of great value in many instances by finding deficiencies and problems before the equipment is accepted.

When repairs or modifications are made to equipment, the CMMS must alert the thermographer to conduct a follow-up inspection. Data suggests repairs are often inadequate, for a variety of reasons, so re-inspections are a critical part of quality maintenance.

Conditions for inspecting a particular asset may not be optimum or even acceptable when the time comes due. Such work must be rescheduled rather than put off until the next cycle. Expect to end up with a list of equipment needing increased monitoring until repairs can be scheduled. Some programs leave room in the calendar for this kind of "catch up" work one day/month.



Initial recommendations to clean this fuse clip and re-install the fuse were inadequate. A follow-up thermal inspection suggested that the fuse clip itself had been damaged beyond repair and needed to be replaced.

Over time, and with planning and support, you will be inspecting all assets at appropriate frequencies given the available resources. While this approach may take a bit more time and energy initially, doing it right from the beginning pays big returns over time. You may not look like a superhero when you fail to find "smoking hot" problems every week but you can take pride in the fact that you've documented the actual thermal condition of all the assets you inspect, allowing them to be maintained appropriately, and that is worth far more over time.

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.

Increase Your Sample Quality

Representative Samples Dependent on Method, Location and Interval

by Jacque Powers

Consistent, representative sampling is key to receiving quality oil analysis results and recommendations. Properly identifying sampling points, intervals and the methods by which samples are taken will maximize data density, minimize data disturbance and ensure that consistent, representative samples are being submitted for testing.

Identify Sampling Points

Samples taken from live or turbulent fluid zones – typically return or drain lines – upstream of filters will be most representative of the amount of particulate contamination and wear debris present (see Sampling Interval and Location Chart, page 26). If testing specifically for filter performance, sample before and after the filter. Always sample downstream of bearings, gears, pumps, cylinders and actuators. During sampling, or just before, equipment should be run under typical working conditions at normal operating temperatures. Dirt, system debris, water and light fuels tend to separate from the lubricant when system operating temperatures cool.

Note: Although sampling from static lines, tanks and reservoirs should be avoided, equipment location often prohibits access to return or drain lines, making inactive zone sampling a better option than not sampling at all. However, static lines should be thoroughly flushed to make sure the sample drawn is representative of the fluid circulating throughout the system.

Determine Proper Sampling Intervals

Equipment manufacturer recommendations provide a good starting point for developing preventive maintenance practices, but sampling intervals can easily vary according to application. How critical a piece of equipment is to production is a major consideration in determining how often a component should be sampled, as are environmental factors such as hot, dirty operating conditions, short trips with heavy loads and excessive idle times. Developing a sampling schedule for each unit being sampled is the best way to maintain consistent intervals. Consult your testing laboratory for assistance. Those with the most advanced reporting software applications will support sample scheduling and help you track actual frequency.

Vacuum Pump Sampling - Most common method for non-pressurized systems.

Pressurized and Non-Pressurized Systems

Permanently installed pressure valves are the best method for sampling pressurized equipment. Quick Draw or Red Cap Push Button Valves are fast and easy to use, help prevent external sample contamination and can be used on systems with 4 to 100 lbs. psi. The Vacuum Pump is the most commonly used method for sampling non-pressurized systems. However, always be sure to exercise extreme caution when sampling sumps or reservoirs to avoid extracting any system debris that has settled. Various Minimess systems can be used for sampling both pressurized and non-pressurized systems.

Sampling Procedures

Any sample should be taken while the unit is at operating temperature or within 10 minutes of shutdown and once the oil has been in service for at least 10

Sampling with a Quick Draw Valve

1. Replace sample jar lid with needle cap probe.
2. Insert needle probe into Quick Draw Valve to extract sample.
3. Fill sample jar ¾ full.
4. Remove needle cap probe from valve when sample reaches shoulder of sample jar.
5. Replace needle cap with sample jar lid.
6. Discard needle cap probe after each use to avoid cross contamination.

Quick Draw Sampling - Using a permanently installed pressure valve allows for quick and easy use, and minimizes risk of external contamination.

hours or 500 miles. Consult operating manuals for proper sampling intervals and requirements or consult your testing laboratory. Wear gloves or the necessary protective clothing and eyewear when sampling units at operating temperature to avoid injury. Never remove the sample jar lid until prepared to draw the sample, never leave the sample jar open once the sample has been extracted and never attempt to wipe any excess oil from the sample jar until the lid has been secured.

Sampling with a Vacuum Pump

1. Measure length or depth of fill port tube, reservoir or dipstick.
2. Add 6 inches and mark the measurement on the tubing.
3. Cut the tubing 12 inches beyond this mark.
4. Insert tubing into top of vacuum pump and tighten lock ring.
5. Remove sample jar lid and attach jar to bottom of vacuum pump and tighten securely.
6. Insert tubing into fill port, reservoir or dipstick retaining tube only to the mark on the tubing. DO NOT ALLOW CONTACT BETWEEN TUBING AND BOTTOM OF RESERVOIR.
7. Push and pull vacuum pump plunger until sample jar is ¾ full.
8. When sample reaches shoulder of jar, unscrew jar from pump, replace jar lid and tighten securely.
9. Unscrew pump locking ring, remove tubing and drain excess fluid back into reservoir.
10. Discard tubing after each sample to avoid cross contamination.
11. Complete sample jar label and affix to sample jar.

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.

Sampling Interval and Location Chart

Equipment Type	Interval (Normal/Intermittent Use)	Method & Location
Diesel Engines	Monthly or at 250-500 Hours/Quarterly Just Prior To Oil Drain	By Vacuum Pump Through Dipstick Retaining Tube or Pressure Valve Installed in Filter Return Upstream of Filter
Natural Gas Engines	Monthly or at 250-500 Hours/Quarterly Just Prior to Oil Drain	By Vacuum Pump Through Dipstick Retaining Tube or Pressure Valve Installed in Filter Return Upstream of Filter
Transmissions, Differentials, Final Drive/Planetary	At Least Every 500 Hours No Less Than 3 Times Per Year Just Prior to Oil Drain	Pressurized: By Pressure Valve Installed Upstream of Filter Non-pressurized: Either by Vacuum Pump or Through Oil Drain Plug, Fill Port or Dipstick
Hydraulics	Bi-Monthly or Monthly/Quarterly Just Prior to Oil Drain	By Pressure Valve Installed Upstream of Filter and Pump or by Vacuum Pump Through Fill Port
Gas Turbines	Monthly or at Least Every 500 Hours	Through Sample Valve Installed Upstream of the Filter on the Return Line or by Vacuum Pump Out of System Reservoir
Steam Turbines	Bi-Monthly or Monthly/Quarterly	Through Sample Valve Installed Upstream of the Filter on the Return Line or by Vacuum Pump Out of System Reservoir
Gas/Air Compressors	Monthly or at 500 Hours/Quarterly	Through Sample Valve Installed Upstream of the Filter on the Return Line or by Vacuum Pump Out of System Reservoir
Refrigeration Compressors	Start, Mid & End of Season	Through Sample Valve Installed Upstream of the Filter on the Return Line or by Vacuum Pump Out of System Reservoir
Gear & Bearing Systems	Bi-Monthly or Monthly/Quarterly	Through Petcock Valve at Exit of Each Gear or Bearing Set or by Vacuum Pump Through System Reservoir

How Clean Is Your Motor Cleaning Program?

Dry Ice Makes Cool Clean Up

by Jeffrey LaPointe

Dry ice blasting is a relatively new cleaning process using solid CO_2 pellets (known as dry ice). It is primarily used for industrial use in a variety of applications. The pellets sublimate (convert directly from a solid blast pellet to a vapor (CO_2) leaving no residue. The process has advantages over sand blasting, glass bead blasting and other types of cleaning methods for numerous reasons (see Table 1).

Today, the dry ice method of cleaning is quickly becoming favored for environmental as well as production reasons. Because of tremendous environmental regulations, industry has needed to minimize wastes. Also, there is a growing consciousness that many are placing now on the global environmental impact of their production practices. Since companies experience tremendous performance gains through dry ice blasting -- little or no production downtime, quality of clean and minimized damaged to equipment -- the environmental benefits can actually be seen as a welcome additional bonus.

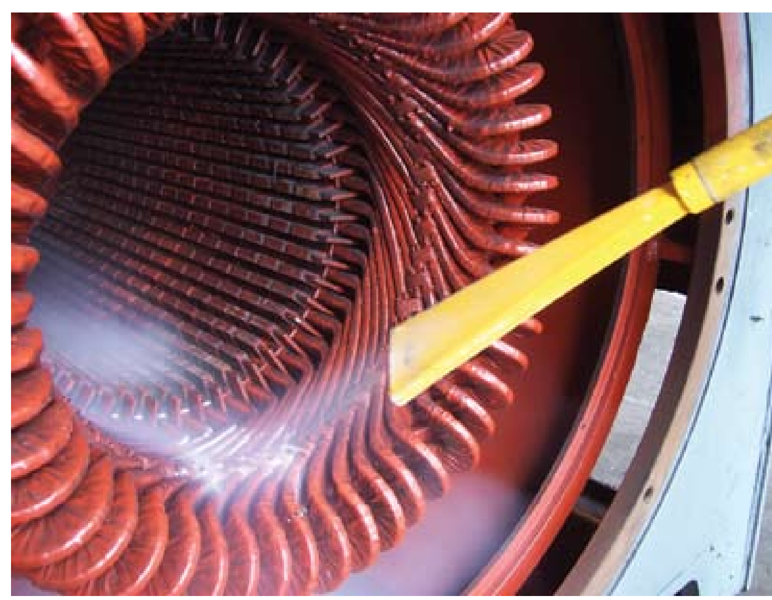
What Is Dry Ice?

Dry ice pellets are made by taking liquid carbon dioxide (CO_2) from a pressurized storage tank and expanding it at ambient pressure to produce snow. The snow is then compressed through a die to make hard pellets.

What Is Dry Ice Blasting?

It is a process in which dry ice particles are propelled to supersonic speed, to impact and clean a surface. The particles are accelerated by compressed air, just as with other blasting systems.

The micro-thermal shock (caused by the dry ice temperature of -79º C), the kinetic energy of dry ice pellets and the air pressure break the bond between the coating and the substrate. It pops off the coating from inside out and the air stream removes it from the surface.



Dry ice blasting a large motor while in place.

Industries can utilize the dry ice blasting cleaning method through equipment that fires the pellets through a blasting gun. Upon impact the dry ice sublimates (vaporizes).

Dry Ice Blasting Compared to Traditional Methods

Table 1 compares the pros and cons of the most common cleaning methods in industry. Table 2 illustrates the issues encountered with both traditional and dry ice blasting. The two charts give a helpful perspective of how dry ice blasting compares with the traditional cleaning methods -- sand, blasting, solvents, and others.

The Process

With the dry ice blasting process, dry ice (CO_2) particles are propelled to supersonic speed impacting and cleaning a surface. The particles are accelerated by compressed air, just as with other blasting methods. Overall, there are three steps involved in dry ice blasting, which are outlined in Diagram 1 on the following page.

Table 1
Blast Cleaning Comparison

Blast Cleaning Technique	Waste For Disposal	Abrasive	Toxic	Electrically Conductive	Performance Comparison
Dry Ice	No	No	No	No	Excellent
Sand	Yes	Yes	No*	No	Good
Glass Beads	Yes	Yes	No*	No	Good
Walnut Shells	Yes	Yes	No*	No	Limited
Steam	No	No	No	Yes	Poor
Solvents	Yes	No	Yes	Yes	Limited

* Each of these blast cleaning materials becomes contaminated upon contact if used to clean hazardous objects. When that happens, these materials are then classified as toxic waste requiring safe disposal.

Table 2
Cleaning Method Comparison

Issue	Traditional	Dry Ice Blasting
Equipment Downtime	Cleaned in dedicated cleaning area; Disassembly/reassembly; Drying time required	Equipment can be cleaned in place; Dry process - equipment restart immediately after cleaning
Hazardous Waste	Cleaner becomes and treated as a secondary contaminant	No additional contaminant; Dry ice sublimates on contact with targeted surface
Labor Hours	Intensive hand scrubbing; Lengthy cleanings; Follow-up cleaning-up can be lengthy	Dramatically reduced - often completed in a quarter of time or better
Quality of Cleaning	Average	Excellent
Potential Equipment Damage	Grit abrasions; Grit contamination; Movement of equipment to and from cleaning area	No equipment damage; Preventive maintenance very realistic as labor hours are significantly less
Safety	Health threats from solvents; Water-based cleaning pose hazards around electrical equipment; Threats to environment	Standard safety precautions; Dry process - safe around electrical equipment
Cost	Cleaner becomes additional hazardous waste; expensive solvents; Additional labor	Equipment Rental or Purchase, cost of dry ice

Step 1 - Energy Transfer

Dry ice pellets are propelled out of the blasting gun at supersonic speed and impact the surface. The energy transfer knocks off the contaminant without abrasion. The force of this impact is the primary means of cleaning.

Step 2 - Micro-Thermal Shock

The cold temperature of the dry ice pellets hitting the contaminant creates a micro-thermal shock (caused by the dry ice temperature of -79° C) between the surface contaminant and the substrate. Cracking and delamination of the contaminant occurs furthering the elimination process.

Step 3 - Gas Pressure

The final phase has the dry ice pellet explode on impact, and as the pellet warms it converts to a harmless CO_2 gas which expands rapidly underneath the contaminant surface. This forces off the contaminant from behind. The contaminant is then relocated, typically falling to the ground.. Since the dry ice evaporates, only the contaminant is left for disposal.

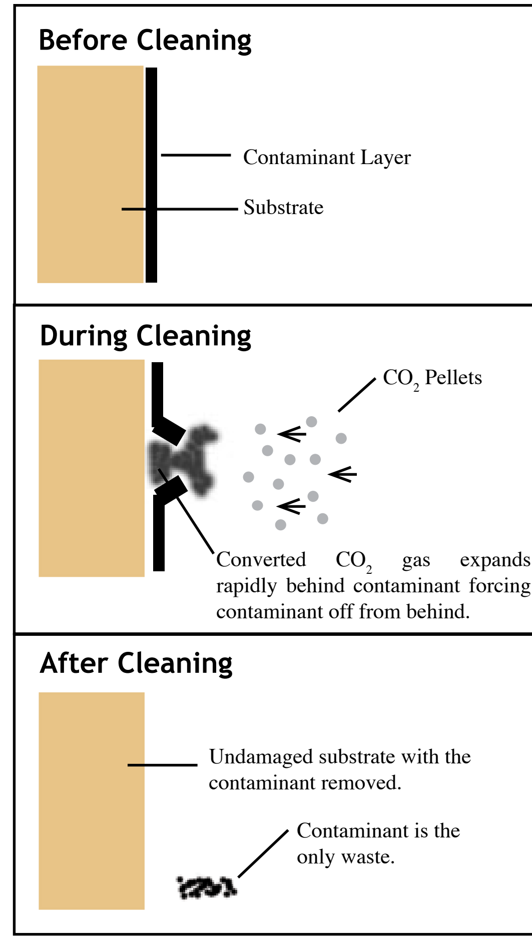


Diagram 1 - Dry Ice Blasting Process

Benefits of Dry Ice Blasting Technology

Dry ice blasting benefits can be broken down into six general areas. Following each benefit is discussed:

Decreased Downtime through Cleaning In-Place

Typical cleaning procedures require that equipment be disassembled and moved to an assigned area for proper cleaning. That is not the case with dry ice blasting. Equipment can be cleaned in-place and hot in most situations. Because of that, many time-consuming, labor-intensive steps which were required with other methods such as sand blasting can be eliminated including:

- Cool down
- Disassembly
- Transport of the equipment to and from a dedicated cleaning area
- Reassembly
- Reheating time
- Dry ice blasting can shorten the downtime for cleaning from days down to hours.

Faster and More Thorough Cleaning

With dry ice blasting, a superior cleaning can be achieved while reducing hours when compared to scrubbing with abrasive pads or wire brushes. A tremendous labor savings is accomplished. In addition, the dry ice blasting method cleans in crevices that can't be reached by hand. As a result, equipment runs more efficiently and potential leaks are revealed possibly preventing major system failures.

Dry Ice Blasting A Rotor

Before

After

Elimination of Equipment Damage

Cleaning methods such as sandblasting leave an aggressive and abrasive effect on the surface. They can actually remove part of the surface, changing the surface structure considerably. Dry ice is non-abrasive to surfaces and does not change a surface's structure. It lifts the contaminants away. Secondly, because equipment can now be cleaned in place, potential damage from moving equipment to and from a dedicated cleaning area is eliminated.

Reduction or Elimination of Solvents

No solvents are used when using CO_2 pellets. This can be a critical need for certain companies in order to comply with environmental regulations or to improve worker safety. There are no issues pertaining to toxicity.

Reductions in Waste Disposal

With other cleaning methods, whether it be with solvents, sand blasting or some other means, the cleaning agent becomes a secondary contaminant and must be disposed of as toxic waste along with the primary contaminant. However, with dry ice blasting because the CO_2 pellet vaporizes upon contact, the only waste created is the contaminant itself. This alone can result in significant waste reduction.

Increased Safety

CO_2 blasting pellets are non-toxic, non-hazardous creating advantages to the environment, your employees, and production facility:

- No secondary waste
- Safe for the environment
- Safe for employees
- Safe for end products
- Safe for equipment

For many companies in many industries, the dry Ice blasting method of cleaning equipment offers many benefits -- both economical and environmental. Your company could experience a drop in the overall cost of cleaning equipment by switching methods. It is always nice when an economical solution to our problems is also the best environmental answer.

See how and why one company made the switch from more traditional cleaning methods to dry ice blasting in the case study on the following pages.

Visalia Electric Motor Shop Embraces Dry Ice Blasting

The Dilemma

What do you do when you're an electric motor shop in California and you're faced with waste disposal costs of $600 per week and feeling the squeeze from ever-growing environmental regulations?
That was the quandary that Gene Quesnoy, president of Visalia Electric of Visalia, CA found himself in 2002. Visalia Electric Motor Shop repairs large electric motors and generators and rebuilds and balances turbine generators. They see dirty motors day in and day out.

The Solution

Gene decided to rent a dry ice blasting machine and test it by cleaning a few electric motors. He found that the performance was quite good. The use of dry ice (CO_2) pellets shot out from a blasting gun at high velocity effectively removed the contaminants from all parts of the motor – stator, rotor, end bells and other parts. It cleaned fast and very thoroughly. But what was most attractive was that after the pellets came in contact with the target surface, they evaporated. There was nothing remaining to be cleaned up. The soiled materials on the motor had fallen to the floor and just needed to be swept up. That was it.

Mr. Quesnoy initially investigated dry ice blasting technology for use in field work. If this cleaning method effectively cleaned faster, as thoroughly or more thoroughly than his traditional methods and could reduce his waste disposal costs, he felt he would have valuable tool. However, after, viewing the blasting unit clean, he realized it could also be integrated into daily in-house motor cleaning.

As Gene began to further investigate dry ice blasting technology, he found there was a wide discrepancy in pricing among manufacturers. The prices ranged from under $10,000 to over $24,000 for units that seemed to offer similar results.

After several conversations with RSG Technologies, Inc., Gene decided to purchase ICEsonic's base model machine. He felt he was buying a well performing system that would meet his needs.

Traditional Cleaning Methods

Mr. Quesnoy wanted the dry ice blasting machine to replace his prior cleaning methods – blasting with walnut shells, sand blasting, and solvents. Each of these methods had serious drawbacks, especially in California's regulation-happy climate.

Visalia had typically used walnut shells for cleaning. They were inexpensive to purchase and in large supply in California. However, walnut shells become a contaminant in the motor cleaning process. The cost of disposal was averaging $600 per week or over $30,000 per year. Another drawback, they found was grit entrapment of the shells in the rotor. This problem could potentially compromise the performance of the motor. Lastly, walnut shells required extensive clean-up to sweep up -- often an additional hour or two of labor costs.

Frequently, motors needed to be steam cleaned. The results were fair. It provided a reasonably quick clean. The main drawback, however, was that this method required significant drying time. Often, a full day of waiting was necessary, prior to reassembly.

Another cleaning method used by Visalia was sand blasting. This posed additional concerns. In addition to potential grit entrapment, the possibility of shorting out the core was legitimate. Mr. Quesnoy also worried about environmental issues. The dust cloud created by the sand caused him to seriously wonder if a neighboring business might not issue a complaint to the EPA.

Cleaning motors in place is a benefit of dry ice blasting. When cleaning is ccomplete, the motor can be reassembled immediately.

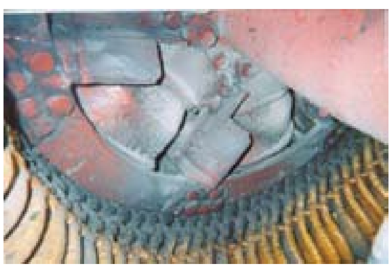
Safety issues were a major threat posed by a few of the traditional cleaning methods used at Visalia Electric. Both the extremely strong chemicals used in the solvents they employed plus the dust generated from sand blasting were potential worker's comp cases waiting to happen. The need to correctly wear high quality respirators was an absolute requirement.

Cleaning with Dry Ice Blasting

Since Visalia purchased the ICEsonic IS-35 in May 2003, they have used it almost daily to clean all of their motors after disassembly. They clean stators, rotors, endbells and all other disassembled parts regardless of the size of the motor. At the time this document was being written, Visalia had an 1100 HP and a 5500 HP motor in the shop for overhaul. They were in the process of completely cleaning the units with the IS-35.

Visalia found that dry ice blasting was an easy process. To clean a motor, a technician simply fills the blaster's hopper with about 40 pounds of dry ice. Adjusting the pressure anywhere from 70 to 90 PSI, the technician moves the blasting gun from side to side and lets the propelled dry ice clean the target area. The surface contaminants impacted by the dry ice blasting process then fall to the ground. The results include a thorough

2000 HP Motor at Visalia Electric



Before

After

cleaning of the motor windings and removal of all paint from endbells on metal surfaces that isn't firmly adhered. All surfaces end up dry with no component damage.

Gene Quesnoy has been very pleased with dry ice blasting. New technicians need very little training to learn the process, and he has few concerns that the operator will damage the motor windings during the process. What he has observed is that technicians will occasionally waste dry ice because of unnecessary overcleaning. He has had to stress that a limited amount of dry ice covering an area is sufficient.

Return on Investment

The purchasing cost of the ICEsonic IS-35 was not a decisive factor in the purchasing decision for Mr. Quesnoy. He was confident he could generate a very fast ROI. Since he was spending approximately $600/week in waste disposal, he was confident that he would more than recoup his investment within a year. He ended up srecouping his investment in about six onths. In addition to waste disposal savings, dy ice blasting has given him the opportunity to go on-site to perform motor cleanings during his customer's shutdowns. Visalia Electric's customers have been pleased with the results and the new service, and happy customers are good for business.

Jeffrey Lapointe is President and owner of both RSG-Technologies and EMS Industrial Servicenter. He has a substantial background in the repair and maintenance of rotating electrical equipment as well as first hand experience and certification in Infrared Thermography, Laser Shaft Alignment and Vibration Analysis. He started RSG-Technologies to provide environmentally friendly and economical solutions to various industrial and commercial cleaning needs through the promotion and use of Dry Ice Blasting. He resides in Lee, NH with his wife of 28 years, Sara. They have 7 children ranging in age from 26 to 13. He can be reached at JLapointe@RSG-Technologies.com.

Is Your Facility Leaking?

Compressed Air Leaks - Overlooked & Underestimated

by Terrence O'Hanlon, CMRP

Leaks are a common problem for almost all industrial compressed air systems. As energy costs soar, compressed air leaks are a significant source of waste. Compressed air is also used in manufacturing or production and problems associated with leaks can affect efficiency, output and reliability.

According to the US Department of Energy, 20-30% of a compressor's output leaks to atmosphere. A typical plant that has not been well maintained will likely have a leak rate equal to 20% of total compressed air production capacity. A 20% leak rate translates into a waste of big money, but even if your facility's compressed air system is more efficient than that, the savings can still be significant.

Sources of compressed air leaks and waste

I have walked into plants to find compressed air shut off valves and condensate drains wide open, causing a great deal of compressed air waste. Some companies still practice personal cooling with compressed air and others may use compressed air for workplace clean up. Inappropriate use of compressed air is usually a matter of company culture - the "we've always done it that way" syndrome. It should be addressed because inappropriate use may cause as much waste as leaks. Compressed air leaks are usually found in couplings, hoses, tubes, and fittings.

Proactive Leak Detection

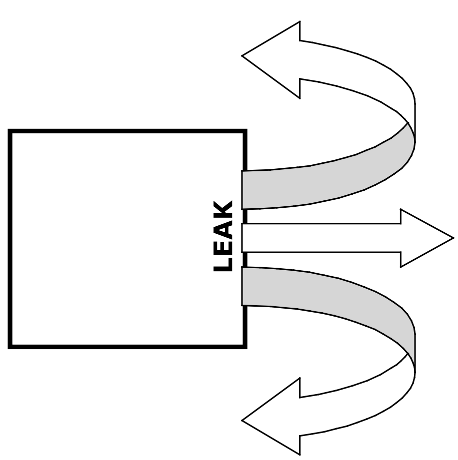


FIG 1 - Turbulence created by high pressure air escaping through the leak site is quickly pinpointed with an ultrasonic leak detector.

A team should be assembled to quickly locate, tag and repair compressed air leaks on a monthly basis. Although you can hear the hissing of compressed air leaks in many plants it can be very useful to use a high frequency ultrasonic detector with headphones to pinpoint leak sources in noisy factory environments. These devices detect the turbulence in the air flow that results when high pressure compressed air escapes through the leak site into the atmosphere.

Portable Detectors

Most Ultrasonic detection systems are hand held, portable and battery operated. They detect high frequency sound waves in the 40 kHz (kilohertz or cycles per second) range using a sensitive microphone. Most detectors then translate or heterodyne the signal into an audible and recognizable sound that the technician hears through noise attenuating headphones. The leak sound

FIG 2 - Ultrasonic Leak Detector
Photo courtesy of SDT North America

will be loudest at the leak source. System prices range from $1000 to $10,000. A detailed list of suppliers is listed at Reliabilityweb.com (www.reliabilityweb.com)

Leak Detection Alternatives

Many companies use bubble solution to "soap" connections. The technician then looks for a steady stream of bubbles indicating the leak site. This low tech method is very effective but can be slow and requires clean up.

Repairing Leaks

Simple leak repair includes tightening and properly applying thread sealant. Many sealant vendors offer basic sealing training courses that can go a long way toward eliminating sources of future waste. Make sure you

Common Sources of Compressed Air Leakage

- Couplings
- Hoses
- Tubing
- Pipe joints
- Quick Disconnects
- Filters, regulators and lubricators
- Condensate Traps
- Valves
- Flanges
- Packing
- Thread Sealants
- Pneumatic Hand Tools
- Out of service equipment

are purchasing high quality fittings as well as compressed air hoses and tubing. The money you save purchasing low quality, low priced components will quickly evaporate as new leaks form in the system.

The Biggest Waste

If you have equipment that is no longer in operation yet still has a compressed air supply line, be sure you have isolated the air supply with a quality shut-off valve.

Under Pressure

When systems include numerous compressed air leaks, production often suffers from lack of adequate pressure. Over time, pressure is increased to meet the demand for air on the production line. This quick fix simply compounds leaks as the higher the system pressure, the greater the amount of leaks that result, creating a treadmill of waste and unproductive behavior.

Once you begin to gain control, consider lowering overall system pressure. This will save energy and lower the leak rate of leaks as they crop up. If you have already added new compressors and controls, it may be useful to revisit the overall system design once the number and severity of leaks have been reduced, and there is less waste of the air supply.

Preventing Future Leaks

Everyone should be made aware of the costs associated with compressed air and its waste. Employees should be encouraged to tag and report any leaks they find in the course of their work. All repairs should be verified and all leaks should be documented to ensure a financial justification for an ongoing program.

Cost and Potential Revenue Sources

It seems like common sense would simply dictate that all companies would want to eliminate the waste associated with compressed air leaks but sadly, that is not the case. Company management wants to know why they should support a proactive compressed air leak detection program and it will be up to you to create a business case or financial argument to justify the budget for tools, training, supplies and labor to accomplish a proactive leak detection program. The good news is, for most facilities, financial justification for the program will not be hard to accomplish.

As you can see from Figure 3, leaks can add up to thousands of dollars per year. Most plants have hundreds of large leaks and a proactive leak detection program can create over $100,000 in savings.

Sources of justification can include actual savings (labor, energy, and material), increased production (more units per hour) and less required capital investment (new compressors).

- Wasted Energy from Leaks
- Operating losses (low air pressure or no air pressure)
- Leaks cause a drop in system pressure
- Pneumatic air tools function less efficiently, reducing production output
- More frequent cycling for compressed air equipment reduces system life, including the compressor itself
- Increased running time can also lead to additional maintenance requirements and increased unscheduled downtime
- Adding unnecessary compressor capacity to keep up with leaks

In addition to the elements listed above, top quartile performers have top quartile behaviors. In other words, you have to act "Best Practices" to be "Best Practices". Wasting compressed air is not best practice behavior.

At home, we would never think of running our heating or air conditioning system with a window or door open. We recognize that behavior as wasteful. Not addressing the leaks in the compressed air system in your facility is much the same, on a larger scale.

Starting a proactive compressed air leak detection program today and documenting the savings could be the start of increasing company support for future maintenance improvement programs. The payback can be quick and impressive. In today's short term, quick hit business environments, this program could launch you as a maintenance superstar.

FIG 3 The Cost of Leaks

Size	Cost Per Year
1/16"	$ 523.00
1/8"	$2,095.00
1/4"	$8,382.00

Costs calculated using electricity rate of $0.05 per kWh, assuming constant operation and an efficient compressor.

(Source of graphic: US DOE)

Terrence O'Hanlon, CMRP is the Publisher of Reliabilityweb.com, Uptime Magazine and co-Publisher of Reliability® Magazine. He is a Certified Maintenance & Reliability Professional and is the Director of Strategic Alliances for the Society for Maintenance & Reliability Professionals (SMRP). Terry is also a member of the American Society of Mechanical Engineers, The Association of Facilities Engineers and the Society of Tribologists and Lubrication Engineers. He can be reached via e-mail at tohanlon@reliabilityweb.com or online at http://www.reliabilityweb.com.

Leak Detection Program

Finding Leaks Is Finding Money

by Allan Rienstra

For many manufacturers compressed air represents the second or third highest utility cost in their facility. Without an effective maintenance program in place leaks can account for as much as 40% of the total air system demand. Proactive and preventative maintenance efforts with a minimal investment can see the leak target reduced from 40% to a more reasonable 5%. The following provides a step by step guide to start a program to find the leaks that are costing your organization more than you might think.

Establish a Strategy

At the heart of any sound strategy lies a goal. What are the goals of your air leak management program? Here are some ideas:

- Maintain a leak rate of 5%
- Increase the life of your compressors
- Heighten employee awareness about energy conservation, and compressed air in general
- Include constant surveillance of the system for integrity and safety issues
- Educate employees about compressed air best practices
- Decrease energy waste

Write the goals down and publish them in an area where they can receive constant review. Surely, during the process of strategy making, questions will arise about the state of the current compressed air system. Managing the system is more than just finding leaks; it's about reviewing it in its entirety looking for areas where improvements can be made. The web is full of resources and there are several reputable consultant companies that offer training and consulting services strictly for compressed air systems.

Create a Procedure

Some procedural elements of a good leak management program to consider are:

- Safety – Publish a safety guidebook for ultrasonic leak detection, leak repairs, and general inspection of the system

- Frequency - A compressed air maintenance program involves a complete inspection of your airlines 3-4 times per year. Regular inspections will ensure that new leaks are found, and also confirm that tagged leaks from past surveys were repaired.

- Know the System – Familiarize everyone with the supply side, demand side, number of compressors, operating pressures, and any additions that were made to the system since it was installed.

- Diagrams – Obtain drawings of the system from engineering and check to see they are up to date. Use these drawings to map out a route that will be followed each time an inspection is done. Use copies of the drawings for making annotations during the leak survey. At the end of the day will you remember the positioning of over 100 leak tags?

Leak Detection
(Photo courtesy of SDT)

- Equipment – Decide what accessories will best suit the leak inspections demanded by the system. Be sure whoever uses the ultrasonic equipment has received proper certification training from a reputable trainer.

- Find, Tag, and Fix the Leaks

- Re-Check – Be sure to re-check the leak area with ultrasonic detector after the leaks are repaired. Remember the perso making the repair may not be the same person who tagged the leak. Also, while making the repair it is possible a new leak was created.

- Document Everything – Make sure management knows the great job done to save company money.

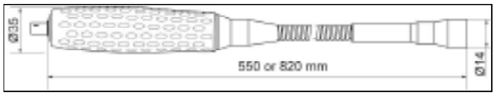
METHODS FOR LEAK DETECTION
Equipment Set-Up

Select the airborne ultrasound sensor to best suit the inspection. Different sensors are designed for different types of inspections. The sensors commonly available include:

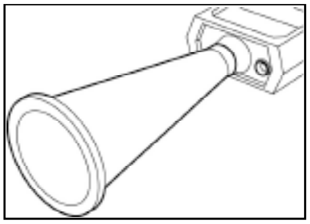
a. Internal sensor
b. Flexible sensor
c. Mid Range Collecting Cone
d. Parabolic sensor

Most ultrasonic detectors are equipped with an internal airborne sensor for detection of pressure and vacuum leaks. This sensor is ideal for day to day leak detection where the source of the leak is within reach of the inspector.

For inspections in hard to reach areas, check with your supplier for the availability of plug in extensions. Some models offer flexible extensions and others are rigid.
Overhead piping in ceilings are prone to leakage but normally inaccessible without a ladder or scissor lift. Inspection is now possible with a long range collecting cones. Originally designed by NASA, the unique taper-shape funnels medium distance ultrasonic waves (50' – 100') onto the acoustic sensor of the ultrasonic detector providing the inspector with extended distance sensing and extreme directionality.

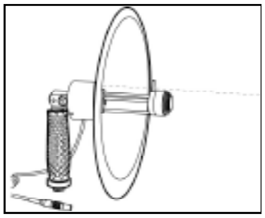


Example of Flexible Sensor



Mid Range Collecting Cone

Select the parabolic sensor if the leaks you are detecting are outside the range of the mid range detection cone. The parabolic shape focuses faint ultrasonic waves onto a super sensitive ultrasonic crystal amplifying and thereby extending the detection range by up to 250'. Some instruments offer optional laser sighting to pinpoint the exact source of the leakage, or you can use the rifle sight in bright sunlight.



Parabolic Sensor

Procedure For Leak Testing

1 Attach the sensor appropriate for the inspection to sensor input on attach headphones or speakers to audio output.

2 Switch equipment on.

3 Ensure battery charge is sufficient to take measurements by viewing battery indicating light.

4 After ensuring all safety procedures for your facility have been followed, proceed to the required inspection method described as follows.

5 Set sensitivity to the environment you will be working in. With the amplitude as high as allowable for that environment, scan with an up

Leak Detection using Flexible Sensor
(Photo courtesy of SDT)

and down, back and forth motion. Scan the possible leak area for a hissing sound. Listen through he headphones or speakers and watch the signal on the meter or indicator.

6 If a hissing sound is heard, get closer to the source of the hissing sound. Decrease amplitude sensitivity as you get closer if hissing sound gets too loud.

7 When you are near the leak, you may attach a localization probe to pinpoint the source of the leak. Scan back and forth, up and down, to confirm. Watch the meter or screen for increase or decrease in signal as you scan. Listen to the sound get louder and fainter as you scan. The spot where the sound is loudest is the leak site.

8 Mark the leak source and repair on spot or tag for later repair.

9 Document leak information (location, type of leak, size of leak, inspector, etc...).

10 Confirm the effectiveness of repairs. This is a crucial step that many programs overlook. It is not uncommon for the repair on a documented leak to cause a new leak somewhere close to the original leak.

The Bottom Line

By following these steps, you will be able to implement a successful compressed air leak detection program. Depending on its size, the program could save your organization thousands, tens of thousands or hundreds of thousands of dollars through increased efficiency and lower energy costs.

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.

Digging Down Deep

Operating Deflection Shape Analysis Solves Hidden Vibration Problem

By Dan Ambre

This article is a vibration case history using Operating Deflection Shape (ODS) analysis tools and computer animation techniques to solve difficult rotating machinery problems.

Mr. Bill Hansen, Plant Manager of New England Fertilizer Company, requested the services of Full Spectrum Diagnostics to perform a vibration investigation on a troublesome RTO Fan at their Shakopee, Minnesota facility.

New England Fertilizer (NEFCO) designs, constructs and operates "biosolids" granulation and heat drying facilities throughout the US. Biosolids is an industry term for sewage sludge solids derived from wastewater treatment plants. The finished product from the process is a "Class A" fertilizer that is similar in physical characteristics to synthetic conventional fertilizers and is marketed primarily for agricultural use. The F202 RTO Main Fan is a "plant-critical" piece of equipment at the Shakopee production facility.

Historically, vibration problems tended to emerge when the fan blades build up a coating over time. When the blades are dirty, the fan, which is driven by a variable frequency motor, runs at slightly higher speeds to retain process efficiencies. The elevated vibration levels (at 1x RPM) were typically resolved by cleaning the fan buildup on the blades.

Recently, plant personnel observed an increase in structural frame vibration. The excessive vibration levels were still predominantly found at 1x RPM. However they were highly directional and were not reduced by cleaning the fan blades. NEFCO requested that Full Spectrum Diagnostics (based in Minneapolis) perform a vibration diagnostic investigation in an attempt to understand the underlying causes of the vibration and to help define a method to reduce or eliminate their detrimental effects.

Full vibration diagnostics of rotating machinery problems typically involve both operating analysis techniques, as well as non-operating analysis. In this case, the RTO unit was required to maintain plant operations, thus it could not be shut down for natural frequency testing (modal analysis). However, limited use of the Variable Frequency Drive (VFD) controls was granted for some controlled transient (speed sweep) testing.

Machine Design Information

Drive:

- Westinghouse AC Induction Motor
- 100 HP @ 1780 RPM
- Variable Frequency Drive (VFD)
- 890 RPM @ 50% Speed
- 1605 RPM @ 90% Speed (typical)
- Rolling Element Bearings: OB: 6313, IB: 6317

Driven Machine:

- 54-inch F202 RTO Main Fan
- Direct Drive Coupled
- 890 RPM @ 50% Speed
- 1605 RPM @ 90% Speed (typical)
- Rolling Element Bearings, #3, #4 Dodge 517
- Fan Blade Count Nine (9)

FIG 1
F202 RTO Main Fan

Analysis Discussion

Prior to the plant visit, NEFCO transmitted digital pictures, machine drawings and information, as well as vibration spectra taken during the months preceding the analysis. The in-house program detected that the current problem was considerably different from their past experiences with unbalance due to blade buildup.

Since the machine could not be shut down for the scheduled plant visit, an Operating Deflection Shape analysis was recommended to visually animate the machine's motions and determine the root cause of the vibration problems.

The Operating Deflection Shape (ODS) analysis gives the analyst insight into how the entire structure is responding at each fault frequency. By measuring the vibration response at numerous locations on the structure and the phase relationships with respect to a reference transducer, we can computer animate the operating shapes of the structure. The operating response of the fan was measured at 293 predetermined (x, y, z) locations, effectively mapping the structure. Special attention was made to define measurement points across each bolted interface on the structure (see FIG 2).

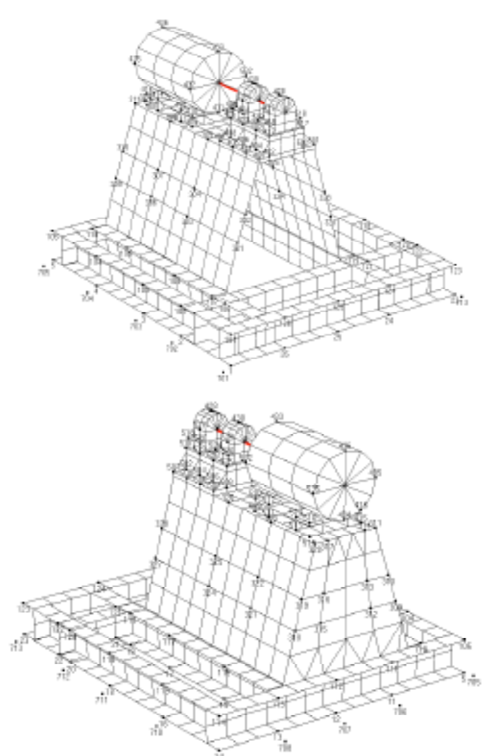


FIG 2 ME'scope Computer Animation Model (Fan Removed for Clarity)

Definition

An Operating Deflection Shape is measured with the machine at its' normal operating condition. This analysis measures the machines' response at a specific time or frequency. Both amplitude and phase information are collected at various locations on the structure and, via special software, the vibrating "shape" or response of the machine can be animated.

These animations show the analyst "how" the machine is moving during normal operation. Note that this is not a resonant response of the machine, but its operational response. The forces within the machine are responsible for the motion, or shape of motion measured with this analysis tool. For example, the unbalance response of any rotating system will produce a response or driving force at 1x RPM. Misalignment and looseness generally produce synchronous multiples of running speed (2x RPM, 3x RPM).

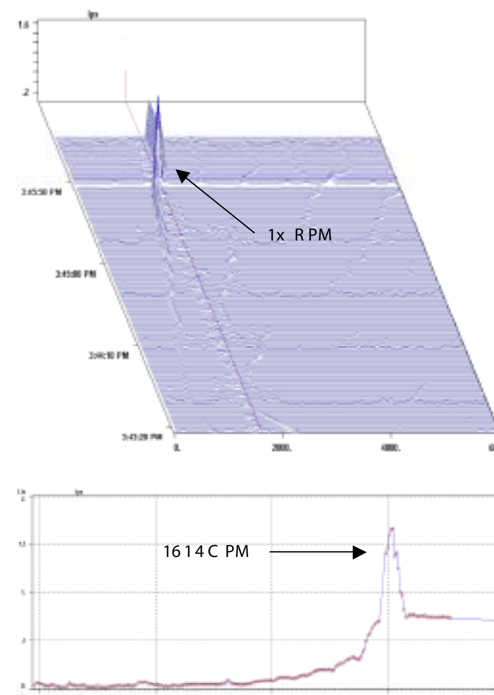


FIG 3 Waterfall Map Plot

The computer ODS animations showed significant response on the fan support frame structure. Vertical flexing of the inner base support beam was inducing excessive lateral (horizontal) motions at the motor and fan bearings. The dominant response amplitude near 1.00 inches/second was noted at the Fan Outboard pillow-block bearing support pedestal at 1594 RPM (90% VFD speed).

Based on the highly directional unit response and significant changes in amplitude with modest speed changes, a support frame natural frequency was suspected near the 90% speed point.

Since the unit could not be shut down for resonance testing, the speed of the VFD motor was varied through its frequency range of 20%-100% operating speed to map the structural natural frequencies. The Waterfall Map Plot (see FIG 3) shows that a maximum response was reached at a frequency of 1614 RPM. A transition in amplitude as speed was increased indicated a natural frequency at this speed. A profile plot of the overall vibration during the sweep is also provided, clearly indicating a classic resonant response.

A review of the ODS animations (see FIG 4) indicated a local weakness or flexibility in the Northwest side inner fan base support beam. The motions originated from a vertical weak spot on the fan side inner frame, resulting in an overall excessive lateral response higher on the structure. The inner beam is not fastened to the concrete slab but supported by the outer frame. The color contour plot in FIG 4 shows increasingly more vibrant colors with greater vibration amplitude levels. The highest (red) levels measured in this analysis were in excess of 1.0 ips.

Since the machine's response changed so rapidly based on its historic trend, it was more likely that the inner frame C-Channel may have a weak, loose, or cracked connection to the main beams. A detailed inspection of this "hidden" channel was recommended to resolve this issue, if present.

In correcting structural resonance problems, the analyst typically addresses the source(s) or driver(s) of the vibration first prior to making structural modifications. The rule-of-thumb is to perform the simplest changes first and to eliminate the known problems from the machine. The simplest solution would be to restrict fan operation in the suspect frequency range. The VFD range of the motor could be "tuned" to limit operation in a +/- 10% speed range around 1614 CPM. This option was not deemed to be practical from a plant operations standpoint.

Other more permanent solutions were explored next. It was possible that the inner frame beam was resonant at 1614 CPM due to

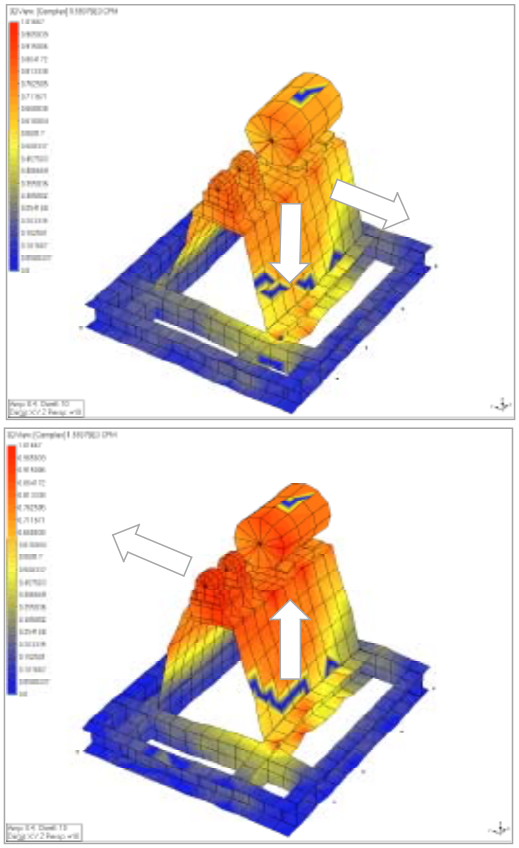


FIG 4 - RTO Fan ODS Animations

(Request animations via email: modalguy@aol.com)

its unsupported span. If this were the case, the beam could be shimmed with removable wedges spaced at close intervals along its length to better support the span and raise its natural frequency above the fan operating range. The problem location was considered inaccessible in required areas for any shimming or mount modifications.

Natural frequencies can also be altered by changes in mass or stiffness. The simpler modification is the change in mass. Full Spectrum Diagnostics returned to the sight a few days after the initial visit for an on-line mass modification. New structural developments included a broken foundation-mounting bolt on the weak side of the unit, indicating the response was getting worse. The broken bolt was replaced prior to the mass testing. In all, a quantity of fifty, thirty-pound sand bags were added to the responsive (Northwest) side of the base structure.

No appreciable change in amplitude response was measured from a mass load of 1,500 lbs!

At this point, the case for an internal cracked beam or weld failure was building. Mr. Hansen, the plant manager for New England Fertilizer, called the fan manufacturer to discuss the possibility of this type of hidden fault. The fan manufacturer outlined the historical success of this fan frame model and the details of their welding requirements, concluding that a weld failure was not likely. Mr. Hansen pressed on and asked if any warranty provisions excluded him from cutting a hole in the base to visually inspect the welds. The OEM granted permission, where upon two, 8-inch diameter inspection holes were cut.

Visual inspections confirmed a split weld that originally provided lateral structural support to the frame (see FIG 5).

Appropriate weld repairs were made, effectively reducing the vibration levels measured at the fan bearings to below 0.100 ips at normal operating speeds.

A follow-up VFD speed sweep from 50%-100% operating speeds was performed, noting peak vibration levels at a top speed 1725 RPM, indicated the natural frequency has been successfully moved above the operating speed range. Normal operating speeds are at or below 90% of full speed (1605 RPM).

FIG 5 - Weld Inspection Port

Conclusions

An improper weld, weld procedure, or weld defect was responsible for the structurally weak fan frame. Over time, with the slow loss of weld integrity also came a loss in frame stiffness. A fundamental frame natural frequency originally above the operating speed range crept into the running speed range and was amplified by residual unbalance in the rotor system. The fan's structural motions originated from a vertical weak spot on the northwest side fan inboard frame, resulting in an overall excessive lateral response measured higher on the structure at the bearing blocks.

The Operating Deflection Shape (ODS) analysis was instrumental in localizing the fault and defining the root cause of this "hidden" vibration problem.

Dan Ambre, P.E. is a Mechanical Engineer and founder of Full Spectrum Diagnostics, PLLC, a Full Service Predictive Maintenance Consulting company. Dan specializes in Resonance detection, Experimental Modal Analysis, and Operating Deflection Shape machinery diagnostics. Please visit his web site at www.fullspec.net, or email him at modalguy@aol.com.

Bill Hansen is the Plant Manager of the New England Fertilizer Company Shakopee, MN facility. Bill joined NEFCO in 2000 at which time he managed the commissioning and startup of the Shakopee facility. Bill has a degree in Chemical Engineering from the University of Minnesota and his career has taken him from New Jersey to California with a few places in between. Bill is a Level I Vibration Analyst and also supervises the vibration program at his NEFCO facility.

Meet the iCan™

Institution Solutions Inc. is marketing a new line of clean containers designed to improve the storage, handling and identification of industrial fluids. These containers are an important component not only to fluid contamination control programs, but also to safety programs designed to safely store and clearly identify industrial fluids in the workplace. Our publisher, Terrence O'Hanlon, caught up with Mark Hill, developer of iCan™ brand products, to get a behind the scenes glimpse at this exciting new product line.

Why did you develop this product line?

I saw a need for the product, and had a desire to fill the need. Well, I perceived a need for the product. Please tell me I'm right to think that people need a better way to store, identify and dispense industrial fluids.

What makes your products different from a plain old plastic jug?

First of all, iCan products seal completely. This not only prevents fluid contamination, but also greatly minimizes the risk of spills. They are also made from very sturdy high-density polyethylene (HDPE), so they can take a beating and still protect your workplace from spills. The other benefit of HDPE is that it doesn't rust. Also, foremost in our mind was to give people the ability to clearly label the containers so everyone would know what's inside them. We did this in two ways. One was to make the drums square, which resulted in a large area to affix a label to. The other was through the use of iPouches and iTags. iPouches are clear, adhesive-backed pouches with a zipper across the top. They come in three sizes (one for each drum size) and they simply stick onto the front of the drum. The iTag is a blank piece of card stock that can be printed using our easy-to-use online labeling system. The system gives you the choice of 24 different colors, and also allows you to add text. You simply print the iTags using a color printer, slip them into the iPouches, and viola, you have clearly labeled containers. It's that simple. Another thing that is really neat is that the iPouch has enough depth to hold documents such as MSDS sheets, user instructions or fluid data sheets. We figured that the ability for users to keep an MSDS with the container should keep the OSHA folks happy. In the end, I think we designed a solid, functional product.

Can a business case be made to justify the cost of the containers?

Absolutely. There's been a plethora of documented evidence published in the past 5 years about how important it is to keep industrial fluids clean. This is especially true with lubricants. The one statement that sticks out in my mind is that the cost of keeping contamination out of lubricants is only about 10% of what it will cost if it's allowed into the oil. So keeping oil clean is of utmost importance. Why spend good money on perfectly specified, high quality lubricants when their performance capabilities are completely negated because of dirty, rusty old oil fill cans? There are so many really great lubricants that provide documented, real world benefits, but they're totally ineffective if you allow them to be contaminated with dust, dirt, water or other everyday culprits. In addition to keeping lubricants clean, iCan also gives users the ability to enjoy the benefits of using intermediate bulk containers such as totes. This not only saves money (bulk fluids are typically cheaper than packaged fluids), but also reduces the waste associated with fluids packaged in small one-time-use containers. The business case for keeping industrial fluids clean is very easy to make.

Are iCan products used solely for controlling contamination?

No, as I've already mentioned, iCan containers give users the ability to clearly and accurately label fluids. They also facilitate a cleaner, more organized workplace. In my mind, this is all important. Just think about the ramifications of a customer (or potential customer) walking through a dirty, unorganized plant. Do you think that customer is going to walk away with a good feeling? And what about OSHA inspectors. What do you think their reaction will be when they see unlabeled containers? Taking into account that Hazard Communication was the second most cited OSHA standard last year, it might be a good time to make sure containers are clearly labeled.

How were things done prior to iCan products?

To a large degree, the management of industrial fluids has been done poorly and haphazardly. But we're starting to see a big change, for two very good reasons. One is because the government is becoming stricter with regard to how fluids are handled in industrial environments. For this reason alone, companies need to do better. But a less obvious, but far more costly reason to take better care in handling fluids is because dirty fluids are a financial drain. It doesn't matter what type of fluid we're talking about. Contamination is bad. Dirty fluid degrades faster and is less effective – even harmful – on equipment. It's really that simple.

What kind of impact does iCan have on overall plant and machinery reliability?

This is a great question, and goes at the heart of why iCan was developed. As I just mentioned, fluid cleanliness has a tremendous effect on machine reliability. The absolute best statement I ever saw with regard to cleanliness and reliability came as an answer to a question posted on maintenanceforums.com. The person posing the question asked what areas he needed to focus on first when implementing a reliability program. The answer came from V. Narayan, author of "Effective Maintenance Management – Risk and Reliability Strategies for Optimizing Performance". His answer included this statement: "If we take care of basics, i.e. keeping equipment clean, dry and lubricated, we get 70%+ of the benefits". That's one heck of a statement, not just because of what it says, but also because of who's saying it. V. Narayan is not just an author of another maintenance book. He also has 38 years of experience in the trenches and led Royal Dutch Shell Group's Center of Excellence in Maintenance and Reliability Engineering. So here's a guy with decades of experience and mountains of knowledge, and look what he says: keep equipment clean, dry and lubricated. That statement is so simple it almost hurts. In fact, I bet it does hurt those who have paid dearly for underutilized tools such as CMMS systems, infrared cameras, vibration monitoring equipment, etc. I'm not saying companies shouldn't invest in these tools. I just agree with Mr. Narayan – if you want to capture the low hanging fruit, start with the basics. And that's what iCan is about – the basics.

Do you find you have to educate potential customers as to why they might benefit from iCan products?

Yes, to a certain degree. But most of the education is coming from folks like yourself that publish books, magazines, newsletters and websites devoted to reliability issues. I'm just a salesman, and will always be perceived as one. People like you and V. Narayan are the real reason behind the success of not only iCan, but all reliability enhancing products and services.

What is the best success story you have heard from the use of iCan products?

iCan products are still very new to the scene. Get back to me in a few months, and I'm sure we'll have some good stories to tell.

What are your future plans and goals for iCan?

Creating a global distribution system will be one of our main goals in the next 12 months. We want to give people all over the world easy access to iCan products. We'll also be working hard to identify and fill the needs that continue to be generated from the reliability revolution that's taking the world by storm. But most of all, we plan on having lots of fun. As Dr. Seuss said: "If you never did, you should. These things are fun, and fun is good."

To see details of the iCan™ product line visit www.intelligentcan.com.

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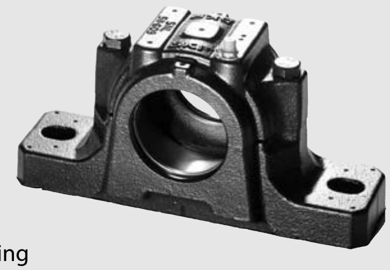

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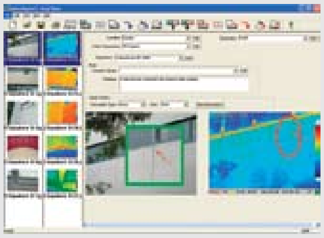

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www.dualviewsoftware.com

The MX Series, portable maintenance instrument, part of the Microlog® family of products, represents a new concept in vibration analysis instrumentation. The MX Series re-defines traditional approaches to vibration analysis and simplifies industrial maintenance, servicing and inspection techniques. It also offers new possibilities for manufacturers of rotating and reciprocating machinery.

Diagnostic Instruments (an SKF group company)
Fax: +44 (0)1506 470012 **www.skf.com/reliability**

MOLYKOTE® DEVELOPS NEW SYNTHETIC OILS TO IMPROVE GEARBOX LIFE

Six new full synthetic Molykote® extreme pressure gear oils help lower overall maintenance costs by providing superior wear protection plus greater thermal and oxidative stability when compared to conventional oils.

Available in ISO viscosities:
100 (L-2110), 150 (L-2115), 220 (L-2122), 320 (L-2132), 460 (L-2146), and 680 (L-2168).

www.Molykote.com
e-mail - LSeries@molykote.com.

PumPac® angular contact ball bearing arrangements from MRC Bearing Services are ideally suited for centrifugal pump applications. Their optimized internal designs promote reduced operating temperatures and vibration levels for smoother operation and longer service life in demanding pump conditions.

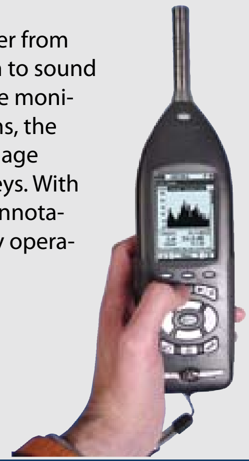
Jay S. Carlson,
716-661-2727
Fax: 716-661-2740
www.mrcbearingservices.com

Rotating torque transducers from the Force/Torque Division of PCB Piezotronics, Inc. (PCB®), utilize non-contact, rotary transformers for sending excitation voltage to, and receiving measurement signals from, the strain gage instrumented rotating sensor element. The rotary transformer design eliminates the need for replacing worn brushes, as is the case with conventional slip ring type rotating torque sensors.

PCB Piezotronics, Inc.
888-684-0004 (U.S. and Canada)
716-684-0001
fax 716-684-8877
force@pcb.com
www.pcb.com

The new Soundtrack LxTT sound level meter from Larson Davis offers an innovative approach to sound measurement for compliance and exposure monitoring. Available in Type 1 or Type 2 versions, the SoundTrackT provides an easy way to manage route- or task-based workplace noise surveys. With operator route prompts and digital voice annotation, surveys are done quickly and easily by operators at all skill levels.

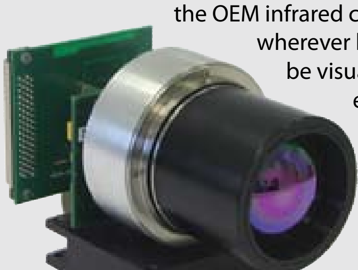
Rob Brauch
(888) 258-3131
Fax: (716) 926-8215
rbrauch@pcb.com



New SKF® Explorer single-row cylindrical roller bearings feature optimized design and contact geometry for enhanced bearing performance and reliability even under misaligned conditions. These bearings serve as ideal solutions for applications including compressors, industrial gearboxes, transmissions, and countless others.

Al Martin
SKF USA Inc.
800-440-4SKF
skfusainfo@skf.com
www.skfusa.com

Systeme GmbH is now launching a diversified range of thermographic camera modules. Designed to meet industry standard requirements, the OEM infrared camera modules can be installed wherever heat distribution patterns have to be visualized or measured. The camera modules provide an image resolution of 160x120, 320x240, 384x288 or 640x480 pixels. Temperature variances smaller than 60 mK can be thermally detected.



Mr. Heiko Richter
+49 (0) 3641 65-3942
infraredtechnology@jenoptik.com
www.jenoptik-los.com

PCB Piezotronics, Inc. (PCB®), introduces two new High-temperature, Radiation Hardened, Single Axis, Ceramic, Charge Output Accelerometers. Models 357B53 and 357B54 have sensitivities of 100 pC/g, a measurement range of ±150 g peak, operate in temperatures from −95 to +500° F (-71 to +260° C), and survive accidental shock inputs to ±2,000g. These new sensors are ideally suited for shock and vibration measurements in high temperature and/or nuclear radiation environments.

Vibration Division
888-684-0013 (U.S. & Canada)
vibration@pcb.com
Fax 716-685-3886

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.

JLM Systems Limited
888-RENU OIL(736-8645)
604-521-3248
Fax: 604-521-1244
info@oilmiser.com

PCB Piezotronics,Inc. (PCB®), introduces Series 354B, a new family of Triaxial ICP® Ceramic Shear accelerometers, which simultaneously measure vibration in three orthogonal directions. Each sensor has three separate, hermetically sealed, titanium cased, single axis sensors permanently mounted onto a single, hard anodized mounting block. These sensors are ideally suited to legacy applications, where both the footprint of the sensor and mounting hole locations are fixed.

Vibration Division
888-684-0013 (U.S. & Canada)
vibration@pcb.com
Fax 716-685-3886

Poor fitting accounts for 16 % of premature bearing failures. The SKF® bearing fitting tool kit TMFT 36 is designed for quick and precise mounting of bearings, while minimizing the risk of bearing damage. The kit contains 36 impact rings, 3 impact sleeves and a dead-blow hammer packed in a lightweight carrying case.

www.mapro.skf.com
www.skf.com/mount

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800-952-8776
www.alltestpro.com

CD International
716-741-8851
www.balancingweights.com

Chevron
www.chevron-lubricants.com

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865-588-2946
www.commtest.com

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888-277-5153
408-871-3300
www.datastick.com

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800-668-4745
www.daytronic.com

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615-672-8800
www.des-case.com

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800-923-3674
www.desmaint.com
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727-299-9304
www.edatai.com

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www.electrophysics.com

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www.filterelement.com

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www.ivara.com

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www.mikroninfrared.com

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